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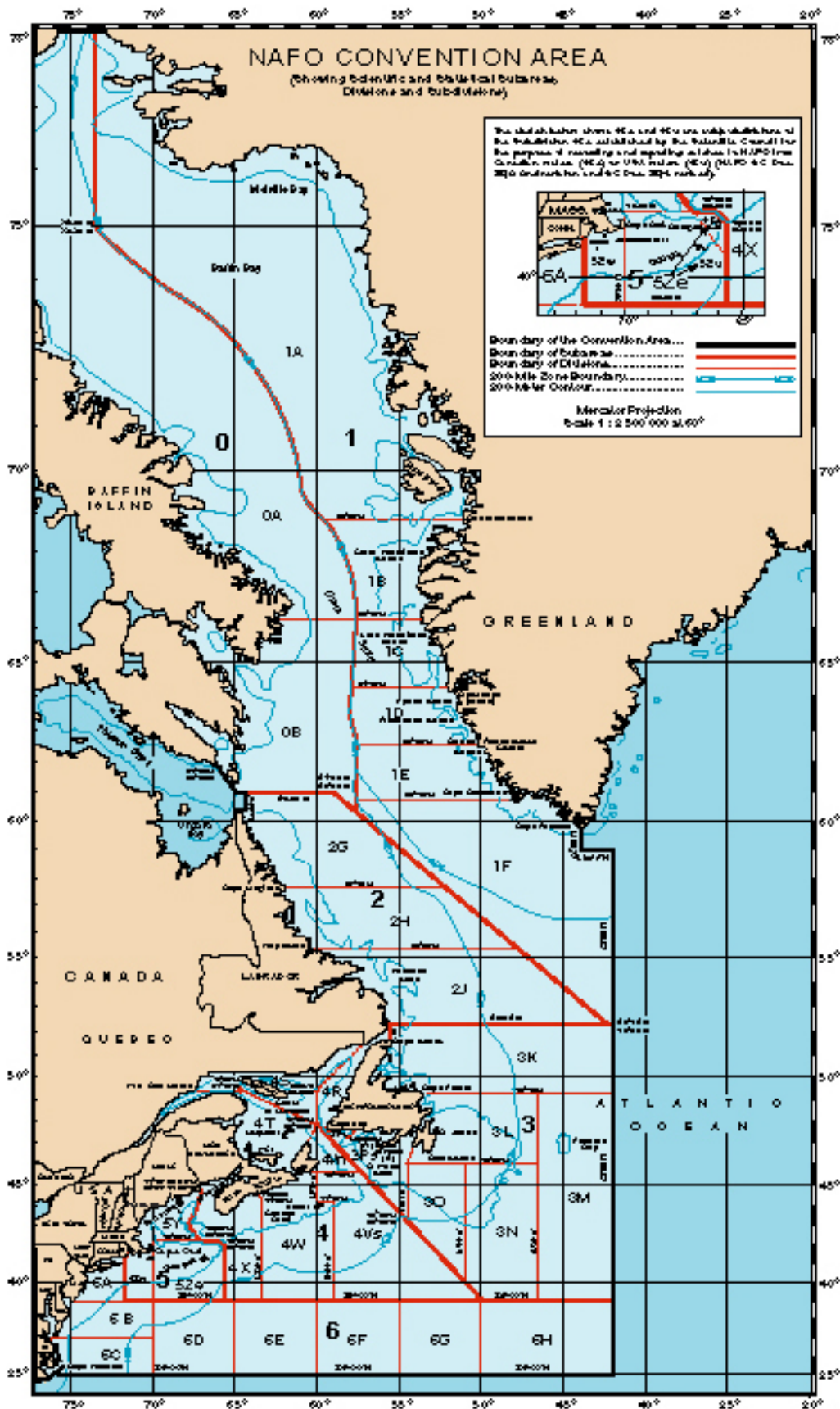
PREFACE

This electronic issue of *NAFO Scientific Council Reports* contains reports of Scientific Council Meetings held in 2003. This publication is compiled by extracting relevant sections from the previously published *NAFO Scientific Council Reports, 2002/2003* (published in August 2003), and *NAFO Scientific Council Reports, 2002/2003 Supplement* (published in January 2004), in order to maintain similarity among the publications. Every effort was made to maintain a standard scheme of labeling of the Parts and retaining the pagination.

This volume is compiled in five parts: **Part C** - Report of NAFO Scientific Council Workshop on the Precautionary Approach to Fisheries Management during 31 March-4 April 2003, **Part D** - Report of the Scientific Council Meeting during 5-19 June 2003, which addressed most of the annual requests for scientific advice on fisheries management. **Part E** - the miscellaneous information on Agendas, Lists of Research and Summary Documents, List of Representatives, Advisers/Experts and Observers, and List of Recommendations covering the period between Parts C and D. **Part F** - Report of the Scientific Council Meeting during 15-19 September 2003, which includes the Report of the "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment", held during 10-12 September 2003, **Part G** - Report of the Scientific Council Meeting during 5-11 November 2003, which addressed the requests for scientific advice on northern shrimp in Division 3M, Divisions 3LNO, Subareas 0 and 1 and Denmark Strait and off East Greenland, and **Part H** contains the Agendas, Lists of Research and Summary Documents, List of Representatives, Advisers/Experts and Observers, and List of Recommendations in relation to Parts F and G.

February 2004

Tissa Amaratunga
Deputy Executive Secretary



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PART C

Report of the Scientific Council Workshop on the Precautionary Approach to Fisheries Management

31 March – 4 April 2003

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Front Row: Konstantin Gorchinsky, Dave Orr, Hilario Murua, Katherine Skanes, Fernando Gonzalez, Karen Dwyer, Antonio Vazquez, Dawn Maddock Parsons, Brian Healey, Bill Brodie, Don Power

Missing: Joanne Morgan, Dave Kulka, Eugene Murphy, Todd Janes, Ian Burry

REPORT OF THE SCIENTIFIC COUNCIL WORKSHOP ON THE PRECAUTIONARY APPROACH TO FISHERIES MANAGEMENT

31 March – 4 April 2003

Chair: R. K. Mayo

Rapporteur: T. Amaratunga

I. Opening

The Scientific Council Workshop on the Precautionary Approach to Fisheries Management was held at the Delta St. John's Hotel and Conference Centre, St. John's Newfoundland, Canada during 31 March-4 April 2003.

Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Portugal and Spain), Russia and United States of America. The Executive Secretary and the Deputy Executive Secretary were in attendance.

Scientific Council Chair, Ralph Mayo welcomed everyone to St. John's and to this Workshop. Special appreciation was extended to Canada, and in particular to Science, Oceans and Environment Branch, Northwest Atlantic Fisheries Science Centre for hosting this meeting and providing the great facilities along with a state-of-the-art wireless LAN system.

The Chair took the opportunity to welcome the new Executive Secretary, Johanne Fischer, and express his pleasure to see her attend this meeting.

The Deputy Executive Secretary, Tissa Amaratunga was appointed rapporteur, noting contributors and Designated Experts will summarize their presentations to the meeting.

The **Agenda** was adopted and the Terms of Reference as described for this meeting by the Scientific Council at its meeting in 16-20 September 2002 were reviewed. The Chair noted the overall Precautionary Approach (PA) will be addressed at the plenary, while subgroups will be struck to derive PA reference points for individual stocks.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, and List of Representatives and Advisers/Experts of this meeting are given in Part E, this volume.

II. Review of Progress on Precautionary Approach

1. Basis for Existing PA Reference Points for NAFO Stocks

In September 1996, the Fisheries Commission, in reference to UNFA, requested Scientific Council to provide information for Fisheries Commission managed stocks. This included:

- Recommendations on limit and target reference points,
- Medium term considerations and risks,
- Longer term research requirements and monitoring to refine reference points,
- Any other aspects of UNFA Article 6 and Annex II that Scientific Council may consider useful for implementation,
- Criteria for re-opening fisheries.

Scientific Council developed a Precautionary Approach framework in 1997 (Serchuk *et al.*, 1997) to include limit, buffer and target reference points for fishing mortality and biomass. The Scientific Council conducted an extensive review of recent developments in the Precautionary Approach and re-opening criteria, and

- Reviewed available documentation including recent reports from FAO, ICES, etc.,
- Endorsed the Precautionary Approach as described in UNFA Article 6 and Annex II,

- Agreed to use the practical guidance from FAO (Article 7.5 of the Code of Conduct for Responsible Fisheries),
- Initiated the development of a framework and Action Plan including conducting a Workshop in March 1998.

Scientific Council also developed the following reference point terminology:

Biomass:

- B_{lim} - SSB below which stock should not fall.
- B_{buf} - Buffer to ensure SSB does not fall below B_{lim} .
- B_{tr} - target B (that which would give MSY).

Fishing mortality:

- F_{lim} - rate that should not be exceeded.
- F_{buf} - buffer (lower) rate to ensure F_{lim} is not exceeded.
- F_{tr} - target zone ($\leq F_{buf}$).

In accordance with the Action Plan a Scientific Council Workshop on the Precautionary Approach to Fisheries Management was held in March 1998 (NAFO, 1998a). Data requirements were identified for most stocks, and one or more analytical methods were applied to determine reference points. Detailed analyses were developed for American plaice in Div. 3LNO as a case study. Other stocks including Greenland halibut in SA 2 and Div. 3KLMNO, shrimp in Div. 3M, redfish in Div. 3M, and Northern shortfin squid in SA 3 + 4 were analyzed using one or more models appropriate to the available data.

The report of the Workshop was presented in May 1998 to the initial meeting of the Fisheries Commission/Scientific Council Working Group on the Precautionary Approach (NAFO, 1998b). The Working Group discussed the roles of scientists and managers with respect to implementation of the Precautionary Approach. The Working Group defined the roles of scientists as:

- Determine status of stocks,
- Classify stock status with respect to biomass/fishing mortality zones,
- Calculate limit reference points and security margins (buffers),
- Describe and characterize uncertainty, and
- Conduct risk assessments.

The roles of managers were defined as:

- Specify management objectives, select target reference points, and set limit reference points,
- Specify management strategies (courses of action) for biomass/fishing mortality zones,
- Specify time horizons for stock rebuilding and for fishing mortality adjustments, and
- Specify acceptable levels of risk.

The Scientific Council held another meeting during 27 April-1 May 1999 (NAFO, 1999a) in advance of the second meeting of the Joint Fisheries Commission/Scientific Council Working Group on the Precautionary Approach that convened 3-5 May 1999. At its 1999 meeting, the Scientific Council focused on three stocks for further development of the PA methodology and estimation of reference points: cod in Div. 3NO (closed fishery), yellowtail flounder in Div. 3LNO (open fishery), and shrimp in Div. 3M (data limited fishery). Reference points derived for these stocks were as follows: B_{lim} , for cod in Div. 3NO and F_{lim} (F_{msy}) and F_{buf} for yellowtail flounder in Div. 3LNO. The Traffic Light approach (Caddy, 1998) was applied to shrimp in Div. 3M but the results were treated in a qualitative manner.

At the May 1999 Joint Working Group meeting (NAFO, 1999b), the analyses for the three stocks were reviewed and a set of management strategies was developed for each stock. The Joint Working Group **recommended** that the Fisheries Commission and the Scientific Council consider these strategies in designing and formulating further action in implementing the Precautionary Approach in 2000 and beyond. It was also **recommended** that similar actions be taken for other stocks with related characteristics that are under the NAFO purview.

A third meeting of the Joint Working Group was held during 29 February-2 March 2000 (NAFO, 2000). This meeting focused on operationalizing the Precautionary Approach into management plans for the three stocks evaluated in 1999, but the Working Group also developed an implementation plan for American plaice in Div. 3LNO based on a template for cod in Div. 3NO. The implementation plans were defined as next steps and included detailed management objectives and strategies, data collection procedures and supportive management measures/good practices.

In 2002, the Fisheries Commission charged a Working Group of Technical Experts to meet to develop recommendations for future work of the Joint Scientific Council/Fisheries Commission Working Group. This meeting occurred during June 2002 (NAFO, 2002) and the Working Group reviewed the state of existing PA Frameworks developed within NAFO and ICES. The Working Group expressed concern with both PA Frameworks. Specific concerns with the NAFO Scientific Council PA Framework included:

- Prescribed harvest control rules (no fishing) below B_{lim} or B_{buf} .
- A fishing mortality limit at F_{msy} .
- The perception of a linear decrease in fishing mortality from the biomass target to the biomass buffer.

The Working Group also agreed that the specific issues and the general question of implementation of the Precautionary Approach would benefit NAFO by addressing specific cases and problems and **recommended** that the Fisheries Commission determine one or more appropriate examples and the instruct the Joint FC/SC Working Group on the Precautionary Approach to meet intersessionally to address the above concerns as they apply to the examples. At the 24th Annual Meeting of NAFO in September 2002, the Fisheries Commission did not pursue the issue any further.

References

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2. Evaluation of Existing Scientific Council PA Framework

The existing framework (Fig. 1) was developed by the Scientific Council in 1997 (Serchuk *et al.*, 1997), and has been discussed in several Joint Scientific Council/Fisheries Commission meetings. Some progress has been made: for example, in the definition of roles of scientists and managers in the PA process (Table 1). However, the framework was never formally adopted by the Fisheries Commission. Concerns expressed by managers include:

- Prescribed harvest control rules (no fishing) below B_{lim} or B_{buf} .
- A fishing mortality limit at F_{msy} .
- The perception of a linear decrease in fishing mortality from the biomass target to the biomass buffer.
- No consideration of the desirability for stable TACs.
- No consideration of multi-species situations.

Table 1. Roles of Scientific Council and Fisheries Commission, as previously agreed (NAFO, 1998).

Scientific Council	Fisheries Commission
1. Determine status of stocks.	1. Specify management objectives, select target reference points, and set limit reference points.
2. Classify stock status with respect to biomass/fishing mortality zones.	2. Specify management strategies (courses of actions) for biomass/fishing mortality zones.
3. Calculate limit reference points and security margins.	3. Specify time horizons for stock rebuilding and for fishing mortality adjustments to ensure stock recovery and/or avoid stock collapse.
4. Describe and characterize uncertainty associated with current and projected stock status with respect to reference points	4. Specify acceptable levels of risk to be used in evaluating possible consequences of management actions.
5. Conduct risk assessments.	

To address these concerns, a revised framework is proposed (Fig. 2).

Definitions of the biological reference points based on both fishing mortality and biomass, and the zones defined in Fig. 2 together with associated actions are detailed below:

Fishing Mortality Reference Points

F_{lim} = A fishing mortality rate that should only have a low probability¹ of being exceeded. F_{lim} cannot be greater than F_{msy} . If F_{msy} cannot be estimated, then an appropriate surrogate may be used instead.

F_{buf} = A fishing mortality rate below F_{lim} that is only required in the absence of analyses of the probability that current or projected fishing mortality exceeds F_{lim} . F_{buf} should be specified by managers and should satisfy the requirement that there is a low probability¹ that F_{target} exceeds F_{lim} . The more uncertain the stock assessment, the greater the buffer zone should be.

F_{target} = A flexible fishing mortality rate to be selected by managers from the hatched area in Fig. 2 to achieve desired management objectives, subject only to the constraints defined by the limit and buffer reference points. In particular, F_{target} must be chosen to ensure that there is a low probability¹ that F_{target} exceeds F_{lim} and a very low probability² that biomass will decline below B_{lim} within the foreseeable future³.

¹ Low probability might be defined as $\leq 20\%$, but the actual level should be specified by managers.

² Very low probability might be defined as $\leq 5-10\%$, but the actual level should be specified by managers.

³ Foreseeable future might be defined as 5-10 years, but the actual time horizon should be specified by managers.

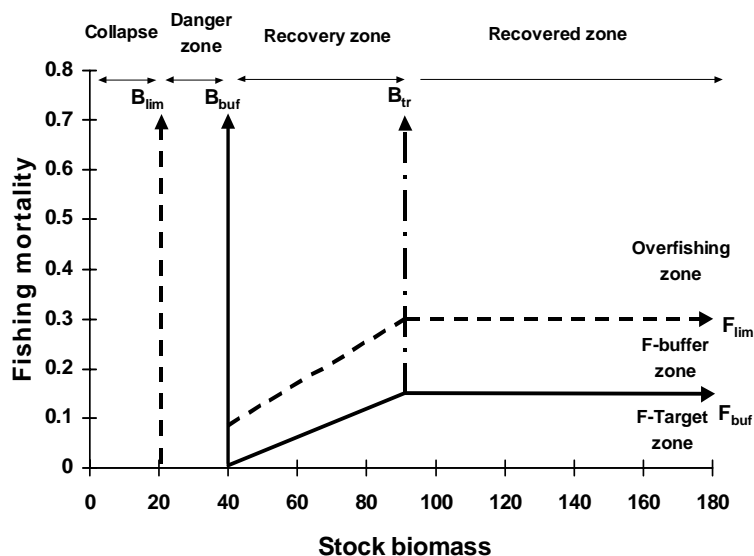


Fig. 1. Existing NAFO Scientific Council PA framework.

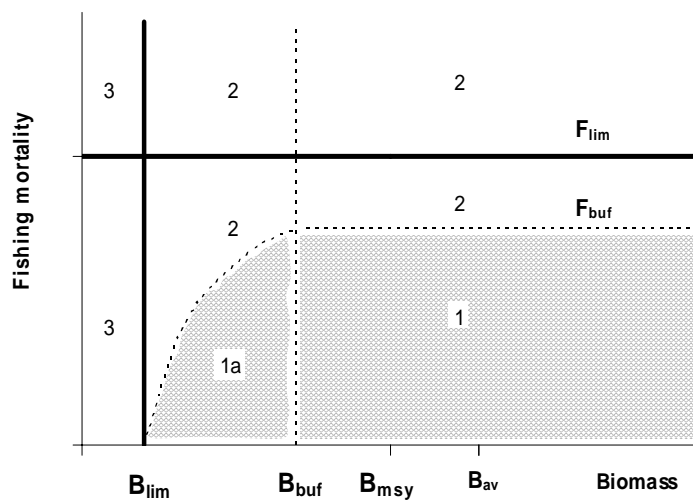


Fig. 2. A schematic representing the Scientific Council's proposed revision to the Precautionary Approach Framework. See text for definitions of biological reference points, numbered zones and associated actions.

Stock Biomass Reference Points

- B_{lim} = A stock biomass level that should have a very low probability² of being violated. This is defined to be a biomass level below which stock productivity is likely to be seriously impaired.
- B_{buf} = A stock biomass level above B_{lim} that is only required in the absence of analyses of the probability that current or projected biomass is below B_{lim} . B_{buf} should be specified by managers and should satisfy the requirement that there is a very low probability² that any biomass estimated to be above B_{buf} will actually be below B_{lim} . The more uncertain the stock assessment, the greater the buffer zone should be.
- B_{msy} = Average stock biomass associated with fishing at F_{msy} .

B_{av} = Average stock biomass associated with fishing at F_{buf} .

Zones and Associated Actions

Zone 1. (hatched area). The F_{target} zone. F_{target} must be selected so as to have low probability¹ of exceeding F_{lim} and a very low probability² of driving biomass below B_{lim} within the foreseeable future³.

Zone 1a. The Cautionary F_{target} zone. The shape of this region in Fig. 2 is not necessarily meaningful; it simply indicates that the closer the current or projected biomass is to B_{lim} , the lower F_{target} must be to ensure that biomass remains above B_{lim} .

Zone 2. The Overfishing Zone. The fishing mortality rate must be reduced into the F_{target} zone.

Zone 3. The Collapse Zone. The fishing mortality must be as close to zero as possible.

Thus, the key features of the framework include:

- i) There must be a very low probability² that management actions result in projected biomass dropping below B_{lim} within the foreseeable future³. Below B_{lim} , fishing mortality should be kept as close to zero as possible.
- ii) The fishing mortality limit should be no higher than F_{msy} (see below). There should be a low probability¹ that realized fishing mortality will exceed F_{lim} .
- iii) Fishing mortality targets are flexible, as long as they remain in Zone 1 of Fig. 2.
- iv) If a stock assessment generates a current or projected biomass with some probability distribution, the biomass distribution would be evaluated against B_{lim} . In other words, a risk analysis will provide the probability that current or projected biomass is below B_{lim} . If no probability distribution of biomass is available, but a value for B_{lim} exists, Fisheries Commission should establish a security margin, equivalent to a buffer zone, against which the biomass would be evaluated. The same procedure should be used to establish a fishing mortality buffer (F_{buf}). If biomass is in the zone between B_{lim} and B_{buf} , action to reduce F below F_{buf} is required to ensure that there will be a very low probability² that biomass declines below B_{lim} in the foreseeable future³.

The revised framework attempts to address the managers' concerns as follows:

- 1) Prescribed harvest control rules (no fishing) below B_{lim} or B_{buf} :

The new framework allows fishing below B_{buf} , subject to constraints such as ensuring a very low probability² that biomass will fall below B_{lim} in the foreseeable future³. However, below B_{lim} , fishing mortality should be as close to zero as possible.

- 2) A fishing mortality limit at F_{msy} :

Reasons for continuing to advise that $F_{lim} = F_{msy}$ are:

- Perhaps most importantly, F_{msy} as a limit is in conformance with the Precautionary Approach as described in several United Nations agreements (in particular, Annex 2 of the United Nations Straddling Stocks Agreement).
- Fishing somewhat below F_{msy} results in a relatively small loss in average catch, but a large increase in average biomass (which, in turn, results in a decreased risk to the fish stock, an increase in CPUE, and a decrease in the costs of fishing)⁴.
- Traditional bio-economic models indicate that the fishing mortality associated with maximum economic yield (F_{mey}) is usually considerably less than F_{msy} .

⁴ For example, one set of model results derived from an age-structured deterministic model showed that for 600 combinations of life history parameters and stock-recruitment relationships, fishing at 75% F_{msy} resulted in an average yield of 94-98% MSY and a biomass of 125-131% B_{msy} (Restrepo *et al.*, 1998).

- Ensuring no major stock is fished harder than the single-species F_{msy} has often been recommended as a good first step towards ecosystem-based management (NRC, 1999; Mace, 2001). Ecosystem-based management will likely require even more conservative fishing mortality targets than "traditional" single-species-based management

3) The perception of a linear decrease in fishing mortality from the biomass target to the biomass buffer:

There is a range of options open to managers in this part of the framework (for example, no reduction in F is prescribed if stock biomass is above B_{buf} and F is below F_{buf}). Managers also decide on the levels of B_{buf} and F_{buf} in those cases where the risk of biomass being below B_{lim} or the risk of fishing mortality being above F_{lim} cannot be provided.

4) No consideration of the desirability for stable TACs:

This is a difficult concept to capture in a simple schematic such as Fig. 2; however, considerable flexibility exists for managers in setting target F levels. Stable TACs are easier to achieve if the fishery remains in Zone 1. Furthermore, maintenance of biomass well above B_{lim} will minimize the instability caused by fishery closures.

5) No consideration of multi-species situations:

Although the proposed PA Framework is focused on single species, ensuring that no individual species is fished harder than the single-species F_{msy} has frequently been suggested as a first step towards satisfying several important and common ecosystem objectives (NRC 1999; Mace, 2001; Sissenwine and Mace, 2003). In addition, two other aspects of multi-species management were considered in the proposed revision of the PA Framework. First, the de-emphasis of B_{msy} avoids the problem of the impossibility of maintaining all stocks in a multi-species assemblage simultaneously at their respective single-species B_{msy} levels. Second, by replacing the requirement that fishing mortality be zero when biomass is below B_{lim} with a requirement that fishing mortality to be as close to zero as possible in this situation, there is now a recognition of the need for a certain amount of flexibility to account for technical interactions that result in unavoidable by-catch of depleted species.

Recommendation for study group

The above proposed Scientific Council PA Framework requires B_{lim} to be defined for each stock in a scientifically defensible manner. B_{lim} is a limit below which the productivity of the stock is likely to be impaired to a serious degree. Stocks that are below B_{lim} may not recover, or may take a long time to recover. A number of approaches are discussed in the primary literature and in research documents, working papers and meeting reports for defining B_{lim} . A study group is needed to review the strengths and weaknesses of alternative approaches and to make recommendations to Scientific Council on the most appropriate approach to defining B_{lim} for NAFO stocks ranging from data-rich to data-poor situations, and for a range of life history parameters. Where existing simulation trials of the robustness and other properties of each candidate reference point are available, these can be referred to, but in other cases new trials will have to be undertaken and the results evaluated. The methods to be reviewed should include approaches such as those based on parametric models, non-parametric smoothers, segmented regression, replacement ratio and other methods of interpreting stock-recruit or stock production data in terms of the PA. The value of heuristics such as $\%B_{msy}$, $\%B_0$, $\%R_{max}$ and $\%SPR$ should be thoroughly evaluated and results from, for example, the recent NMFS and FAO experience with respect to CITES listing criteria, should be reviewed.

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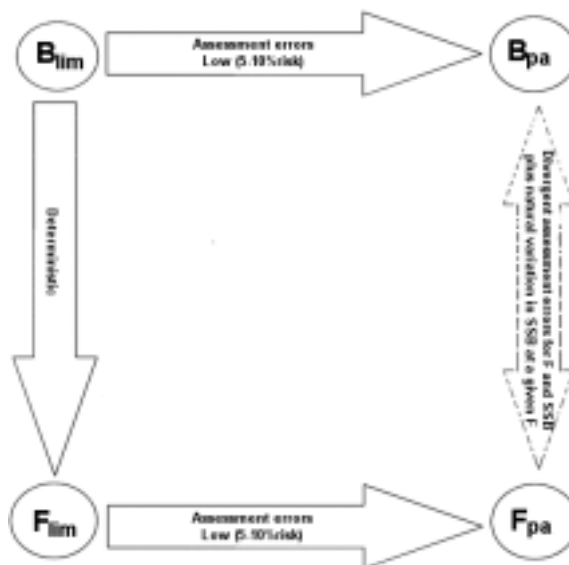
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3. Report of ICES SGPA Meeting, 2-6 December 2002 and ICES SGPRP Meeting, 24-26 February 2003

SGPA (Study Group on the Further Development of the Precautionary Approach to Fishery Management) Meeting. The discussion focused primarily on the development of a new framework for defining and linking reference points taking into account uncertainty and the causes of uncertainty. After extensive discussion of the management of risk in calculating reference points, a more explicit framework, taking into account stochastic variability and assessment uncertainty, was adopted by the ICES SGPA. The links between reference points is given in the figure below.



With the new framework:

B_{lim} , the cornerstone reference point, is defined as the SSB below which there is a substantial increase in the probability of obtaining reduced (or 'impaired') recruitment. Its estimate should be risk averse.

F_{lim} will be set on the basis of B_{lim} and should be risk neutral to B_{lim} , i.e. F_{lim} should be the fishing mortality at which the deterministic equilibrium SSB is B_{lim} .

F_{pa} , derived from F_{lim} , is the value not to be exceeded such that the fishing mortality actually realized by an advised catch derived from F_{pa} should have a very low probability of being above F_{lim} . F_{pa} should therefore be estimated by a method that takes assessment uncertainty into account.

Similarly, if B_{pa} is derived from B_{lim} taking assessment uncertainty into account, there should be a very low probability that a stock currently estimated to be at B_{pa} is actually at B_{lim} .

Only two methods for estimating B_{lim} were presented, the segmented regression and the Kernel method. The segmented regression had already been presented and reviewed in a previous SGPA meeting and was tested on a few stocks. The method was able to determine change points and is considered to be a candidate to estimate B_{lim} . No stand alone software was made available to test the Kernel method.

SGPRP (Study Group on Precautionary Reference Points) Meeting. The main term of reference for SGPRP was to review the proposal prepared by the ICES Secretariat on revision to Reference Points for the stocks dealt with by different Working Groups. The proposal was built on the framework developed and agreed by SGPA in December 2002 and the outcome of the Study Group on Biological Reference Points for Northeast Arctic Cod (SGBRP) held in January 2003.

The ICES Secretariat provided a compilation of limit reference points for 65 stocks for review at the ICES SGPRP in February 2003. The compilation comprised a summary of existing reference points and their technical basis as well as revised reference points based on segmented regression analyses. There was no compilation of PA reference points.

SGPRP reviewed the limit reference points and identified those that have potential for meaningful revision. It also commented on the analyses of those that were less clear and indicated the problems associated with their development.

The results of these reviews will now be sent to the respective assessment Working Groups to assist in more thorough analysis of revisions to reference points. The SGPRP also noted that this framework had worked well with the Northeast Arctic cod. However, it was recognised that to be able to compile the full set of PA reference points, integrated software was required. This has not been developed yet.

4. Recent Advances in Coastal States

a) Canada

The evolution of the Precautionary Approach in a Canadian context over the decade following major collapses of a number of cod stocks was reviewed. The collapses of these cod stocks in the late-1980s and early-1990s precipitated evaluations of alternative scientific and fisheries management approaches. Meetings and workshops in Canada in the early-1990s gave considerable momentum to move towards new and improved approaches based on a foundation of objective methods, quantification of uncertainty, establishment of management objectives, definition of reference points and the quantification of risk associated with alternative management options. These were important elements in the way Canadian scientists have approached the initiatives on "precaution" that emerged in the mid-1990s through various international initiatives such as UNFA, the Rio Declaration and the FAO Code of Conduct. It also led to discussions between Science and Fisheries Management within the Dept. of Fisheries and Oceans (DFO) in terms of developing a management framework which incorporated the Precautionary Approach.

Two National Science workshops (Rice and Schnute, 1999; Richards and Schnute, 2000) made progress on a number of technical aspects of implementing the Precautionary Approach during the late-1990s, and came up with a general framework that was considered to be consistent with UNFA. There was consensus that DFO Science should identify limits. In the early-2000s, two further National Workshops (Rice and Rivard, 2002; Rivard and Rice, 2003), the second involving fisheries managers, adopted "serious harm" as the definition of a conservation limit reference point and reviewed a number of reference points in terms of this definition (Shelton and Rice, 2002). The interpretation of serious harm as the increased probability of poor recruitment at low stock size emerged as a guiding principle and a non-parametric kernel smoother approach for computing the probability of poor recruitment was reviewed. Results from this approach were considered to be very promising in defining the probability of poor recruitment, but required further evaluation. More traditional approaches were applied for determining limit reference points. These approaches including:

- the "Serebryakov method" (Serebryakov, 1991; Shepherd, 1991) in which an SSB limit is defined below which the population fails to produce average recruitment under good early-stage survival conditions,
- SSB corresponding to the point below which the population fails, on average, to produce half the estimated maximum recruitment (Mace, 1994), and
- the SSB level below which either SSB is not expected to commence recovery quickly when fishing mortality is removed, or stock dynamics are unknown.

These approaches were applied to the three cod stocks of concern, Northern Gulf Cod (Subdiv. 3Pn + Div. 4RS), Southern Gulf Cod (Div. 4T + Subdiv. 4Vn) and northern Cod (Div. 2J+3KL), leading to the adopting of SSB limit reference points for the two Gulf stocks and a "bench mark" SSB level for Northern Cod, a point at which the appropriate limit reference point will be re-evaluated. These limits/bench marks were applied in the Canadian National assessment (ZAP) of these three stocks in March 2003 (<http://www.dfo-mpo.gc.ca/csas/>).

While much has been achieved in developing a Canadian PA Framework, there is still some distance to travel before the destination of a fully articulated PA Framework is arrived at. Robust limit reference points need to be developed in terms of both spawner biomass and fishing mortality, and uncertainty associated with these reference points in relation to uncertainty in the current state of the stock and uncertainty in the projected future states needs to be explicitly accounted for. Approaches for linking the harvest strategy framework to the uncertainties in the limits, current state and future projected state need to be developed. Although it is true that the Canadian Framework has yet to deal explicitly with competing risks, ecosystem considerations, or socio-economic aspects of fisheries management objectives, a broad Canadian PA Framework is now in place which is consistent with UNFA and which could provide the basis for management decisions at the present time.

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b) United States of America

United States domestic law does not explicitly recognize the Precautionary Approach to fisheries management. However, the most recent amendment to the Magnuson Fisheries Conservation and Management Act, termed the Sustainable Fisheries Act (SFA) of 1996 (and subsequently merged into the

Magnuson-Stevens Fisheries Conservation and Management Act), embodies many of the principles of the PA. National Standard 1 (NS1) states that "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry". Although this standard has not changed over the years, the definitions of optimum yield (OY) and overfishing have. In particular, the SFA changed the definition of OY from "maximum sustainable yield [MSY] as modified by relevant factors" to "MSY as reduced by relevant factors". This implies that MSY, or perhaps more correctly, some MSY control rule such as $F = F_{MSY}$, should represent an upper limit on fishing activity. As such, it is in conformance with Annex 2 of the United Nations Straddling Stocks Agreement of 1995, which specifies that F_{MSY} should be considered a minimum standard for a limit reference point. In addition, the SFA defined overfishing as "... a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis".

Subsequent to passage of the SFA, the US National Marine Fisheries Service (NMFS) developed a set of guidelines for implementing NS1. The guidelines treat MSY-related reference points in a dynamic context, rather than a static one. For example, a constant fishing mortality equal to F_{MSY} will result in stock size fluctuating around B_{MSY} and annual yields fluctuating around MSY. The dynamic interpretation takes such fluctuations into account, whereas the static interpretation does not. One of the major consequences of this approach is that while F_{MSY} may be treated as an upper limit on fishing mortality, B_{MSY} is not treated as a lower limit on biomass. Rather, the minimum stock size threshold (MSST) is defined either as a biomass ($<B_{MSY}$) from which it is possible to rebuild back to the average B_{MSY} within 10 years, or $\frac{1}{2} B_{MSY}$, whichever is greater. The maximum fishing mortality threshold (MFMT) is defined by an MSY control rule. Exceeding the MFMT constitutes "overfishing", while falling below MSST denotes an "overfished" or depleted stock. Overfishing simply requires action to reduce fishing mortality below the MFMT, while an overfished stock requires the development of a formal rebuilding plan to restore the stock at least back to the level of the average B_{MSY} within a specified period of time, often as short as 10 years. Note that the MSST is not associated with closure of a fishery. The requirement to keep fishing mortality below MFMT can be thought of as a "first line of defense" which, if properly applied, should result in a low probability that a stock will fall below the MSST. The requirement to rebuild when the stock does fall below the MSST is a second line of defense. The requirement that an overfished stock be rebuilt all the way back to the average B_{MSY} , rather than just above the MSST, implies that a stock is treated differently depending on whether it is approaching the MSST from above or below. The reason for the difference is that a stock that has become overfished is likely to have a more distorted age distribution and therefore requires stronger remedial action.

Recently, a Working Group has been set up to revisit the NS1 guidelines. Problems that have been identified during almost five years of working with the guidelines include the definition and use of the MSST, acceptable surrogates for MSY-based reference points, calculation of biological reference points when environmental regime shifts have taken place, determination of maximum permissible rebuilding times, procedures to follow when rebuilding plans require revision after initiation, and more explicit guidance on the relationship between fishing limits and fishing targets.

III. Review of Methods for Determining PA Reference Points

1. Replacement Ratio Method

This section describes the development and application of an index-based assessment methodology for stocks in the NAFO area. More detailed discussions on the method and illustration of its applicability may be found in NEFSC (2002a, b). A number of index-based approaches are developed to more fully utilize the data sets from the surveys and historical landings. The methods are technically simple but are based on linear population models, modern graphical methods, and robust statistical models. General trends in abundance and fishing mortality, deducible from a time series of catch (or landings for some species) and survey indices, are explored. Relative fishing mortality rate is defined as the ratio of catch to survey index. The replacement ratio is introduced here as an analytical tool for examining the historical behavior of a population and any potential

influence of removals due to fishing activities. To test these concepts and to facilitate comparisons, the analyses were applied to a number of stocks in the NAFO area.

Reduced-parameter models are often used to analyze non-age structured models. The most common example is the surplus production model (see Prager, 1994 for review and modern approaches) but the Collie-Sissenwine model (Collie and Sissenwine, 1983), and delay-difference models (Schnute, 1985) are also candidates. Even these simple models may fail when the dynamic range of population responses and/or fishing mortality rates is small (Hilborn and Walters, 1993). For example, a time series characterized by continuously declining abundance indices contains relatively little information about the productive capacity of that stock. Under these circumstances the maximum population biomass (K) is estimable only if it is assumed that the initial population size represents an unfished stock. This assumption is rarely tenable for Northwest Atlantic stocks that have been fished for hundreds of years and monitored since 1960.

Replacement Ratio Theory

The replacement ratio draws from the ideas underlying the Sissenwine-Shepherd model, delay-difference models, life-history theory, Collie-Sissenwine model, and statistical smoothing (Simonoff, 1996). First, begin by defining $I_{j,s,t}$ as the j^{th} relative abundance index for species-stock unit s at time t and $C_{s,t}$ as the catch (or landings) of species-stock unit s at time t . The simple relative fishing mortality rate with respect to index type j , stock s and time t is defined as the ratio of $C_{s,t}$ to $I_{j,s,t}$. This ratio can be noisy, owing to imprecision of survey estimates, and the variation can be damped by writing the relative F as a ratio of the catch to some average of the underlying indices. Following the recommendation of a reference point panel review team (Applegate *et al.*, 1998), relative F is defined as the ratio of catch in year t to a centered 3-yr average of the survey indices:

$$relF_{j,s,t} = \frac{C_{s,t}}{\left(\frac{I_{j,s,t-1} + I_{j,s,t} + I_{j,s,t+1}}{3} \right)} \quad (1)$$

Note that under this definition, the estimates of relative F for the first and last years of a time series are based on only 2 years of data.

Noise in the survey indices also affects the ability to relate inter-annual changes in abundance estimates to removal from fishing. The general approach of averaging adjacent years to estimate current stock size underlies statistical smoothing procedures (e.g. LOWESS) as well as formal time series models (e.g. ARIMA methods). One of the difficulties of applying such approaches in the present context is that the derived parameters, if any, are unrelated to the species biology or any aspect of the fishery. Moreover, basic questions of whether the current stock is replacing itself and whether the current level of catch is too high or low are of primary interest. If the recent history of the fishery is uninformative, most mathematical models will fail. The underlying reasons for model failure may not be immediately obvious from analysis of standard diagnostic measures. Of greater concern is the issue of the model misspecification, wherein an inappropriate model adequately fits the data but leads to deductions inconsistent with basic biology and the fishery. The proposed replacement ratio is a data-based technique relying on fewer assumptions. No technique however, can fully compensate for model misspecification errors.

If it is assumed that the survival from eggs to the juvenile stage is largely independent of stock size, then the number of recruits will be proportional to stock size. Locally, (i.e. in the neighborhood of a given stock size) this assumption holds for any stock-recruitment function. Since a population is a weighted sum of recruitment events, the inter-annual change in total stock size tends to be small relative to the total range of stock sizes (at least in the Northeast USA). Recruitment in any year is likely to be small relative to the biomass of the total population. Thus, the change in total biomass is likely to be small relative to the change in annual recruitment. Although the mathematics are more complicated than this, the argument is based on the premise that if $\text{Var}(x/1) = \sigma^2$ then $\text{Var}(\sum x/n) = \sigma^2/n$. Of course, the magnitude of such changes depends on the variation of recruitment and the magnitude of fishing mortality.

Using the linearity assumption defined above, basic life history theory can be employed to write abundance at time t as a function of the biomasses in previous time periods. The number of recruits at time t (R_t) is assumed to be proportional to the biomass at time t (B_t). More formally,

$$R_t = S_o \text{Egg} B_t \quad (2)$$

where Egg is the number of eggs produced per unit of biomass, and S_o is the survival rate between the egg and recruit stages. Survival for recruited age groups at age a and time t ($S_{a,t}$) is defined as:

$$S_{a,t} = e^{-F_{a,t} - M_{a,t}} \quad (3)$$

where F and M refer to the instantaneous rates of fishing and natural mortality, respectively. The weight at age a and time t ($W_{a,t}$) and the average longevity (A) of the species must also be considered.

Using these standard concepts, the biomass at time t can be written as a linear combination of the A previous years. Without loss of generality, the subscripts on the survival terms can be dropped assuming that average weight-at-age is invariant with respect to time. Further, set the product $S_o \text{Egg}$ equal to the coefficient α . The biomass at time t can now be written as:

$$B_t = R_{t-1} S^1 W_1 + R_{t-2} S^2 W_2 + R_{t-3} S^3 W_3 + \dots + R_{t-(A-1)} S^{A-1} W_{A-1} + R_{t-A} S^A W_A \quad (4)$$

Substituting Eq. (2) into Eq. (4) leads to:

$$B_t = \alpha B_{t-1} S^1 W_1 + \alpha B_{t-2} S^2 W_2 + \alpha B_{t-3} S^3 W_3 + \dots + \alpha B_{t-(A-1)} S^{A-1} W_{A-1} + \alpha B_{t-A} S^A W_A \quad (5)$$

Dividing the left hand side of Eq. (5) by the right hand side specifies the identity:

$$1 = \frac{B_t}{\alpha B_{t-1} S^1 W_1 + \alpha B_{t-2} S^2 W_2 + \alpha B_{t-3} S^3 W_3 + \dots + \alpha B_{t-(A-1)} S^{A-1} W_{A-1} + \alpha B_{t-A} S^A W_A} \quad (5a)$$

In a steady state, non-growing population, $B_t = B_{t-1} = \dots = B_{t-n}$ for all values of n . Therefore all of the biomass terms drop out of Eq. (5a) leading to:

$$1 = \alpha S^1 W_1 + \alpha S^2 W_2 + \alpha S^3 W_3 + \dots + \alpha S^{A-1} W_{A-1} + \alpha S^A W_A \quad (5b)$$

If we write $\phi_j = \alpha S^j W_j$ then Eq. (5b) implies that:

$$1 = \sum_{j=1}^A \phi_j \quad (5c)$$

Moreover, since all of the component terms of ϕ_j i.e. $\alpha S^j W_j$ are all positive non-zero values, Eq. (5c) also implies that all ϕ_j terms are less than or equal to one. Finally, Eq. 5 to 5c imply that the biomass at time t must be a moving average of the previous biomasses whose offspring comprise the population at time t . Equations 5-5c further imply that coefficients can be written in terms of basic life history and fishery parameters. In particular, if $F_{a,t}$ is written as the product of age specific partial recruitment and a fishing mortality rate, say F_{\max} , then the ϕ_j terms serve as a explicit empirical test of the assumption that the population trajectory is shaped by an optimal fishing mortality rate. Writing $\phi_j = \alpha S^j W_j = S_o \text{Egg} S^j W_j$ and substituting these terms into Eq. (5c) leads to:

$$S_o = \frac{1}{\sum_{j=1}^A \text{Egg} S^j W_j} \quad (5d)$$

Equation 5d is similar to the expression derived by Vaughan and Sails (1976) for the solution of the first year survival terms in a Leslie matrix model. The parameter S_o represents the survival rate from the egg to the age at recruitment. It also serves as the primary scaling factor for the Leslie matrix model in which the dominant eigenvalue is defined as one.

Populations are probably never at equilibrium but the relevant question is whether the departures from equilibrium are important. The structural smoothing equation proposed above constitutes an explicit hypothesis of the age-specific weighting factors that would shape a population at equilibrium.

The hypothesis that the population is at equilibrium can now be explicitly tested by substituting observed indices of abundance into the equilibrium model (Eq. 5a). If the index of abundance I_t is proportional to abundance B_t , $I_t = q B_t$ can be written where q is the catchability coefficient. Substituting this relationship into Eq. 5a results in expression that we have called the replacement ratio Ψ_t :

$$\Psi_t = \frac{\frac{I_t}{q}}{\alpha \frac{I_{t-1}}{q} S^1 W_1 + \alpha \frac{I_{t-2}}{q} S^2 W_2 + \alpha \frac{I_{t-3}}{q} S^3 W_3 + \dots + \alpha \frac{I_{t-(A-1)}}{q} S^{A-1} W_{A-1} + \alpha \frac{I_{t-A}}{q} S^A W_A} \quad (6)$$

By noting that the q 's cancel out, and letting $\phi_j = \alpha S^j W_j$, Eq. 6 simplifies to:

$$\Psi_t = \frac{q I_t}{\sum_{j=1}^A \phi_j q I_{t-j}} \quad (7)$$

Under the null hypothesis that the population is at equilibrium and not growing, Eq. (6) can be used as a measure of population trend. If the coefficients of the moving average are explicitly defined as from externally derived parameters (i.e. S_0 , Egg, F_{TARGET} , M , PR_j , W_j) then the replacement ratio Ψ_t can be used as an explicit test of the equilibrium assumption. Deviations from $\Psi_t = 1$ imply either violations of the assumptions embedded in the estimated ϕ_j weighting terms, measurement variability in the abundance indices I_t , or wide variations in recruitment. Over time, deviations attributable to either measurement error or recruitment are less important than those attributable of variations in the component terms of ϕ_j . The most important of these terms is fishing mortality.

Considerations on the Applicability of the Replacement Ratio

Under the assumption that recruitment is proportional to abundance $R_t = S_0 \text{ Egg } B_t$, and that S_0 and Egg are constants, the population will decline when F increases above its nominal value and increase when F is below its nominal level. Thus Ψ_t will be a decreasing function of F and will equal 1 when $F = F_{\text{TARGET}}$.

If recruitment is assumed to be constant then $R_t = R$, and the behavior of the replacement ratio will be fundamentally different. Increases in F will induce an initial reduction in Ψ_t as the population declines to a new equilibrium level consistent with an increased value of F . However, as the population approaches this new equilibrium level, the replacement ratio will once again approach unity. Conversely, a reduction in F will induce an increase in population size and a transient increase in Ψ_t followed by a gradual return to 1 as the population approaches its new equilibrium level associated with the decreased value of F . For these cases, the relationship between Ψ_t and $\text{rel}F$ would consist of multiple stable points. The replacement ratio will be 1 for multiple levels of $\text{rel}F$. Values of Ψ_t above or below one would be attributable to transient population states as the population moves to its new equilibrium point. It should be noted that the assumption of constant recruitment, irrespective of stock size, invokes the most extreme form of density dependence possible. Constant recruitment implies that the R/SSB ratio approaches infinity at the stock size (SSB) approaches zero. Consistent trends in F , from low to high or *vice versa*, would tend to maintain the transient behavior in the replacement ratio for longer periods. Therefore, the relationship between Ψ_t and relative F would approximate that observed in paragraph 1 above.

The behavior of the replacement ratio in situations where the underlying stock recruitment function invokes varying degrees of compensation (say a Beverton-Holt relation), will be intermediate between behaviors described in paragraphs 1 and 2 above. If the stock is near carrying capacity then deviations from an average level of recruitment will be small. For this situation, the behavior of the replacement ratio will be similar to that described in paragraph 2. When the population is small relative to the level that produces maximum or near maximum levels of recruitment, the behavior of Ψ_t and its relationship to relative F should be similar to that described in paragraph 1. The ability to distinguish between the behaviors in Ψ_t induced by simultaneous

changes in F or constancy in recruitment (as the population increases toward some designated level), will be difficult.

Many stocks in the NAFO area are at relatively low levels of abundance and have experienced, until recently, extended periods of increasing fishing mortality. If the populations are controlled by some form of density-dependent stock recruitment function, it is likely that the recruitment is nearly linear in the vicinity of the current stock size. Under these conditions it is expected that the relationship between Ψ_t and $relF$ should be similar to that described in paragraph 1.

For stocks that are approaching a biomass at which recruitment becomes nearly constant, the utility of the derived value of the $relF$ at replacement is compromised. In this circumstance, a piecewise examination of the data may be instructive.

Appropriate Number of Terms in Moving Average

The survival term S^l is equivalent to the l_x term in the Euler-Lotka equation for population growth (l_x is the probability of surviving to age x). For high levels of fishing mortality the S^l term is decreasing faster than the average weight W_j is increasing. Thus the importance of earlier indices rapidly diminishes. All of the I_t and ϕ_j terms are positive, and at equilibrium, $I_t = I_{t+1}$ and $I_t = \sum \phi_j I_{t-j}$ both hold. Therefore, $\sum \phi_j = 1$ and all of the $\phi_j > 0$. It would be desirable to express each of the ϕ_j weighting terms as function of the underlying population parameters. As expected, increases in fishing mortality increase the weight to more recent indices, whereas the converse hold for lower fishing mortality rates. As an approximation for this initial analyses, we assumed that all of the $\phi_j = \phi$ which implies that $\phi = 1/A$. Additional information on the estimation of number of terms in the moving average function are described in NEFSC (2002b)

Relation between Replacement Ratio and Relative F

Application of any smoothing technique reflects a choice between signal and noise (Rago, 2001). A greater degree of smoothing eliminates the noise but may fail to detect true changes in the signal. Given the abrupt changes in fishing mortality that have occurred in some NAFO stocks, the current year in the numerator of the replacement ratio was chosen. Use of the current index in the numerator rather than a running average of say k years, increases the sensitivity of the ratio to detect such changes. The penalty for such sensitivity is that the proportions of false positives and false negative responses increase. This penalty was judged acceptable for two reasons. First, it is desirable to detect abrupt changes in resource condition given the magnitude of recent and proposed management regulations. Second, the current formulation of the replacement ratio has a natural relationship to stock-recruitment hypotheses and the ratio can be investigated as a function of variations in underlying parameters, especially survival. Alternative formulations of the replacement ratio, say with a 2-yr average population size in the numerator can be developed, but their basic properties have not been investigated.

When fishing mortality rates exceed the capacity of the stock to replace itself the population is expected to decline over time. The expected behavior of Ψ_t under varying fishing mortality and recruitment is complicated, but it will have a stable point = 1 when the fishing mortality rate is in balance with recruitment and growth. Variations in fishing mortality will induce complex patterns, but in general terms, Ψ_t will exceed 1 when relative F is too high, and will be below 1 when F is too low. To account for these general properties and to reduce the influence of wide changes in either Ψ_t or the relative F , we applied robust regression methods (Goodall, 1983) to estimate the relative F corresponding to $\Psi_t = 1$. The parameters of the regression model:

$$\ln(\Psi_t) = a + b \ln(relF_t) \quad (8)$$

were estimated by minimizing the median absolute deviations. Median Absolute Deviation estimators are known as MAD estimators in the statistical literature (e.g. Mosteller and Tukey, 1977). Residuals were downweighted using a bisquare distribution in which the sum of the MAD standardized residuals was set to 6. This roughly corresponds to a rejection point of about plus or minus two standard deviations from the mean. (Goodall, 1983).

The relative F at which $\Psi_t = 1$ was estimated from Eq. 8 as:

$$relF_{threshold} = e^{-a/b} \quad (9)$$

where the estimates of a and b from Eq. 8 were substituted into Eq. 9. This derived quantity may be appropriately labeled as a threshold since values in excess of it are expected to lead to declining populations. Alternatively, populations are expected to increase when $relF_t < relF_{threshold}$.

Randomization Tests

The usual tests of statistical significance do not apply for the model described in Eq. 8. The relation between Ψ_t and $relF_t$ is of the general form of Y/X vs X where X and Y are random variables. The expected correlation between Y/X and X is less than zero and is the basis for the oft stated criticism of spurious correlation. To test for spurious correlation a sampling distribution of the correlation statistic was developed using a randomization test. The randomization test is based on the null hypothesis that the catch and survey time series represent a random ordering of observations with no underlying association. The randomization test was developed as follows:

1. Create a random time series of length T of $C_{r,t}$ from the set $\{C_t\}$ and $I_{r,t}$ from the set $\{I_t\}$ by sampling with replacement.
2. Compute a random time series of relative F ($relF_{r,t}$) and replacement ratios ($\Psi_{r,t}$).
3. Compute the r -th correlation coefficient, say ρ_r between $\ln(relF_{r,t})$ and $\ln(\Psi_{r,t})$.
4. Repeat steps 1 to 3 1000 times.
5. Compare the observed correlation coefficient r_{obs} with the sorted set of ρ_r .
6. The approximate significance level of the observed correlation coefficient r_{obs} is the fraction of values of ρ_r less than r_{obs} .

It should be emphasized that $relF$ is not necessarily an adequate proxy for F_{msy} , since this parameter only estimates the average mortality rate at which the stock was capable of replacing itself. Thus, while $relF$ defined as average replacement fishing mortality is a necessary condition for an F_{msy} proxy, it is not sufficient, since the stock could theoretically be brought to the stable point under an infinite array of biomass states.

Graphical Analyses

The relationships among the catches, abundance indices, relative F, replacement ratios and time are summarized as a six-panel plot (Fig. III.1.1). Panels are aligned to facilitate interpretation of the stock dynamics and to allow for a standard approach for comparison among stocks. The top four panels illustrate the interrelationships among $\ln(relF_t)$, $\ln(\Psi_t)$, I_t and time t . The variables share axes such that the temporal and phase plane interactions are easily followed. The bottom two panels illustrate the temporal patterns between catch C_t and $\ln(relF_t)$. Two of the panels warrant special consideration. The upper left panel plots $\ln(\Psi_t)$ vs $\ln(relF_t)$. The strength of the linear association can be inferred from the shape of the confidence ellipse (or principle component) surrounding the points. When the association is strong the ellipse will be long and narrow; when the association is weak the ellipse will approach a circle. The diagonal line represents the robust regression estimate and the dashed horizontal line represents the replacement ratio of 1.0. The intersection of the diagonal line with the replacement line represents the estimate of $relF_{threshold}$. The middle left panel represents the phase-plane relationship between the log of the survey, $\ln(I_t)$ and the $\ln(relF_t)$. Each point is labeled with the survey year and the points are connected to illustrate the temporal sequence.

The six-panel plots show the interrelationships among survey estimates of abundance, landings, functions of landings and relative abundance and time. The two functions are the replacement ratio (Eq. 6) and relative F (Eq. 1). The concept of using multiple panels to relate multiple variables over time has been advocated for use in fisheries science (e.g. Clark, 1976; Hilborn and Walters, 1992) and other fields (e.g. Cleveland, 1993). The example for Gulf of Maine haddock will be discussed in detail here.

The first aspect to note about the plots are the shared axes in the top four plots (A, B, C, D) and F. Panels B, D and F show the time series for the replacement ratio, the fall survey index, and the relative F, respectively. The horizontal line in A and B is the replacement ratio = 1 line. The relationship between the replacement ratio and

relative F in panel A is the key to understanding the influence of fishing mortality on stock size. Panel A is a phase plane that describes the relationship between two variables ordered by time. The degree of association between these variables is characterized by a Gaussian bivariate ellipsoid with a nominal probability level of $p = 0.6827$ equivalent to ± 1 SD about the mean of the x and y variables. The primary and secondary axes of the ellipse are the first and second principal components, respectively. When the degree of association between relative F and replacement ratio decreases, the ellipse becomes more circle-like. The implication is that either the survey is too imprecise to detect changes induced by historical levels of fishing removals, or that the levels of fishing effort have been too low to effect changes in relative abundance. These alternatives can often be distinguished by consideration of the sampling gear and its interaction with the behavior of the species. Similarly incompleteness of the catch record, particularly for species in which the magnitude of discard mortality has varied widely, is another critical factor in the interpretation of the confidence ellipse.

The assumption that the relative F and replacement ratio have a joint bivariate normal distribution in the log-log scale may not hold for all (or any) species. In particular, the replacement ratio model is designed to be sensitive to contemporary changes, so that by definition it will be highly variable. Large changes that are subsequently validated by future observations imply true changes in population status. When the converse is true, it is proper to conclude that the change was an artifact of sampling variation. The degree to which high residuals influence the pattern is tested using the robust regression method of Tukey (Mosteller and Tukey, 1977) that downweights large residuals using a bisquare distribution (see Goodall, 1983 for details). Thus the regression line in panel A will not be aligned with the primary axis of the ellipse when high residuals distort the confidence ellipse. The expected value of correlation between the replacement rate and relative F is negative. The empirically derived estimate of the sampling distribution for the correlation coefficient, *via* the randomization test, provides a way of judging the significance of the robust regression line.

The predicted value of relative F at which the replacement ratio is 1 is defined by Eq. 8 and denoted by the vertical line in Panel A and B. The precision of that point depends largely upon where it lies within the confidence ellipse. If the confidence ellipse is nearly centered about the intersection point, then the precision of the relative F threshold will be high. This also indicates that over time, a wide range of F and replacement ratios greater than one have been observed. In contrast, when the intersection point lies in the upper right portion of ellipse, the precision will be low. This is, of course, is a common property of linear regression in which the prediction interval for Y increases with the square of the distance between the independent variable X and its mean. Thus a high degree of correlation between relative F and the replacement ratio does not necessarily ensure high precision in the threshold if relatively few observations have replacement ratios greater than one. Panel A demonstrates, in a slightly different way, the implications of the "one-way trip" described in Hilborn and Walters (1992).

Panel C depicts the phase plane for relative biomass (i.e. the index) and the relative F. If the population declines with increases in fishing mortality and increases when the fishing mortality is reduced, the population should move up and down a linear isocline. The degree of departure from linearity reflects both sampling variation as well as true variations induced by recruitment pulses and its transient influence on total biomass. Thus the trace of points can give useful insights into parametric model selection of population dynamics under exploitation. In many species it is interesting to note that the return path for biomass, when F is reduced, tends to deviate sharply from the decline path. This general result may suggest that the rebuilding of stocks will be less predictable than the path of decline. In particular, the influence of truncated age structures on reproduction may be important and certainly, the presence of strong year-classes will have a substantial, yet unpredictable influence on stock rebuilding.

The simple data of catch and survey are generally not sufficient to estimate simultaneously both the threshold F and biomass targets. This property characterizes the common property of indeterminacy of r and K in standard surplus production models. For the Gulf of Maine (GOM) haddock example, the relative biomass target is defined external to the model (Panel C and D).

To facilitate the detection of temporal patterns, LOWESS smoothing is applied in panels B, D, and F. A relatively low tension = 0.3 (i.e. 30% of the span of data are used for the estimate of each smoothed Y value) is used to allow for more sensitive flexing of the smoothed line. As noted earlier, the heightened sensitivity is desirable for this particular application in fisheries management. In a sense, the LOWESS smoothing

counterbalances the sensitivity built into the definitions of replacement ratio and relative F, by damping the rates of change and allowing for detection of general trends.

The final point to note is that the 6 panel plot may allow one to develop a reasonable picture of the population dynamics in relation to exploitation. With the exception of a brief period in the late-1970s the replacement rate for GOM haddock was below 1 and continued its downward trend until 1990 (Panel A). This was accompanied by a continuously decreasing population size (Panel D). The reduction in landings from nearly 8000 tons in 1984 to less than 500 tons by 1989 (Panel E) greatly reduced the relative F (Panel F) below the threshold level and subsequently led to the replacement ratio exceeding one. The inter-relationships among Panels B, D, and F resemble the kinetics of simple chemical reactions and conceptually one should look for counteracting trends among indices and the influence of the trends in catch and relative survey abundance.

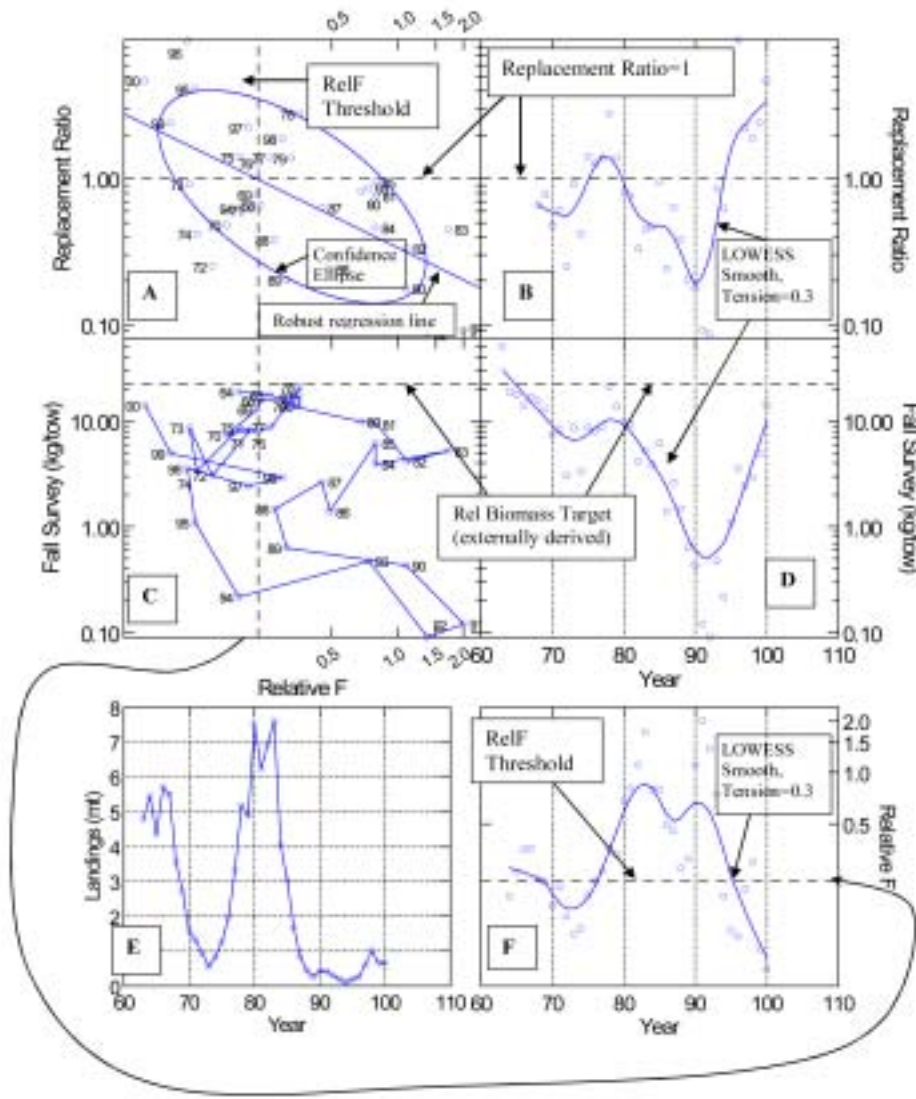


Fig. III.1.1. Annotated six-panel plot depicting trends in relative biomass, landings, relative fishing mortality rate (landings/biomass index) and replacement ratios. Horizontal dashed lines (---) represent replacement ratios = 1 in (A) and (B), threshold relF in (F) and target relative biomass in (C) and (D). Vertical dashed lines in (A) and (C) represent the derived relF thresholds. Smooth lines in (B), (D) and (F) are LOWESS smoothes (tension = 0.3). The confidence ellipse in (A) has a nominal probability level of 0.68. The regression line in (A) represents a robust regression using bisquare downweighting of residuals. See text for additional details.

Utility of f_{rep} in the NAFO PA Framework

The relationship of the replacement ratio (f_{rep}) as a proxy F_{msy} was evaluated by comparing reported estimates of f_{rep} to estimates of f_{msy} from ASPIC in the same units as the replacement ratio, catch/survey biomass (see table below). Four pairs of estimates were available for three northwest Atlantic flatfish stocks. Yellowtail flounder in Div. 3LNO (ASPIC in Walsh *et al.*, 2002; f_{rep} reported here), Yellowtail flounder in Div. 5Z (NEFSC, 2002a, b) and Winter flounder in Div. 5Z (NEFSC, 2002a, b). The comparisons show that f_{rep} was consistently similar to f_{msy} , and was 6% less than f_{msy} on average (Fig. III.1.2). The theoretical basis of f_{rep} suggests that it may be a useful proxy for f_{msy} , if the data used in its estimation come from a period when the stock was fluctuating around B_{msy} . In a peer review of biological reference points for New England groundfish, f_{rep} was proposed as a proxy for F_{msy} for six stocks (Gulf of Maine haddock, Mid-Atlantic yellowtail flounder, pollock, northern windowpane flounder, southern windowpane flounder and ocean pout; NEFSC, 2002b).

Stock	Survey	f_{msy}	f_{rep}	% difference
Yellowtail flounder in Div. 3LNO	spring	0.07	0.06	-6%
Winter flounder in Div. 5Z	fall	1.21	1.18	-3%
Yellowtail flounder in Div. 5Z	spring	2.25	1.96	-13%
Yellowtail flounder in Div. 5Z	fall	2.43	2.42	-1%
				mean -6%

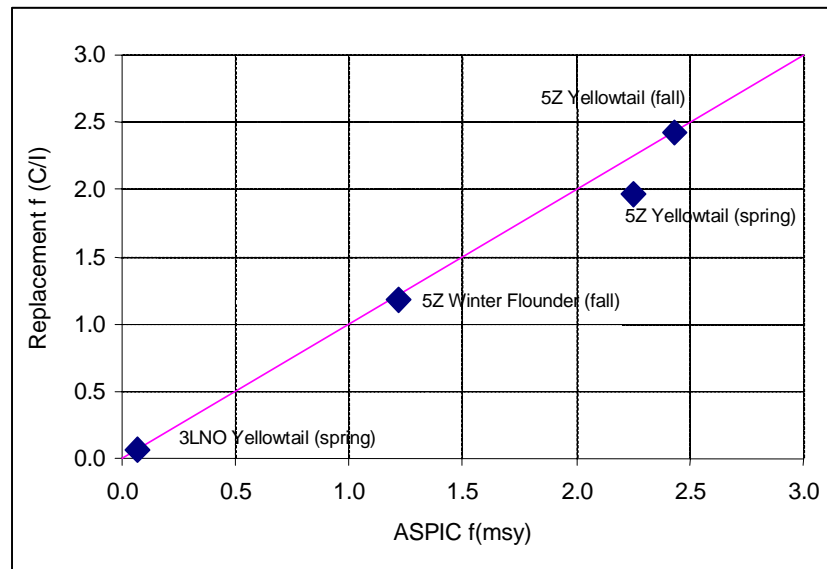


Fig. III.1.2. Comparison of ASPIC f_{msy} and Replacement Ratio.

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2. Segmented Regression

The segmented regression method to estimate Biological Reference Points proposed in ICES (2002) was defined as "an objective statistical method for identifying S^* , the specific value of SSB below which recruitment is impaired". The method was described in a working document in ICES (2002)(O'Brien and Maxwell, 2002. "Towards an operational implementation of the Precautionary Approach within ICES – biomass reference points" Working Document 8).

The approach is to fit a segmented regression to the current assessment data, identify the changepoint of the stock recruitment curve where recruitment is impaired, and its confidence limits, and designate this as a candidate for B_{lim} .

This method involves fitting linear regressions where the coefficients are allowed to change at given points. For one unknown change point or delta (δ) the segmented regression is defined as:

$$f(x_i) = \begin{cases} \alpha_1 + \beta_1 x_i & \text{if } X_0 \leq x_i \leq \delta \\ \alpha_2 + \beta_2 x_i & \text{if } \delta \leq x_i \leq X_1 \end{cases}$$

For S-R data the model is simplified, that is, it must pass through the origin ($\alpha_1 = 0$) and after the changepoint the line is horizontal ($\beta_2 = 0$). The biological implications for these assumptions are that before the changepoint the recruitment is somewhat proportional to the SSB and after the changepoint R is independent of any SSB value.

$$f(x_i) = \begin{cases} \beta_1 x_i & \text{if } X_0 \leq x_i \leq \delta \\ \alpha_2 & \text{if } \delta \leq x_i \leq X_1 \end{cases}$$

At this Workshop, this method was explored using a version of the segmented regression code in R language (L. Ibaibarriaga, AZTI, Spain, pers. comm).

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3. Bayesian Production Model

A new integrated framework for making quantitative assessments, predictions and risk analyses of shrimp (*Pandalus borealis*) stock development was presented. Parameters relevant for the assessment and management of the stock were estimated, based on a stochastic version of a surplus-production model that included an explicit term for predation by cod (*Gadus morhua*). Process and observation error were incorporated simultaneously using a state-space modeling framework. A Bayesian approach was used to construct probability distributions of possible values of model parameters and derived variables relevant for developing management

advice – including quantification of future risk of transgressing reference points in relation to alternative management options (Hvingel and Kingsley, 2002).

The model synthesized information from input priors and the following data: a 14-year series of a survey biomass indices of shrimp larger than 17 mm CL (Kannevorff and Wieland, 2002); a 26-year series of combined CPUE indices (Hvingel, 2002); a 47-year series of a cod biomass estimates; and a short series (4 years) of estimates of the shrimp biomass consumed by cod based on stomach sampling (Hvingel and Kingsley, 2002)

Biomass was estimated on a relative scale in order to cancel out the uncertainty of the 'catchability' parameters (the parameters that scale absolute stock size). Biomass, B , is thus measured relative to the biomass that yields Maximum Sustainable Yield, B_{msy} . The estimated mortality, Z , refers to the removal of biomass by fishing and cod predation and is scaled to Z_{msy} – the combined mortality at MSY.

In this approach, buffer reference points are not needed as the risk of exceeding the limit reference can be directly calculated integrating the uncertainty associated with the entire process. Instead of limit reference 'points', limit reference probability 'distributions' were used to accommodate the uncertainty in the determination of where the border to the dangerous area actually lies. Furthermore, the framework can accommodate many types of data and take ecosystem effects into account.

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4. Stock/Recruitment Model

Age-based production models derive MSY reference points from stock-recruit models in combination with yield and spawning biomass-per-recruit calculations (Sissenwine and Shepherd, 1987; Mace, 1994). For iteroparous species, equilibrium recruitment at a given fishing mortality rate (R_F^*) can be derived by replacing S in any stock-recruit function with $(SPR_F \cong R_F^*)$ where SPR_F is the SSB per recruit at the given F . For example, for a Beverton-Holt function,

$$R = (\forall S)/(\exists + S)$$

equilibrium recruitment can be calculated for each value of F :

$$R_F^* = (\forall SPR_F - \exists)/SPR_F$$

Equilibrium yield (Y_F^*) at each F can be derived as the product of YPR_F and R_F^* , and equilibrium spawning stock (S_F^*) can be derived as the product of SPR_F and R_F^* . Yield curves can be plotted as functions of F or stock size. The F that produces the greatest Y^* is the estimate of F_{msy} , and the S_F^* at F_{msy} is the estimate of SSB_{msy} . One important diagnostic for such age-based production models is the comparison of equilibrium expectations to observed stock dynamics, with respect to historical SSB, F and yield. Age-based production models were explored for American plaice in Div. 3LNO, cod in Div. 3NO, redfish in Div. 3M and cod in Div. 3M.

References

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Sissenwine, M. P. and J. G. Shepherd. 1987. An alternative perspective on recruitment overfishing and biological reference points. *Can. J. Fish. Aquat. Sci.*, **44**: 913-918.

5. Serebryakov Method

$B_{50\%R90\%Surv}$ is defined as the level of SSB corresponding to the intersection of the 90th percentile of observed survival rate (i.e. the F corresponding to the replacement line for which 10% of the S-R data points are above the line) and the 50th percentile of the recruitment observations. This approach was suggested by Serebryakov (1991) and Shepherd (1991) as providing a widely applicable and useful definition of the critical level of SSB. The definition of “critical” provided by Serebryakov (1991) is the SSB that provides for the appearance of strong year-classes only in the best survival conditions, but fails to ensure average year class strength under average survival conditions. $SSB_{50\%R90\%Surv}$ is the point below which the population fails to produce average recruitment under good early-stage survival conditions. This method has the advantage of not requiring the fitting of a stock-recruit model and attempts to consider the impact of environmental conditions on early stage survival. However it is sensitive to the addition of stock-recruit pairs which may be a particular problem at low stock size.

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Serebryakov, V. P. 1991. Predicting year-class strength under uncertainties related to the survival in the early life history of some North Atlantic commercial fish. *NAFO Sci. Coun. Studies*, **16**: 49-56.

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6. SSB at 50% Maximum Recruitment

$SSB_{50\%Rmax}$ is defined as the level of SSB at which average recruitment is one half of the maximum of the underlying stock-recruit relationship, it is the point below which the population fails, on average, to produce half the maximum recruitment. The level of SSB is found by first fitting a stock-recruit relationship and finding the maximum predicted recruitment. $SSB_{50\%Rmax}$ is then simply the SSB at half of the maximum predicted recruitment. This level of SSB has been suggested by Mace (1994) as a threshold biomass. She considered that, because estimates of this quantity are unlikely to be conservative, it should be considered as an absolute boundary not to be crossed. Myers *et al.* (1994), in an investigation of methods for estimating spawner biomass thresholds for recruitment overfishing applied to stock-recruit data for 72 fish stocks, concluded that, although arbitrary, $SSB_{50\%Rmax}$ is relatively robust if only data at low stock sizes are available (not always the case with other limit reference points). Myers *et al.* (1994) also found that higher levels of recruitment usually occur at SSB values above this biomass, so by inference productivity is impaired below this level. However, this approach is very sensitive to the uncertainty in stock-recruit model fits, particularly where the asymptote or peak is poorly defined (i.e. data mostly from the descending limb of a stock-recruit curve).

References

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7. Non-Parametric Smoother

An alternative way of thinking about impaired productivity and recruitment overfishing was developed in the CSAS November 2002 Workshop (Rivard and Rice, 2003). Under this approach B_{lim} can be defined, in terms of impaired productivity, as the SSB below which the probability of poor recruitment either increases sharply or rises above a predetermined probability level. The non-parametric kernel smoother approach applied to modeling stock-recruit data by Rice and Evans (1986, 1988) and Evans and Rice (1988) is particularly suitable for this kind of analysis because the kernel is a pdf (e.g. Gaussian, Cauchy, etc.) that provides the probability of any previously observed R at any specified level of SSB.

Locally weighted regression smoother (LOWESS) has been applied to S-R data in ICES, but the next step of deriving recruitment probabilities at a particular stock size from the tricube weighting function with the assumed span has not been investigated in ICES. The non-parametric kernel approach has been applied extensively to the Div. 2J+3KL cod stock (Rice and Evans, 1986, 1988; Shelton and Morgan, 1993, 1994) and in the assessment of the cod stock in Div. 3NO (Stansbury *et al.*, 1999; Rivard *et al.*, 1999) to obtain recruitment probabilities at different SSB levels. The Rice-Evans method appears to perform well and a cross-validation prediction sums of squares method using the kernel weighted mean as the predictor can be used to obtain the optimal shape parameter for the pdf. Generally, clear minima for both Cauchy and Gaussian distributions are found – the only two that have been examined in the context of the cod S-R data.

Having obtained a non-parametric smoother that allows the probability of recruitment to be computed at any SSB level in the range of observed data, it follows that the method can also be used to compute the probability of recruitment being less than or equal to any particular value. If poor recruitment can be defined, such as for example the 10th percentile of observed recruitment values, then the probability of recruitment being less than or equal to the 10th percentile value can be used to define a B_{lim} . B_{lim} could be defined as the point below which the probability of poor recruitment increases substantially with further decrease in SSB. Alternatively, B_{lim} could be the point at which the probability of poor recruitment rises to some level, for example 0.5.

The non-parametric approach is easy to apply to any set of S-R data. The statistics involved in applying the method constitute nothing more complicated than computing a weighted mean. A suite of SAS code programs for carrying out the necessary steps and plotting the results are available (sheltonp@dfm-mpo.gc.ca) and can be easily modified for any stock-recruit data set. One noted advantage is that the method translates what might look like a somewhat flat smoother through the recruitment data to a probability profile for poor recruitment that often has some distinct features useful in applying the Precautionary Approach. The method is applied to cod in Div. 3NO in Section IV.3 below as an example, and to illustrate the steps involved and the results that can be obtained.

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IV. Application to NAFO Stocks

1. Greenland Halibut in Subarea 2 and Div. 3KLMNO

a) Replacement Ratio Method

This method was applied to the total commercial catches of Greenland halibut throughout Subarea 2 and Div. 3KLMNO and the Canadian fall surveys in Div. 2J and 3K during 1978-2001 (Fig. IV.1.1). Since the surveys are conducted near the end of the year the commercial catches were lagged by one year in comparison to the survey data.

Based upon the description of the method described above, the annual replacement ratios were estimated as the ratio of the current stock size estimate divided by the average of the stock size estimates from the five previous years. This was considered to provide a reasonable approximation of replacement rate given the life history of the species. The relative F estimates were computed as the ratio of the current catch divided by a centered 3-year average of relative abundance. This degree of smoothing was judged to be reasonable especially since the development of the survey index for Greenland halibut was generally systematic with no major fluctuations between years.

Estimates of relative F show a marked increase between 1991 and 1994 resulting from a rapid increase in catches complemented by a declining stock size index. Relative F during this period was 4-5 higher than other years in the time series. A general decline in stock abundance appeared to commence about 1985, at a time immediately prior to the large increase in catches. Several above average year classes during the mid-1990s, combined with a sharp decline in relative F resulted in a rapid rate of increase in the stock during the late-1990s. The replacement ratio in the late-1990s exceeded a value of 1.0 but appears to have declined to near 1.0 in the most recent two years. A replacement ratio of 1.0 occurs when the fishing mortality rate is in balance with recruitment and growth.

The relationship between the replacement ratio and relative F shows a reasonably high degree of coherence with an underlying correlation of -0.67 . The randomization test for spurious correlation suggests an expected median correlation of -0.19 and a significance level <0.01 . In other words, the randomization test suggests that the association between the replacement ratio and the relative F is not simply an artifact of the data manipulations. A relative F = 1.08 corresponding to a replacement ratio of 1.0 defines the replacement F. Therefore, when the replacement F is multiplied by a survey index that best represents current stock size, an estimate of catch, which allows for stock stability is obtained. Based on the results presented here, the model indicates that the relative F has exceeded the replacement F by about 35% in the last two years.

There are a number of important factors to consider when applying the replacement ratio methodology. For Greenland halibut, above average recruitment during a period of low adult stock size may have artificially inflated the estimates of the replacement ratio. The robust regression method downweights the importance of such estimates but cannot eliminate their influence entirely. Another important consideration is the issue of population closure. Removals are assumed to occur from the area surveyed and large deviations from this basic tenet could be problematic. Nevertheless, for Greenland halibut this factor is thought not to be too problematic since the survey series used here is believed to track the status of the resource throughout the area reasonably well.

The estimation of relative F at replacement provides an objective means of estimating an appropriate level of fishing. This exploitation rate is independent of stock size in the vicinity of the average stock size observed. The combination of statistical graphics and randomization tests provide a measure of the uncertainty of the results. In particular it is noted that the model may be useful for characterizing the relative risk of alternative catch levels to the population status.

Within the range of the data set analyzed here it is considered that the estimated replacement F (f_{rep}) is a reasonable proxy for the commonly used biological reference point F_{rep} . For several other stocks it has been noted that f_{rep} from similar analyses could also be representative of F_{msy} as described in Section III.1 above. However, without a more thorough examination of the stock dynamics it is premature to infer any such relationship between f_{rep} and F_{msy} for Greenland halibut.

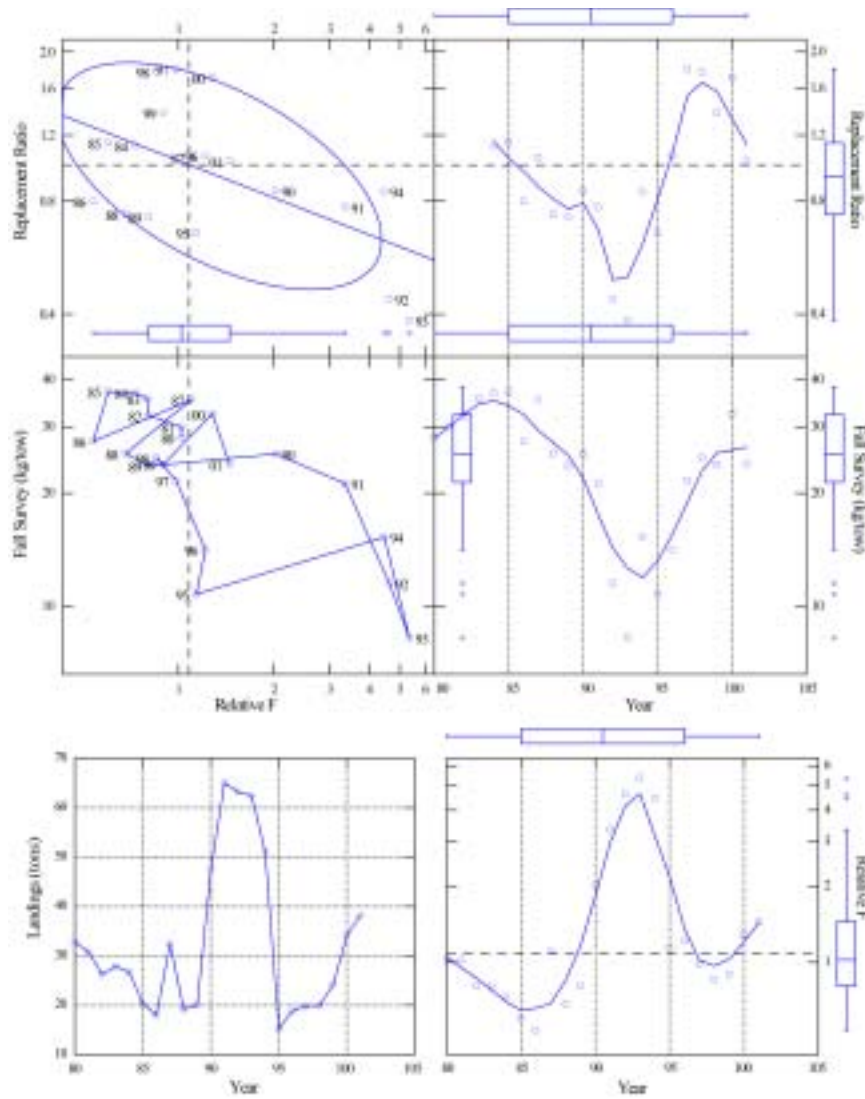


Fig. IV.1.1 Trends in relative biomass, estimated catches, relative fishing mortality rate (estimated catches/index) and replacement ratios for Subarea 2 and Div. 3KLMNO Greenland halibut, using the fall survey series in Div. 2J and 3K and estimated catches. Horizontal dashed lines represent replacement ratios = 1. The confidence ellipse has a nominal probability level of 0.68, and the diagonal line uses a robust regression estimator. (See section III.1 for full description).

2. **American plaice in Div. 3LNO**

The current B_{lim} for American plaice in Div. 3LNO of 50 000 tons is based on a visual examination of the stock recruit scatter from the VPA which indicates that there was no good recruitment below this level (Morgan et al 2002, Fig IV 2.1). This was based on recruitment at age 5 which is the first age in the VPA. Further analyses were conducted in an attempt to examine the validity of this B_{lim} .

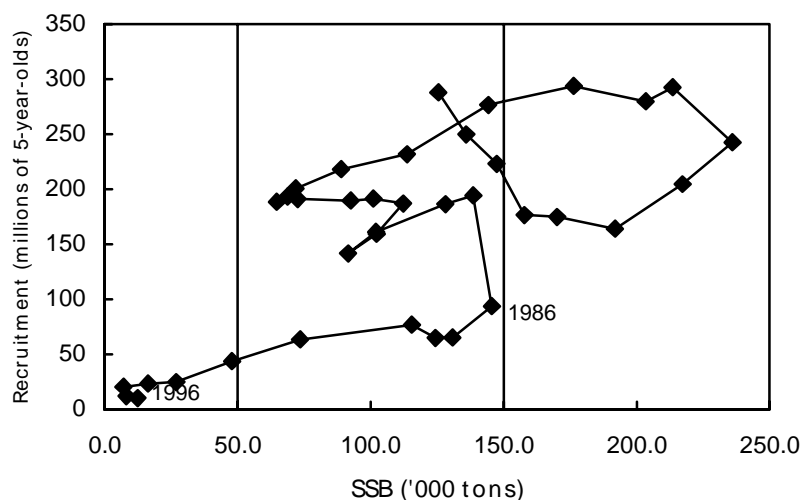


Fig. IV.2.1 American plaice in Div. 3LNO: stock-recruit scatter. The vertical lines indicate the three zones of recruitment: below 50 000 tons where only poor recruitment is observed, between 50 and 150 000 tons where both poor and good recruitment is observed, and above 150 000 tons where only good recruitment is observed.

a) **SSB at 50% Maximum Recruitment (age 5 recruits)**

The SSB which produced 50% of the maximum recruitment was determined by fitting a Beverton-Holt stock recruit relationship to the data by maximum likelihood. The asymptote of the relationship lies well outside the range of the observed data (Fig. IV.2.2). 50% R_{\max} was estimated to be 415 million 5 year olds and the SSB giving this level of recruitment was 425 000 tons. This is not likely to be a realistic value given that the asymptote of the relationship is beyond the range of the data and given the history of the stock.

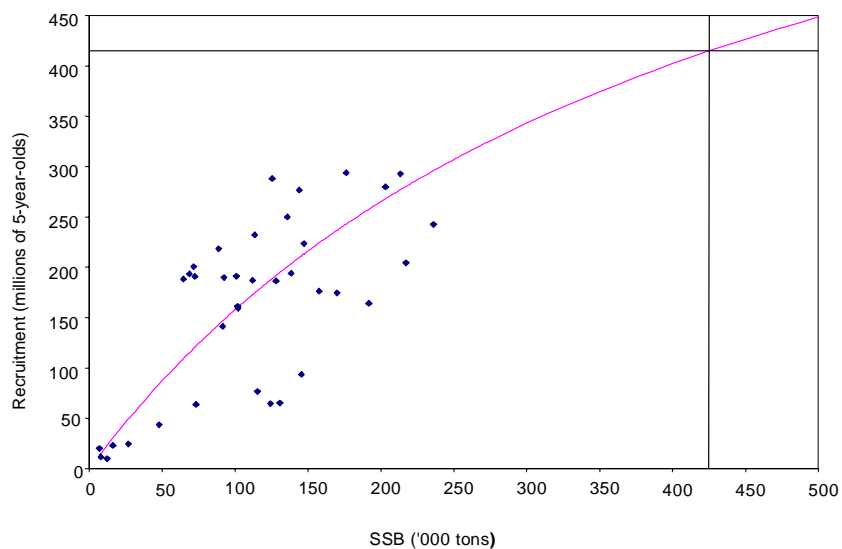


Fig. IV.2.2 American plaice in Div. 3LNO: stock-recruit scatter with fitted Beverton-Holt stock recruit curve. The horizontal line indicates 50% of maximum recruitment and the vertical line shows the SSB which gives this level of recruitment.

b) **Serebryakov Method** (age 5 recruits)

The stock-recruit scatter was also used to derive the SSB at $B_{50\%R90\%survival}$ (Fig. IV 2.3). This indicates that a limit reference point for this stock would be 70 000 tons of SSB. This is in close agreement with the visual inspection of the stock-recruit scatter given that there are no stock-recruit pairs between 50 000 and 65 000 tons. However, this may not be a good method at low stock size for reasons stated in Section III.5.

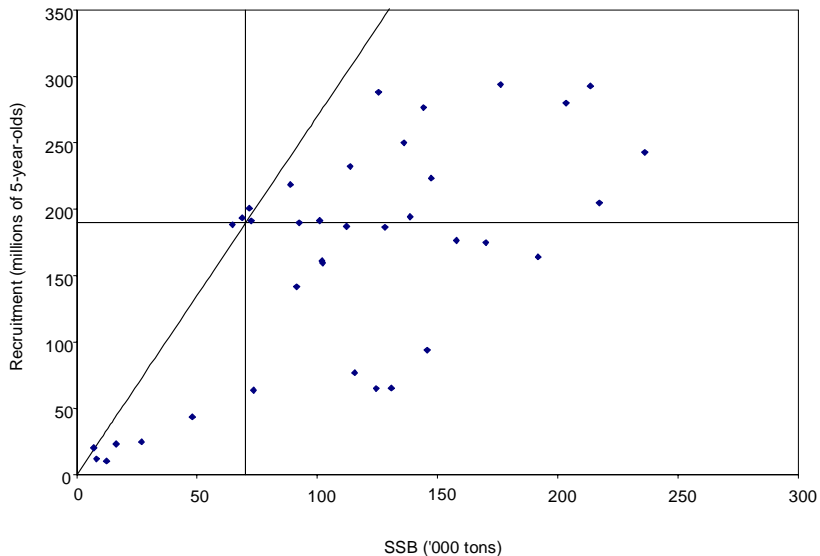


Fig. IV.2.3 American plaice in Div. 3LNO: stock-recruit scatter. The horizontal line represents the median level of recruitment. The line through the origin bisects the scatter so that 10% of the recruitments are above the line.

c) **YPR – SPR**

Yield-per-recruit (YPR) and spawner-per-recruit (SPR) analyses were run to estimate $F_{0.1}$ and F at 35% SPR using current values of average weights-at-age, maturities-at-age and partial recruitment-at-age. These values were the same as those used in the projections conducted in Morgan *et al.* (2002). These analyses indicated that $F_{0.1}$ is 0.2 and that F at 35% SPR is 0.25 (Fig. IV.2.4).

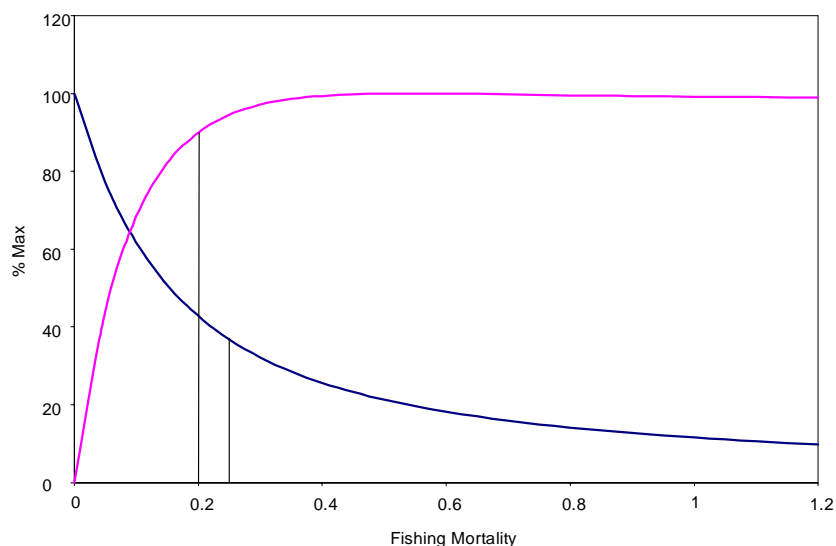


Fig. IV.2.4. American plaice in Div. 3LNO: yield-per-recruit and spawner-per-recruit. The vertical dotted line represents $F_{0.1}$ and the vertical solid line represents the F at 35% maximum spawner-per-recruit.

d) **Age-based Production Model (age 0 recruits)**

Stock-recruit observations for the 1960-1996 cohorts were obtained from Morgan *et al.* (2002). However, estimates of age-5 recruits (N_5) were adjusted to age-0 recruits (N_0) according to natural mortality ($M = 0.2$ for 1960-1988, $M = 0.53$ for 1989-1996):

$$N_{0+t} = N_{5,t+5} e^{(M_{t+1} + M_{t+2} + M_{t+3} + M_{t+4} + M_{t+5})}$$

The adjusted recruitment values provided a different perception of the stock-recruit relationship, particularly with respect to the 1989-1991 cohorts (Fig. IV.2.5). A Beverton-Holt relationship (see Section III.4) was fit to the observed data with lognormal error. Yield and spawning biomass-per-recruit were calculated using the mean weights at age, maturity and partial recruitment reported in Morgan *et al.* (2002) for medium-term projections.

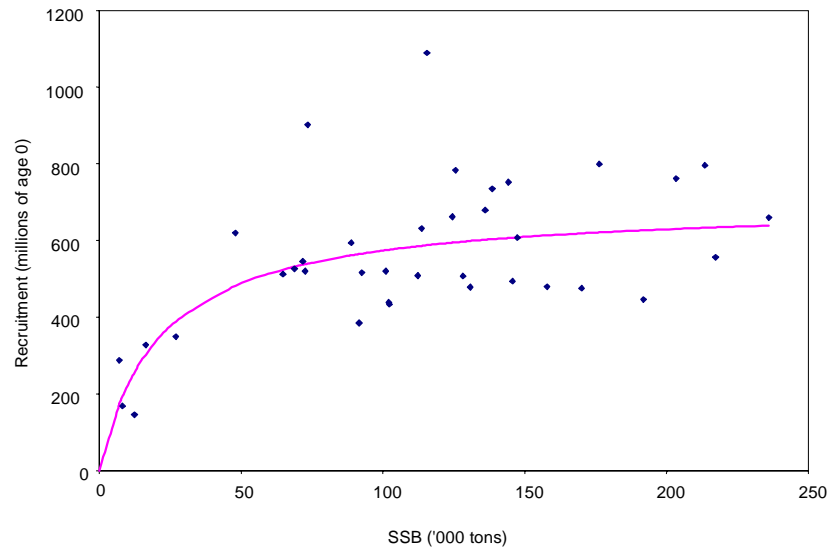


Fig. IV.2.5. American plaice in Div. 3LNO: stock-recruit observations and Beverton-Holt model predictions, 1960-1996 where recruitment is adjusted to age 0.

Equilibrium recruitment, yield and SSB were calculated for each value of F (see Section III.4). Production curves indicate that $F_{msy} = 0.33$ and $SSB_{msy} = 1\ 75\ 000$ tons (Fig. IV.2.6). These reference points are consistent with historical productivity and other reference points for the stock (e.g. $F_{0.1} = 0.20$, $B_{lim} = 50\ 000$ tons).

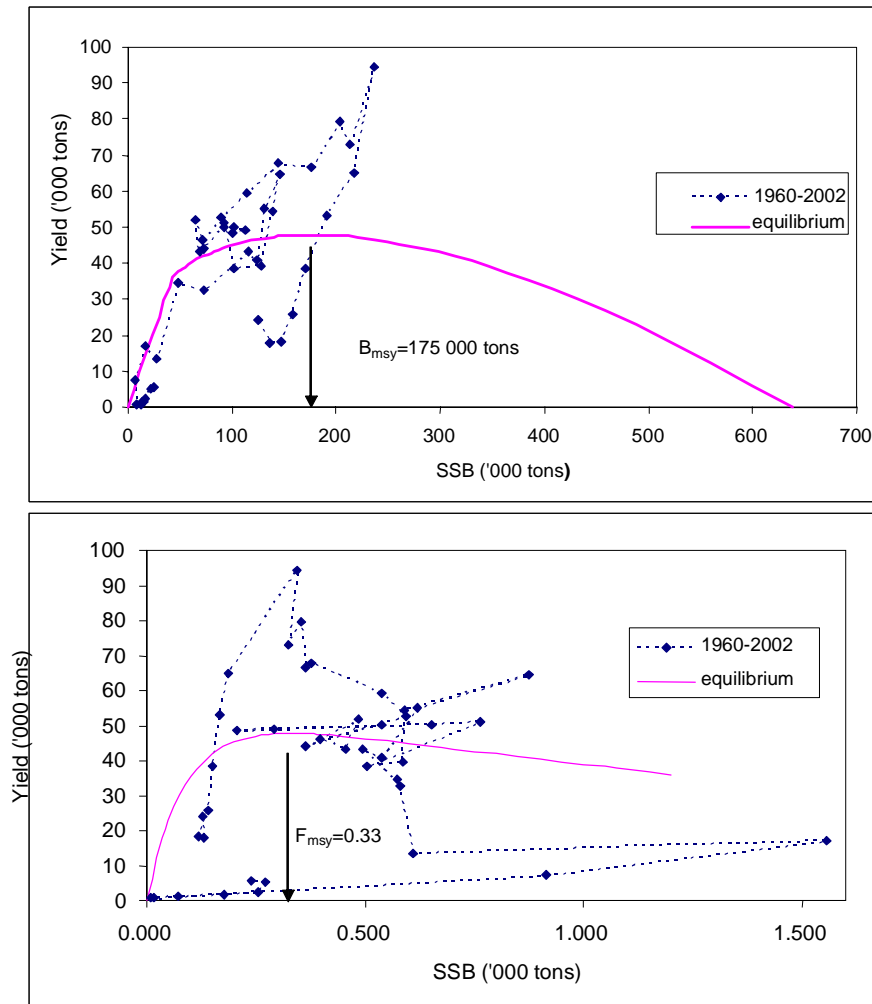


Fig. IV.2.6. American plaice in Div. 3LNO: equilibrium yield expectations from an age-based production model, with historic observations of catch, F and SSB, 1960-1996.

There was some concern about the accuracy of the level of M , its application to young ages and the resulting perception of strong recruitment from 1989 to 1991. Sensitivity analyses were completed to assess the effect of those cohorts on the age-based production model. The estimate of F_{msy} was not sensitive to the exclusion of those observations, and estimates of B_{msy} and MSY changed by five percent or less. Information on year-class strength from surveys was investigated to confirm the magnitude of calculated recruitment through graphical comparisons and correlations. Results indicated good agreement of survey indices and calculated abundance at ages 3 and 4, but less agreement at younger ages (with fall surveys agreeing with calculated recruitment more than spring indices).

Given the robustness of F_{msy} reference points to the observed recruitment from 1989 to 1991, the estimate (0.33 on ages 11+) as F_{lim} may be appropriate. However, further research is **recommended** to refine stock-recruit modeling, such as continued analysis on the estimation of M and exploration of trends in spawning potential (e.g. age structure and geographic distribution of the spawning stock) that may refute the perception of high reproductive potential (R/S) since the late-1980s.

The estimate of B_{msy} (175 000 tons SSB) may also serve as a provisional reference point. Given the current state of the resource (23 000 tons SSB in 2002, $F = 0.24$ in 2001), imprecision in the estimate will not

affect short-term management. The provisional estimate can be re-evaluated as the stock rebuilds and provides more observations of recruitment at intermediate stock sizes.

e) **SSB at 50% Maximum Recruitment (age 0 recruits)**

Given the stock recruit series described above the SSB which would produce 50% of the maximum recruitment was recalculated using recruitment at age zero calculated as above. 50% R_{\max} was estimated to be 360 million recruits at age 0 and the SSB giving this level of recruitment was 21 000 tons (Fig. IV 2.7).

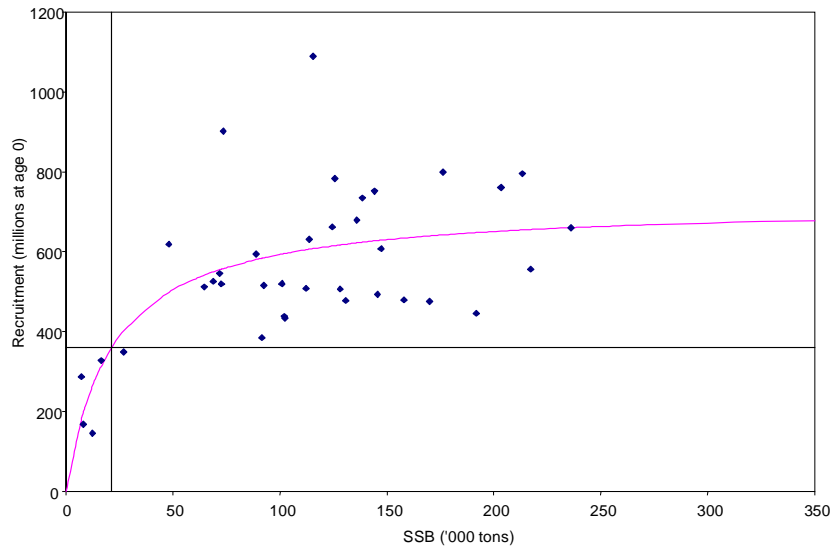


Fig. IV.2.7 American plaice in Div. 3LNO: stock-recruit scatter with fitted Beverton-Holt stock recruit curve. Recruits have been adjusted to age zero. The horizontal line indicates 50% of maximum recruitment and the vertical line shows the SSB which gives this level of recruitment.

f) **Serebryakov Method (age 0 recruits)**

The adjusted stock recruit scatter was also used to derive the SSB at $B_{50\%R90\%survival}$ (Fig. IV 2.8). This indicates that a limit reference point for this stock would be 40 000 tons of SSB.

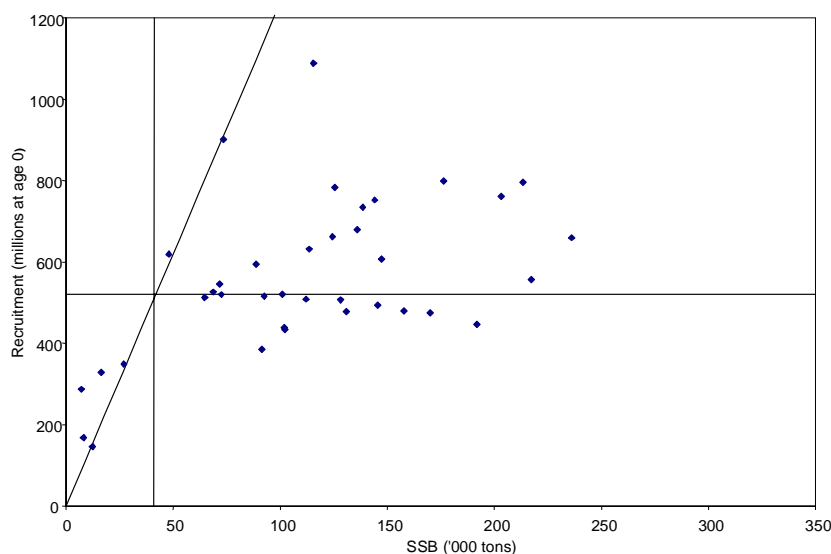


Fig. IV.2.8 American plaice in Div. 3LNO: stock-recruit scatter. Recruits have been adjusted to age 0. The horizontal line represents the median level of recruitment. The line through the origin bisects the scatter so that 10% of the recruitments are above the line.

g) Segmented Regression

A segmented regression was fit to the stock-recruit observations with recruits as millions of 5 year olds. However, the fit of the model was very poor. The estimated change point in this analysis was 121 000 tons.

A second segmented regression (see Section III.2) was fit to the stock-recruit data with the recruits adjusted to age 0 as above. The segmented regression fit is statistically significant at the 95% level of significance (p -value = 0), and the model explains 52% of variability in recruitment (coefficient of determination). Maximum likelihood estimate of the change point, the SSB at which recruitment is impaired, is 30 861 tons, and 80% profile likelihood confidence interval is given by 24 644 tons and 36 602 tons (Fig. IV.2.9).

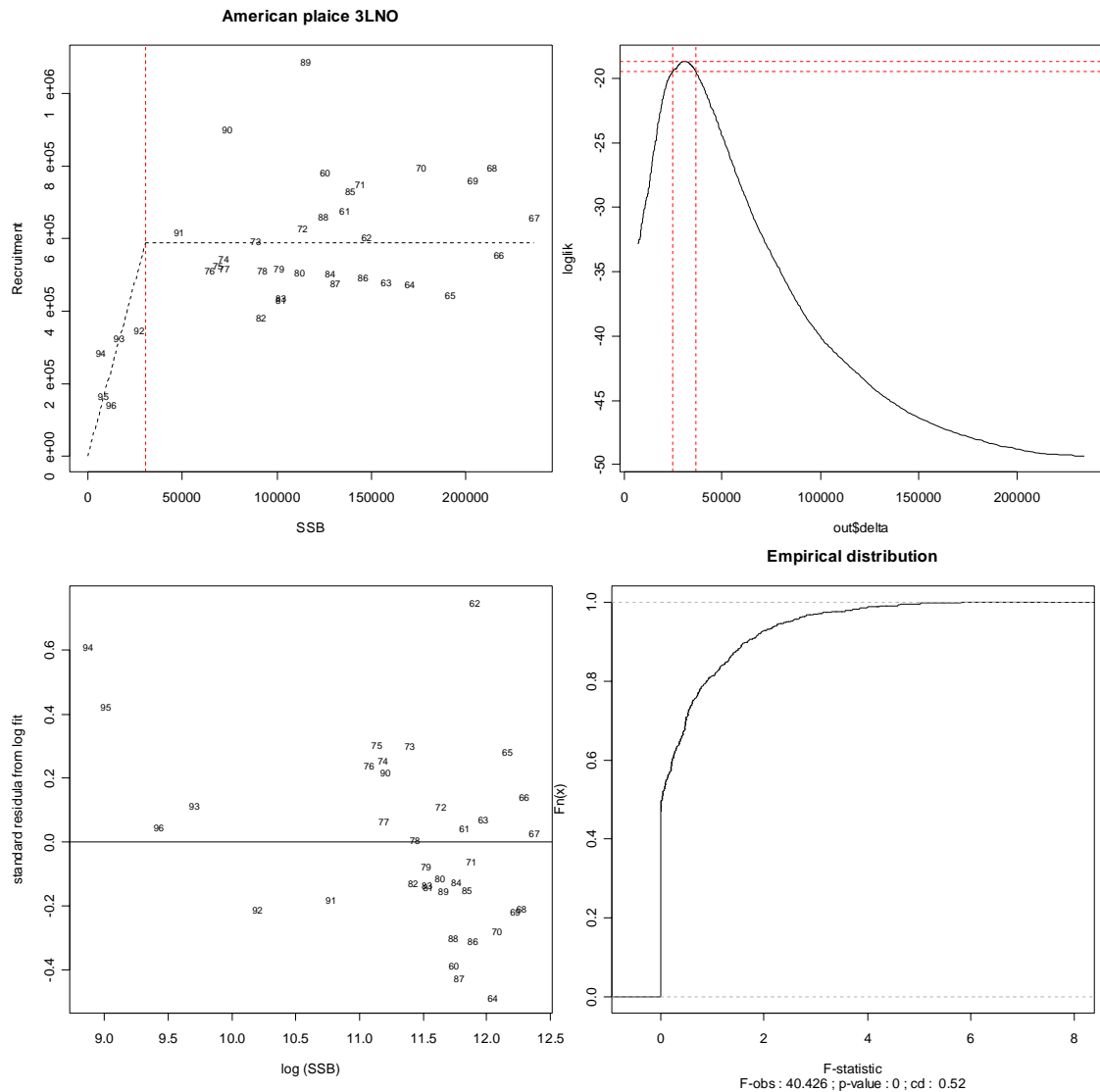


Fig. IV.2.9. American plaice in Div. 3LNO: Top left: stock-recruitment pairs identified by year-class, the segmented regression fitted model (dotted line) with the change point (vertical line). Top right: profile likelihood for changepoint (lower horizontal line – 80% likelihood ratio confidence interval for changepoint). Bottom left: standardized residuals vs SSB. Bottom right: bootstrapped empirical distribution of the F statistic vs the F observed. The corresponding p value and coefficient of determination are also given.

Sensitivity analyses of the segmented regression were also made to analyze the robustness and sensitivity of this method to the stock recruitment data analyzed (Fig. IV.2.10). This was performed to find out whether change points are stable and robust. This analysis was made eliminating a single year-class in turn and adding consecutively one year for the last years of the S-R time-series.

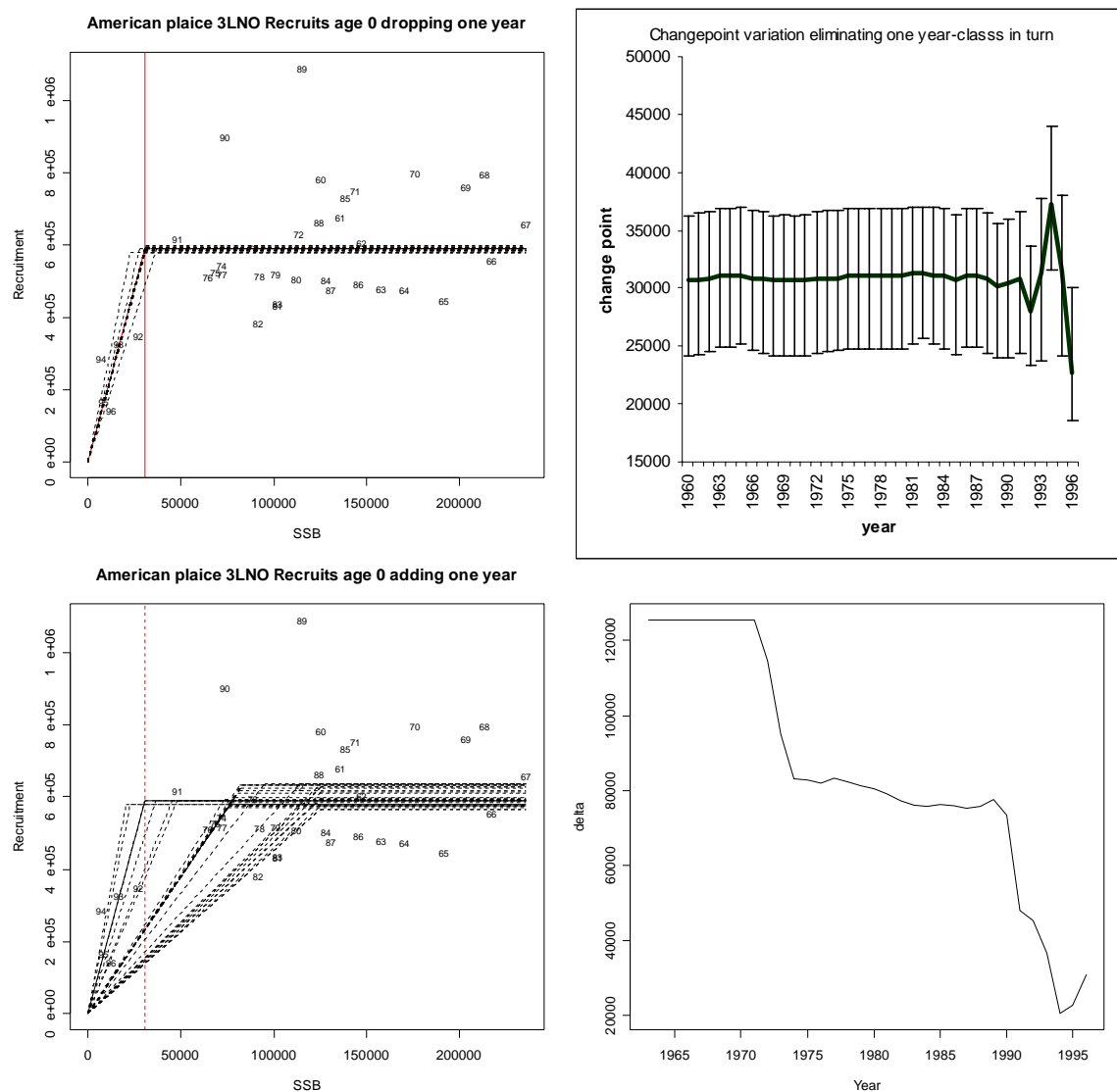


Fig. IV.2.10. American plaice in Div. 3LNO: Top left: stock-recruitment pairs identified by year-class; red solid line is the segmented regression model; and dotted lines are the changepoint models estimated by eliminating a single year-class in turn. Top right: changepoint vs eliminated year-class with 80% confidence interval. Bottom left: stock-recruitment pairs identified by year-class; solid line is the segmented regression model; and dotted lines are the changepoint models estimated by adding consecutively one year to the S-R time-series. Bottom right: changepoint vs added year-class

The analysis eliminating a single year-class in turn showed that the change point was rather stable, although change points vary when the 1994 and 1996 year-class are eliminated. The analysis of adding one year-class consecutively shows that there could be different productivity regimes in the time series. When the most recent year-classes are not used in the analysis the change point is greater than 70 000 tons indicating that these year-classes have a strong influence on the estimation of the change point.

h) Replacement Ratio Method

Catch and survey biomass reported in Morgan *et al.* (2002) were used to explore biomass dynamics of American plaice in Div. 3LNO. The data series is essentially a "one-way trip" with a recent period of slight rebuilding (Fig. IV.2.11). However, the effect of the recent increase in M for this stock is illustrated in the second panel on the left in which the survey biomass index is declining during a period of what appears to be a fairly constant relative F . This confounds the estimate of f_{rep} .

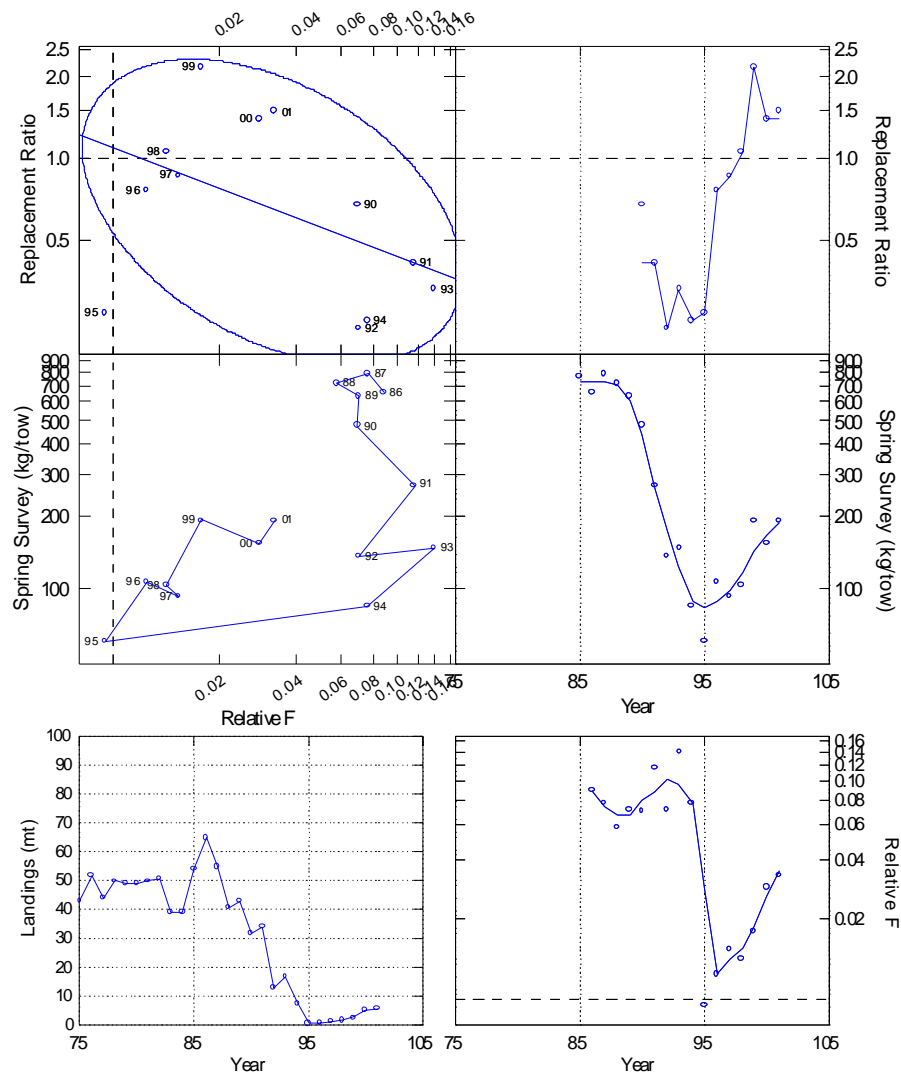


Fig. IV.2.11. American plaice in Div. 3LNO: trends in relative biomass, landings, relative fishing mortality rate (landings/index) and replacement ratios, using the spring survey and landings. Horizontal dashed lines represent replacement ratios = 1. The confidence ellipse has a nominal probability level of 0.68, and the diagonal line uses a robust regression estimator. (See section III.1 for full description).

Summary

The various analyses conducted here would indicate a B_{lim} in the range of 20 000 tons to 70 000 tons, bracketing the current B_{lim} of 50 000 tons. A possible candidate limit F reference point could be F_{msy} , estimated at 0.33. The use of recruitment adjusted to age zero is not definitive and must be examined further.

References

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3. Cod in Div. 3NO

a) Serebryakov Method

The Serebryakov method (Serebryakov, 1991) was applied to the spawning stock-recruit data for the cod stock in Div. 3NO (Fig. IV.3.1). This method uses an intersection of two lines to determine B_{lim} . First, the median recruitment for the stock is computed. Then, a line is constructed through the origin having a slope equal to the 90th percentile of recruits per spawner. Where these two lines intersect, a potential reference point is obtained. However, in a collapsed stock, all stock recruit points for the near future will likely be below both the median recruitment line, and less than the 90th percentile of R/S. These effects may cause the limit reference point derived from the Serebryakov method to change substantially over time with the accumulation of stock-recruit pairs at low stock size and might make the method inappropriate for a collapsed stock.

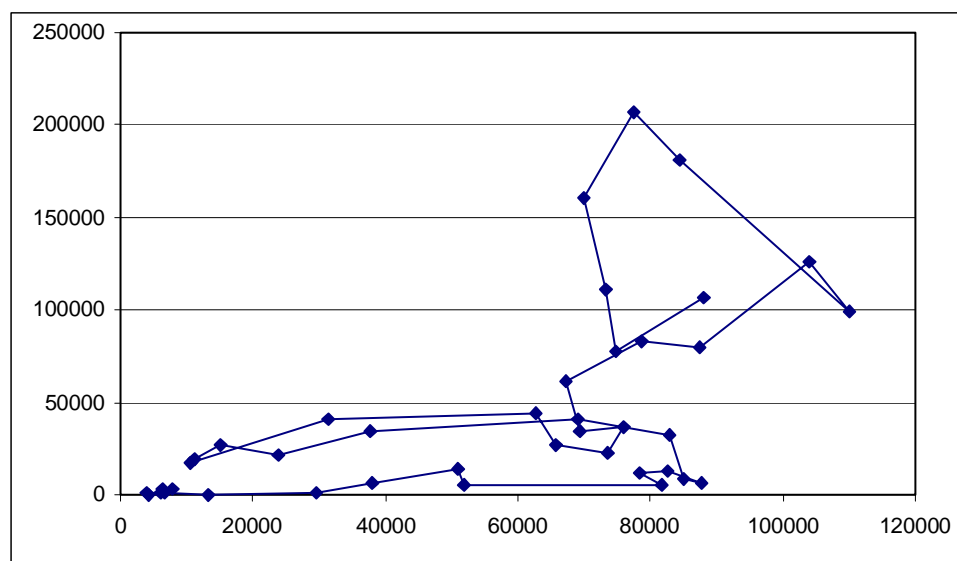


Fig. IV.3.1. Cod in Div. 3NO: stock-recruit scatter from the most recent assessment (Stansbury *et al.*, 2001).

b) Replacement Ratio Method

The replacement ratio method was attempted for this stock, but the results were considered uninformative in deciding upon any reference points for the stock because biomass declined continuously during the period covered by the survey.

c) Bayesian Production Model

A version of the Bayesian production model (Hvingel and Kingsley, 2002) without a predation term was applied to this cod stock in Div. 3NO. Results indicated that the available input data contained little information with respect to model parameters e.g. MSY and K.

d) Segmented Regression

The segmented regression approach (O'Brien and Maxwell, 2002) using an implementation available in the R language (L. Ibaibarriaga, AZTI, Spain, pers. comm.) was explored as a parametric method of modeling the stock-recruit time series for cod in Div. 3NO (Stansbury *et al.*, 2001). Using this methodology, the changepoint indicates an SSB level below which stock recruitment is impaired.

The resulting fit from this method is a straight line. It indicates that the changepoint occurs at the highest observed SSB, at about 110 000 tons (Fig. IV.3.2), however, the results are quite tenuous. Sensitivity analyses conducted suggest that using this method, the changepoint could be as low as 20 000 tons. Thus, application of the method to this stock-recruit scatter was considered uninformative for modification of B_{lim} .

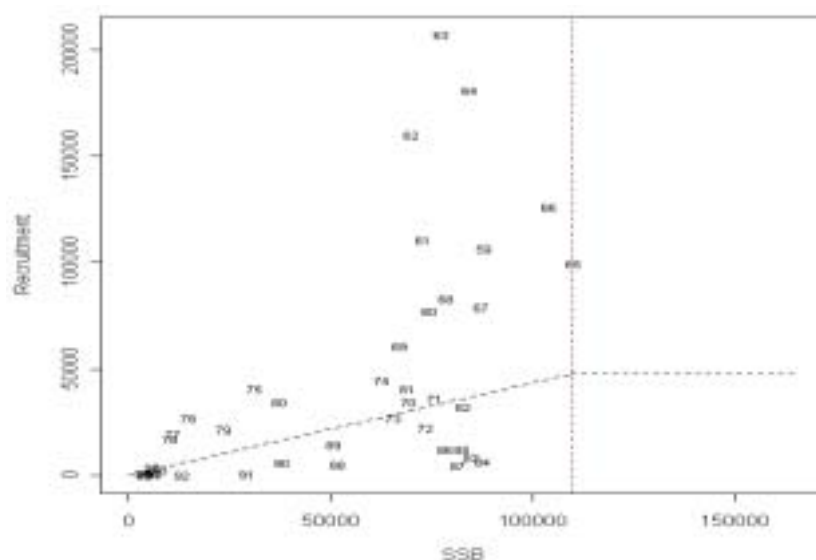


Fig. IV.3.2. Stock-recruit scatter for cod in Div. 3NO, with segmented regression fit. The estimated changepoint occurs at the highest observed Spawning Stock Biomass.

Other parametric stock-recruit models were also examined for this data set. However, the stock-recruit data for cod in Div. 3NO were not amenable to either the Beverton-Holt or Ricker curves, and both model fits were linear and uninformative with respect to amending B_{lim} .

e) Non-Parametric Methods

The Rice-Evans non-parametric kernel smoother approach described in Section III.7 was applied to S-R data for cod in Div. 3NO from the most recent assessment (Stansbury *et al.*, 2001). The stock-recruit scatter is shown in Fig. IV.3.1. A Cauchy kernel was selected and the shape parameter was estimated to be 12 800 tons SSB by minimizing the cross-validated prediction sums of squares using the kernel weighted mean as the predictor. The sums of squares surface is shown in Fig. IV.3.3. The resulting smoother is plotted together with the stock-recruit data in Fig. IV.3.4. The 10th percentile of "observed" (SPA estimated) recruitment values was used to define "poor recruitment". This value is 1.074×10^6 recruits at

age 3. The probability profile for recruitment being less than or equal to this value for the range of observed SSB values is shown in Fig. IV.3.5. The point at which the probability of poor recruitment increases markedly with decreasing SSB is approximately 60 000 tons, using the Cauchy kernel and the 10th percentile of observed recruitments as a definition of "poor recruitment". It is suggested that this be considered as support for the existing B_{lim} of 60 000 tons identified for cod in Div. 3NO in NAFO (1999).

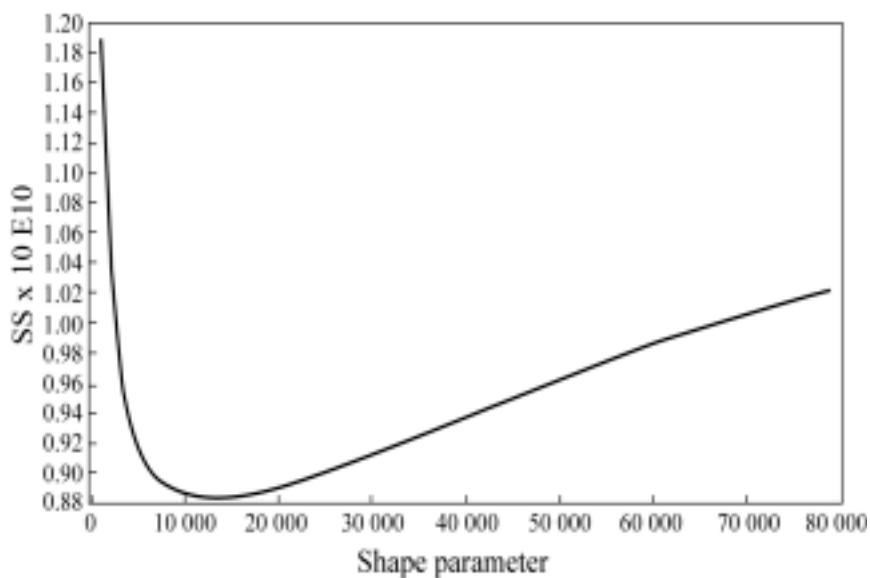


Fig. IV.3.3. Cod in Div. 3NO: the cross-validated prediction sums of squares for the Cauchy kernel weighted smoother in which the predictor is the kernel weighted mean.

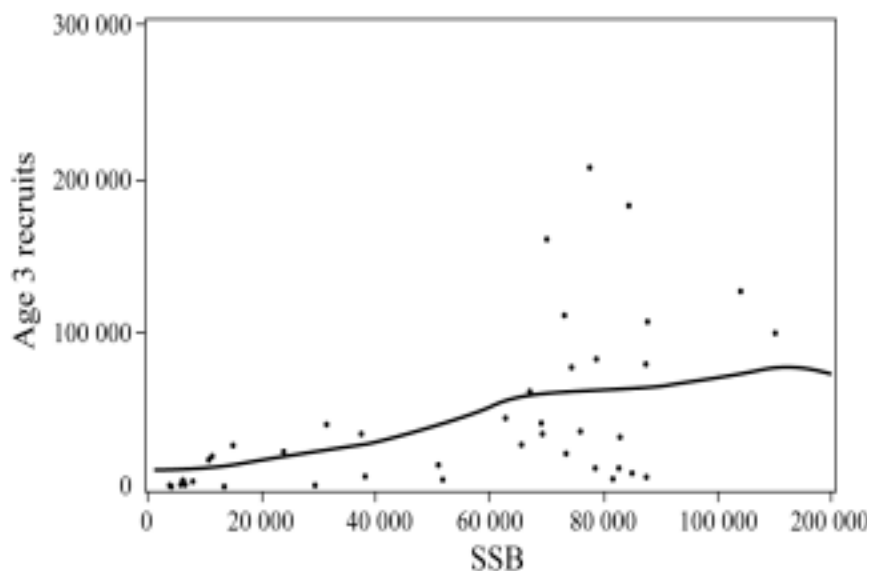


Fig. IV.3.4. Cod in Div. 3NO: the fitted non-parametric Cauchy kernel smoother together with the S-R data.

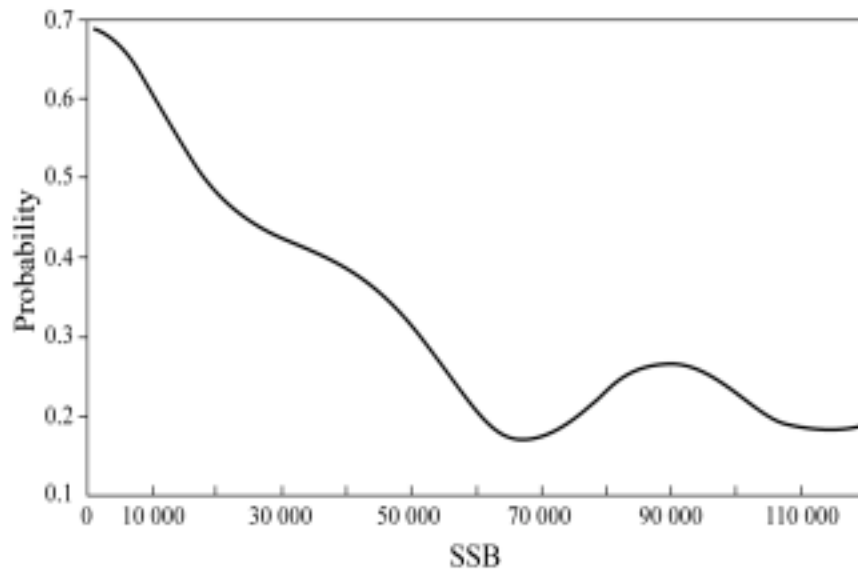


Fig. IV.3.5. Cod in Div. 3NO: the probability of poor recruitment ($\leq 1.074 \times 10^6$ recruits age 3) over the range of SSB. The point below which the probability of poor recruitment increases markedly is about 60 000 tons SSB, which is the current estimate of B_{lim} .

As a result of all these analyses, there is no basis upon which to amend the current Scientific Council PA B_{lim} reference point for the Div. 3NO cod stock. Therefore, 60 000 tons remains the current best estimate of B_{lim} .

References

- Hvingel, C. and M. C. S. Kingsley. MS 2002. A Framework for the Development of Management Advice on a Shrimp Stock Using a Bayesian Approach. *NAFO SCR Doc.*, 158, Serial No. N4787, 28 p.
- NAFO. 1999. Scientific Council Reports, Part A. Scientific Council Meeting on Precautionary Approach, 27 April-1 May 1999. p. 5-26.
- O'Brien, C. M. and D. L. Maxwell. MS 2002. Towards an operational implementation of the Precautionary Approach within ICES - biomass reference points. Working paper to the ICES Study Group on the Further Development of the Precautionary Approach to Fishery Management, Lisbon, Portugal, 4-8 March 2002.
- Serebryakov, V. P. 1991. Predicting year-class strength under uncertainties related to the survival in the early life history of some North Atlantic commercial fish. *NAFO Sci. Coun. Studies*, **16**: 49-56.
- Stansbury, D. E., P. A. Shelton, E. F. Murphy, B. P. Healey and J. Brattey. MS 2001. An assessment of the cod stock in NAFO Div. 3NO. *NAFO SCR Doc.*, No. 72, Serial No. N4450, 64 p.

4. Yellowtail Flounder in Div. 3LNO

Although indices of SSB and recruitment are available from survey data, no attempts were made at this workshop to use methodologies on the yellowtail flounder stock which employ SSB/recruitment relationships. Scientific Council noted that work on ageing of yellowtail flounder is progressing, and that development of age-structured models remains a priority for this stock.

A version of the Bayesian production model without a predation term was applied to yellowtail flounder in Div. 3LNO. The workshop recognized further work will be required to determine the applicability of this approach.

a) **ASPIC**

It is not possible to use age-structured methods with this stock at present, and the current stock assessment within Scientific Council is based on the ASPIC stock production model. Recent management advice for yellowtail flounder in Div. 3LNO has been based on an ASPIC biomass dynamics model (Walsh *et al.*, 2002). Results indicate that 2003 biomass = 121%B_{msy} and 2002F = 67%F_{msy}. Scientific Council considers the ASPIC estimate of relative F_{msy} to be an estimate of F_{lim}, and 2/3F_{msy} to be a target. Probability distributions of F_{msy} from a bootstrapped ASPIC model can also be used to calculate a buffer reference point for F. The relative biomass when the stock was closed to fishing in 1994, which is the lowest observed and corresponds to 20% of B_{msy}, could serve as a proxy for B_{lim} (NAFO, 2002). It was noted that the ASPIC-based reference points should be treated as interim values until age-based assessments and reference points are developed.

b) **Replacement Ratio Method**

The replacement ratio/index method was applied to the total commercial catches of yellowtail flounder in Div. 3LNO, and the Canadian spring survey series in the same area, from 1984-2002 (Fig. IV.4.1). Catch estimates and survey results for 2002 have not yet been reviewed by Scientific Council. Estimates of relative F were much higher prior to the mid-1990s, resulting initially from a rapid increase in catches in 1985-86, and subsequently from a decline in the survey index. With a moratorium on fishing, relative F declined to very low levels in 1995-97, then increased when the fishery reopened in 1998. The presence of several above-average year-classes during the 1990s, combined with a sharp decline in relative F during the moratorium, resulted in a rapid rate of increase in the stock during the late-1990s. From 1996-2001, the replacement ratio exceeded a value of 1.0 (which occurs whenever the fishing mortality rate is in balance with recruitment and growth).

The relationship between replacement ratio and relative F shows a correlation of -0.55. The randomization test for spurious correlation suggests an expected median correlation of -0.09 and a significance level = 0.04. In other words, the randomization test suggests that the association between the replacement ratio and the relative F is not simply an artifact of the data manipulations. Based on the results presented here, the model indicates that the relative F has been below the replacement F since 1993, but is approaching this level in recent years.

The same method was also tried with the fall survey data, but was not informative, likely because of the short time series of these data.

The utility of the replacement ratio (f_{rep}) as a proxy F_{msy} for yellowtail flounder in Div. 3LNO was evaluated by comparing reported estimates of f_{rep} to estimates of f_{msy} from ASPIC (in the same units as the replacement ratio, catch/survey biomass). Four pairs of estimates were available for three northwest Atlantic flatfish stocks. Yellowtail flounder in Div. 3LNO, yellowtail flounder in Div. 5Z and Winter flounder in Div. 5Z. The comparisons show that f_{rep} was consistently similar to f_{msy} , and was 6% less on average (see Section III.1 for full details of this analysis).

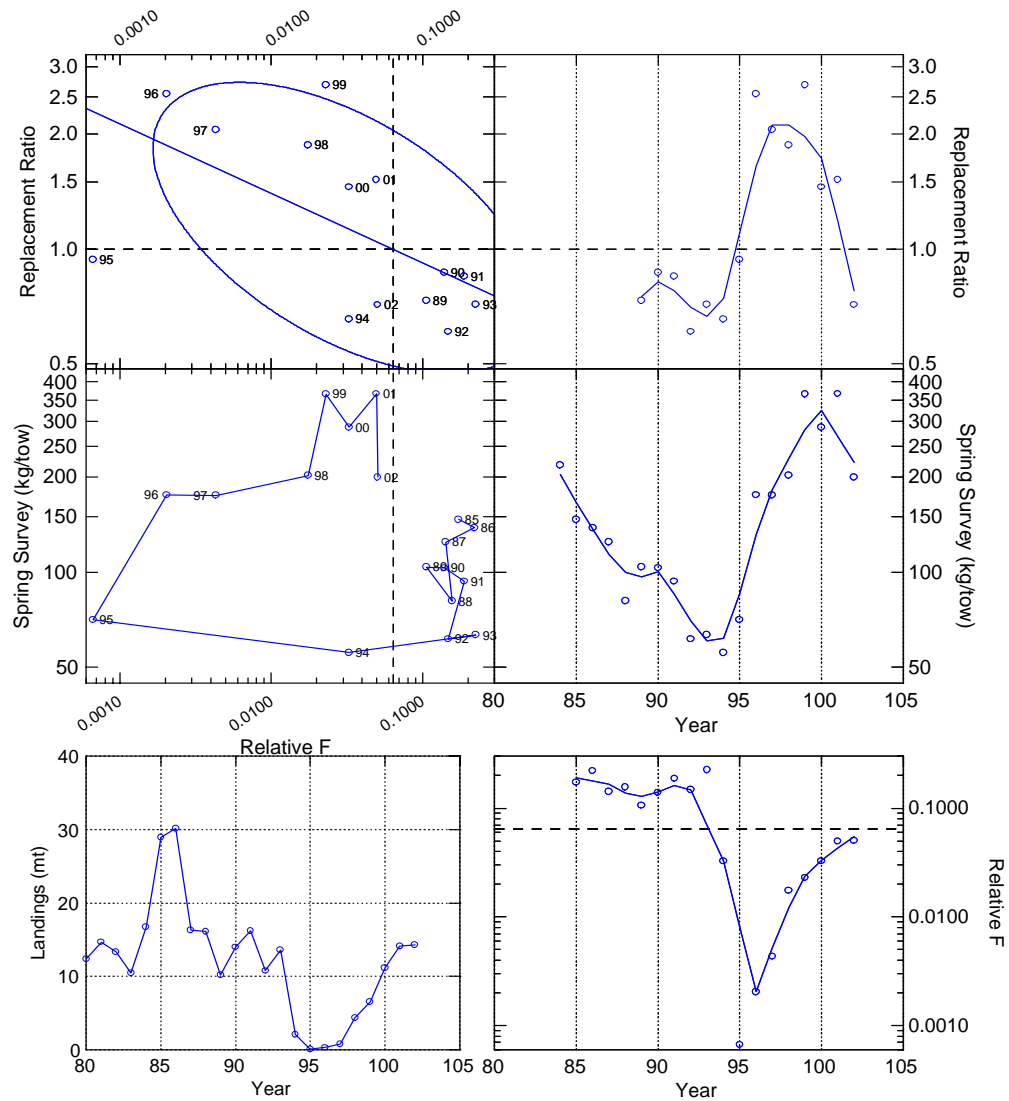


Fig. IV.4.1. Yellowtail flounder in Div. 3LNO: trends in relative biomass, landings, relative fishing mortality rate (landings/index) and replacement ratios, using the spring survey and total landings. Horizontal dashed lines represent replacement ratios = 1. The confidence ellipse has a nominal probability level of 0.68, and the diagonal line uses a robust regression estimator. Note that the survey data are actually biomass indices in '000 tons instead of kg/tow. (See section III.1 for full description).

References

NAFO. 2002. Scientific Council Reports, Part A. Scientific Council Meeting, 6-20 June 2002. p. 156.

5. **Redfish in Div. 3M**

Information was available to apply the Replacement Ratio method and the age-based MSY model (Sissenwine and Shepherd, 1987) to redfish in Div. 3M. Yield/SSB-per-recruit analysis was also applied to the average 1989-2001 XSA recruits extended to age 1. The Survey Proxy method did not provide any informative results because of a positive relationship between replacement ratio and relative fishing mortality. The results of the Age-Based MSY model provided an estimate of F_{msy} that was consistent with an ASPIC model from the most recent assessment of redfish in Div. 3M (Ávila de Melo *et al.*, 2002) whereas the corresponding female spawning B_{msy} was at the level of virgin total biomass given both by ASPIC and yield-per-recruit analysis. The

estimates of SSB and recruitment utilized in the age-based MSY model were derived from XSA, and yield and SSB-per-recruit were from the most recent assessment. It was acknowledged that the Scientific Council has only used the results of the XSA or ASPIC models for illustrative purposes to indicate trends in the resource over time. Therefore, there were no informative results from any of the analyses at this Workshop to provide reference points under a Precautionary Approach.

However, there may be some utility of the provisional F reference points from ASPIC and YPR analysis for providing management advice. For example, when F was greater than F_{msy} and $F_{0.1}$ the stock decreased, and when F was reduced to less than those reference points, the stock increased.

References

- Ávila de Melo, A., R. Alpoim and F. Saborido-Rey. MS 2002. The present status of beaked redfish (*S. mentella* and *S. fasciatus*) in NAFO Division 3M and medium term projections under a low commercial catch/high shrimp fishery by-catch regime. *NAFO SCR Doc.*, No. 54, Serial No. N4666, 60 p.
- Sissenwine, M. P. and J. G. Shepherd. 1987. An alternative perspective on recruitment overfishing and biological reference points. *Can. J. Fish. Aquat. Sci.*, **44**: 913-918.

6. Cod in Div. 3M

A preliminary estimate of B_{lim} at 14 000 tons was based on the analysis of the stock-recruitment relationship according results of the 1972 to 1999 XSA (Cerviño and Vázquez, 2000). This SSB level defines two different zones where the probability of getting good recruitments is different, being much lower when SSB was below 14 000 tons. This perception did not change in later analyses.

A replacement ratio analysis was carried out based on total catches from 1988-2001 and stock indices from the EU survey series 1988-2002. These data are considered the best and most representative series, but the 15-year time-series is at the limit of sensitivity of the method because the 5 year lag reduced the series to 10 points for the replacement ratio analysis. A regression of replacement ratio on relative fishing mortality was uninformative and the relative F equivalent to a replacement ratio of 1.0 was not determined. The stock has declined in most recent years in absence of fishing, illustrated by the declining trend in EU survey and low recent catches. Other external factors may need to be taken into account to explain the continued population decline as a consequence of poor recruitment since 1992. The trend in smoothed EU survey data is similar to trends in biomass from the XSA. The pattern in relative F, high throughout the 1990s and sharply declining in 1999, is similar to the pattern of fully recruited fishing mortality estimated by the XSA, and has been well below the replacement rate. Although results from this method are consistent with XSA, relative F reference points can not be developed from the current time series. However, the analysis indicates that replacement ratio has been below one for the entire time series.

A Segmented Regression Analysis was applied to the results of the last XSA, covering the 1972 to 2001 period. The analysis concluded that the SSB level was below the changepoint during the whole period, but this interpretation is considered unrealistic, and no further results were accepted.

An estimate of B_{lim} of 4 000 tons was estimated using the Serebryakov method (Serebryakov, 1991) for the period 1972-2000. The B_{lim} estimate is near the lowest observed value in the SSB time series. The same analysis was applied to the period before recruitment collapsed (1972-1991) and estimated a B_{lim} of 6 000 tons. Given the conclusions based on the analysis applied to the Div. 3NO cod stock, it is considered that these results are inconclusive for the Div. 3M cod stock.

In conclusion, 14 000 tons remains as a preliminary estimate of B_{lim} , although the Serebryakov method suggests a lower value.

References

Cerviño, S. and A. Vázquez. 2000. An assessment of the Cod stock in NAFO Division 3M. *NAFO SCR Doc.*, No. 40, Serial No. N4269, 13 p.

Serebryakov, V. P. 1991. Predicting year-class strength under uncertainties related to the survival in the early life history of some North Atlantic commercial fish. *NAFO Sci. Coun. Studies*, **16**: 49-56.

7. Northern Shrimp in Subareas 0 and 1

a) Bayesian Production Model

The analysis indicates that the stock dynamics have responded to two different environmental regimes: one with high and the other with low cod abundance. The trajectory of the median estimate of 'biomass –ratio' (B_t/B_{msy}) plotted against 'mortality – ratio' (Z_t/Z_{msy}) (Fig. IV.7.1) starts in 1956 at half the optimum biomass ratio and at a mortality-ratio well above 1. The stock maintained itself in this region during the years when cod were abundant. When the cod stock declined in the late-1960s, and predation pressure was lifted, shrimp stock biomass increased and eventually began cycling in the left upper corner of the graph (Fig. IV.7.1) during the current regime of low cod abundance.

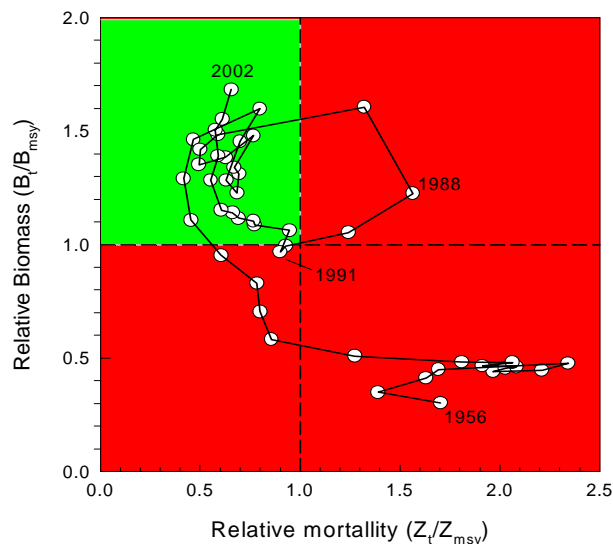


Fig. IV.7.1. Shrimp in Subareas 0 and 1: estimated annual median biomass-ratio (B/B_{msy}) and mortality-ratio (Z/Z_{msy}) 1956-2002.

Since the early-1970s the estimated median biomass-ratio ranged from about 0.96 to 1.67 (Fig. IV.7.1) and the probability that it had been below the optimum level was small for most years (Fig. IV.7.2), i.e. it seemed likely that the stock had been at or above its MSY level throughout the modern fishery. A steep decline in CPUE was noted in the late-1980s and early-1990s following a short-lived resurgence of the cod stock and the median estimate of biomass-ratio dipped just below the optimum in 1990-1991 (Fig. IV.7.1). The stock has increased since then and reached its highest level ever in 2002 with a median estimate of biomass-ratio of 1.67, corresponding to about 82% of estimated median carrying capacity. The estimated risk of stock biomass being below B_{msy} was less than 0.01 (Fig. IV.7.2).

The mortality ratio (Z ratio, which includes mortality by fishing and predation by cod) has been below 1 for most of the time since 1970, except for the period of high cod predation in the late-1980s (Fig. IV.7.1). Since 1997, annual median Z ratio has been stable at approximately 0.6, i.e. well below the optimum. The median of estimate for 2002 is 0.67 with a risk of only 0.04 of being above 1 (Fig. IV.7.2).

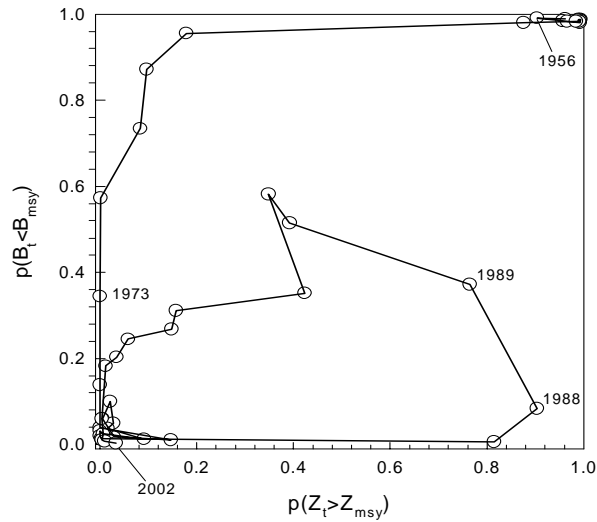


Fig IV.7.2. Shrimp in Subareas 0 and 1: risk of annual biomass being below B_{msy} and of mortality caused by fishing and cod predation being above Z_{msy} 1956-2002.

The median estimate of the maximum annual production surplus (MSY), available equally to the fishery and to the cod was estimated to 101 400 tons (Fig. IV.7.3). The risk function relating the probability of exceeding MSY to the combined removal by fishery and cod predation is given as the integral of this distribution (Fig. IV.7.3).

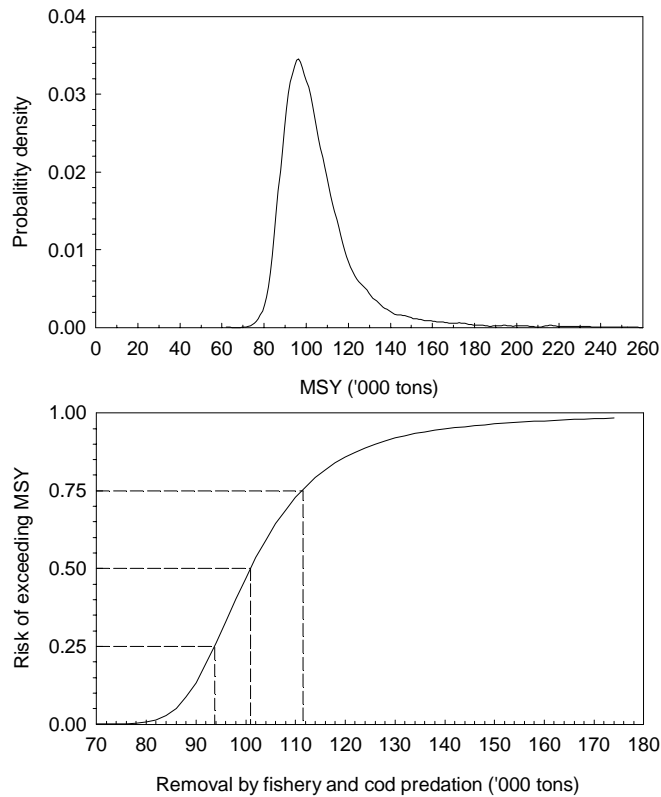


Fig. IV.7.3. Shrimp in Subareas 0 and 1: Posterior probability distribution of the maximum annual production surplus, available equally to the fishery the cod (MSY) (upper panel) and the cumulative probability of exceeding MSY.

Ten-year projections of stock development were made under the assumption that the cod stock will remain at its current low abundance. Five levels of annual catch: 80 000, 90 000, 100 000, 110 000 and 120 000 tons were investigated (Fig. IV.7.4).

The investigated catch options of 80 000 and 90 000 ton/yr have a small risk of being above MSY (Fig. IV.7.3) and the stock is therefore likely to remain above B_{msy} (Fig. IV.7.4) during the ten years of projection. The combined relative fishing and cod predation mortality, Z/Z_{msy} , has a high probability of being below 1 within this period (Fig. IV.7.5).

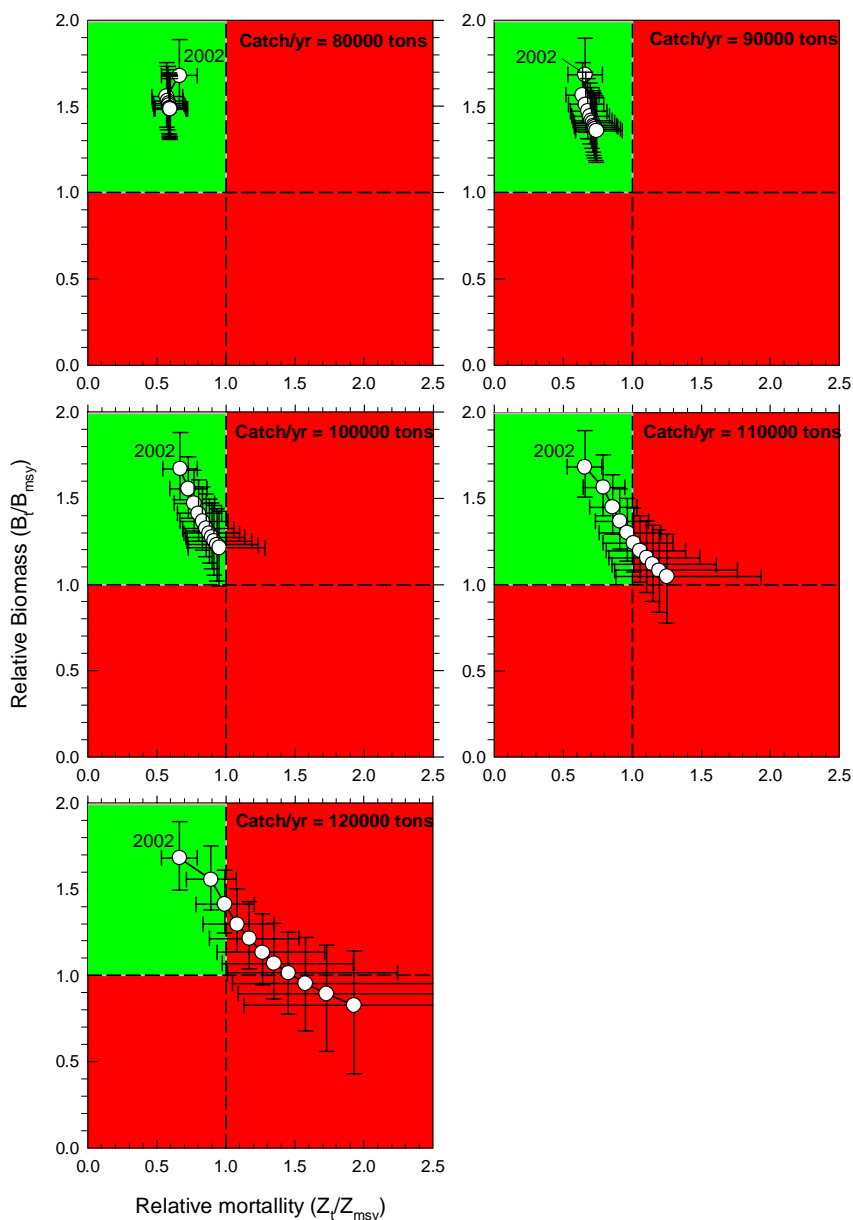


Fig. IV.7.4. Shrimp in Subareas 0 and 1: projections of stock development for the period 2002-2012 quantified in a biomass (B/B_{msy})-mortality (Z/Z_{msy}) continuum. Dynamics at 80 000, 90 000, 100 000, 110 000 and 120 000 tons of fixed annual catch levels are shown as medians with error-bars at the 25th and 75th percentiles. Dashed lines indicate level of biomass and mortality at MSY.

A catch option of 100 000 tons/yr will just about meet the estimated median MSY and is not likely to drive the stock below B_{msy} in the short to medium term (Fig. IV.7.4), i.e. the risk is less than 10% within the first five years and just above 25% after year 10 (Fig. IV.7.5). However, this level of exploitation might not be sustainable in the longer term, as risk of falling below B_{msy} continues to increase through time.

Fishing 110 000 tons/yr bears a 75% risk of being above MSY (Fig. IV.7.3), thus this catch level is not likely to be sustainable in the longer term. Owing to the current high stock level the risk of falling B_{msy} is still less than 20% after five years at this catch level, although after 10 years it is close to 50% (Fig. IV.7.5).

A catch of 120 000 tons/yr is associated with an 85% risk of exceeding MSY (Fig. IV.7.3) and the stock biomass will rapidly decline to below B_{msy} (Fig. IV.7.4). After just two years there is a 50% risk of exceeding Z_{msy} (Fig. IV.7.5).

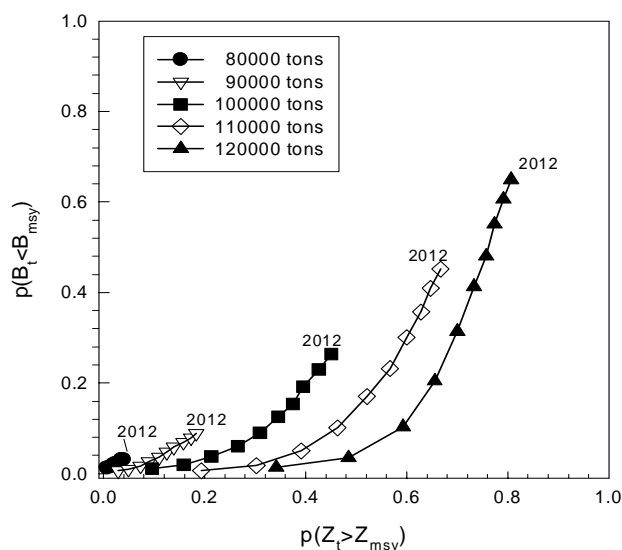


Fig. IV.7.5. Shrimp in Subareas 0 and 1: risk of exceeding Z_{msy} and of driving the stock below B_{msy} by maintaining optional annual catch levels of 80 000-120 000 tons/yr during the period 2003-2012.

The probabilities of transgressing chosen limits in response to different management options may readily be derived within this modeling framework. Hence explicit buffer reference points are not needed as the risk of exceeding the limit reference is quantified and uncertainty associated with the entire process is taken into account.

The limit reference mortality in the present example is Z_{msy} , i.e. Z-ratio=1. This applies in the current regime of low predation mortality where $Z_{msy} \sim F_{msy}$. If predation becomes significant this reference has to be re-evaluated.

V. Recommendations

American plaice Div. 3LNO

- Further research is **recommended** on the adjustment of recruits to age 0 for American plaice in Div. 3LNO to refine stock-recruit modeling, such as continued analysis on the estimation of M and exploration of trends in spawning potential (e.g., age structure and geographic distribution of the spawning stock) that may refute the perception of high reproductive potential (R/S) since the late-1980s.

- A possible candidate limit F reference point could be F_{MSY} , estimated at 0.33 for American plaice in Div. 3LNO American plaice.

Yellowtail flounder Div. 3LNO

- Continue work towards development of reference points based on age structured models.

Precautionary Approach Framework

- It is **recommended** that a study group be formed to evaluate methods for defining and deriving measures of B_{lim} .

VI. Other Business

There was no other business.

VII. Adoption of Report

The final draft of the report of this meeting was reviewed and **adopted**. It was noted that minor editorial details and the final formatting of the report will be done at the Secretariat in consultation with the Designated Experts and the Chair.

VIII. Adjournment

There being no other business, the Chair noted this report will be reviewed by the Scientific Council at its meeting of 5-19 June 2003, and subsequently submitted to the Fisheries Commission in September 2003.

The Chair thanked the participants for their long hours of very constructive and creative work, with special appreciation extended to the Designated Experts and subgroup leaders.

The Chair extended special thanks, on behalf of the participants, to the Canadian hosts from the Science, Oceans and Environments Branch, Department of Fisheries and Oceans, for the facilities and gracious hospitality. Thanks were extended to the Secretariat and the meeting was closed.

PART D

Scientific Council Meeting, 5-19 June 2003

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Participants at Scientific Council Meeting, 5-19 June 2003 (Bottom to top – left to right):

Antonio Vazquez, Dave Kulka, Margaret Treble, Eugene Murphy, Tissa Amaratunga
 Bruce Atkinson, Manfred Stein, Don Power
 Helle Siegstad, Dorothy Auby, Ralph Mayo, Eugene Colbourne, Konstantin Gorchinsky
 Joanne Morgan, Jean-Claude Mahé, Dawn Maddock Parsons, Don Stansbury, Chris Darby
 Hilario Murua, Brian Healey, Stanislov Lisovsky, David Cross, Bill Brodie
 Taro Ichii, Fernando Gonzalez, Ricardo Alpoim, Antonio Avila de Melo
 Karen Dwyer, Ray Bowering, Ole Jørgensen

Missing from picture: Ken Drinkwater, Cindy Kerr, Lisa Hendrickson, Johanne Fischer, Leonid Kokovkin,
 Gary Maillet, Barb Marshall, Gordie Moulton, Árni Nicolajsen, Trevor Platt, Cara Schock,
 Fred Serchuk, Peter Shelton, Katherine Sosebee and Scott Tomlinson



The Chairs, Scientific Council Meeting, 5-19 June 2003:

(Top: L to R) Don Stansbury (Chair STACFIS), Manfred Stein (Chair STACPUB), Eugene Colboune (Chair STACFEN)
(Bottom: L to R) Ralph Mayo (Chair Scientific Council), Joanne Morgan (Chair STACREC)



STACFIS in session during 5-19 June 2003 Meeting

REPORT OF SCIENTIFIC COUNCIL MEETING

5-19 June 2003

Chair: Ralph K. Mayo

Rapporteur: Tissa Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at the Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, during 5-19 June 2003, to consider the various matters in its agenda. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Germany, Portugal, Spain and United Kingdom), Japan, Russian Federation and United States of America. The Deputy Executive Secretary, Tissa Amaratunga, was in attendance and the Executive Secretary, Johanne Fischer, attended when available.

The Executive Committee met prior to the opening session of the Council, and the Provisional Agenda, plan of work and other related matters were discussed.

The opening session of the Council was called to order at 1015 hours on 5 June 2003.

The Chair welcomed everyone to Dartmouth and to this venue for the June Meeting. The Chair particularly welcomed the new Executive Secretary, and noted that she would make a presentation of the new NAFO website as well as address the Council on some agenda issues. The Executive Secretary then made an introductory address to the Council.

The Deputy Executive Secretary was appointed rapporteur.

The Deputy Executive Secretary informed the Council that prior to the meeting, authorization had been received for proxy votes from Latvia and Norway to record their abstentions during any voting procedures.

The Council noted it had invited one observer from FAO of the UN to attend this meeting, to address some STACREC agenda items.

The Chair noted that this is the election year for the officers of The Council and its Standing Committees. The Council was informed that a Nominating Committee consisting of three Contracting Party representatives, Bruce Atkinson (Canada), Antonio Vazquez (EU) and Fred Serchuk (USA), will consult the Council participants and make proposals for the nominations before the closure of this meeting.

Having reviewed the work plan for each Agenda item, the Agenda was **adopted**, and the opening session was adjourned at 1045 hours.

The Council through 6-19 June 2003 addressed various outstanding agenda items as needed. The Standing Committee reports were **adopted** through the course of the meeting.

The concluding session was called to order at 1015 hours on 19 June 2003.

The Council considered and **adopted** the Report of the Scientific Council of this meeting of 5-19 June 2003, noting changes as discussed during the reviews would be made by the Chair and the Deputy Executive Secretary.

The meeting was adjourned at 1145 hours on 19 June 2003.

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

The Agenda, List of Research (SCR) and Summary (SCS) Documents, List of Representatives and Advisers/Experts are given in Part E, this volume.

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

II. REVIEW OF SCIENTIFIC COUNCIL RECOMMENDATIONS IN 2002

The Council noted recommendations made in 2002 pertaining to the work of the Standing Committees were addressed directly by the Standing Committees, while recommendations pertaining specifically to the Council's work will be considered under each relevant topic of its Agenda.

III. FISHERIES ENVIRONMENT

The Council **adopted** the Report of the Standing Committee on Fisheries Environment (STACFEN), as presented by the Chair, Eugène Colbourne. The full report of STACFEN is at Appendix I.

STACFEN made no formal recommendations during this 2003 meeting.

IV. PUBLICATIONS

The Council **adopted** the Report of the Standing Committee on Publications (STACPUB) as presented by the Chair, Manfred Stein. The full report of STACPUB is at Appendix II.

STACPUB made no formal recommendations during this 2003 meeting.

V. RESEARCH COORDINATION

The Council **adopted** the Report of the Standing Committee on Research Coordination (STACREC) as presented by the Chair, Joanne Morgan. The full report of STACREC is at Appendix III.

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

1. *the Notes for Completion of STATLANT 21A and 21B questionnaires be revised to include the requirement for national authorities to report the absence of fishing activities.*
2. *the Deputy Executive Secretary attend the CWP Intersessional Meeting to be held in 2004.*
3. *the observer data be collected and archived on a set by set basis in a format consistent with SCS Doc. 00/23, as adopted by the Fisheries Commission, including all identifiers but that the data be made available to users without any identification of vessel name or country. Rather a unique identifier will be associated with each vessel and country and the user will not have access to the key to this code.*
4. *in 2004 the summed abundance and biomass based on conversion of the length frequencies be presented for American plaice, cod, Greenland halibut and yellowtail flounder in the Div. 3NO surveys conducted by EU-Spain, and these be compared to the estimates from the method used to convert the CPUE.*

VI. FISHERIES SCIENCE

The Council **adopted** the Report of the Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Don Stansbury. The full report of STACFIS is at Appendix IV.

The Council endorsed **recommendations** specific to stock considerations and they are highlighted under the relevant stock considerations in the STACFIS Report at Appendix IV.

VII. MANAGEMENT ADVICE AND RESPONSES TO SPECIAL REQUESTS

1. Fisheries Commission (Annex 1)

For stocks within or partly within the Regulatory Area, the Fisheries Commission requested the following scientific advice.

a) Request for Advice on TACs and Other Management Measures for the Year 2004

The Scientific Council and the Fisheries Commission during the Annual Meeting of September 2002 agreed to consider certain stocks in 2004. This section presents advice for which the Scientific Council provided scientific advice for 2004 during this meeting.

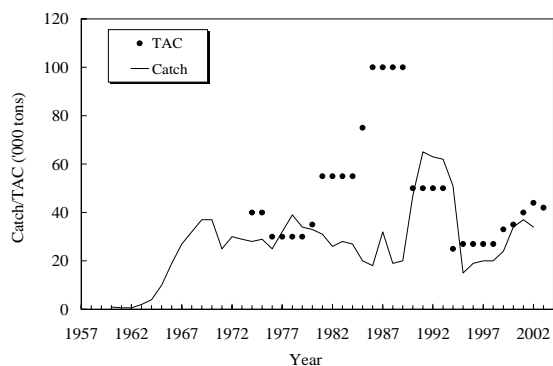
Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 2 and Divisions 3KLMNO

Background: The Greenland halibut stock in Subarea 2 and Div. 3KLMNO is considered to be part of a biological stock complex, which includes Subareas 0 and 1.

Fishery and Catches: Catches increased sharply in 1990 due to a developing fishery in the NAFO Regulatory Area in Div. 3LMNO and continued at high levels during 1991-94. The catch was only 15 000 to 20 000 tons per year in 1995 to 1998 as a result of lower TACs under management measures introduced by the Fisheries Commission. The catch increased since 1998 and by 2001 was estimated to be 38 000 tons, the highest since 1994. The estimated catch for 2002 was 34 000 tons.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	34	32 ¹	~30	35
2001	38	29 ¹	40	40
2002	34	29 ¹	40	44
2003	-	-	36	42

¹ Provisional.

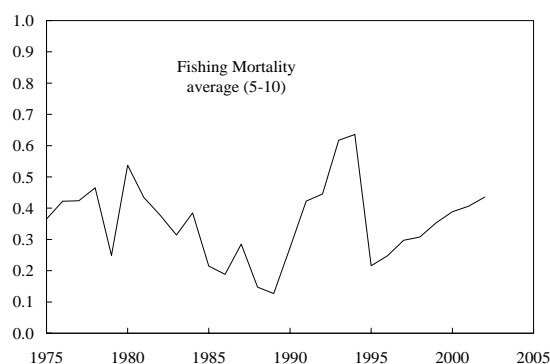


Data: CPUE data were available from international otter trawl fisheries throughout the stock area and the Portuguese otter trawl fishery in the NAFO Regulatory Area of Div. 3LMN. Abundance and biomass indices were available from research vessel surveys of Canada in Div. 2J+3KLMNO (1978-2002), EU in Div. 3M (1988-2002) and EU-Spain in Div. 3NO (1995-2002). International commercial catch-at-age data were available from 1975-2002.

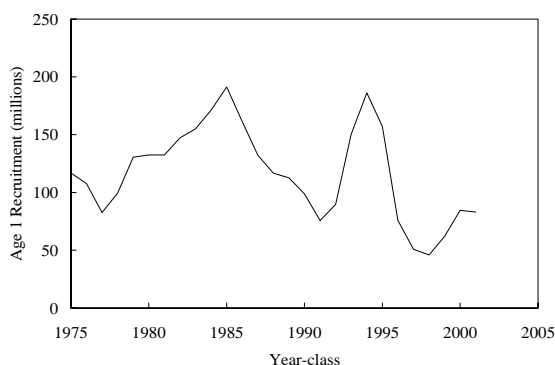
Assessment: An analytical assessment using Extended Survivors Analysis (XSA) tuned to the Canadian spring (Div. 3LNO), and fall (Div. 2J, 3K) and the EU (Div. 3M) surveys for the years 1995-2002 was used as an assessment of the 5+ exploitable biomass, level of

exploitation and recruitment to the stock. Natural mortality was assumed to be 0.20 for all ages.

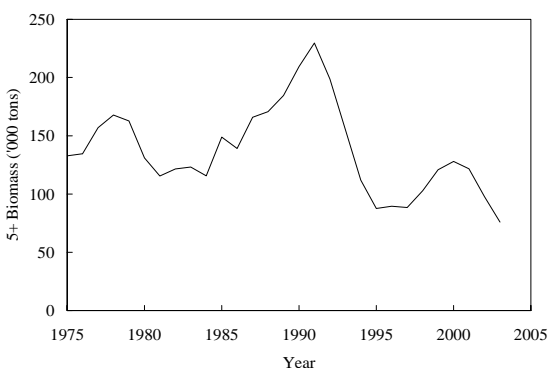
Fishing Mortality: High catches in 1991-94 resulted in F_{5-10} exceeding 0.50. F_{5-10} then dropped to about 0.20 in 1995 with the substantial reduction in catch. F_{5-10} has been increasing in recent years with increased catch. F_{5-10} in 2002 is estimated to be 0.44.



Recruitment: The above average 1993-95 year-classes have comprised most of the fishery in recent years although their overall contribution to the stock was less than previously expected. Subsequent recruitment to the fishable stock over the next few years will be comprised of below average year-classes.



Biomass: The fishable biomass (age 5+) reached a historic low in 1995-97 due to very high catches and high fishing mortality. It increased during 1998-2000 due to greatly reduced catches, much lower fishing mortality and improved recruitment. However, increasingly higher catches and fishing mortality since then accompanied by poorer recruitment has caused it to decline again.



State of the Stock: The exploitable biomass has been declining in recent years and is presently estimated to be at its lowest level. Recent recruitment has been poor and if catches continue at recent levels, then the stock will decline further.

Recommendation: The present view of the stock is considerably more pessimistic than in recent years. All observed indicators are showing persistent declines over the past several years while catches have generally been increasing. Assuming a catch of 30 000 tons in 2003 and in order to prevent a further decline in exploitable biomass during 2004, the catch in 2004 should not exceed 16 000 tons.

The Council again recommends that measures be considered to reduce, as much as possible, the exploitation of juvenile Greenland halibut in all fisheries.

Reference Points: Precautionary reference points have not been defined for this stock as yet.

Medium-term considerations: Stochastic medium-term, stock projections were generated in order to illustrate a series of potential management scenarios for rebuilding exploitable biomass. Each projection was conditioned on the assumption of a 30 000 tons catch in 2003, with constant landings or exploitation rate in each of the years 2004-2007. The results are illustrated in the following figures.

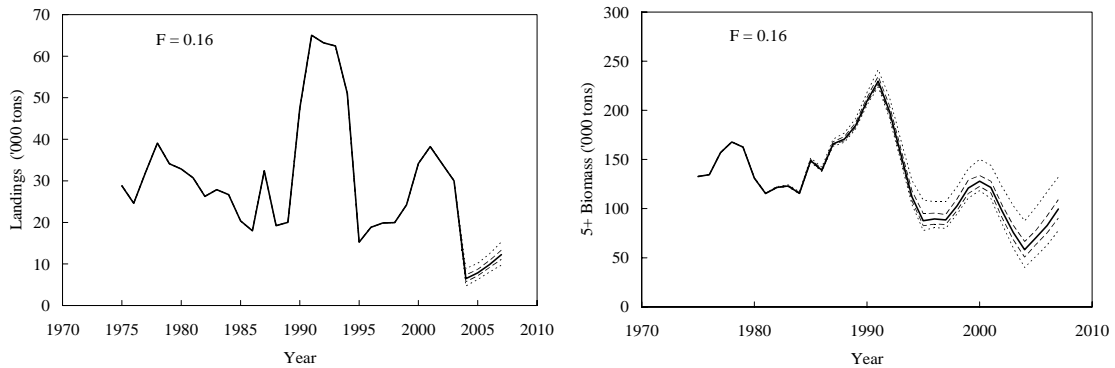
The lower fishing mortality scenarios ($F_{0.1}$, F_{max}) result in a recovery of the exploitable biomass to the previous low level (1995-97) by 2007. Exploitable biomass would remain constant with a *status quo* F (0.44) or constant landings at 20 000 tons but at a new low level. The stochastic projections indicate that there is a high probability that constant landings of 20 000 tons or 30 000 tons will result in high mortality rates that exceed those of the early-1990s.

Special Comments: The Council reiterates its concern that the catches taken from this stock consist mainly of young, immature fish of ages several years less than that at which sexual maturity is achieved.

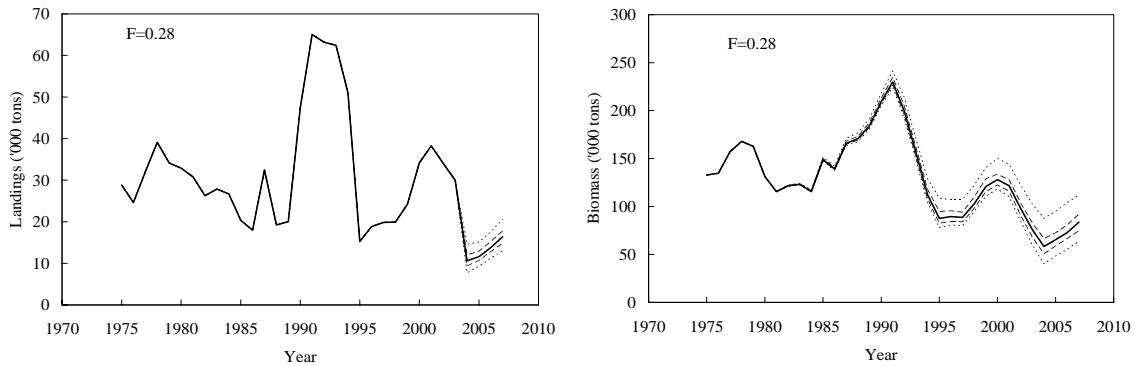
During previous assessments, Scientific Council has noted that fishing effort should be distributed in a similar fashion to biomass distribution in order to ensure sustainability of all spawning components.

It is strongly recommended that Fisheries Commission take steps to ensure that any by-catches of other species during the Greenland halibut fishery are true and unavoidable by-catches.

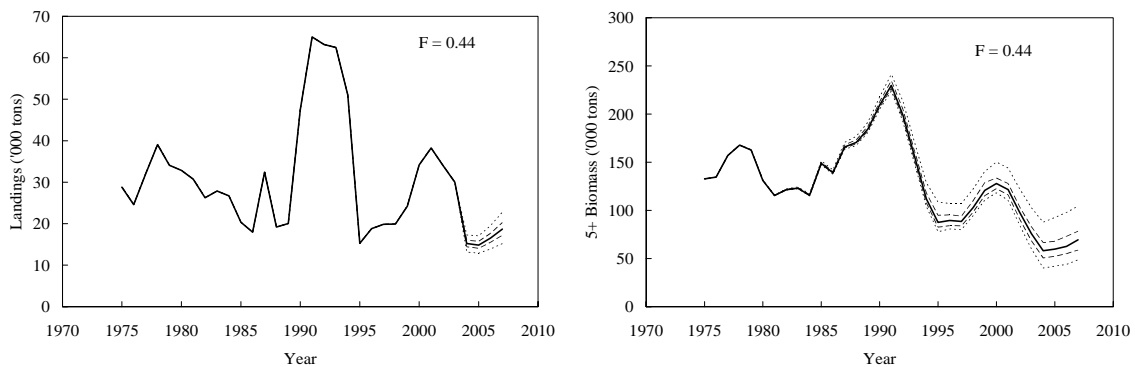
Sources of Information: SCR Doc. 03/8, 9, 24, 36, 40, 42, 51; SCS Doc. 03/6, 7, 11.



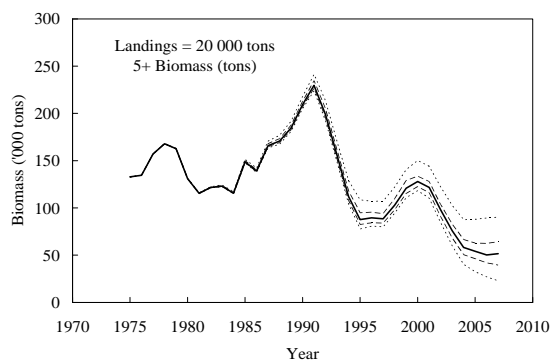
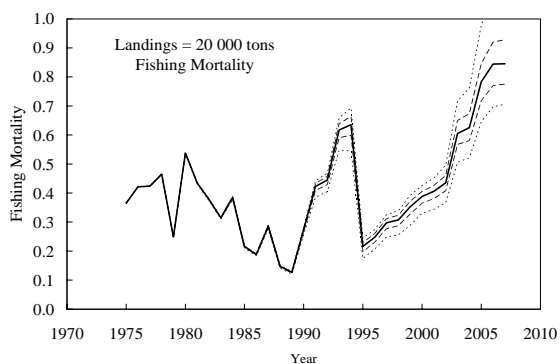
A stochastic projection for Greenland halibut in Subarea 2 and Div. 3KLMNO landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.16$ ($F_{0.1}$) in the years 2004-2007.



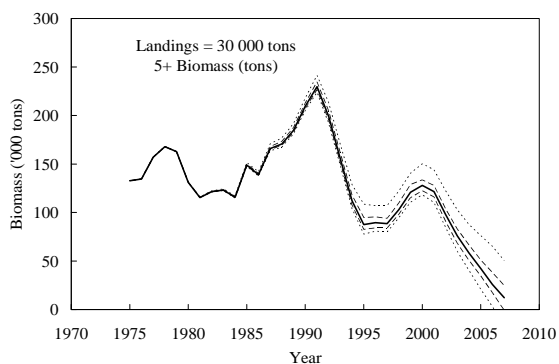
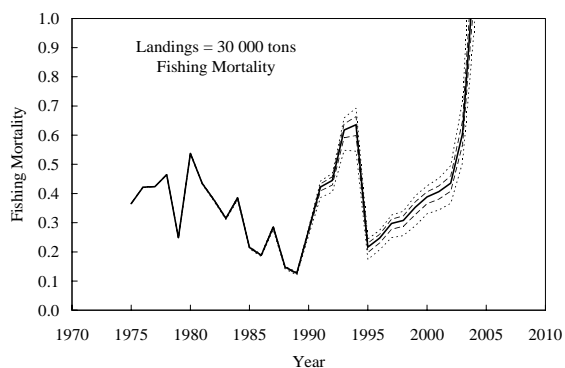
A stochastic projection for Greenland halibut in Subarea 2 and Div. 3KLMNO landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.28$ (F_{max}) in the years 2004-2007.



A stochastic projection for Greenland halibut in Subarea 2 and Div. 3KLMNO landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.44$ ($F_{status\ quo}$) in the years 2004-2007.



A stochastic projection for Greenland halibut in Subarea 2 and Div. 3KLMNO fishing mortality and ages 5+ exploitable biomass at a constant catch of 20 000 tons in the years 2004-2007.



A stochastic projection for Greenland halibut in Subarea 2 and Div. 3KLMNO fishing mortality and ages 5+ exploitable biomass at a constant catch of 30 000 tons in the years 2004-2007.

b) Request for Advice on TACs and Other Management Measures for the Years 2004 and 2005

The Scientific Council at its meeting of September 2000 agreed to consider certain stocks on a multi-year rotational basis. This section presents those stocks for which the Scientific Council provided advice for the years 2004 and 2005. The next assessment of these stocks will be held in 2005.

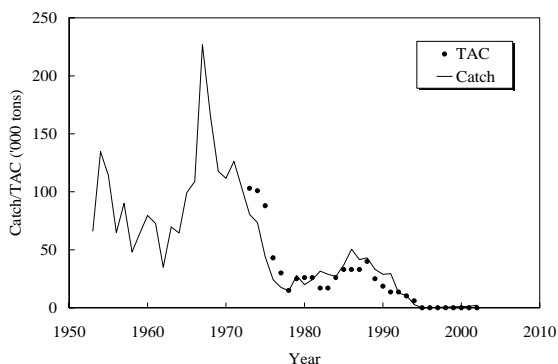
Cod (*Gadus morhua*) in Divisions 3N and 3O

Background: This stock occupies the southern part of the Grand Bank of Newfoundland. Cod are found over the shallower parts of the bank in summer, particularly in the Southeast Shoal area (Div. 3N) and on the slopes of the bank in winter as cooling occurs.

Fishery and Catches: There has been no directed fishery since mid-1994. Catches have increased steadily during this moratorium.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	1.1	0.5 ¹	ndf	ndf
2001	1.3	0.9 ¹	ndf	ndf
2002	2.2	1.2 ¹	ndf	ndf
2003			ndf	ndf

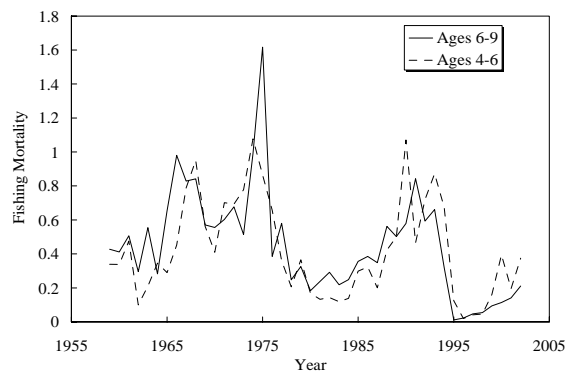
¹ Provisional
ndf No directed fishing.



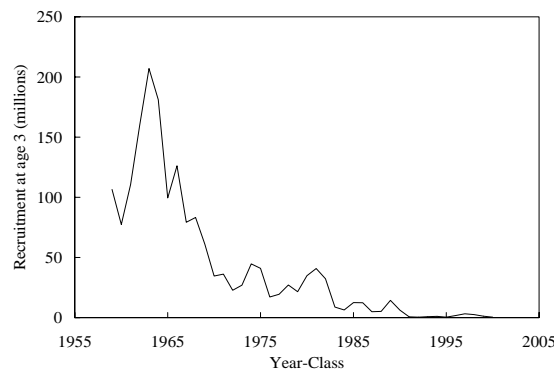
Data: Length and age composition were available from the 2001 and 2002 fisheries to estimate the total removals at age. Canadian spring and autumn survey data provided abundance, biomass and age structure information. Canadian juvenile research survey data were available up to 1994.

Assessment: An analytical assessment was presented to estimate population numbers in 2003.

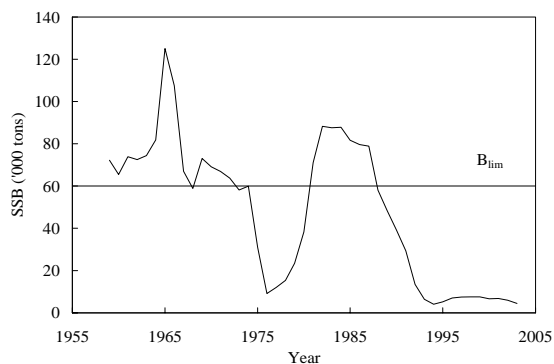
Fishing Mortality: Has increased since the moratorium, particularly on younger fish.



Recruitment: Recent surveys, model estimates of cohort strength and the VPA suggest that all recent year-classes have been at an extremely low level.



Biomass: The 2003 total biomass and spawning biomass are estimated to be at extremely low levels.

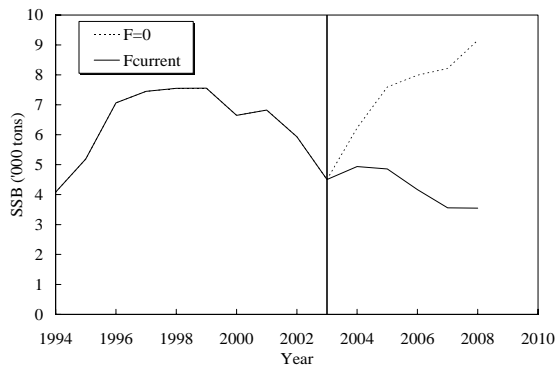


State of the Stock: The stock remains close to its historical low with weak representation from all year-classes.

Recommendation: There should be no directed fishing for cod in Div. 3N and Div. 3O in 2004 and 2005. By-catches of cod should be kept to the lowest possible level and restricted to unavoidable by-catch in fisheries directing for other species. Efforts should be made to reduce current levels of by-catch.

Reference Points: The current best estimate of B_{lim} is 60 000 tons. It was also concluded that in the recent period of low productivity, there is an indication of even further reduction in recruitment at about half the B_{lim} level. The Scientific Council **recommended** that it review in detail the biological reference points in the context of the PA framework when the SSB has reached half the current estimate of B_{lim} .

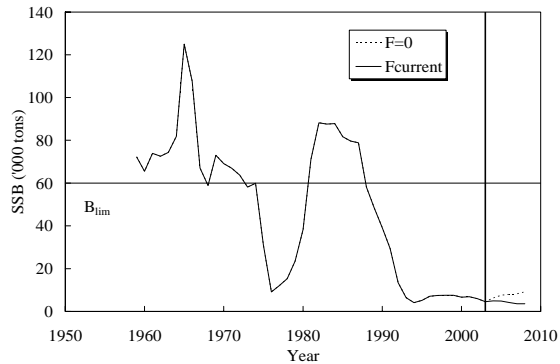
Medium-term considerations: Deterministic projections were conducted to examine stock biomass over the next five years. Projections were limited to five years as extended projections are increasingly driven by recruitment assumptions. Spawner biomass was projected assuming $F = 0$, and under recently observed fishing mortality ($F = 0.32$). Continued fishing at current levels will further deplete the stock. If there is no fishing, spawner biomass is projected to double over the next five years. In the Figure below the upper panel gives the entire time series trajectory of the SSB, and the lower panel highlights trends since 1994.



Special Comments: Scientific Council is concerned that catches of cod have increased substantially since 1995. Fishing mortality is now at levels comparable to those during periods in the past when substantial fisheries existed, even though the stock is currently under moratorium and at a very low SSB.

The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/2, 14, 18, 19, 21, 26, 30, 59; SCS Doc. 03/6, 7, 10, 11, 12.



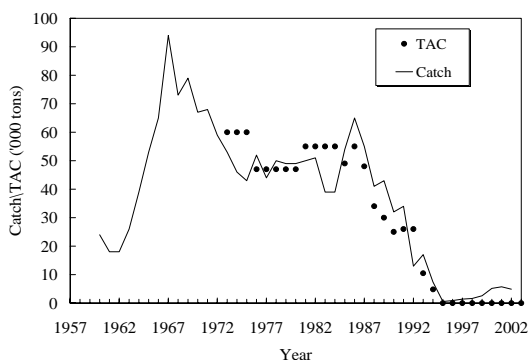
American Plaice (*Hippoglossoides platessoides*) in Divisions 3L, 3N and 3O

Background: Historically, American plaice in Div. 3LNO has comprised the largest flatfish fishery in the Northwest Atlantic.

Fishery and Catches: In most years the majority of the catch has been taken by offshore otter trawlers. There was no directed fishing in 1994 and there has been a moratorium from 1995 to 2003. Even under the moratorium, catches have increased substantially in recent years.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	5.2	2.7 ¹	ndf	ndf
2001	5.7	2.8 ¹	ndf	ndf
2002	4.8	3.1 ¹	ndf	ndf
2003			ndf	ndf

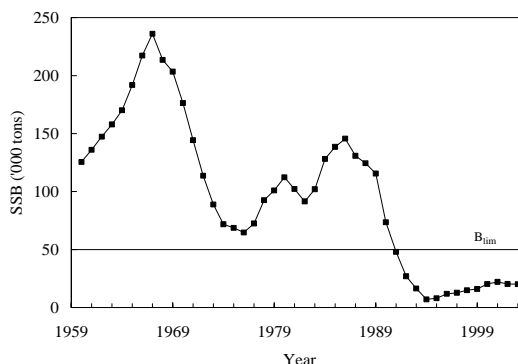
¹ Provisional
ndf No directed fishing.



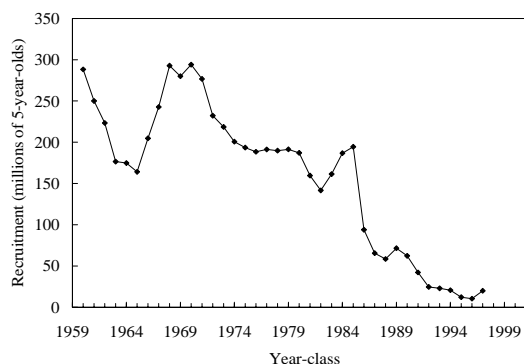
Data: Biomass and abundance data were available from several surveys. Age sampling data from Canadian by-catch as well as length sampling from by-catch from Russia, EU-Spain and EU-Portugal were available.

Assessment: An analytical assessment using the ADAPTive framework tuned to the Canadian spring and autumn surveys was used. Natural mortality was assumed to be 0.2 for all ages, except from 1989 to 1996 it was assumed to be 0.53.

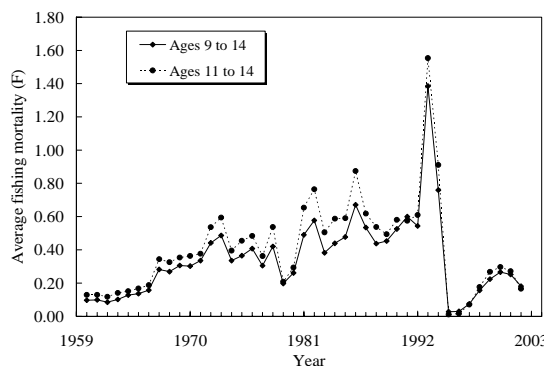
Biomass: Biomass and SSB are very low compared to historic levels. SSB declined to the lowest observed level in 1994 and 1995. It has increased since then, but still remains very low at just over 20 000 tons.



Recruitment: There has been no good recruitment to the exploitable biomass since the mid-1980s.



Fishing mortality: The average fishing mortality on ages 9 to 14 was above 0.2 from 1999-2001 and decreased to 0.18 in 2002.



State of the Stock: The stock remains low compared to historic levels.

Recommendation: There should be no directed fishing on American plaice in Div. 3LNO in 2004 and 2005. By-catches of American plaice should be kept to the lowest possible level and restricted to unavoidable by-catch in fisheries directing for other species. Efforts should be made to reduce current levels of by-catch.

Special Comment: The next assessment will be in 2005.

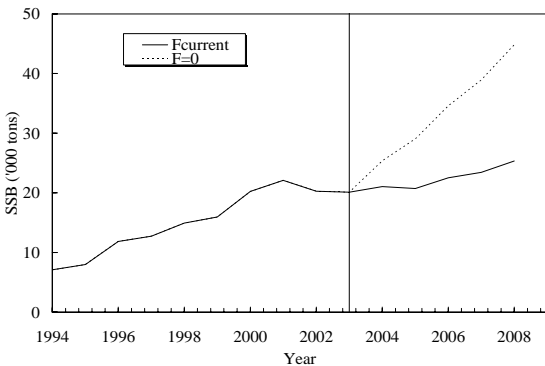
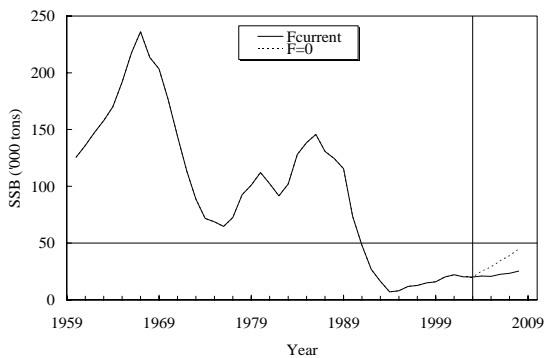
Sources of Information: SCR Doc. 03/, 5, 7, 11, 18, 39, 56; SCS Doc. 03/5, 6, 7, 11.

Reference Points: Good recruitment has not occurred in this stock when SSB has been below 50 000 tons and this is currently the best estimate of B_{lim} .

Medium-term considerations: Deterministic projections were conducted to examine stock biomass over the next 5 years. Projections were limited to 5 years as extended projections are increasingly driven by recruitment assumptions. Spawner biomass was projected assuming $F = 0$ and under recently observed fishing mortality ($F = 0.26$).

The first graph below shows the period of the projection along with the historic trajectory of SSB. The lower panel shows only from 1994 on.

The increase in SSB is projected to be five times greater at $F=0$ than at current F . In neither case does SSB reach the B_{lim} of 50 000 tons by 2008.



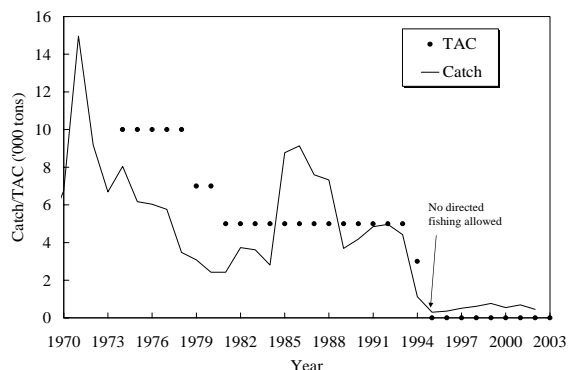
Witch Flounder (*Glyptocephalus cynoglossus*) in Divisions 2J, 3K and 3L

Background: Historically, the stock occurred mainly in Div. 3K although recently the proportion of the stock in Div. 3L is greater. In the past, the stock had been fished mainly in winter and spring on spawning concentrations but is now only a by-catch of other fisheries.

Fishery and Catches: The catches during 1995-99 ranged between 300-1 400 tons including unreported catches. The 2002 catch was about 450 tons.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	0.7	0.5 ¹	ndf	ndf
2001	0.8	0.6 ¹	ndf	ndf
2002	0.4	0.7 ¹	ndf	ndf
2003			ndf	ndf

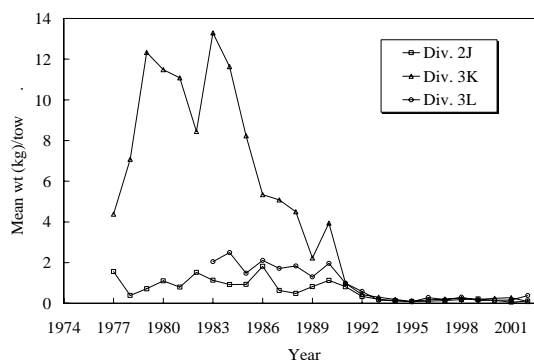
¹ Provisional and includes estimates from Div. 3M from 1998 onwards.
ndf No directed fishing.



Data: Abundance and biomass data, as well as mean numbers and weights (kg) per tow, were available from Canadian autumn surveys during 1978-2002. Age based data have not been available since 1993 and none are anticipated in the near future.

Assessment: No analytical assessment was possible.

Biomass: Survey mean weights (kg) per tow showed a rapid downward trend since the mid-1980s and since 1995 have remained at an extremely low level.



Recruitment: No information was available to this meeting.

State of the Stock: Stock remains at a very low level.

Recommendation: No directed fishing on witch flounder in the years 2004 and 2005 in Div. 2J, 3K and 3L to allow for stock rebuilding. By-catches of witch flounder in fisheries targeting other species should be kept at the lowest possible level.

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

Special Comments: The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/47; SCS Doc. 03/6, 7, 11.

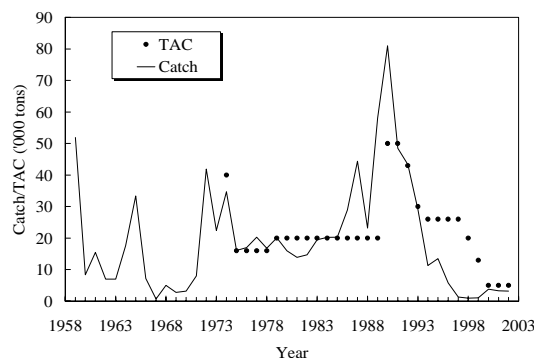
Redfish (*Sebastes spp.*) in Division 3M

Background: There are 3 species of redfish, which are commercially fished on Flemish Cap: deep-water redfish (*Sebastes mentella*), golden redfish (*Sebastes marinus*) and Acadian redfish (*Sebastes fasciatus*). The present assessment evaluates the status of the Div. 3M beaked redfish stock, regarded as a management unit composed of two populations from two very similar species (*Sebastes mentella* and *Sebastes fasciatus*). The reason for this approach is that evidence indicates this is by far the dominant redfish group on Flemish Cap.

Fishery and Catches: The redfish fishery in Div. 3M increased from 20 000 tons in 1985 to 81 000 tons in 1990, falling continuously since then until 1998-99, when a minimum catch around 1 100 tons was recorded mostly as by-catch of the Greenland halibut fishery. This decline was related with the simultaneous quick decline of the stock biomass and fishing effort. There was an overall increase of the redfish catches to 3 800 tons in 2000. In 2001-02 provisional catch is somewhat lower at around 3 000 tons with the directed fishery primarily prosecuted by EU (Portugal) and Russia. The start in 1993 and further development of a shrimp fishery on Flemish Cap led to high levels of redfish by-catch in 1993-1994. Since 1995 this by-catch in weight fell to apparent low levels but in 2001-02 redfish by-catch was at 750 tons, the highest level observed since 1994. Translated to numbers this represents an increase from the recent by-catch level of 3.4 million redfish (1999-2000) to 22.1 millions in 2001-02, representing 71% of the total 2001-02 catch in numbers.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	3.7	3.8 ¹	3-5	5
2001	3.2	3.2 ¹	3-5	3-5
2002	2.9	3.0 ¹	3-5	3-5
2003			3-5	3-5

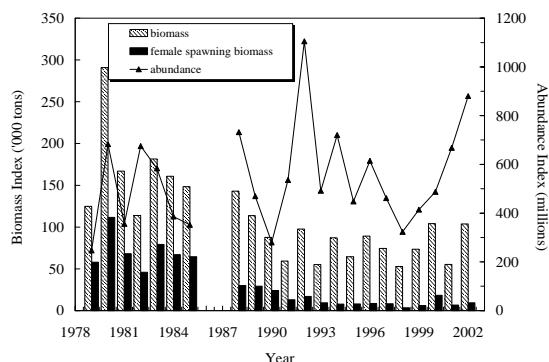
¹ Provisional



Data: Catch-at-age data were available from 1989-2002 including by-catch information from the shrimp fishery. Catch-rate data for 1959-93 were available from the NAFO database.

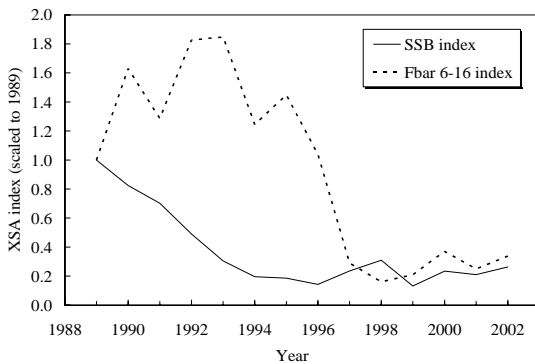
There are three survey series providing bottom biomass indices as well as length and age data for the Flemish Cap redfish stocks; Russia (1983-93, 1995-96 and 2001-02), EU (1988-2002) and Canada (1979-85 and 1996). The Russian survey was complemented with an acoustic estimate of the redfish pelagic component for the 1988-92 period.

Assessment: Survey bottom biomass and female spawning biomass were calculated from 1979-85 Canadian and 1988-2002 EU surveys.

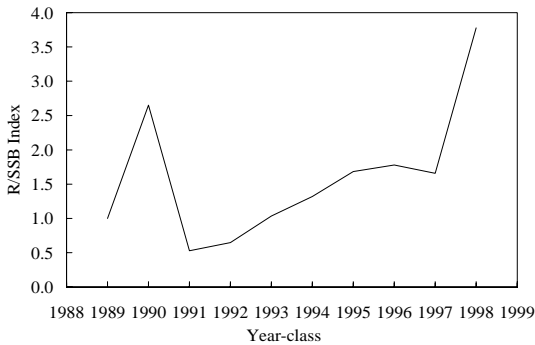


A virtual population analysis (XSA) and a surplus production analysis (ASPIC) were carried out for 1989-2002, providing indicators of stock biomass, female spawning biomass and fishing mortality trends.

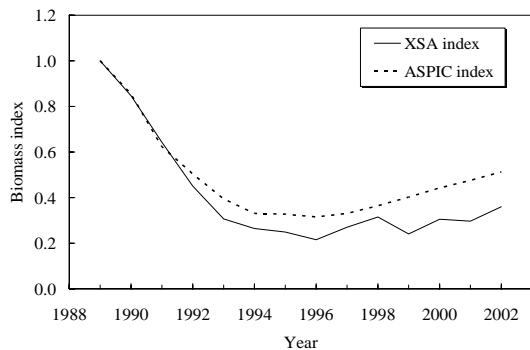
Fishing Mortality: Fishing mortality was at very high levels until 1995 and then dropped to relatively very low levels since 1997.



Recruitment: The recruits per SSB have increased through the 1990s, compensating for the SSB decline. Based on XSA, the 1998 year-class is relatively abundant.



Biomass: The Div. 3M beaked redfish stock experienced a steep decline from the second half of the 1980s until 1996. Since 1997 fishing mortality was relatively low, allowing the survival and growth of the population. Despite recent fluctuations, biomass and female spawning biomass appear to have increased marginally since 1997 but are still well below the SSB that produced the 1990 year-class.



State of the Stock: Scientific Council concluded that while the decline in stock biomass appears to have halted, it is still unclear as to whether there has been any actual increase. The total stock and spawning stock are currently at a low level compared to the earlier period in the time series. At the low fishing mortalities of the most recent years, with growth of the relatively strong 1990 year-class followed by the promising 1998 year-class, spawning biomass should gradually increase.

Recommendation: Scientific Council was unable to advise on a specific TAC for 2004 and 2005. However, in order to maintain relatively low fishing mortalities so as to promote stock recovery, Scientific Council recommends that catch for Div. 3M redfish in year 2004 and 2005 be in the range of 3 000-5 000 tons.

Reference Points: No updated information on biological reference points was available.

Special Comments: At present, stock growth in biomass and in abundance is dependent upon the appearance and survival of cohorts past their early life stage so that they recruit to the SSB and commercial fishery. Scientific Council is extremely concerned about sharp increases of by-catch of small redfish taken in the shrimp fishery in 2001-2002 (750 tons). Scientific Council considers that it is important to keep the by-catch of this very small redfish to a minimum.

The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/9, 25, 42, 45; SCS Doc. 03/06 (Part 2), 7, 11.

Redfish (*Sebastes spp.*) in Divisions 3L and 3N

Background: There are two species of redfish, *Sebastes mentella* and *Sebastes fasciatus*, which occur in Div. 3LN and are managed together. These are very similar in appearance and are reported collectively as redfish in statistics. The relationship to adjacent NAFO Divisions, in particular to Div. 3O, is unclear and further investigations are necessary to clarify the integrity of the Div. 3LN management unit.

Fishery and Catches: The average reported catch of redfish in Div. 3LN from 1959 to 1985 was about 22 000 tons, ranging between 10 000 tons and 45 000 tons. Catches increased sharply from about 21 000 tons in 1985, peaked at an historical high of 79 000 tons in 1987 then declined steadily to about 600 tons in 1996. Catch increased to 850 tons in 1998, the first year under a moratorium on directed fishing, with a further increase to 2 300 tons in 1999 and a decline to 1 200 tons in 2002. Catches since 1998 were taken as by-catch primarily in Greenland halibut fisheries by EU-Portugal, EU-Spain and Russia. A portion of the catches, in some years substantial, have been taken by non-Contracting Parties from 1987 to 1994. These countries have not fished in Div. 3LN since 1994.

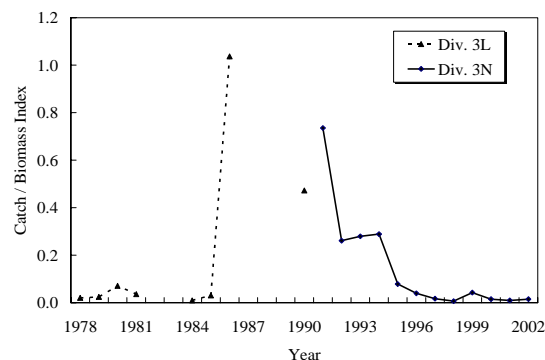
	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	1.7	1.5 ¹	ndf	0
2001	1.4	0.9 ¹	ndf	0
2002	1.2	1 ¹	ndf	0
2003			ndf	0

¹ Provisional
ndf No directed fishing

Data: Bottom trawl surveys conducted by USSR/Russia from 1984 to 1994, and by Canada from 1978 to 2002 are the basis for the assessment of stock status.

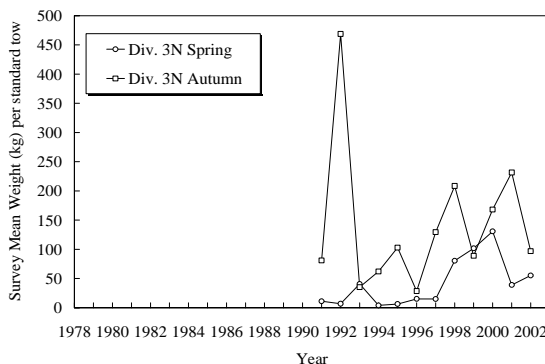
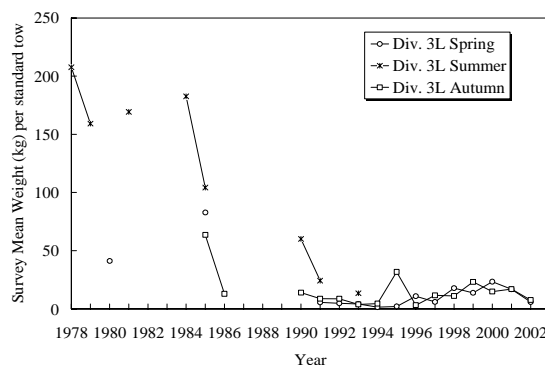
Assessment: No analytical assessment was possible.

Fishing Mortality: Reduced from relatively high levels in 1991-1992 and has been relatively low since 1995 in both Div. 3L and Div. 3N.



Recruitment: No sign of good recruitment since the 1986 and 1987 year-classes.

Biomass: Estimates from recent surveys are considerably lower than those from the 1980s indicating a reduced and low stock size in Div. 3L.



State of the Stock: Based on the available data, the stock appears to be at a very low level. There are indications of some increases in the stock since 1996 due to growth in weight of the relatively strong 1986-87 year-classes and possibly through some immigration of fish from Div. 3O to Div. 3N.

Recommendation: No directed fishing for redfish in Div. 3LN in years 2004 and 2005, and by-catches of redfish in fisheries targeting other species should be kept at the lowest possible level.

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

Special Comments: The most recent relatively good year-classes, those of 1986-87, are recruiting to the SSB. These same year-classes will make up the greatest proportion of the SSB until at least 2010.

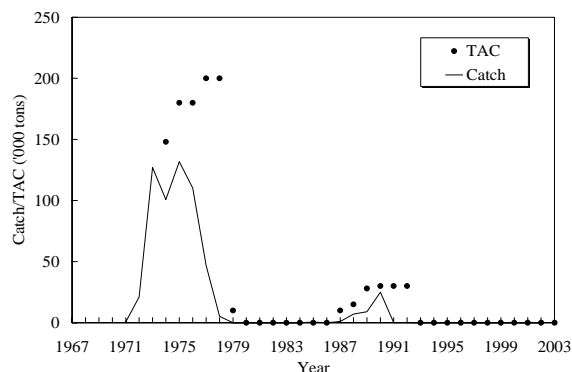
The continuing uncertainties regarding the relationship between redfish in Div. 3LN and Div. 3O have important impacts on interpretation of available data.

The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/55, 60; SCS Doc. 01/6, 7, 11.

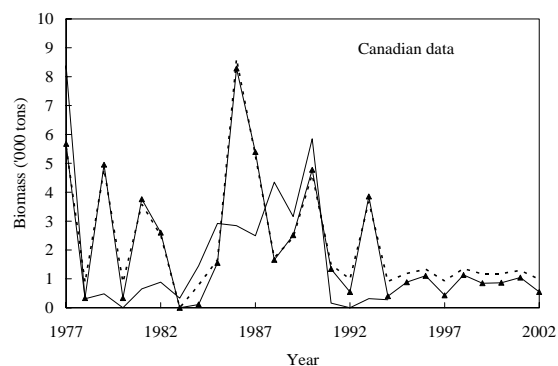
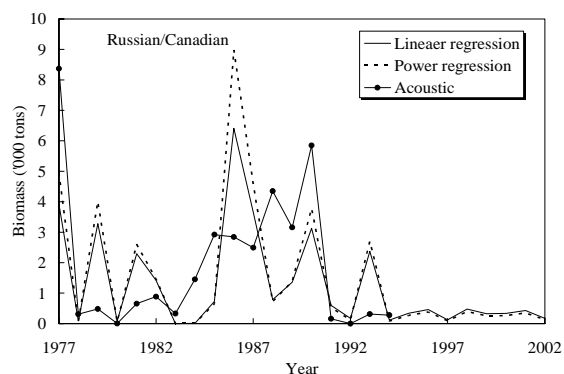
Capelin (Mallotus villosus) in Divisions 3N and 3O

Fishery and catches: There has not been a directed fishery since 1993 when a moratorium was established, and no commercial catches have been reported since then.



Data: Capelin catches from Canadian bottom trawl surveys conducted in 1977-2002, as well as historical data sets from Russian and Canadian trawl acoustic surveys directed to capelin.

Assessment: The only indicator of stock dynamics presently available may be capelin biomass indices obtained during Canadian stratified-random bottom trawl surveys. Trawlable biomass of capelin in Div. 3LNO and 3NO for 1977-2002 was converted into absolute values on the basis of the relationship between trawl and acoustic estimates of capelin stock in Div. 3LNO in spring 1977-1994. Assuming the existence of a correlation between biomass estimates derived by the acoustic and the trawl methods, it was concluded that in 1990-1994, both the calculated and the trawlable biomass of capelin in Div. 3LNO fluctuated within a wide range. Since 1995, capelin biomass has remained at a low level compare to late-1980s.



Recommendation: Scientific Council recommends no directed fishery on capelin in Div. 3NO in 2004-2005.

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

Special Comments: Scientific Council noted that NAFO recognizes the role that capelin play in the Northwest Atlantic ecosystem as a very important prey species for fish, marine mammals and seabirds.

Historically, the spawning biomass was determined through the use of hydroacoustics.

It is not clear how precise the capelin indices from the bottom trawl surveys reflect the real stock distribution and stock status.

The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/37.

c) **Special Requests for Management Advice** (see Annex 1 Items 3-9)

i) **Redfish in Division 3O** (see Item 3)

The Fisheries Commission with the concurrence of the Coastal State requested the Scientific Council, at a meeting in advance of the 2003 Annual Meeting to: *provide advice on the scientific basis for the management of redfish in Div. 3O including recommendations regarding the most appropriate TAC for 2004 and 2005. This stock will be assessed in alternate years thereafter.*

Redfish (*Sebastes spp.*) in Division 3O

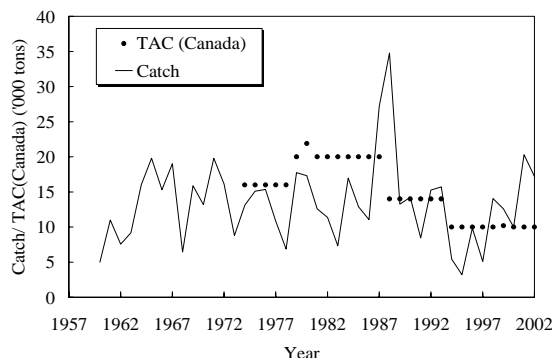
Background: There are two species of redfish, *Sebastes mentella* and *Sebastes fasciatus*, which occur in Div. 3O. These are very similar in appearance and are reported collectively as redfish in statistics. The relationship to adjacent NAFO Divisions, in particular to Div. 3LN, is unclear and further investigations are necessary to clarify the relationship between redfish in Div. 3O and Div. 3LN.

Fishery and Catches: Catches have ranged between 3 000 tons and 35 000 tons since 1960. Up to 1986 catches averaged 13 000 tons, increased to 27 000 tons in 1987 with a further increase to 35 000 tons in 1988. Catches declined to about 16 000 tons in 1993 and declined further to about 3 000 tons in 1995, partly due to reductions in non-Canadian allocations within the Canadian zone since 1993. Catches increased to 14 000 tons by 1998, declined to 10 000 tons in 2000 and increased to 20 000 in 2001. The 2002 catch was at 17 000 tons.

Russia predominated in this fishery up until 1993 but ceased directed fishing in 1994 because of reductions in non-Canadian allocations within the Canadian zone. Russia resumed directed fishing in the NRA in 2000 rapidly increasing their catch from 2 200 tons to about 11 000 tons in 2001 and 2002. EU-Portugal began fishing in 1992 and averaged about 1 800 tons between 1992 to 1998. Catches escalated to 5 500 tons in 1999 and have averaged about 4 200 tons to 2002. EU-Spain, who had taken less than 50 tons before 1995, increased catches from 1 200 tons in 1997 to a peak of 4 500 tons in 1999 with a subsequent decline to 700 tons in 2002. Between 1996 and 2002 Canadian catches have fluctuated between levels of about 9 000 tons and 2 500 tons.

Year	Catch ('000 tons)	
	STACFIS	21A
2000	10	13 ¹
2001	20	22 ¹
2002	17	19 ¹
2003		

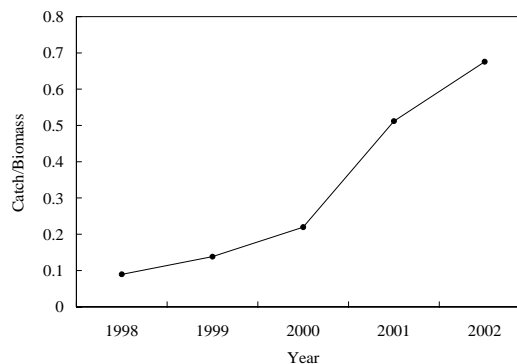
¹ Provisional



Data: Data from bottom trawl surveys conducted by USSR/Russia from 1983 to 1993, and by Canada from 1991 to 2002 are the basis for the assessment of stock status.

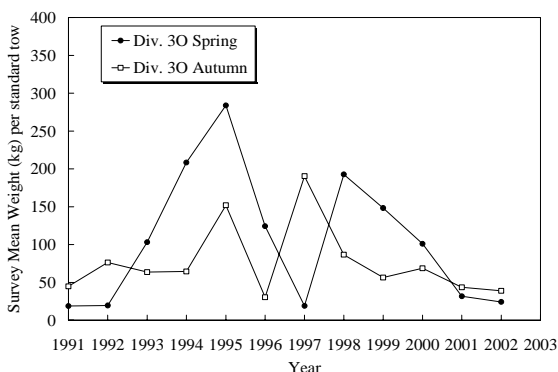
Assessment: No analytical assessment was possible.

Fishing Mortality: Likely increased in 2001 and 2002.



Recruitment: No sign of good recruitment since the 1988 year-class.

Biomass: There has been no increase in survey biomass indices the last few years.



State of the Stock: Surveys indicate no overall trend in stock size in the last decade.

Recommendation: Scientific Council is unable to advise on a specific TAC for 2004 and 2005. The Scientific Council noted there is insufficient information on which to base predictions of annual yield potential for this resource. Stock dynamics and recruitment patterns are also poorly understood. Catches have averaged about 13 000 tons since 1960 and over the long term, catches at this level do not appear to have been detrimental.

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

Special Comments: Given that the bulk of the catches in recent years are comprised of fish less than 25cm, these fisheries are targeting predominantly immature fish.

The continuing uncertainties regarding the relationship between redfish in Div. 3LN and Div. 3O have important impacts on interpretation of available data.

The next assessment will be in 2005.

Sources of Information: SCR Doc. 03/12, 26, 60, 63; SCS Doc. 03/6, 7, 11.

ii) **Formulation of advice under the Precautionary Approach** (Items 5 and 6)

The Fisheries Commission noting the progress made by the Scientific Council on the development of a framework for the implementation of the Precautionary Approach requested the Scientific Council, at a meeting in advance of the 2003 Annual Meeting to: *provide certain information on, and to take into account some elements, when considering the Precautionary Approach (see Annex 1 Item 5 and 6 for details).*

The Council addressed this topic under the Agenda Item on the Implementation of Precautionary Approach, as reported below under Section XII Item 1a) and b).

iii) **Pelagic *S. mentella* (redfish) in Subareas 1-3 and adjacent ICES area** (Item 8)

Scientific Council was requested by the Fisheries Commission to: *review the most recent information on the distribution of this resource, as well as on the affinity of this stock to the pelagic redfish resource found in the ICES Sub-area XII, parts of SA Va and XIV and to the shelf stocks of redfish found in ICES Sub-areas V, VI and XIV, and NAFO Subareas 1-3*(Annex 1 Item 8).

The Council responded as follows:

Scientific Council was provided a report on the deliberations of the ICES North-Western Working Group (NWWG) meeting that took place from 29 April to 8 May 2003.

Scientific Council noted that there was no trawl-acoustic survey carried out in 2002. The NWWG reported that the fishery for oceanic *S. mentella* in ICES Subareas Va, XII, and XIV and in NAFO Div. 1F, 2H and 2J has shown a persistent seasonal pattern in terms of geographical and depth distribution for the past five years. The main fishing occurs in the second and third quarters of the year. In the second quarter, the fishery takes place in the area east of 32°W and north of 61°N at depths deeper than 500 m. In the third quarter, the fleet moves towards the southwest to ICES Subarea XII and NAFO Convention Area and the depth of the hauls are in waters shallower than 500 m. There has traditionally been very little fishing activity from November until late March, and in 2002 no activity was reported during that time. The size of the fish caught in the southwest areas in the third quarter of the year is smaller than the fish caught in the northwest area in the second quarter. Based on the distribution of the fishery information it was concluded that the fishing pattern in 2002 was similar as it was in the past five years.

Scientific Council noted that the NWWG concluded that there are still uncertainties in the stock structure of *S. mentella* in ICES Sub-areas V, XII and XIV and NAFO Convention Area. However, all information suggests that the fishery in the NAFO Convention Area is on the same stock as fished in western part of ICES Sub-area XII. The Scientific Council agreed with this evaluation. Scientific Council noted there was new information presented to the NWWG regarding results of different methods that were used to investigate the issue of stock structure. The NWWG considered that as its primary functions as an assessment working group, it did not have sufficient expertise to thoroughly review the scientific research on redfish stock identification. The NWWG recommended that a separate group be formed with the appropriate expertise that would review existing and future scientific material.

Scientific Council noted that the issue of possible relationships between pelagic *S. mentella* and demersal *S. mentella* in the NAFO area has not been considered by the NWWG.

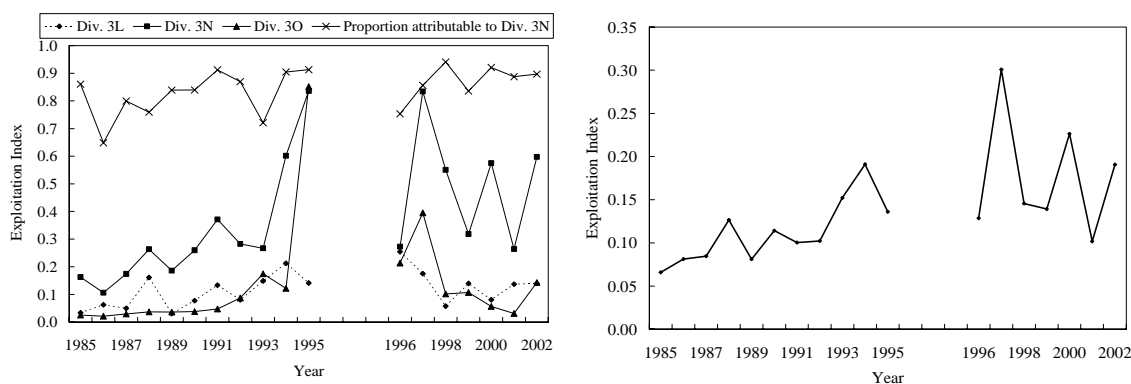
iv) **Information on thorny skates in Div. 3LNO** (Item 9)

The Fisheries Commission with the concurrence of the Coastal State requested Scientific Council, at a meeting in advance of the 2003 Annual Meeting, to provide the following with respect to thorny skate in Div. 3LNO.

Scientific Council responded to each request as follows (review documents: SCR Docs. 03/57, 39, 02/011, 118, 121, 01/78; SCS Docs. 03/6, 7 and 11):

- a) *Information on exploitation rates in recent years, as well as information on by-catches of other groundfish in the 3LNO skate fishery.*

Catches used for the index of exploitation (commercial catch/spring survey biomass index) were derived from Zonal Interchange Format (ZIF) for Canada and STATLANT21A and Canadian surveillance estimates for other countries. The index of exploitation or relative F for thorny skate increased from 0.07 in the mid-1980s fluctuating around 0.18 in 1996-2002. The increasing index is concurrent with the period of stock decline. The index varied among areas; highest was in Div. 3N corresponding to the majority of the skate fishery in the NRA. The Div. 3N index increased from about 0.2 in the early-1980s, fluctuating around 0.5 after 1995. About 80% of the commercial catch was from Div. 3N in the 1980s, increasing to about 90% in the 1990s. The following graphs show the index of exploitation in each Division and the proportion attributable to Div. 3N (left panel) and the index over all areas (right panel).



By-catch reported by EU-Spain in the Div. 3NO skate fishery diminished with time. By-catch consisted mainly of American plaice, yellowtail flounder and cod (see Table below). Considerably higher by-catch rates were reported by EU-Portugal, totaling about 79% for all species combined in a Div. 3NO fishery. Dominant by-catch species (proportions not specified for the entire year) were Greenland halibut, American plaice and white hake although in certain months, American plaice and cod were each reported to exceed 20%. Reported by-catch in the Russian directed fishery in Div. 3NO amounted to 12%, mainly yellowtail flounder (5%), American plaice (4%) and cod (3%). By-catch in the Canadian fishery, further to the west in Div. 3O was 16%, comprising mainly monkfish and Atlantic halibut with very little cod and plaice and no yellowtail flounder.

Reported by-catch in fishery by country and year.

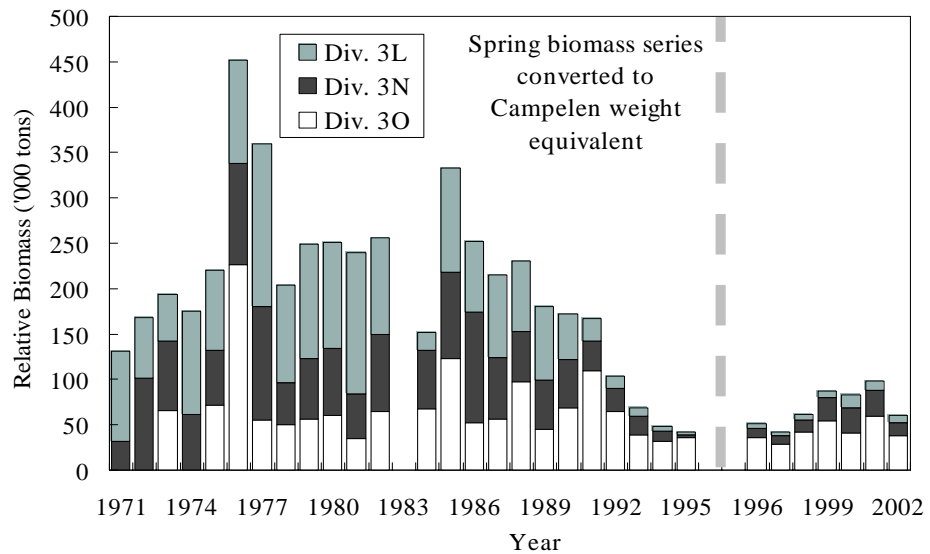
Country	Area	Year	Percent by-catch of			
			All species	Yellowtail	Am. Plaice	Atl. Cod
Canada	3O	2002	16.0	0.0	1.0	0.3
Portugal	3NO	2002	79.0			
Spain	3NO	1998	22.5	6.7	14.1	0.6
		2000	18.5	5.7	11.9	0.6
		2001	21.0	6.0	13.8	0.7
		2002	8.8	1.5	5.4	0.7
Russia	3NO	2000			3.1	
		2002	12.0	5.0	4.0	3.0

The above statistics are summarized reported values. The areas of required research (see section g below) indicate the need to collect and analyze commercial set-by-set geo-referenced data in order to adequately address the second part of this request.

- b) *Information on abundance indices and the distribution of the stock in relation to groundfish resources, particularly for the stocks which are under moratorium.*

The spring relative abundance of thorny skate in Div. 3LNO mirrored biomass trends (see Fig. below). The indices increased between the early-1970s and the mid-1980s then declined rapidly between 1985 and 1994.

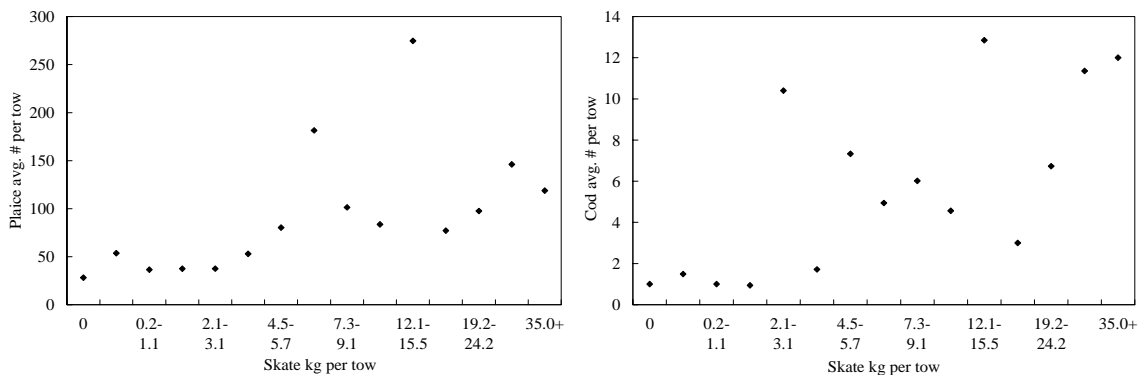
Relative biomass based on Canadian spring research surveys. There was no survey in 1983:



Most of the decline occurred on the northern part of the Grand Bank in Div. 3L and northern Div. 3O. Biomass has remained low since 1994 and the trend has remained relatively flat.

Based on 2001-2002 autumn survey data in Div. 3LNO, corresponding to the season of the directed fishery, areas of high abundance of American plaice and cod corresponded to mid- and high-range abundance of thorny skate (see following figure).

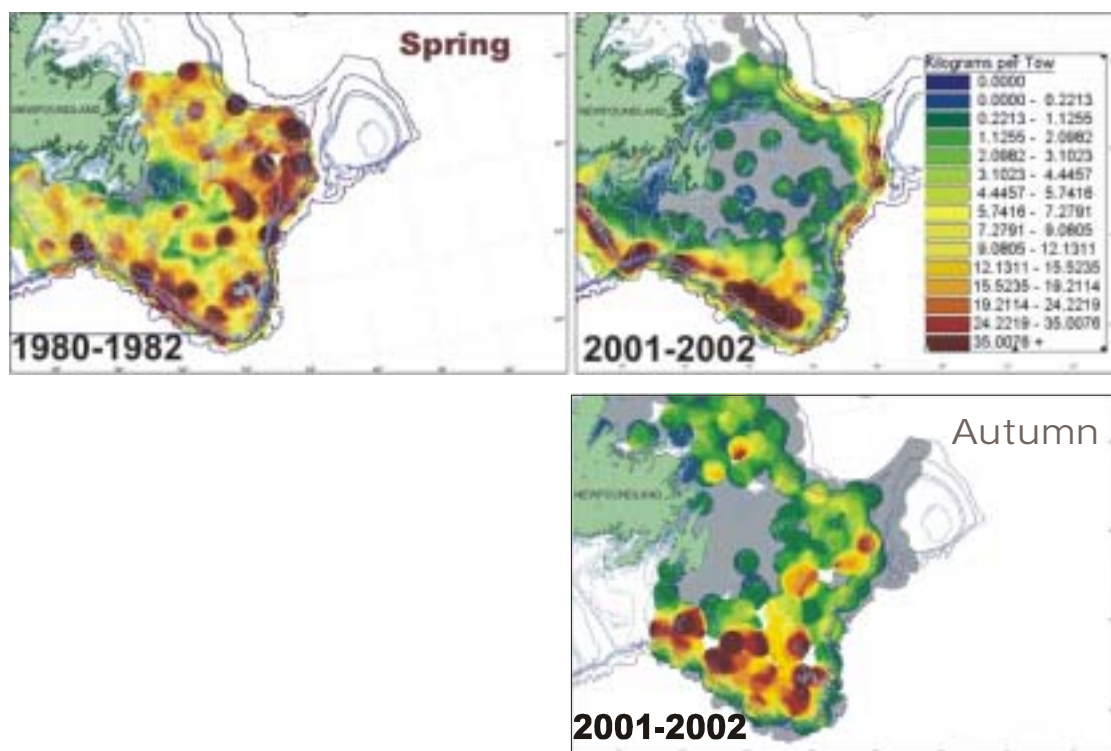
Spatial relationship between the abundance of thorny skate in relation to the abundance of American plaice and cod based on 2001-2002 autumn survey data.



- c) *Information on the distribution of thorny skate in Divisions 3LNO, as well as a description of the relative distribution inside and outside the NAFO Regulatory Area (NRA).*

Thorny skate on the Grand Bank undergo a seasonal migration, concentrating toward the bank edge from December to June and onto the bank in the other months. Also, the distribution of thorny skate on the Grand Bank has undergone significant changes over time. In the early-1980s, they were widely distributed over the entire Grand Banks in moderate to high concentrations (see distribution maps below). In the recent period (2000-2001), corresponding to where bottom temperatures are the coldest, much of the northern Grand Bank had no thorny skate.

Distribution in 1980-82 compared to 2000-2001 based on Canadian spring surveys. Grey indicates areas where no skate were caught. Brown represents highest catch rates.



The remaining biomass has become increasingly concentrated (hyper-aggregated) on the southwestern part of the Grand Bank. Although the biomass has been stable since the mid-1990s, the distribution has continued to hyper-aggregate. Areas fished correspond to where the skate are aggregating and thus commercial catch rates have remained high during the period of decline.

Based on spring and autumn Canadian survey data from Div. 3LNO in 1995-2002, 26.4% and 22.5% of the biomass of thorny skate was found in the NRA in autumn and spring respectively, mainly in Div. 3N.

Percent of biomass inside and outside of 200 miles is shown in table below. Coverage was incomplete for the spring of 1995. Data were not available for autumn 2002:

	Autumn Percent		Spring Percent	
	OUTSIDE	INSIDE	OUTSIDE	INSIDE
1995	28.0%	72.0%		
1996	26.2%	73.8%	14.0%	86.0%
1997	23.2%	76.8%	14.5%	85.5%
1998	25.3%	74.7%	19.9%	80.1%
1999	20.1%	79.9%	20.4%	79.6%
2000	35.5%	64.5%	28.1%	71.9%
2001	24.5%	75.5%	31.8%	68.2%
2002			30.5%	69.5%
AVERAGE	26.4%	73.6%	22.5%	77.5%

- d) *Advice on reference points and conservation measures that would allow for exploitation of this resource in a precautionary manner.*

Although reference points are not available for thorny skate, their life history characteristics suggest that a conservative approach to their management is appropriate. Thorny skate has late sexual maturation, low fecundity and long reproductive cycles. These characteristics result in low intrinsic rates of increase and are thought to have very low resilience to fishing mortality. Although elasmobranchs are not as fecund as most teleosts, it does not immediately follow that they have lower reproductive capacity because newly hatched skate have a much higher survival probability. Abundance of thorny skate on the Grand Banks is at its lowest historic level. Thus, even if environmental conditions were favorable and fishing pressure was low, recovery would be a much longer process than for more fecund species.

- e) *Information on annual yield potential for this stock in the context of (d) above.*

There is insufficient information at this time on which to base predictions of annual yield potentials.

- f) *Identification and delineation of fishery areas and exclusion zones where fishing would not be permitted, with the aim of reducing the impact on the groundfish stocks which are under moratoria, particularly juveniles.*

Cod and American plaice juvenile distributions are associated with the Southeast Shoal and area to the west but are variable with some degree of overlap with the thorny skate fishing grounds. An area closed to fishing intended to protect juvenile cod would constitute a significant portion of the northern extent of the thorny skate fishing grounds while one intended to protect American plaice would overlap with the southern portion of the grounds. If data from fisheries can verify that there is low capture of juveniles, exclusion zone(s) would not necessarily be beneficial.

- g) *Determination of the appropriate level of research that would be required to monitor the status of this resource on an ongoing basis with the aim of providing catch options that could be used in the context of management by Total Allowable Catch (TAC).*

The following areas of research would be required to facilitate monitoring the status of thorny skate and providing management advice:

- Recent work on maturity has permitted the examination of life stage dis-aggregated trends such as SSB/recruitment relationships. Derivation of exploitation indices series

for various life stage components, particularly the SSB, can provide some of the input required to derive reference points and conservation limits.

- Age based analyses of the population would yield more options in terms of providing management advice for the stock. Thorny skates have not previously been aged but thorns and vertebrae may provide the best materials for aging.
- Spatial dynamics of various population components should be examined in relation to environmental and fishery related influences to better understand the factors that affect the population status.
- Thorny skate extend over a wide area. Research is required to determine stock structure of the species.
- Fishing mortality and its effects on the population are not well understood. Continued and enhanced collection of information on size, sex and maturity of commercial catches of thorny skate is required to define the effects of fishing on the population.
- Analysis of detailed, geo-referenced commercial fishery data for NAFO Div. 3NO corresponding to the directed skate fishery in the NRA is required to quantify by-catch levels and to spatially define species interactions.
- Information on annual yield potential and reproductive potential is required to provide quantitative fisheries management advice.
- The application of assessment models that may allow Scientific Council to provide quantitative fisheries management advice for this stock should be examined.

h) *Information on the size composition in the current catches and comment on these sizes in relation to the size at sexual maturity.*

Minimum and maximum size and percent mature thorny skate in the commercial fisheries varied by year and country. Table shows size of thorny skate, proportion mature in the commercial trawl catches in Div. 3NO and size of codend mesh used.

Country	Area (Div.)	Year	Size Range (cm)	Percent mature	Codend Mesh Size (mm)
Canada	3O	1995-2002	27-99	20	300
Portugal	3NO	2002	18-61	1	
Spain	3NO	1997	13-91	34	220
		1999	28-91	42	220
		2000	25-91	46	220
		2001	25-91	49	220
		2002	30-96	53	280
Russia	3NO	2000	20-72	4	
		2001	27-90	50	280
		2002	30-102		280

Median size-at-maturity used to determine proportion of mature fish in the catches was 54 cm based on ogives developed by EU-Spain. Canada fished for thorny skate in the western part of Div. 3O while the other countries fished primarily in Div. 3N and to a lesser extent in Div. 3O.

d) **Monitoring of Stocks for which Multi-year Advice was Provided in 2002**

The Scientific Council in 2002 provided 2-year advice (for 2003 and 2004) for five stocks (cod in Div. 3M; American plaice in Div. 3M; witch flounder in Div. 3NO; yellowtail flounder in Div. 3LNO; and northern shortfin squid in Subareas 3 and 4). The Scientific Council reviewed the status of these five stocks at this meeting of June 2003, and found no significant change in status for any of the stocks. Therefore, the Scientific Council has not provided updated/revised advice for 2004 for these stocks. The next Scientific Council assessment of these stocks will be in 2004.

2. **Coastal States**

a) **Request by Canada for Advice** (Annex 2)

The Scientific Council was requested by the Coastal State Canada to *provide advice on stock distribution for Greenland halibut in Subareas 0-3 and recent trends for cod in Div. 2J3KL.*

This section provides the Scientific Council responses.

i) **Greenland halibut in Subareas 2 and 3** (Annex 2 Item 1)

Canada, in the request for advice from Scientific Council for 2003, included a specific request as follows: *Scientific Council has, in the past, advised that fishing effort for Greenland halibut in SA2 + 3KLMNO should be distributed in relation to biomass. Scientific Council is requested to comment on:*

- a) *the current distribution of the resource between SA2 + 3K and 3LMNO and comment on how this compares with the current distribution of quota allocation; and*
- b) *the appropriate distribution of quota allocation if it was based on the distribution of biomass.*

The Scientific Council responded:

- a) Canadian research survey data covering depths to 1 500 m suggest reasonable stability in the proportion of biomass in SA2+Div. 3K and Div. 3LMNO, ranging between 75% and 84% in SA2+Div. 3K, and averaging about 80% SA2+Div. 3K:20% Div. 3LMNO over the 7 years for which data are available. The quota table information indicates that the distribution of quota is in the proportion of 26% SA2+Div. 3K:74% Div. 3LMNO. This is based on a total quota of 42 000 tons with 31 122 tons being allocated to Div. 3LMNO.
- b) If the 2003 quota for Greenland halibut in SA2+Div. 3KLMNO was apportioned according to biomass distribution, the split would be 33 802 tons (80%) from SA2+Div. 3K and 8 198 tons (20%) from Div. 3LMNO.

ii) **Cod in Divisions 2J and 3KL** (Annex 2 Item 3)

Canada requested: *For the cod stock in Divisions 2J+3KL, the Scientific Council is requested to report on recent trends in the total and spawning biomass based on the most recent Stock Status Report.*

The Scientific Council responded:

The total and spawning biomass indices are both extremely low relative to historic levels.

Information is available for the offshore and the inshore, but not for the two combined.

For the offshore, the total biomass index from the autumn bottom-trawl survey in 2002 remained extremely low at only 2% of the average in the 1980s. A spawning biomass index computed from the

same surveys and commercial weights-at-age remained at less than 2% of the biomass in the 1980s. Furthermore, the total biomass index from the spring bottom-trawl survey in Div. 3L is currently less than 1% of the average in the 1980s.

For the inshore, the results of a virtual population analysis, applied for the first time to fish in the inshore alone, indicated that the exploitable (4+) biomass increased from 1995 to a peak in 1996 and subsequently declined to a low level in 2002, from which there was a small increase in 2003. The spawning biomass increased from 1995 to a peak of 41 000 tons in 1998, and has subsequently declined to 14 000 tons at the beginning of 2003.

b) **Request by Denmark (Greenland) for Advice** (Annex 3)

The Scientific Council was requested by the Coastal State Denmark (Greenland) to *provide advice for various stocks*.

The Council consideration on these stocks is reported below:

i) **Multi-year advice for demersal redfish and other finfish in Subarea 1** (Annex 3 Item 2)

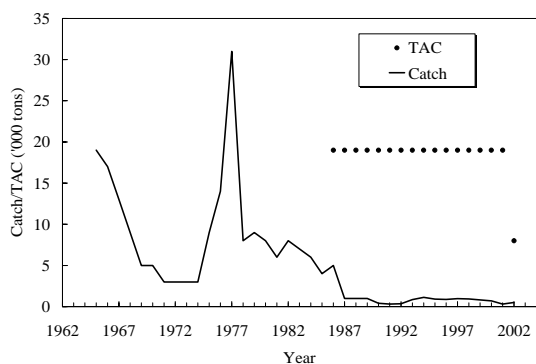
Demersal Redfish (*Sebastes spp.*) in Subarea 1

Background: There are two species of commercial importance in Subarea 1, golden redfish (*Sebastes marinus*) and deep-sea redfish (*Sebastes mentella*). Relationships to other North Atlantic redfish stocks are unclear.

Fishery Development and Catches: During the last decade, redfish were taken mainly as by-catch in the trawl fisheries for cod and shrimp. Both redfish species were included in the catch statistics since no species-specific data were available. Recent catch figures do not include the weight of small redfish discarded by the trawl fisheries directed to shrimp.

Year	Catch ¹ (‘000 tons)	TAC (‘000 tons)	
		Recommended	Autonomous
2000	0.7	ndf	19
2001	0.3	ndf	19
2002	0.5	ndf	8
2003		ndf	

¹ Provisional.
ndf No directed fishing, by-catch be at the lowest possible level.

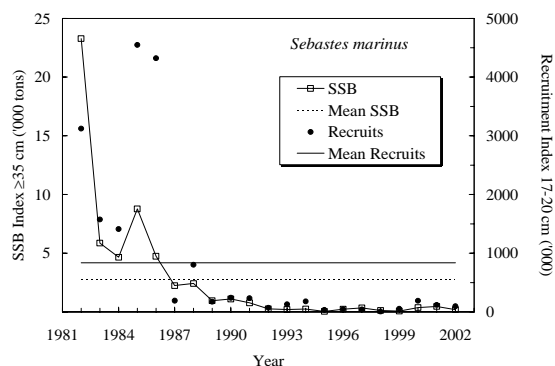


Data: No data on commercial CPUE were available. Spawning stock biomass and recruitment indices were calculated based on EU-Germany groundfish surveys.

Assessment of Golden Redfish: No analytical assessment of *Sebastes marinus* was possible.

Recruitment: Recruitment index has been low during the last decade.

SSB: SSB index has remained at the historical low level since 1989.

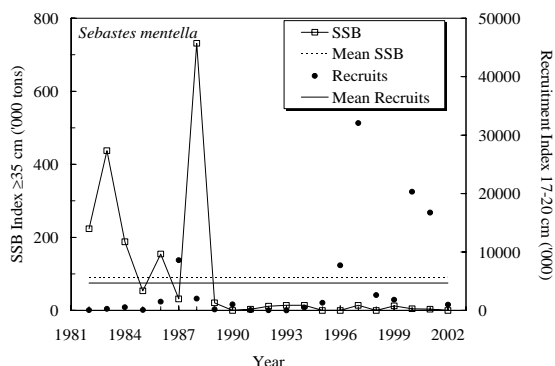


State of the Golden Redfish Stock: The stock of golden redfish in Subarea 1 remains severely depleted. There are indications that the probability of future recruitment is reduced at the current low SSB. Short-term recovery is very unlikely.

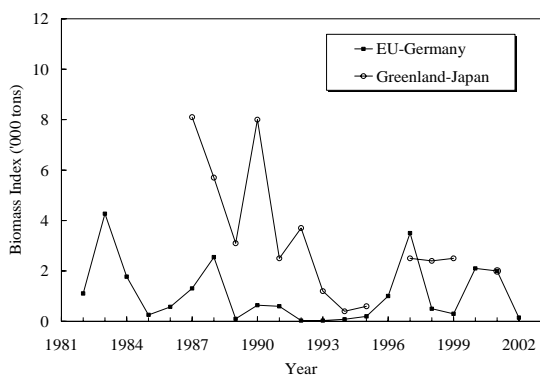
Assessment of Deep-sea Redfish: No analytical assessment of *Sebastes mentella* was possible.

Recruitment: Recruitment variation for deep-sea redfish is high, although there is indication of recent improvement (1997, 2000 and 2001).

SSB: SSB index remained at the historical low level since 1989.



Biomass: Total stock biomass indices were low in 1998-99, increased in 2000 and 2001, but decreased again in 2002. However survey coverage in 2002 was incomplete. The stock is composed of mostly immature fish.



State of the Deep-sea Redfish Stock: The spawning stock of deep-sea redfish in Subarea 1 remains severely depleted, and an increase is unlikely in the short term.

Recommendation for Golden and Deep-sea Redfish Stocks: No directed fishery should occur on redfish in Subarea 1 in 2004 and 2005. By-catches in the shrimp fishery should be at the lowest possible level.

Special Comments: The probability of recovery of the redfish stocks in Subarea 1 would be enhanced if the by-catch of demersal redfish taken in the shrimp fishery is significantly reduced.

Sources of Information: SCR Doc. 03/20, 29, 15, 33, 35; SCS Doc. 03/8, 16.

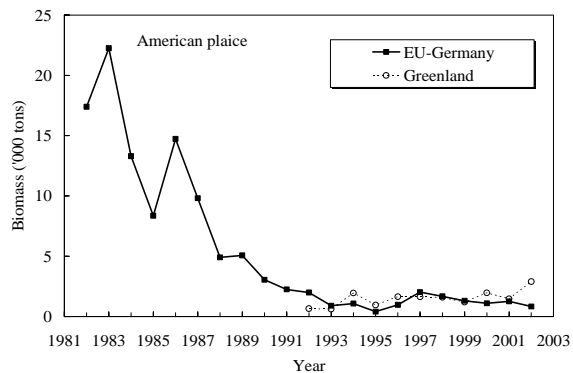
Other Finfish in Subarea 1

Background: The resources of other finfish in Subarea 1 are mainly Greenland cod (*Gadus ogac*), American plaice (*Hippoglossoides platessoides*), Atlantic and spotted wolffishes (*Anarhichas lupus* and *A. minor*), thorny skate (*Raja radiata*), lumpsucker (*Cyclopterus lumpus*), Atlantic halibut (*Hippoglossus hippoglossus*) and sharks. No recommendations can be made for Greenland cod, lumpsucker, Atlantic halibut and sharks.

Fishery Development and Catches: Greenland cod and lumpsucker are taken inshore by directed fisheries. Other species are mainly taken as by-catch offshore in trawl fisheries directed to shrimp and Greenland halibut. In 2002, reported catches of other finfish amounted to 7 437 tons, representing an increase by about 2 400 tons, compared to the 2001 catch (5 800 tons). This was mainly caused by an increase in catch of lumpsucker. The catch figures do not include the weight of fish discarded by the trawl fisheries directed to shrimp.

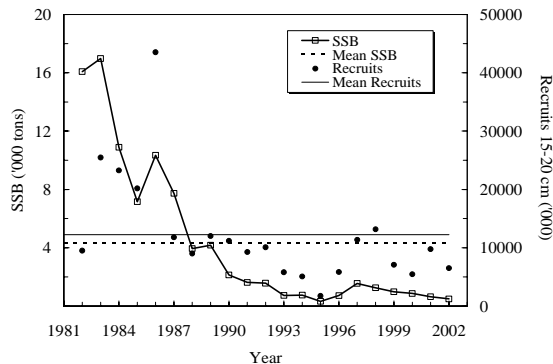
Data: No data on CPUE, length and age composition of the catches were available. Length frequencies were derived from the Greenland bottom trawl surveys. Assessments of recent stock abundance, biomass, and size structure for these stocks were based on annual bottom trawl surveys conducted by EU-Germany and Greenland. Spawning stock biomass and recruitment indices for American plaice and Atlantic wolffish were derived from EU-Germany survey data.

Assessment of American plaice: No analytical assessment was possible.



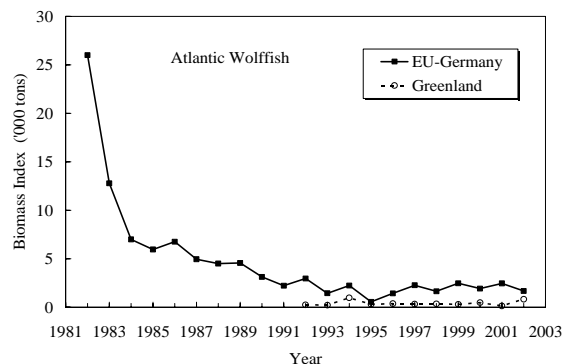
Recruitment: Indices indicate a general higher level before 1991 compared to recent years.

Biomass: During 1982-91, the SSB and total biomass index decreased drastically to a very low level without a significant increase since then.



State of the American plaice stock: The stock remains severely depleted.

Assessment of Atlantic wolffish: No analytical assessment was possible.

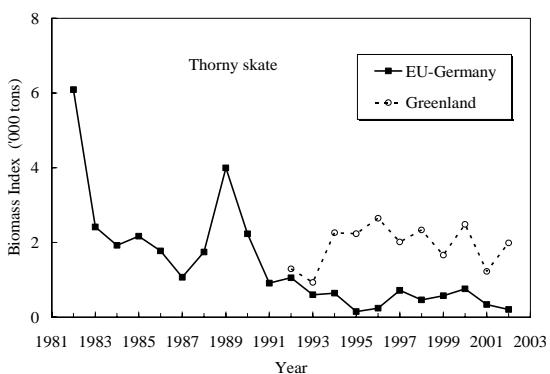
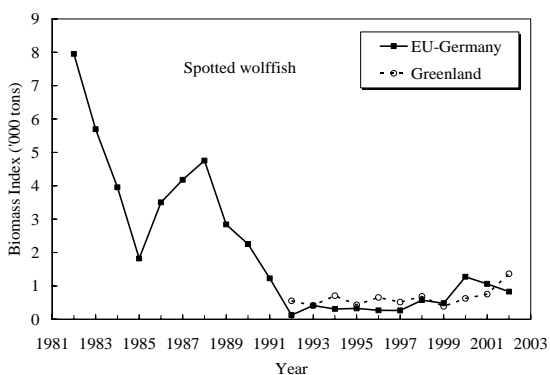


Recruitment: Index increased steadily since the 1980s but varied considerably since 1995.

Biomass: Since 1982, the SSB and total biomass index decreased drastically and remained severely depleted since the early-1990s.

State of the Atlantic wolffish stock: The stock remains severely depleted despite a steady increase in recruitment since the early-1980s.

Assessment of spotted wolffish and thorny skate: No analytical assessment was possible.



Biomass: Survey results revealed dramatic declines for spotted wolffish and thorny skate to a very low level.

State of the stocks of spotted wolffish and thorny skate: The stocks of spotted wolffish and thorny skate remain severely depleted.

Recommendation for the stocks of American plaice, Atlantic wolffish, spotted wolffish and thorny skate: No directed fishery in Subarea 1 for American plaice, Atlantic wolffish, spotted wolffish and thorny skate should occur in 2004 and 2005. By-catches of these species in the shrimp fisheries should be kept at the lowest possible level.

Reference points: For all these stocks, Scientific Council is not in a position to propose reference points at this time.

Special Comments: The probability of recovery of these stocks would be enhanced if the by-catch taken in the shrimp fishery is significantly reduced.

The increase in lumpsucker catches together with the lack of information of the stock status is raising concern.

Sources of Information: SCR Doc. 03/20, 29, 15, 33, 35 SCS Doc. 03/8, 16.

ii) **Roundnose grenadier in Subareas 0 and 1** (monitor) (Annex 3 Item 1)

In the Scientific Council report of 2002 scientific advice on management of roundnose grenadier in Subareas 0+1 was given as 3-year advice for 2003, 2004 and 2005. Denmark, on behalf of Greenland, requested the Scientific Council to: *continue to monitor the status of roundnose grenadier in Subareas 0+1 annually and, should significant changes in stock status be observed (e.g. from surveys), the Scientific Council is requested to provide updated advice as appropriate.*

The Scientific Council responded:

At its June 2002 meeting, Scientific Council provided 3-year advice for 2003, 2004 and 2005 for roundnose grenadier in Subareas 0+ 1. The Scientific Council reviewed the status of this stock at this June 2003 meeting and found no significant changes in the status. Therefore, Scientific Council has not provided updated/revised advice for 2004. The next Scientific Council assessment of this stock will be in 2005.

iii) **Greenland halibut in Division 1A Inshore** (Annex 3 Item 3)

Greenland Halibut (Reinhardtius hippoglossoides) in Division 1A inshore

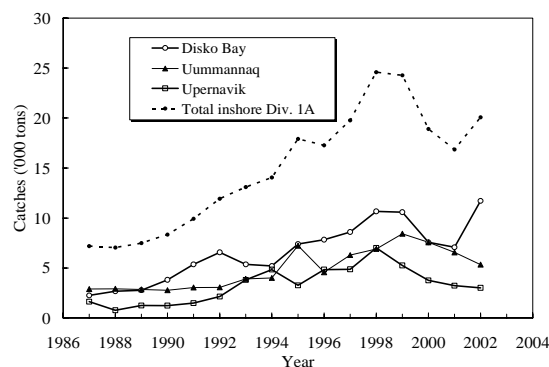
Background: The inshore stock is dependent on the spawning stock in Davis Strait and immigration of recruits from the offshore nursery grounds in Div. 1A and 1B. Only sporadic spawning seems to occur in the fjords, hence the stock is not considered self-sustainable. The fish remain in the fjords, and do not appear to contribute back to the offshore spawning stock. This connection between the offshore and inshore stocks implies that reproductive failure in the offshore spawning stock for any reason will have severe implications for the recruitment to the inshore stocks.

Fishery and Catches: The fishery is mainly conducted with longlines and to a varying degree gillnets. Total landings in all areas were around 7 000 tons in the late-1980s but then increased gradually until 1998 when the landings were almost 25 000 tons. Landings then declined to 16 900 tons in 2001 but increased again to 20 000 tons in 2002. The decline in landings observed in most recent years continued in Uummannaq and Upernavik while landings increased abruptly in Disko Bay in 2002. The increase in landings in Disko Bay in 2002 is a result of a rise in effort. The effort in Upernavik in 2002 was reduced due to various reasons.

	Catch ('000 tons)		TAC ('000 tons)	
	Year		STACFIS	21A
Disko Bay	2000		7.6 ^{1,2}	7.9
	2001		7.0 ¹	7.9
	2002		11.7 ¹	7.9
	2003			7.9
Uummannaq	2000		7.6 ^{1,2}	6.0
	2001		6.6 ¹	6.0
	2002		5.4 ¹	6.0
	2003		6.0	
Upernavik	2000		3.8 ^{1,2}	4.3
	2001		3.2 ¹	4.3
	2002		3.0 ¹	4.3
	2003		2.4	

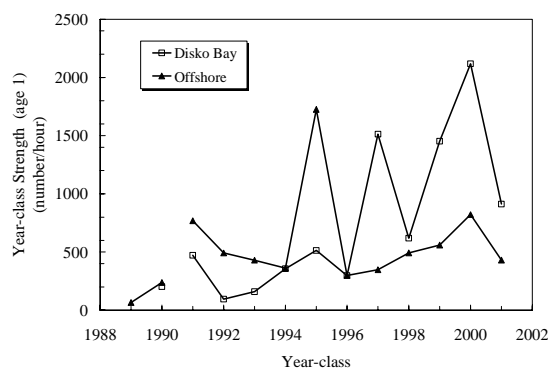
¹ Provisional

² The total catches are likely to have been underestimated by about 2 000 tons in Div. 1A inshore total.



Data: Data were available on length composition in the commercial landings. A recruitment index for age 1 was available from the Greenland shrimp trawl survey.

Assessment: Data deficiencies for 2002, both for commercial and survey data, in combination with landing statistics not divided on gears, impedes an updated assessment of the populations.



Recruitment: In the traditional offshore nursery areas the numbers of one-year-olds from the 2001 year-class were a little below average, while it was a little above average in the Disko Bay. The strong 2000 year-class also appeared to be relatively strong at age 2 in Disko Bay. There is uncertainty to what degree these year-classes will contribute to the inshore fishery in the future.

State of the Stock: Scientific Council is not able to evaluate the state of the stock due to lack of relevant information.

Recommendation: Scientific Council still considers that separate TACs are appropriate for each of the three areas.

Due to lack of recent data Scientific Council is not able to update its advice from that proposed in 2002.

Reference Points: Scientific Council is not in a position to propose reference points.

Special Comments: The TAC values for Disko Bay and Uummannaq were proposed in the 1998 Scientific Council report to prevent escalating effort and are based on the average catches for 1995-97. The TAC for Upernavik of 2 400 tons (25% below the catches in 2001) was proposed in 2002 based on a continued decline in survey indices since 1994 concurrent with a decrease in catches since 1998.

Because the stock is dependent on recruitment from Davis Strait, exploitation of the spawning stock and by-catches in the shrimp fishery should be taken into account when managing the fishery in the fjords.

Sources of Information: SCR Doc. 03/29, 49; SCS Doc. 03/16.

c) **Request by Canada and Denmark (Greenland) for Advice on TACs and Other Management Measures** (Annexes 2 and 3)

The Scientific Council was requested by the Coastal States Canada and Denmark (Greenland) to: *provide advice on Greenland halibut in Subareas 0 and 1*. This section presents the Scientific Council advice for the year 2003.

Scientific Council noted the request usually makes reference to Greenland halibut in Subareas 0 and 1. The Council noted that the specific stock area to be addressed under this request is Greenland halibut in Subarea 0, Div. 1A offshore and Div. 1B-1F. The Council considerations are as given below.

Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 0 + Division 1A Offshore and Divisions 1B-1F

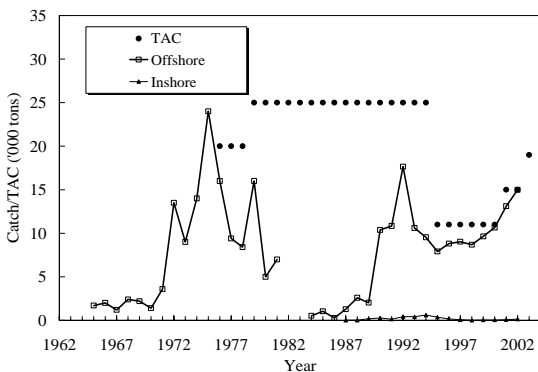
Background: The Greenland halibut stock in Subarea 0 + Div. 1A offshore and Div. 1B-1F is part of a common stock distributed in Davis Strait and southward to Subarea 3.

Fishery and Catches: Due to an increase in offshore effort, catches increased from 2 000 tons in 1989 to 18 000 tons in 1992 and have remained at about 10 000 tons annually until 2000. Catches increased to 13 000 tons in 2001, primarily due to increased effort in Div. 0A and further to 15 000 in 2002, primarily due to an increase in effort in Div. 1A.

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	11	7 ¹	11	11
2001	13	13 ¹	15 ²	15
2002	15	12 ¹	15 ²	15
2003			19 ²	

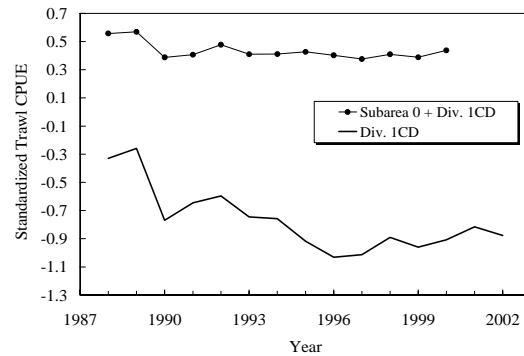
¹ Provisional.

² Including 4 000 tons allocated specifically to Div. 0A and 1A in 2001 and 2002 and 8 000 tons in 2003.



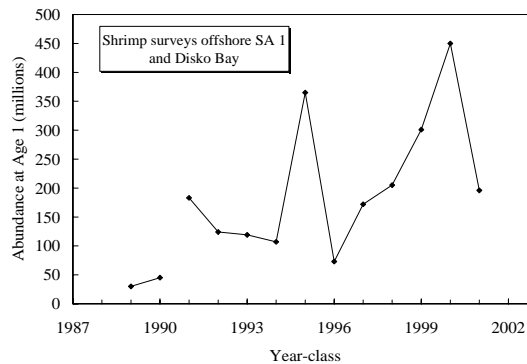
Data: Catch-at-age data were available for assessment from SA0 and SA1. Standardized and unstandardized catch rates were available from Div. 0A, Div. 1A and 1CD. Biomass estimates from 2001 surveys were available from Div. 1A-D and Div. 0AB. Biomass estimates from 2002 surveys were available from Div.1CD, only. Recruitment data were available from surveys in Div. 1A-1F from 1989-2002.

Assessment: No analytical assessment could be performed. Combined standardized catch rates for SA 0 + Div. 1CD during 1990-2000 and standardized catch rates from Div. 1CD during 1990-2002 have been stable. Unstandardized catch rates in Div. 0A increased between 2001 and 2002 while they were stable in Div. 1A.

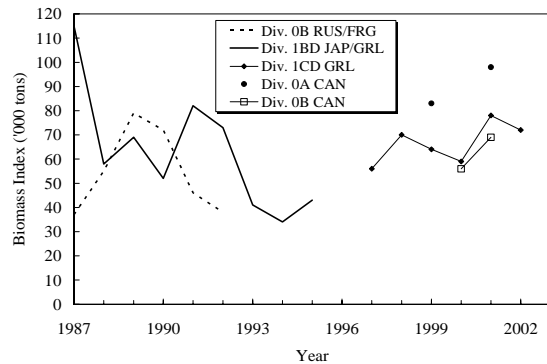


Fishing Mortality: Level not known.

Recruitment: Recruitment of the 2000 year-class at age 1 was the largest in the time series, while the 2001 was a little below average.



Biomass: The biomass in Div. 1CD in 2002 was estimated at 72 000 tons, the second highest in the six years time series.



State of the Stock: The age composition in the catches has been stable in recent years. Based on survey indices the stock has been increasing since 1994 and is now at the level of the late-1980s and early-1990s

Recommendation: As indicated Scientific Councils response to the coastal states (see VII.2.c) Scientific Council **recommends** that Div. 1B be included in the management area with Div. 0A and Div. 1A.

Considering the relative stability in biomass indices and CPUE rates, for Greenland halibut in Div. 0B and 1C-1F the TAC for year 2004 should not exceed 11 000 tons

In 2002, Scientific Council advised a catch of 8 000 tons for the developing fisheries in Div. 0A+1A. This was considered to generate a relatively low F based on available data. Until sufficient data are available to more fully evaluate the state of this stock, Scientific Council advises that this level of catch not be exceeded. Scientific Council therefore advises a TAC of 8 000 tons for Greenland halibut in Div. 0A+1AB for 2004.

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

Sources of Information: SCR Doc. 03/20, 29, 33, 41, 50, 53, 54; SCS Doc. 03/6, 8, 10, 12, 16.

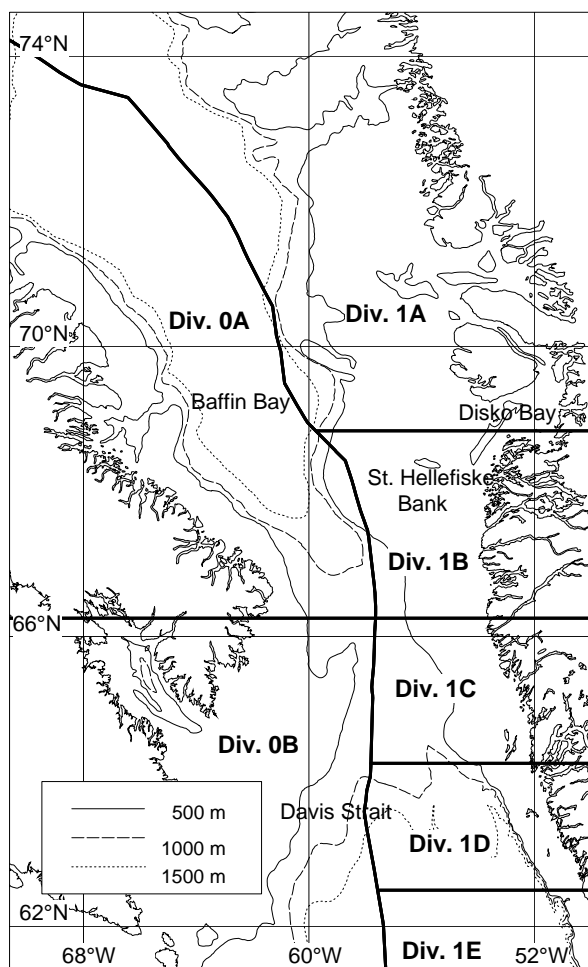
Responses Specific to Requests by Canada:

Canada had noted Greenland halibut in the offshore area of Division 0A+1A is currently being managed separately from the remainder of SA 0+1. However, given the bathymetry of Baffin Bay and its proximity to the NAFO boundaries of Div. 0A, 1A and 1B, the Scientific Council was requested to:

- a) *advise on whether it is more appropriate for management purposes to include Division 1B with the current management area of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-F* (See Annex 2, Item 1).

The Council responded:

In 2000 Scientific Council advised that an additional TAC of 4 000 tons may be set for Div. 0A and 1A combined based on survey results for Div. 0A. Given the bathymetry of Baffin Bay and its proximity to the NAFO boundaries of Div. 0A, 1A and 1B it would have been more appropriate to set the TAC for Div. 0A+1AB. Scientific Council therefore **recommended** that *Div. 1B be included in the management area with Div. 0A and 1A*. (map below shows NAFO boundaries, depth contours and place names).



Canada requested the Scientific Council to:

- b) *advise on appropriate TAC levels for 2004, separately, for Greenland halibut in the offshore area of Divisions 0A+1A (plus Division 1B depending on the result of (a) above) and Divisions 0B+ 1C-F (plus Division 1B depending on the result of (a) above) (See Annex 2, Item 1).*

The Council responded:

Considering the relative stability in biomass indices and CPUE rates, for Greenland halibut in Div. 0B and 1C-F the TAC for year 2004 should not exceed 11 000 tons.

In 2002, Scientific Council advised a catch of 8 000 tons for the developing fisheries in Div. 0A+1A. This was considered to generate a relative low F based on available data. Until sufficient data are available to more fully evaluate the state of this stock, Scientific Council advises that this level of catch not be exceeded. Scientific Council therefore advises a TAC of 8 000 tons Greenland halibut in Div. 0A+1AB for 2004.

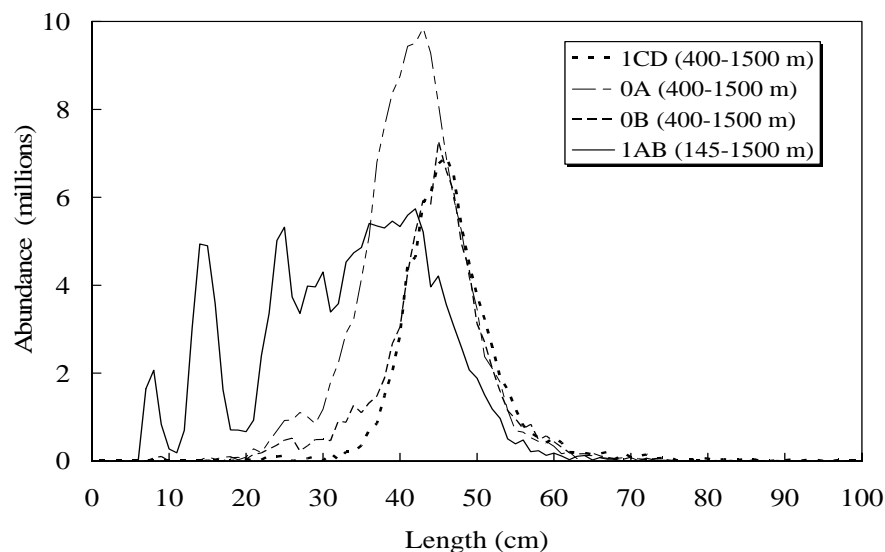
Canada requested the Scientific Council to:

- c) *comment on the Greenland halibut size composition throughout SA 0+1 (offshore), the potential relationship between fish in Baffin Bay and Davis Strait and the impact of harvesting on these stock components; (See Annex 2, Item 1)*

The Council responded:

The fish are generally smaller in Div. 0A+1AB (see length distribution Fig. below), but in both areas size increases with depth. In the Canadian trawl fishery in Div. 0A in 2002 38% of the fish caught were <46 cm compared to 21% in Div. 0B (SCR Doc. 03/50). In Div. 1A 50.8 % and 33.8% of the fish caught by Russia (SCS Doc. 03/6) and Faroe Islands, respectively, were <46 cm. In Div. 1D 9.6%, 15.8% and 23.2% of the catches taken by EU/Germany, Faeroe Islands and Russia (SCS Doc. 03/06), respectively, were <46 cm, while 25.1% of the fish taken by Norway were <46 cm (SCR Doc. 03/33). The differences in length composition within Divisions amongst the different fleets probably reflect differences in fishing depth. (The length distributions from EU-German and Faeroe Islands vessels were sampled by Greenland observers.)

Length distribution for depths 400-1 500 m from otter trawl surveys conducted by Canada and Greenland in 2001.



Greenland halibut in the Baffin Bay and the Davis Strait are believed to belong to the same stock. Tagging experiments have shown that Greenland halibut migrate from the Baffin Bay to the Davis Strait, probably to spawn (SCR Doc. 99/25). A fishery in the Baffin Bay will probably reduce the numbers that migrates to the Davis Strait but the impact can not be estimated. The fishing mortality in the Baffin Bay is, however, considered to be relatively low.

Canada requested the Scientific Council to:

- d) *advise on the most appropriate protocols for the conduct of exploratory fisheries in Division 0A north of 71°30'N including precautionary catch limits. (See Annex 2, Item 1).*

The Council responded:

The area north of 71°30'N in Canada and north of 74°N in Greenland has not been surveyed and the distribution and size composition of the Greenland halibut stock in the area is not known. Until such surveys have been conducted the fishing effort should be restricted and it should be ensured that logbooks from such a fishery, including information on CPUE, fishing depths and position, are made available. Further, information on size composition should be recorded on a tow by tow basis, through the use of 100% coverage by onboard observers. Catches should be included in the TAC (8 000 tons).

Responses Specific to Requests by Denmark (Greenland)

Denmark (Greenland noted: *subject to the concurrence of Canada as regards Subarea 0, the Scientific Council is requested to provide advice on the scientific basis for management of Greenland halibut overlapping Subarea 0 and 1 in 2004, and as many years forward as data allow (Annex 3, Item 3).*

The Council responded:

See the response given to Canada in item *b)* above.

Denmark (Greenland) noted: *given the bathymetry of Baffin Bay and Davis Strait, the Scientific Council on whether it is more appropriate for management purposes to include Division 1B with current management of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-1F. (Annex 3, Item 3).*

The Council responded:

See the response given to Canada in item *a)* above.

Further Denmark (Greenland) asked the Scientific Council to: *advise on the most appropriate protocols for the conduct of exploratory fisheries in Divisions 1A north of 74°N including precautionary catch limits (Annex 3, Item 3).*

The Council responded:

See the response given to Canada in *d)* above.

Further, Denmark (Greenland) asked the Scientific Council to: *for Subarea 1A inshore, provide advice on allocation of TACs distributed in the areas of Ilulissat, Uummannaq and Upernavik, respectively (Annex 3, Item 3).*

The Council responded:

Scientific Council still considers that separate TACs are appropriate for each of the three areas.

Due to lack of recent data Scientific Council is not able to update its advice from that proposed in 2002.

Denmark (Greenland) asked the Scientific Council: in its advice *to assess the impact from the offshore fisheries in Baffin Bay and Davis Strait on the status and trends of the Subarea 1A inshore stock components, and vice versa* (Annex 3, Item 3).

The Council responded:

Greenland halibut spawn in the Davis Strait. There has been little evidence of spawning in Baffin Bay and inshore areas. Eggs and larvae drift with the currents from Davis Strait towards the main nursery area in the Disko Bay and Store Hellefiske Bank where they settle. Some larvae probably drift further north into the Baffin Bay or to the Canadian coast. Larvae settle at 200-300 m depth and start to migrate towards greater depths as they grow. At Northwest Greenland some will migrate into the fjords, others into the Baffin Bay. From Store Hellefiske Bank fish will migrate either into the Disko Bay or out into the Davis Strait. The off shore fishery takes place at depth >800 m and fish at that depth will probably not migrate back to the shallow areas where they originally settled and then into the fjords. This is supported by tagging experiments because only very few fish tagged off shore in the Baffin Bay have been captured in inshore areas (SCR Doc. 99/25). Hence the off shore fishery will probably not affect the inshore fishery. However, the connection between the offshore and inshore stocks implies that reproductive failure in the offshore spawning stock for any reason will have severe implications for the recruitment to the inshore stocks. A reduction in the abundance of juveniles on the shallow nursery grounds of the Banks due to by-catch will probably also reduce the recruitment to the inshore stocks.

Tagging experiments have shown that fish migrated into the fjords, stay there and do not contribute back to the spawning biomass in the Davis Strait (SCR Doc. 99/25).

3. **Scientific Advice from the Council on its Own Accord**

a) **Roughhead Grenadier in Subareas 2 and 3**

The Scientific Council on its own accord considered roughhead grenadier in Subareas 2 and 3 as given below:

Roughhead Grenadier (*Macrourus berglax*) in Subareas 2 and 3

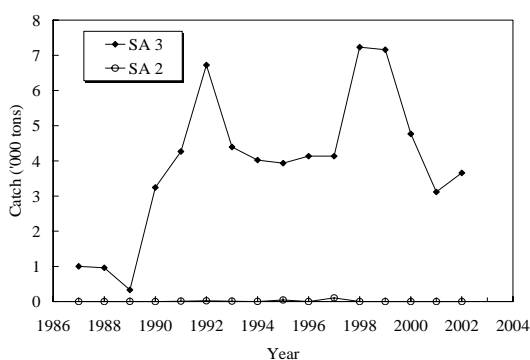
Background: Roughhead grenadier are distributed throughout Subareas 2 and 3 in depths between 300 and 2 000 m. This is not a regulated species

Fishery and Catches: There is no directed fishery for roughhead grenadier and most of the catches are taken as by-catches in the Greenland halibut fishery in Subareas 2 and 3. Roughhead grenadier is taken mainly in Div. 3LMN Regulatory Area. At the beginning of the Greenland halibut fishery in Subarea 3 of the Regulatory Area in 1988, the grenadier catches were systematically misreported as roundnose grenadier. Since 1997 the roughhead catches have been correctly reported, but the mis-reporting problem is not still solved in the statistics prior 1996. The level of catches remains uncertain in Subareas 2 and 3 before the start of the Greenland halibut fishery in the Regulatory Area.

Catches since 2000 are as follows:

	Catch ('000 tons)	
	STACFIS	STATLANT 21A
2000	4.8	2.7 ¹
2001	3.2	1.6 ¹
2002	3.7	1.9 ¹

¹ Provisional

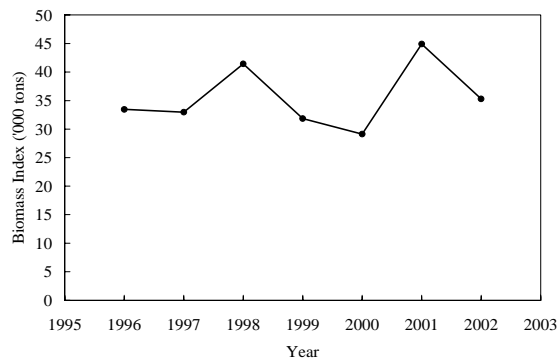


Data: Biomass indices were derived from: the Canadian stratified bottom trawl autumn surveys in Div. 2GHJ and 3KL since 1978, the Canadian stratified random bottom trawl spring surveys in Div. 3LN since 1971, the Canadian stratified deepwater bottom trawl surveys in Div. 3KLMN in 1991, 1994 and 1995, the EU (Spain and Portugal) stratified bottom trawl summer survey in Div. 3M since 1988. The EU (Spain-Portugal) longline deepwater survey in

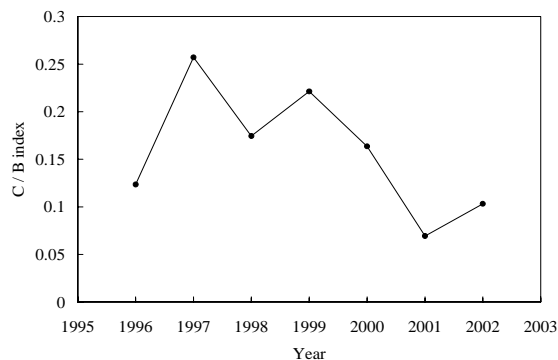
Div. 3LMN in 1996 provided information on the roughhead grenadier depth distribution.

Assessment: No analytical assessment was possible with current data.

Biomass: The Canadian autumn survey biomass index, which is the best input for the assessment of this stock, has been rather stable since 1996.



Fishing mortality proxy: The catch / biomass (C/B) index obtained using the Canadian autumn survey biomass index has been declining since 1997.



Recruitment: Not known.

State of the Stock: The state of the stock is not known.

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

Special Comments: It should be noted that immature fish constituted 80% of the catch in 2002.

The next assessment will be in 2005.

Sources of information: SCR Doc. 03/9, 13, 42; SCS Doc. 03/6, 7, 13.

VIII. FUTURE SCIENTIFIC COUNCIL MEETINGS 2003 AND 2004

1. **Scientific Council Meeting and Special Session, September 2003 Dartmouth, NS, Canada**

The Council reconfirmed that the Annual Meeting will be held during 15-19 September 2003 in the Holiday Inn, Harbourside in Dartmouth, Nova Scotia, Canada. The Scientific Council Workshop on "Mapping and Geostatistical Methods for Fisheries Stock Assessments" will be held during 10-12 September 2003 at the same venue.

2. **Scientific Council Meeting, October/November 2003 (assessment of shrimp stocks) Dartmouth, NS, Canada**

Scientific Council at its 6-13 November 2002 meeting discussed the possibility of extending its October/November 2003 meeting to accommodate the ICES request to assess northern shrimp stocks in the Northeast Atlantic. Recent communication with the ICES Secretariat indicated that a 2003 meeting would be premature and that planning for such a meeting for 2004 could be undertaken in the interim. Noting this, the Council revised the previously proposed dates and shortened the meeting period.

The Scientific Council confirmed the meeting will be held during 5-11 November 2003 at NAFO Headquarters in Dartmouth, NS, Canada.

3. **Scientific Council Meeting, June 2004**

The Scientific Council reconfirmed the meeting will be held during 3-17 June 2004, at Alderney Landing, 2 Ochterloney Street, Dartmouth, NS, Canada.

4. **Scientific Council Meeting and Special Session, September 2004**

The Council noted that the Annual Meeting will be held during 13-17 September 2004 and the Scientific Council Special Session is scheduled for 8-10 September 2004. The venue has not been determined.

5. **Scientific Council Meeting, November 2004 (assessment of shrimp stocks)**

Taking into account the Council Meeting of November 2004 may include the ICES request to assess northern shrimp stocks in the Northeast Atlantic, the Scientific Council considers it premature to tentatively set dates for the 2004 northern shrimp assessment meeting. The dates and venue of the 2004 meeting will be discussed by the Council at the November 2003 Meeting. In the interim, the Chair of Scientific Council will communicate with the Chair of ACFM to initiate discussion on the roles and responsibilities of both parties, and the NAFO Secretariat will communicate with the ICES Secretariat to develop protocols for institutional arrangements. A report of these activities will be discussed by Scientific Council at the September 2003 Meeting.

IX. ARRANGEMENTS FOR SPECIAL SESSIONS

1. **Progress Report on Special Session in 2003: Scientific Council Workshop on Geostatistics in Fisheries**

A workshop entitled "Mapping and Geostatistical Methods for Fisheries Stock Assessments" on mapping and geostatistical methods for fisheries stock assessment will be held at the Holiday Inn in Dartmouth, NS during 10-12 September, 2003. Dr. Nicolas Bez, from the Centre de Geostatistique, Fontainebleau, France will be the principal instructor. Additional instructors will demonstrate and guide participants through exercises that utilize various GIS/geostatistical software programs and NAFO data sets. The workshop will be limited to 35 people and Scientific Council members must register for the workshop through the NAFO website by 15 August. The co-conveners, Lisa Hendrickson (USA) and Dave Kulka (Canada) will place information for this workshop on the NAFO website in the near future. Prior to the workshop, participants are encouraged to access the NAFO website to obtain a list of the workshop instructors, a course bibliography, and links to relevant geostatistical and mapping software programs.

2. Topics for Special Sessions in 2004

The Council noted there had been some previous discussion on the possibility of a Symposium focusing on Flemish Cap, particularly as there was some interests on the fisheries, biology, oceanography and ecosystems aspects.

The Council agreed a mini-Symposium titled “Ecosystem of the Flemish Cap” would be of interest. The Council requested Joanne Morgan (Canada) and Antonio Vazquez (EU-Spain) to undertake the convenership for this meeting, and prepare a formal proposal to be presented to the Council at its meeting in September 2003.

3. Topics for Special Session in 2005

A proposal for a Symposium considering an update on the Reproductive Potential of Fish was considered. It was recognized that the NAFO Working Group on Reproductive Potential as well as working groups at ICES are active on the subject. The Council requested this matter be addressed with Ed Trippel (Chair of the Working Group on Reproductive Potential) and a proposal for a Symposium be presented to the September 2003 Scientific Council Meeting.

Another proposal as an area of interest for a symposium was on the subject of the incorporation of environmental information into stock assessment. The Council agreed this subject should be further discussed at the Council Meeting of September 2003. The Council requested the STACFEN Chair to develop a proposal and take a lead role on the discussion. The Council noted other bodies such as ICES have also considered this as an area of interest.

X. REPORTS OF WORKING GROUPS

1. Working Group on Reproductive Potential (Chair: E. A. Trippel)

Progress of the NAFO Working Group on Reproductive Potential was provided by E.A. Trippel (Chair). The establishment of the Working Group on Reproductive Potential followed a recommendation of the Symposium on “Variations in Maturation, Growth, Condition and Spawning Stock Biomass Production in Groundfish” hosted by NAFO Scientific Council from 9-11 September 1998, Lisbon, Portugal. The Working Group is comprised of 21 members representing 8 countries (Canada, Denmark, Iceland, Norway, Russia, Spain, United Kingdom, and USA). Two meetings have been held to date, one in San Sebastian, Spain (October 2000) and one in St. Petersburg, Russia (October 2001). Previous updates of progress are provided in NAFO SCS Doc. 01/1 and 01/28.

Two publications are planned as products of the Working Group’s activities. A large volume of the *NAFO Scientific Council Studies* will be published containing short summaries and citation sources on stock structure and reproductive potential data (e.g., abundance, length-at-age data, maturation, condition, and fecundity) for 53 fish stocks (all of the NAFO stocks and several ICES stocks). A special volume of the *Journal of Northwest Atlantic Fishery Science* will be published by November 2003 that will contain 9 peer reviewed articles authored by members of the Working Group. Titles of the contributions fulfilling the first set of ToRs are:

ToR 1: Co-Leaders: J. Tomkiewicz (Denmark) and J. Burnett (USA)

Explore and review availability of information and existing data on reproductive potential by areas and species

- 1) *Available Information for Estimating Reproductive Potential of Northwest Atlantic Groundfish Stocks*
- 2) *The Availability of Data for Estimating Reproductive Potential for Selected Stocks in the North Atlantic (to be published in NAFO Scientific Council Studies)*

ToR 2 Co-Leaders: H. Murua (Spain) and A. Thorsen (Norway)

Explore possibilities to develop standard internationally coordinated research protocols to estimate egg and larval production

- 1) *Female Reproductive Strategies of Marine Fish Species of the North Atlantic*
- 2) *Procedures to Estimate Fecundity of Wild Collected Marine Fish in Relation to Fish Reproductive Strategy*
- 3) *Experimental Methods to Monitor the Production and Quality of Eggs of Captive Marine Fish*
- 4) *Integration of Captive and Wild Studies to Estimate Egg and Larval Production of Fish Stocks*
- 5) *Estimation of Male Reproductive Success of Marine Fish*

ToR 3 Co-Leaders: Y. Lambert (Canada) and N. Yaragina (Russia)

Explore and evaluate alternative methods to estimate reproductive potential annually or part of routine in monitoring and sampling schemes (such as HSI)

- 1) *Using Environmental and Biological Indices as Proxies of Egg and Larval Production of Marine Fish*

ToR 4 Co-Leaders T. Marshall (Norway) and G. Marteinsdottir (Iceland)

Review possibilities to develop methods and opportunities to estimate stock reproductive potential for assessment and management

- 1) *Developing Alternative Indices of Reproductive Potential for Use in Fisheries Management: Case Studies for Stocks Spanning an Information Gradient*
- 2) *Incorporating Early-Life History Parameters in the Estimation of the Stock-Recruit Relationship of Georges Bank Atlantic Cod (*Gadus morhua*)*

In addition to the papers listed above, the Working Group developed 27 recommendations for future activities. Scientific Council discussed the recommendations derived from the first set of terms of reference and agreed that the future direction of the Working Group as discussed at the June 2002 Scientific Council Meeting would focus on continuing to improve the quality and availability of data on fish reproductive potential and to explore means of integrating this information into fishery management advice. Terms of reference for future activities of the Working Group were discussed at the June 2002 Scientific Council Meeting and are given in the 2002 Scientific Council Report (page 47).

The 3rd meeting of the Working Group is scheduled for 15-18 October 2003 in Woods Hole, USA. Discussion will include progress on addressing the second set of ToRs and planning of future activities. New members to the Working Group include Chris Chambers (USA), Coby Needle (UK) and Rick Rideout (Canada).

The overlap with the ICES Study Group on SGGROMAT (Study Group on Growth, Maturity and Condition in Stock Projections) was discussed and noted to be positive. A recommendation was made to include 3LNO American plaice and 3NO Atlantic cod among the stocks examined when addressing the second set of ToRs.

2. Joint NAFO-ICES Working Group on Harp and Hooded Seals

A Workshop to Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice sponsored by the joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) was hosted by the US National Marine Fisheries Service in Woods Hole, MA, USA from 11-13 February 2003. Twenty-one scientists attended from the USA, Canada, Norway, Russia and Greenland. A number of working papers on the history of WGHARP, the models used to estimate abundance of harp seals in the NE and NW Atlantic and approaches to consider when identifying biological reference points were presented. In addition to these working papers, presentations describing data availability for harp and hooded seals and modeling approaches used by other organizations were given.

A total of 7 recommendations were made by the workshop including matters such as model formulation, data requirements and biological reference points. The Report of the Workshop will be reviewed by WGHARP in September 2003 and a full report of the Working Group Meeting and the Workshop will be presented to Scientific Council in June 2004. The report of the Workshop has been posted on the ICES website (www.ices.dk) and linked through the NAFO website (www.nafo.int).

XI. NOMINATION AND ELECTION OF OFFICERS

1. Chairs of all Standing Committees (STACFEN, STACPUB, STACREC, STACFIS)

A Nominating Committee composed of D. B. Atkinson (Canada), A. Vazquez (EU) and F. Serchuk (USA) proposed the following candidates. The Scientific Council noted these positions will be for a 2-year period beginning immediately after the September 2003 Meeting.

For the office of Chair of the Standing Committee on Publications (STACPUB), M. Stein (EU-Germany) was nominated by the Committee. There being no other nominations, the Council elected him by unanimous consent.

The Rules of Procedure determines that the elected Vice-Chair of the Scientific Council would take office of the Chair of Standing Committee on Research Coordination (STACREC). A. Vázquez (EU-Spain) was accordingly appointed to the office.

For the office of the Chair of the Standing Committee on Fisheries Environment (STACFEN), E. Colbourne (Canada) was nominated by the Committee. There being no other nominations, the Council elected him by unanimous consent.

The Nominating Committee regretted to inform the Council that for the office of Chair of the Standing Committee on Fisheries Science (STACFIS), no nomination could be made at this time. The Council noted that experts who usually attend the Scientific Council meetings were unable to commit to this position due to other duties that they hold. The Scientific Council Chair expressed his concern on this unfortunate development, and undertook to look into this situation well in advance of the September 2003 Council Meeting.

2. Chair and Vice-Chair of Scientific Council

For the office of the Chair of Scientific Council, the current Vice-Chair, M. J. Morgan (Canada) was nominated by the Committee. There being no other nominations, the Council elected her by unanimous consent.

For the office of the Vice-Chair of Scientific Council A. Vázquez (EU-Spain) was nominated by the Committee. There being no other nominations, the Council elected him by unanimous consent.

XII. REVIEW OF SCIENTIFIC COUNCIL WORKING PROCEDURES/PROTOCOL

1. Implementation of Precautionary Approach

a) Report of the March/April 2003 Scientific Council Workshop on PA

The Scientific Council held a workshop during 31 March to 4 April 2003, in St. John's, NL, Canada to further develop methodology for calculating biological reference points to be applied within the Precautionary Approach framework. Seven stocks, representing different life history characteristics and data availability, were chosen as candidates to explore various methods. The stocks included: Greenland halibut in Subarea 2 and Div. 3KLMNO, American plaice in Div. 3LNO, cod in Div. 3NO, yellowtail flounder in Div. 3LNO, redfish in Div. 3M, cod in Div. 3M, and northern shrimp in Subareas 0 and 1. In addition, the workshop reviewed the existing PA framework proposed by the Scientific Council in 1997, taking into account concerns expressed by fishery managers at several meetings

between members of the NAFO Fisheries Commission and Scientific Council that have taken place since 1998. A proposed revised framework was developed based on these discussions. The full report of the workshop, including a description of methods, results of application to the 7 stocks and the basis for the proposed revision of the PA framework, is given in SCS Doc. 03/05.

The Workshop noted that it is the responsibility of Scientific Council to calculate limit reference points. Given that a number of approaches for defining B_{lim} have been discussed in the literature, the Workshop concluded that a study group is needed to review the strengths and weaknesses of alternative approaches, and to make recommendations to Scientific Council on the most appropriate approaches to defining B_{lim} for NAFO stocks ranging from data-rich to data-poor situations and for a range of life history parameters.

Scientific Council endorsed this proposal and **recommended** that *a Study Group on the estimation of limit reference points be established. Peter Shelton (Canada) was named as a co-Chair with other co-Chairs to be selected from among the 2003 PA workshop participants, and the Co-Chairs explore with colleagues possible themes for a Study Group working session in 2004.*

b) Further Development of NAFO Scientific Council PA Methodology

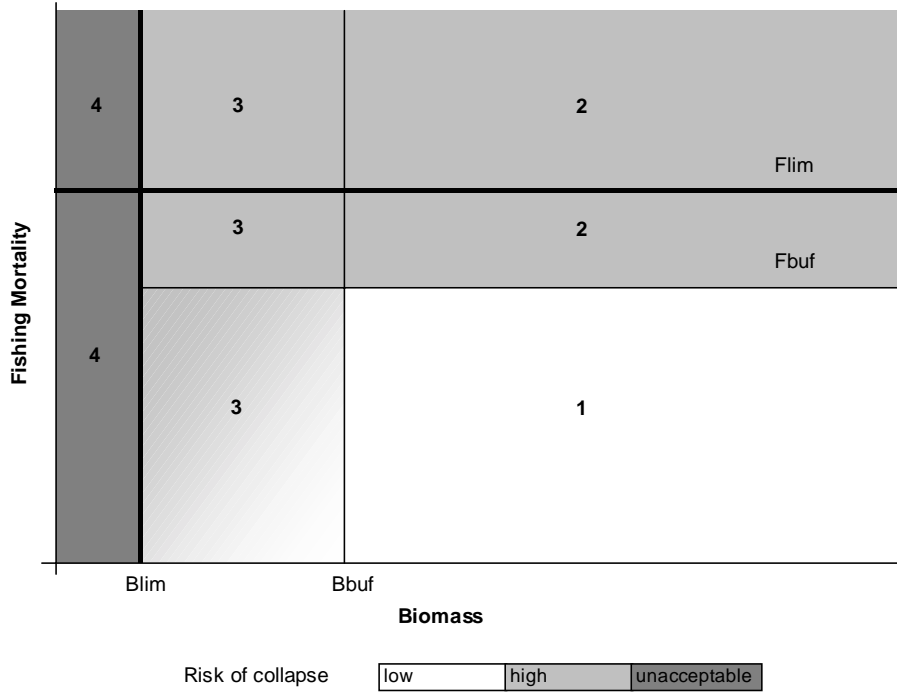
The revised PA framework developed by the March/April 2003 Workshop (SCS Doc. 03/05) was discussed at length at this June 2003 Scientific Council meeting and several areas of improvement were suggested. In particular, Scientific Council was concerned that the depiction of uncertainty with respect to the change in fishing mortality implied by the schematic between B_{buf} and B_{lim} could be presented in a clearer manner. A group of experts was tasked to evaluate the framework proposed by the Workshop and to incorporate modifications based on the suggestions from this Scientific Council Meeting. The resulting PA framework **as adopted** by the Scientific Council is given as follows.

The roles of Scientific Council and Fisheries Commission (as specified in FC Doc. 98/02) are as follows:

Scientific Council	Fisheries Commission
1. Determine status of stocks.	1. Specify management objectives, select target reference points, and set limit reference points.
2. Classify stock status with respect to biomass/fishing mortality zones.	2. Specify management strategies (courses of actions) for biomass/fishing mortality zones.
3. Calculate limit reference points and security margins.	3. Specify time horizons for stock rebuilding and for fishing mortality adjustments to ensure stock recovery and/or avoid stock collapse.
4. Describe and characterize uncertainty associated with current and projected stock status with respect to reference points	4. Specify acceptable levels of risk to be used in evaluating possible consequences of management actions.
5. Conduct risk assessments.	

The following is the proposed revised NAFO Precautionary Approach Framework prepared by the Council at this meeting. For stocks where the Scientific Council can conduct risk analyses, the security margins (F_{buf} and B_{buf}) will be based on the risk levels specified by the Fisheries Commission. For stocks where risk analyses are not possible, the Fisheries Commission will specify the security margins.

Proposed NAFO PA Framework



Management Strategies and Courses of Action <i>(Time horizons and acceptable risk levels specified by managers)</i>	
Zone 1	Safe Zone: Select and set fishing mortality from a range of F values that have a low probability of exceeding Flim in a situation where stock biomass (B) has a low probability of being below Blim. In this area, target reference points are selected and set by managers based on socio-economic management objectives.
Zone 2	Overfishing Zone: Reduce F to below Fbuf.
Zone 3	Cautionary F Zone: The closer stock biomass (B) is to Blim, the lower F should be below Fbuf.
Zone 4	Collapse Zone: F should set as close to zero as possible.

Having adopted this revised PA framework, the Scientific Council **recommended** that: *a meeting of the Joint Fisheries Commission/Scientific Council Working Group on the Precautionary Approach be held to discuss the implementation of the revised PA framework.*

2. NAFO Scientific Council Observership at ICES ACFM Meetings

The Council addressed the availability of experts to represent NAFO Scientific Council at ICES Meetings. It was noted that most Scientific Council participants were busy with other activities during the spring ACFM meetings. Chris Darby indicated he would be in a position to obtain details.

3. Analytical Basis for an Interim Monitoring Evaluation

At its September 2002 Meeting, Scientific Council noted that the basis for the interim monitoring of stock status varies among stocks and a consistent analytical approach has yet to be determined. Following some discussion at the present meeting Scientific Council reiterated that the intent of the interim monitoring process is to determine whether there has been sufficient change in the status of a stock to warrant reconsideration of the multi-year advice developed in a previous year. While noting that the ultimate decision on the content of the interim monitoring report is the responsibility of the Designated Expert, Scientific Council agreed that an examination of catches and updated survey indices should be sufficient to make the status determination, and that model based approaches should not be necessary.

4. Facilitating Workload of Scientific Council during Annual Meeting in September

Scientific Council again discussed the issue of providing advice to the Fisheries Commission on Div. 3M and Div. 3LNO stocks of northern shrimp. A proposal was developed at the November 2002 Scientific Council Meeting in which the advice developed at the meetings in November will be evaluated at the following September Scientific Council Meeting based on additional data acquired during the interim. The evaluation will take the form of an interim monitoring report to determine if the additional information provides sufficient basis to alter the advice developed at the previous November meeting. If this arrangement proves to be problematic in September, Scientific Council may consider having the Div. 3LNO shrimp interim report evaluated at its June meetings.

5. Facilities and Technological Support

The implementation of a wireless LAN system at the PA Workshop and at the present June Scientific Council meeting has added a great deal of flexibility and increased efficiency in completing the meeting agenda. Scientific Council thanked the staff at the Northwest Atlantic Fisheries Centre, St. John's, Newfoundland and Labrador for providing their support and technological expertise for this LAN system.

At this June Scientific Council Meeting, the installation of Netmeeting software allowed direct control of the LCD projector from any station at the meeting. The Council agreed a similar wireless configuration will be required at future Scientific Council Meetings.

6. Reconsidering a Memorandum of Understanding with ICES

Further to Scientific Council comments of September 2002 regarding a possible Memorandum of Understanding (MoU) with ICES, the Executive Secretary reported that ICES had requested a revisit to the subject.

Upon further evaluation during this meeting, the Scientific Council agreed there would be benefits to developing an MoU. The Scientific Council accordingly, based on the initial proposed text submitted by ICES in 2002 (GC WP 02/4), prepared a revised text to focus on the needs of the Scientific Council. The suggested text was presented by the Council to the Executive Secretary with the intention that the Executive Secretary and the ICES General Secretary will pursue the matter further. Any further development will be reviewed by the Scientific Council at the September 2003 Meeting.

XIII. OTHER MATTERS

1. Report of 25th Session of the FAO Committee on Fisheries (COFI) Rome, Italy, 24-28 February 2003

In accordance with the Scientific Council recommendation of 2002, the Deputy Executive Secretary attended the Twenty-fifth Session of the Committee on Fisheries (COFI) of FAO. The Executive Secretary also attended.

The Twenty-fifth Session of the Committee on Fisheries was held in Rome, Italy, from 24 to 28 February 2003. The Committee approved a Strategy for Improving Information on Status and Trends of Capture Fisheries and recommended its further approval by the FAO Council. The Committee further recommended that monitoring of the implementation of the Strategy constitute an integral component of monitoring the implementation of the Code of Conduct for Responsible Fisheries. The Committee reaffirmed the need for global implementation of measures against Illegal, Unregulated and Unreported (IUU) fishing and recommended that IUU fishing be included in the Agenda of the Thirty-second Session of the FAO Conference with a view to calling attention of Members to this issue. The Committee recognized the crucial importance of the Code of Conduct and its related International Plan of Action (IPOA) in promoting long-term sustainable development of fisheries and encouraged Members to establish and implement National Plans of Action to put into effect the International Plans of Actions on Capacity, IUU Fishing, Sharks and Seabirds. The Committee agreed that the Director-General of FAO should enter into consultation with the United Nations Secretary-General with a view to defining practical modalities for the implementation of the (Part VII) trust fund, to facilitate the implementation of the 1995 UN Fish Stocks Agreement by developing States Parties, in particular the least developed among them and small island States. The Committee highlighted the importance of aquaculture and small-scale fisheries as means to increase fishery production to generate income and foreign exchange to alleviate poverty, to increase food security and to provide for diversification of employment. The Committee identified key priority areas of work for the FAO Fisheries Department during the biennium 2004-2005 and the areas of work for its Sub-Committees on Fish Trade and Aquaculture. The Committee agreed to the convening of a number of technical/expert consultations on specific areas of fisheries, including review of progress on promoting the implementation of IPOA-IUU and IPOA-Capacity, on port States measures to prevent, deter and eliminate IUU fishing, on sea turtles interactions and conservation, on subsidies and CITES related issues for commercially exploited aquatic species.

The full meeting report, due to be approved by the FAO Council in June 2003, will be made available through by a direct link from the NAFO website.

The next meeting of COFI is scheduled for February 2005, at FAO Headquarters, Rome, Italy.

2. Report of Regional Fishery Bodies (RFB) Meeting, Rome, Italy, 3-4 March 2003

In accordance with the Scientific Council recommendation of 2002, The NAFO Deputy Executive Secretary attended the Third Meeting of Regional Fishery Bodies. The Executive Secretary also attended. The Deputy Executive Secretary was appointed rapporteur. The FAO Fisheries Department provided the Secretariat for the Meeting.

The Third Meeting of Regional Fishery Bodies was held on 3 and 4 March 2003 at FAO Headquarters, Rome. Participants included representatives from 27 Regional Fishery Bodies and from the Coordinating Working Party on Fishery Statistics (CWP).

The Chair (Robin Allen, IATTC), opened the Meeting and expressed appreciation to FAO on behalf of the RFB for facilitating this meeting and work during the inter-sessional period. Mr. Ichiro Nomura, Assistant Director-General, FAO Fisheries Department, addressed the participants referring to the unprecedented challenges RFB are facing, noting their role of promoting responsible behaviour in the fisheries sector. He stated that cooperation and coordination among RFB is a goal that should be fostered, and commended the RFB for having seized the initiative. FAO will seek to cooperate with RFB and complement their decisions.

From among the many items discussed (SCS Doc. 03/18) this summary focuses on the interests to the Scientific Council (see complete report of the meeting at <ftp://ftp.fao.org/docrep/fao/005/y4654e/y4654e00.pdf>).

Noting the RFB was scheduled for just after the FAO Committee on Fisheries (COFI), the meeting referring to the draft report of the Twenty-Fifth Session of COFI, identified the following as important to RFB:

- The value of State of the World Fisheries and Aquaculture (SOFIA), Aquatic Sciences and Fisheries Abstracts (ASFA), Fisheries Global Information System (FIGIS) and involvement of RFB
- Regional plans of action

- Role of RFB in adopting listings for fishing vessels
- Strengthening RFB, Compliance Agreement: relevant port State measures; improving and extending catch documentation; decommissioning and scrapping of vessels
- FAO's role in disseminating information about activities of RFB in deep sea fisheries
- International cooperation in making VMS more effective
- FAO guidelines on eco-labeling to include fish caught in compliance with RFB rules
- Harmonization of catch certification, noting tuna bodies are considering this
- Status and Trends reporting and strategies, roles for RFB
- Implications of the ecosystem approach to fisheries management – need for close cooperation within RFB
- Cooperation with Convention on International Trade in Endangered Species (CITES).

The Meeting discussed the issue of cooperation with CITES at length, with some participants referring to their cooperation with CITES and others expressing concern about its scientific basis for listing species on CITES appendices. It was noted that FAO members have agreed that FAO become more involved in matters relating to CITES listing with respect to commercially exploited aquatic species in consultation with RFB, and it was suggested that RFB in contact with CITES keep other bodies informed. The FAO Secretariat advised the Meeting it was prepared to continue acting as a conduit between the CITES Secretariat and RFB.

RFB noted external factors can have more significant effects on the stocks than management actions, particularly referring to pollution, river outflows, population growth, aquaculture and other man-made factors as major concerns affecting habitat modification. There was also concern about loss of genetic diversity.

The Meeting reviewed the status of partnerships between RFB and FAO, to develop Fisheries Resources Monitoring System (FIRMS) FAO presented a general introduction (see also Appendix III., Section 5 in the report on this subject). In discussion it was noted that RFB increasingly operate in a global context. One RFB was mandated in principle to join the proposed partnership, some RFB had not been approached and many will bring the matter to the attention of their members. The potential benefits to members and costs to the organization will be considered.

A number of RFB reported on their progress in implementing approaches to incorporate ecosystem considerations into fisheries management. Several RFB are engaged in ecosystem modeling to provide insight into the effects of fisheries on the ecosystem.

It was agreed that the Fourth Meeting of Regional Fishery Bodies will be held after the Twenty-sixth Session of COFI, and will take place in early March, 2005 at FAO headquarters in Rome.

3. Meeting Highlights for NAFO Website

The Chairs of each Committee submitted highlights of the meetings to the Secretariat. These will be placed on the website after this meeting.

4. Other Business

The Council discussed potential areas of funding needed for its business in 2004. The Council noted 2 upcoming events:

- a) The possible Study Group for the estimation of limit reference points under the Precautionary Approach, for the consideration of implementation of the framework.
- b) The Symposium on ecosystem considerations of the Flemish Cap.

The Council noted these events will ideally have invited experts or speakers, and the Council **recommended** that *the estimated \$10 000 should be allocated from the 2004 budget, to accommodate the costs of the 2 proposed upcoming events of the Scientific Council.*

XIV. ADOPTION OF COMMITTEE REPORTS

The Council, during the course of the meeting reviewed the Standing Committee recommendations. Having considered and endorsed each recommendation and also the text of the reports, the Council **adopted** the reports of STACFEN, STACREC, STACPUB and STACFIS. It was noted that some text insertions and modifications as discussed at the Council plenary will be incorporated later by the Chairman and the Deputy Executive Secretary.

XV. SCIENTIFIC COUNCIL RECOMMENDATIONS TO GENERAL COUNCIL AND FISHERIES COMMISSION

The Council Chair undertook to address the recommendations from this meeting and to submit relevant ones, as follows to the General Council and Fisheries Commission:

1. *the Deputy Executive Secretary attend the CWP Intersessional Meeting to be held in 2004.*
2. *a meeting of the Joint Fisheries Commission/Scientific Council Working Group on the Precautionary Approach be held to discuss the implementation of the revised PA framework.*
3. The Council discussed potential areas of funding needed for its business in 2004. The Council noted 2 upcoming events:
 - a) The possible Study Group for the estimation of limit reference points under the Precautionary Approach, for the consideration of implementation of the framework.
 - b) The Symposium on ecosystem considerations of the Flemish Cap.

The Council noted these events will ideally have invited experts or speakers, and the Council **recommended** that \$10 000 should be allocated from the 2004 budget, to accommodate the costs of the 2 proposed upcoming events of the Scientific Council.

XVI. ADOPTION OF SCIENTIFIC COUNCIL REPORT

At its concluding session on 19 June 2003, the Council considered the Draft Report of the meeting, and **adopted** the report with the understanding that the Chair and the Deputy Executive Secretary will incorporate later the text insertions related to plenary sessions of 5-19 June 2003 and other modifications as discussed at plenary.

XVII. ADJOURNMENT

There being no other business, the Chair thanked the members of the Scientific Council for their diligent work and cooperative spirit, noting especially the contributions by the Committee Chairs and the Designated Experts. After expressing special thanks to the NAFO Secretariat for their continued support and dedication, the Chair of the Scientific Council wished all members safe travels. The meeting was adjourned at 1145 hours on 19 June 2003.

APPENDIX I. REPORT OF THE STANDING COMMITTEE ON FISHERIES ENVIRONMENT (STACFEN)

Chair: Eugene Colbourne

Rapporteur: Ken F. Drinkwater

The Committee met at Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, on 6-12 June 2003, to consider environment-related topics and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Germany, Portugal, Spain, and United Kingdom), Japan, Russian Federation and United States of America.

1. Opening

The Chair opened the meeting by welcoming participants to this June meeting of STACFEN. The Chair welcomed Dr. Trevor Platt from the Bedford Institute of Oceanography in Dartmouth, Canada as this year's invited lecturer.

2. Chair's Introduction, Report on Intersessional Activities

The primary work of the Chair between sessions was involved in preparing and organising material for this June 2003 STACFEN Meeting. In addition, STACFEN provided a presentation of scientific advice on decadal trends in environmental conditions in the NW Atlantic and its possible impact on finfish and invertebrates to the 24th Annual Meeting of the Fisheries Commission, 16-20 September 2002, Spain. The Committee also provided research documents and presentations on the oceanographic conditions in Div. 3M and 3LNO (SCR Doc. 02/152) in support of the November 2002 meeting of Scientific Council on assessment of Northern Shrimp. This was the 10th such review presented to Scientific Council in support of the assessment of shrimp in Div. 3M. A research document (SCR Doc. 02/153) was also presented detailing the distribution and abundance of northern shrimp (*Pandalus borealis*) in relation to bottom temperatures in Div. 3LNO based on multi-species surveys from 1995-2002.

3. Agenda and Plan of Work, Appointment of Rapporteur

The Committee **adopted** the agenda and discussed the work plan and noted the following documents would be reviewed: SCR Doc. 03/03, 04, 10, 14, 19, 21, 22, 27, 30, 31, 32; SCS Doc. 03/06, 08, 10, 15 and 16. Ken F. Drinkwater (Canada) was appointed rapporteur.

4. Review of Recommendations in 2002

a) From the June 2002 Meeting

Four recommendations were made by STACFEN during its meeting in June of 2002.

- i) STACFEN had recommended that *the proceedings of the mini-Symposium on "Hydrographic Variability in NAFO Waters for the Decade 1991-2000 in Relation to Past Decades" be published in a special issue of the Journal of the Northwest Atlantic Fisheries Science.*

Ken Drinkwater (Canada) reported on the progress of this publication as detailed below in Section 5.

- ii) STACFEN had recommended that *further studies be conducted attempting to link climate and fisheries and to bring forward such studies for review at STACFEN.*

The Chair reported that several presentations related to this topic are on the agenda (see Section 11 below). In addition, the Chair noted ongoing work by the Fisheries Oceanography Committee of the Canadian Department of Fisheries and Oceans, which is currently examining the response by various marine species in the waters of Atlantic Canada to the warm period of the late-1990s, especially 1999.

- iii) STACFEN had recommended that *the STACFEN Chair, or designate, be included in the presentation of scientific advice from the Scientific Council to the Fisheries Commission at its September 2002 meeting, and further that such presentations be made every 5 years or more frequently if significantly large changes in the environment are observed.*

The Chair reported that his designate Manfred Stein from (EU/Germany) presented the scientific advice on environment and its possible impact on finfish and invertebrates to the 24th Annual Meeting of the Fisheries Commission, 16-20 September 2002, Spain. It was also noted that environmental conditions during 2002 were not significantly different from 2001 and therefore similar advice will not be presented during the September 2003 Annual Meeting.

- iv) STACFEN had recommended that *the an annual climate status report beginning in 2003 to describe environmental conditions during the previous year be produced, that this be compiled prior to the annual June Meeting and posted prominently on the NAFO website.*

The Chair reported that an interim report was posted on the NAFO web site during the 2002 Meeting and the preparation of the 2003 report covering most of the NAFO Convention Area was in progress (details are provided in Section 10 below).

5. **Progress Report on Publication of Proceedings of the Mini-symposium on Hydrographic Variability in NAFO Waters 1991-2000**

STACFEN noted that Ken F. Drinkwater (Canada) and Eugene B. Colbourne (Canada) were the appointed co-editors. Ken Drinkwater reported that of the 8 papers presented at the mini-symposium, 6 have been reviewed, of which 4 have been revised and are undergoing editorial corrections and 2 are awaiting revision. Two papers have not been submitted, but the authors have indicated that these should be submitted by the end of June 2003. The co-editors indicated that all papers for completion of this special issue of the *Journal of the Northwest Atlantic Fisheries Science* should be ready before the September 2003 Meeting of the Council.

6. **Invited Lecture**

The Chair introduced this year's invited speaker, Trevor Platt (Bedford Institute of Oceanography in Dartmouth, Canada). The Committee was informed his research deals with the structure and function of the pelagic ecosystem from both theoretical and observational points of view. His current work deals with the impact of climate change and variations on the pelagic ecosystem. He is also interested in marine optics, and has been engaged in applications of ocean-colour data to problems in biological oceanography, including fisheries issues.

Dr. Platt has been a long time advocate of satellite remote sensing, and its application to the problems of quantifying primary production in the ocean. His talk entitled "*Climate, Weather and the Pelagic Ecosystem*", by Trevor Platt and César Fuentes-Yaco, presented as an abstract here, is based in part on the paper: Platt, T., C. Fuentes-Yaco and K. T. Frank. - 2003 - [Spring algal bloom and larval fish survival](#). - *Nature*, 423, 398-399"

"Using remotely-sensed data on ocean colour, we have established a time-series of the distribution of chlorophyll concentration and sea-surface temperature in the Canadian Atlantic Zone with resolution 1 week in time and roughly 1 km in space. These data provide a context for research programs in which problems can be addressed that were previously intractable because of under sampling.

For example, we have studied the changes in the pelagic ecosystem in the North Atlantic Zone of Canada in response to tropical storms. Passage of the storms results in vertical mixing which reduces the surface temperature and brings nutrients to the surface layer with the consequent increase in chlorophyll concentration. We illustrate this response for three storms in 1998, a very severe storm season. The increment in chlorophyll concentration represents new production. It remains to quantify the total impact on the trophic economy of the ecosystem in a given year and its variations between years.

Another application relates to recruitment of haddock. From the satellite time series, we can extract the following properties of the spring phytoplankton bloom for each year covered (1997 to present): timing of

initiation, timing of peak, amplitude and duration for each of the 1.5 million pixels in the NW Atlantic. These data form the raw material for an operational test of the match/mismatch hypothesis of Cushing. The test was made on the Eastern Scotian Shelf (Div. 4VW) haddock fishery, for which annual survey data are available. We find that some 85% of the variance in abundance of age-1 year class normalized to spawning stock biomass can be explained in a linear regression with timing of bloom peak as independent variable. The results are suggestive that the variance in larval survival may indeed have a detectable component that is associated with interannual variability in the spring bloom. The data series on survival of larval haddock (1970 to present) contains two instances of very strong year classes: both of these occurred in years with abnormally early spring blooms. The null hypothesis that interannual variation in larval survival is independent of fluctuations in timing of the spring bloom will probably have to be rejected."

7. **Marine Environmental Data Service (MEDS) Report for 2002** (SCR Doc. 03/27)

Since 1975, MEDS has been the regional environmental data centre for ICNAF and subsequently NAFO and as such is required to provide an inventory of all environmental data collected annually by contracting countries of NAFO within the convention area. The following is the inventory of oceanographic data obtained by MEDS during 2002 and information on several new initiatives.

a) **Hydrographic Data Collected in 2002**

Data from 4 276 oceanographic stations collected in the NAFO area sent in delayed mode to MEDS in 2002 have been archived, of which 3 078 were CTDs, 617 were BTs and 581 were bottles. A total of 5 088 stations were received through IGOSS (Integrated Global Ocean Service System) and have been archived, of which 770 were BTs and 4 318 were TESAC messages.

b) **Historical Hydrographic Data Holdings**

Data from 12 579 oceanographic stations collected prior to 2002 were obtained and processed during 2002, of which 1 299 were vertical CTDs, 6 018 were towed CTDs, 2 253 were BTs and 3 009 were bottle data.

c) **Thermosalinograph Data**

A number of ships have been equipped with thermosalinographs to collect surface temperature and salinity data while the vessels are under way. These are transmitted as station data via satellite and radio links with over 1 389 stations in the Northwest Atlantic being received during 2002, down significantly over the 28 130 stations received during 2001.

d) **Drift Buoy Data**

A total of 77 drift-buoy tracks within NAFO waters were received by MEDS during 2002 representing 7 074 buoys and over 200 buoy months data. The total number of buoys decreased by 41 over 2001.

e) **Wave Data**

During 2002, MEDS continued to process and archive operational surface wave data on a daily basis around Canada. One-dimensional and directional wave spectra, calculated variables such as the significant wave height and peak period, concurrent wind observations, if reported, and the raw digital time series of water surface elevations were stored. A total of 8 wave buoy stations were operational in the NAFO area during 2002 compared to 15 during 2001.

f) **Tide and Water Level Data**

During 2002, MEDS continued to process and archive operational tides and water level data that are reported on a daily to monthly basis from the Canadian water level network. MEDS archives observed 15-minute heights, hourly heights and monthly instantaneous extremes collected around Canada. Approximately 70 000 new readings are updated every month from the network. The historical tides and

water level data archives presently hold over 30 million records with the earliest dating back before 1900. A total of 28 stations were processed during 2002, a decrease of 18 stations from 2001.

g) **Current Meter Data**

A total 74 current meter instruments were recovered in the NAFO area during 2002 and an additional 28 instruments were deployed. These included both conventional current meters and Acoustic Doppler Current Profilers (ADCPs). The recovered data are processed at the Bedford Institute of Oceanography (BIO) and are available on the web (<http://www.maritimes.dfo.ca/science/ocean/welcome.html>).

h) **Recent Activities**

MEDS reported on four other initiatives during 2002:

- i) Argo is an international program to deploy profiling floats on a 3° by 3° grid in the oceans of the world. Each profiling float samples and reports both temperature and salinity from 2000 m to the surface every 10 days. Data are distributed both on the Global Telecommunications System (GTS) and from two Internet servers within 24 hours of the float reaching the surface. MEDS carries out the processing of the data received from Canadian floats, to distribute the data on the GTS, to distribute the data to the Argo servers and to handle the delayed mode processing. As well, MEDS has developed a Canadian web site (http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Prog_Int/argo/ArgoHome_e.html) that contains information about the Canadian floats, as well as some general information and statistics about the global array. General information is also available from the Argo Information Centre in Toulouse. In September 2002, Canada (MEDS) hosted the second Argo Data Management meeting with R. Keeley (MEDS) and S. Pouliquen (IFREMER, France) as co-chairs. Topics discussed included review of national systems, real-time and delayed mode quality control (QC) procedures and long-term archiving. Representatives from Canada, Korea, Germany, Chile, India, Peru, France, China, Japan, Russia, UK, USA and Australia attended the meeting.
- ii) The International Oceanographic Data and Information Exchange (IODE) Steering Group for Global Ocean Surface Underway Data (GOSUD) (formerly Underway Sea Surface Salinity Data) Pilot Project was established during IODE-XVI. The objective of the project is to organize surface salinity data that are currently collected and to work with data collectors to improve data collection to meet the benchmarks of spatial and temporal sampling and data accuracy set out by the Ocean Observations Panel for Climate (OOPC). The second meeting of interested participants took place at MEDS in Ottawa in September of 2002 with R Keeley (MEDS) and T. Delcroix (France) as co-chairs. The agenda included discussion of recent developments, review of draft project plan, products, transfer, processing and archiving and data collection. Attendees included representatives from Canada, USA, China, Australia, France, Russia, UK, ICES and IOC.
- iii) The Canadian DFO's Atlantic Zone Monitoring Programme (AZMP) activities include regular sampling for 6 fixed stations and 13 standard sections, and research surveys in the AZMP area to collect other physical, chemical and biological data. As part of MEDS' activities in the data management team, MEDS continues to build and maintain the AZMP website: http://www.meds-sdmm.dfo-mpo.gc.ca/zmp/main_zmp_e.html. Physical and chemical data from 1999 to the present are currently available on the web site. Climate indices have also been added to show long-term trends of physical variables. Water level data from 9 gauges dating from 1895 to present are also available. Biological data are stored in a nationally distributed database (BIOCHEM) that is presently being developed by DFO (Bedford Institute of Oceanography and MEDS). Graphical representations of biological data (phytoplankton) are currently being displayed on the website. The Sir Alister Hardy Foundation for Ocean Science (SAHFOS) is an international non-profit organization that operates the Continuous Plankton Recorder (CPR) survey. The CPR data for the AZMP area is presently made available from the MEDS website. Recent additions to the website during 2002 include subsets of meteorological data (solar radiation, hourly weather and rate of rainfall) from Environment Canada for several stations and easier procedures for downloading the zipped station and section data.

- iv) The Centre for Marine Environmental Prediction (CMEP) is an initiative of the Department of Oceanography at Dalhousie University, Halifax, Nova Scotia, Canada. The goal of CMEP is physical, chemical and biological predictions in the marine environment using numerical models guided and tested with environmental observation systems. Observations and predictions will be made available with the help of visualization tools. CMEP will deploy observation systems in three different ocean environments: Bay (Lunenburg Bay, Nova Scotia), Shelf (Charlottetown, Prince Edward Island, Canada) and Basin (North Atlantic). The Lunenburg Bay component was started in 2002. As a major collaborator, MEDS will address data archive/protection, quality control and processing and distribution of data and products to the public through DODS and EPIC servers. Other partners involved include DFO-BIO, Environment Canada, Defense Research Establishment Atlantic (DREA) and Satlantic.

8. Review of Environmental Studies in 2002

Hydrographic observations were conducted along the standard sections off the west coast of Greenland during two groundfish surveys in the summer of 2002 (SCS Doc. 03/16, SCR Doc. 03/03). The 2002 survey was carried out according to the agreement between the Greenland Institute of Natural Resources and Danish Meteorological Institute during the period 2-9 July 2002. In late July/early August the Greenland Institute for Natural Resources also carried out trawl surveys in the Disko Bay area and further north on board F/V "Paamiut". During this survey CTD measurements were carried out on national oceanographic standard stations.

During the German groundfish survey off West Greenland (11 October-21 November 2002), oceanographic measurements were performed at 33 fishing stations using a CTD/Rosette (SCS Doc. 03/08). Additionally, temperature and salinity along the Cape Desolation, and Fyllas Bank NAFO standard sections were measured in order to describe climate trends.

A description of environmental information collected in the Newfoundland and Labrador Region during 2002 was presented (SCS Doc. 03/10). This included physical, chemical and biological data collected as part of the Atlantic Zonal Monitoring Program, which began in 1998. This program was established to include biological and chemical oceanographic monitoring at a fixed coastal station (Station 27) at biweekly intervals and on cross-shelf sections. The Newfoundland and Labrador Region of DFO conducted three annual physical/biological oceanographic surveys during 2002 along several cross-shelf NAFO and AZMP sections from the Southeast Grand Bank to Nain Bank on the mid-Labrador Shelf. These surveys were conducted during mid-spring, summer and during autumn. The main objectives were to establish the seasonal and spatial distribution and abundance of nutrients, plant pigments (phytoplankton) and micro and mesozooplankton in relation to the physical environment. Physical, biological and chemical variables being monitored include temperature, salinity, dissolved oxygen and ocean currents as well as measures of primary and secondary production and biomass, species composition of phytoplankton and zooplankton and nutrients.

Environmental research activities conducted by the Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), in Kaliningrad Russia were presented in SCS Doc. 03/06 Part 1. In 2002, monitoring of sea surface temperatures at 13 selected points located on the shelves of Labrador, Newfoundland, Nova Scotia and adjacent ocean areas and the location of hydrological fronts from the area southwards of the New England and Nova Scotia shelves between 55° and 70°W was continued. The Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Murmansk Russia also conducted hydrographic observations from the RV Remøyfjord. In all, 31 hydrographic stations were made within the depth range of 130-1 075 m in Subarea 3 on the Flemish Cap. In addition, a brief review of hydrographic investigations conducted by the PINRO institute in Subareas 2 and 3 during the past 40 years was presented in SCR Doc. 03/22.

Hydrographic observations were conducted by the Instituto Español de Oceanografía in Vigo Spain (SCS Doc. 03/11) during a stratified random bottom-trawl survey that was carried out on Flemish Cap on board R/V *Cornide de Saavedra* in July 2002. The survey was performed from 30 June to 17 July with a total of 120 CTD stations.

The United States Research Report listed several ongoing oceanographic, plankton and benthic studies conducted by the Northeast Fisheries Science Center (NEFSC) at Woods Hole, USA for NAFO Subareas 5 and 6 (SCS Doc. 03/15). During 2002, more than 1 600 CTD (conductivity, temperature, depth) profiles were made on NEFSC cruises. These data have been processed and made available on an anonymous FTP site. A report on the oceanographic conditions indicated by these observations has been issued and is available via <http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0305/>. Similar reports have been issued for each year since 1991. The Georges Bank GLOBEC program has begun a synthesis phase in which results from the various components of the program will be integrated to provide a greater understanding of how environmental variability influences the Bank's ecosystem, particularly the plankton populations. A number of studies are underway focusing on both the zooplankton populations and the early life stages of the cod and haddock stocks on Georges Bank. The synthesis effort is scheduled to continue for four years. Laboratory studies have been completed evaluating the growth, metabolism, and growth efficiency of larval and juvenile cod and haddock at different temperatures.

9. Review of the Physical, Biological and Chemical Environment in the NAFO Convention Area during 2002

a) General Meteorological, Sea-Ice and Sea-Surface Temperature Conditions.

A review of meteorological, sea ice and sea surface temperature conditions in the Northwest Atlantic in 2002 was presented (SCR Doc. 03/30). During 2002, the NAO index was below normal for the second consecutive year indicating a weakening of the Icelandic Low and Azores High during the winter. Annual mean air temperatures over the northwest Atlantic region were above normal during the year although from Greenland to the Scotian Shelf they decreased on the order of 1°C compared to 2001. In contrast, over the Gulf of Maine and the Middle Atlantic Bight annual air temperatures rose relative to the 2001 values. The relatively warm winter temperatures in eastern Canada resulted in less ice than normal off Newfoundland and Labrador, and in the Gulf of St. Lawrence. Ice generally arrived late. Its departure was early in the Gulf, causing a shorter duration than usual. Off Newfoundland, although there was less ice than normal, it remained around longer-than-usual and contributed to a longer than average duration of sea ice. Little ice reached the Scotian Shelf proper for the fifth consecutive year and seaward of Cabot Strait the integrated ice area over the ice season was the second lowest in the 41-year record. The number of icebergs that reached the Grand Bank was 877, significantly higher than 2001 when only 89 bergs were spotted on the Banks. The analysis of satellite data indicates that most of the Northwest Atlantic experienced above normal sea-surface temperatures in 2002.

The results of SST monitoring in the Labrador Current and Gulf Stream between 40°-55°N and 45°-65°W and dynamics of the water mass boundaries at the surface area between 37°-47°N and 55°-70°W (the boundary of the Cold shelf water mass, the Slope water mass and the northern boundary of the Gulf Stream front) for 2002 were presented (SCR Doc. 03/21). The average monthly deviations of SST values from the long-term average values for 1977-96 and deviations of long-term average indices of the water boundary locations from their long-term averages for 1962-92 were presented. During 2002, SST values in the most selected areas within the Labrador Current system were higher than or closer to normal, however, it was lower than in 2001. Within the Gulf Stream region (including the Nova Scotia shelf, the Slope water mass off the shelf and near the Gulf Stream front), SST values exceeded their long-term averages and were higher than in 2001. The analysis of the three water mass boundaries (the cold shelf water, the Slope water and the northern edge of the Gulf Stream front) in 2002 for three selected areas (New England, 66°-70°W; Nova Scotia, 59°-65°W; and Laurentian Channel, 55°-58°W) revealed that these boundaries had shifted northwards of their long-term average positions or close to them, during 2002. Only in the New England area was the Gulf Stream front located south of its long-term mean.

b) Results of Physical and Biological Oceanographic Studies

Subareas 0 and 1. Results of the 2002 Danish summer surveys to the standard sections along the west coast of Greenland were presented together with CTD data gathered during their trawl surveys (SCR Doc. 03/03). The surface temperatures and salinities show cold and low salinity conditions observed close to the coast off southwest Greenland that reflect inflow of Polar Water carried by the East Greenland Current. Water of Atlantic origin ($T > 3^{\circ}\text{C}$; $S > 34.5$) was found at the surface only at the 3 outermost stations on the Cape Farewell Section. The surface salinity general appears to be relative low, especially on the western part of the area. The 2002 mean salinity value (33.41) on top of Fylla Bank was similar to that in 2001 and equal to the long-term average. In the surface layer (0-100 m) relatively strong gradients between the cold, low-saline Polar Water and the warm, high-saline water of Atlantic origin was observed only at the Cape Farewell section, although the gradient even here was less pronounced than in previous years. On the more northern sections, the lack of strong gradients between the cold, low saline Polar Water and the warm, saline Atlantic Water was unusual. This suggests a reduction in the East Greenland Current component, as well as a lower-than-normal inflow of water of Atlantic origin. Temperature and salinity observations at greater depth showed that pure Irminger Water ($T \sim 4.5^{\circ}\text{C}$, $S > 34.95$ PSU) was hardly present at the Cape Farewell section, and was certainly not observed further north. Modified Irminger Water ($34.88 < S < 34.95$) was traced only as far north as the Fylla Bank section where only small amounts were present at Fylla Bank Station 5. Northwest Atlantic Mode Water ($3.5 < T < 4.5$; $34.5 < S < 34.88$) was observed at all sections from Cape Farewell to Nugssuaq. In general the inflow of Polar Water, as well as Irminger Water, was less-than-normal in 2002.

Results of the 2002 German autumn survey to the standard sections along the west coast of Greenland were presented in SCR Doc. 03/04. Air temperature conditions around Greenland continued to be warmer-than-normal, consistent with the negative NAO index during 2002. Based on satellite derived ice charts and sea surface temperature (SST) anomaly maps for all months of 2002, the distribution of ice in the southwestern area off West Greenland, and especially in the Julianehaab Bight, is reflected in the SST anomalies. During all months in 2002 except December, the surface waters in the southern area off West Greenland were colder than normal. During winter and spring SST anomalies indicate considerable warming exceeding 3.5K in the central Labrador Sea. Colder-than-normal SSTs in the region of Fyllas Bank during most of the second half of 2002 were confirmed by direct measurements during the German surveys. Subsurface oceanographic data from Fyllas Bank reveal considerable cooling in the upper 200 m during autumn 2002. Irminger Water was not found at Fyllas Bank during autumn 2002. In the near-bottom water layer at about 3 000 m depth off Cape Desolation, freshening of the Denmark Strait Overflow water mass was observed.

Subareas 2, 3. Hydrographic conditions on Flemish Cap in July 2002 were described from a Spanish survey with 120 CTD stations (SCR Doc. 03/32). Horizontal temperature distributions show that near surface temperatures reached 10°C in the central part of the Bank and decreased northwards with values below 2°C . At 50 m, temperature ranged between 3°C and 5°C . At 100 m, temperature ranged from 3.5°C in the north to 5°C in the south while at 200 m, temperature ranged between 3.5°C and 4.5°C . Horizontal salinity distribution at 10 m depth show salinities ranged between 33.4 in the southwest and 34.2 in the east; at 50 m depth they ranged between 34.0 in the southeast and 34.5 in the west; at 100 m salinities ranged between 34.4 - 34.6 and at 200 m between 34.7-34.8. In general, it was observed that at the surface, fresher water (33.7) came from the west and salinity increases with depth reaching 34.8 at 200 m. Vertical distributions of temperature and salinity in the north-south transect showed a strong gradient in the upper 30 m with temperature decreasing towards deeper waters to 3.5°C in the North, but being warmer in the South. Salinity increased progressively from 33.8 in surface layers to about 34.8 at the bottom. In the east-west transect, a weak tongue of cold water ($t < 3.5^{\circ}\text{C}$) was observed on both sides of the bank. Temperature/salinity properties of the waters over the Cap in 2002 showed typical Labrador Current Water with temperatures $< 4^{\circ}\text{C}$. Below 100 m, North Atlantic water dominated with temperatures $> 4^{\circ}\text{C}$ and salinities of about 34.85. In general, temperatures increased from the mid-1990s until 1999. Waters above 100 m in 2001 were warmer ($+1^{\circ}\text{C}$) and saltier ($+0.5$) than the mean of the past 25 years. Temperatures in that layer in 2002 decreased to values closer to the long-term mean.

Hydrographic observations made on the Flemish Cap in Subarea 3 during 31 May to 10 June 2002 during the Russian multi-species trawl research survey (SCS Doc. 03/06) showed temperature within the range of

5°C at the surface to 3.5°C at 100-150 m depth. Bottom temperatures fluctuated from 3.4°C to 3.9°C. Salinity generally varied from 34.3 in the surface layers to 34.9 near the bottom and at the depth of over 400 m. In the surface layer, water temperature gradually increased from the northwest (3.0°C) to the southeast (6.7°C) (Fig. 3). Surface salinity distributions were more complicated due to precipitation and winds. On the surface, the salinity varied within the range of 33.6-34.5. The waters with higher salinity were located in the eastern areas. At 100 m, as well as at the surface, the temperature increased from the northwest from 2.7°C to the southeast to 4.8°C. In the bottom layer, the temperature variations from 3.3°C to 3.9°C were considered negligible. The comparative analysis of water temperatures showed that to the north of 47°N, the mean temperature in 2002 was higher by 0.2°-0.6°C than in 2001. Along 47°N, water temperature and salinity practically remained unchanged in all the layers. In the section along 46°30', the water temperature in the 0-200 m layer during 2002 was higher by 1.9°-2.2°C, than in 2001 and the salinity was lower by 0.3-0.4. In waters below 300 m, the values of temperature and salinity essentially remained unchanged.

Oceanographic observations in Subareas 2 and 3 on the Newfoundland and Labrador Shelf during 2002 referenced to their long-term (1971-2000) means were presented in SCR Doc. 03/14. At Station 27, water temperatures observed during 2002 decreased compared to 2001 values, but remained above the long-term mean over most depths. Water salinities observed at Station 27 increased over 2001 to above normal conditions and the highest in 12 years. The cross-sectional areas of <0°C (CIL) water were below normal along all sections from the Grand Bank (Flemish Cap section), to the Seal Island section off southern Labrador. Off Bonavista the CIL area was very similar to that in 2001, below normal for the 8th consecutive year and among the lowest observed since 1978. Bottom temperatures on the Grand Banks during the spring of 2002 ranged from near normal to above normal (up to 0.5°C) over most areas. During the fall, bottom temperatures were generally above normal, except for the shallow waters of the southeast Grand Bank, where they were as low as 2°C below normal. Fall bottom temperatures in Div. 2J and 3K were above normal in most areas, up to 2°C on Hamilton Bank and up to 1°C on Funk Island Bank. In general, over all areas of the Newfoundland Shelf, the near-bottom thermal habitat continued to be warmer than that experienced from the mid-1980s to the mid-1990s. The below-normal trend in water temperature, established in the late-1980s, reached a minimum in 1991 and continued below normal up to 1995. After 1995 temperatures began to moderate and by 1996 were above normal in many areas. During the latter part of the 1990s temperatures continued to increase reaching a maximum in 1999 and have continued above normal up to 2002. Water salinities on the Newfoundland Shelf also reached near-record lows in the early-1990s, remained below normal throughout most of the 1990s and up to 2001. During 2002 however, there was a significant increase with surface salinities being the highest observed in over a decade.

Biological oceanographic observations from a fixed coastal station and oceanographic sections in Subareas 2 and 3 during 2002 were presented and referenced to previous information from earlier periods when data were available (SCR Doc. 03/19). The spring bloom at Station 27 in 2002 was much stronger compared to previous years. The trend in optical conditions at Station 27 was not consistent with the general reduction in attenuation across different oceanographic sections and seasons in 2002, leading to deeper euphotic depths. Water column stability and heating, inferred from stratification and integrated temperature, showed consistent trends between the seasonal occupations at Station 27 and oceanographic sections. The seasonal inventories of silicate and nitrate in the upper 50 m were 2-3-fold higher along most oceanographic sections compared to earlier years (2000 and 2001). Similar positive trends in the deep layers were apparent for the southern Grand Bank, but smaller differences were observed along the other sections. Although the spring chlorophyll-a levels (proxy of phytoplankton biomass) were higher in 2002 at Station 27 compared to earlier years, the pattern at the fixed station was not reflected in the offshore waters, where a decreasing trend was observed along the sections. The abundance of the copepodite stage of small and large copepod species was comparable to previous years. The development and production of dominant copepod species in 2002 was similar to 2000 and earlier than observed in 2001. The relative abundance and occurrence of copepod species normally found in colder waters increased in contrast to warm water species.

Subareas 4. Warm and salty conditions tended to dominate most of the Scotian Shelf and Gulf of Maine areas in 2002 (SCR Doc. 03/31). Mean annual sea-surface temperature at Boothbay Harbor was the 3rd warmest in 97 years and St. Andrews the 9th warmest in 81 years. Particularly warm waters were observed in the Gulf of Maine for all depths at Prince 5, the long-term monitoring site in the Bay of Fundy, in

Georges Basin, on Georges Bank and on Lurcher Shoals. Where data were available, such as at Prince 5, waters were generally saltier-than-normal. At Halifax Station 2 (H2), the surface and near bottom layers were warmer-than-usual but at mid-depths they varied through the year between colder and warmer than average. Waters at all depths at H2 tended to exhibit above normal salinities. Similarly warm waters were found in the deepest reaches of Emerald Basin and in the upper 50 to 100 m over Misaine Bank and on Sydney Bight. In these latter two areas, the lower layer waters tended to be cold. Cabot Strait deep-water (200-300 m) temperatures measured on the high side of normal. Exceptions to the warm conditions included the SSTs at Halifax as well as over most of the Scotian Shelf during the groundfish survey in July.

Subsurface temperatures and salinities on the Shelf varied spatially but tended to be dominated by positive anomalies. There was a noticeable increase in bottom temperatures compared to 2001, however. The vertical stratification in the upper water column (between surface and 50 m) over the Scotian Shelf continued to weaken in 2002 relative to the last few years, and was below normal for the second consecutive year. The surface manifestations of the Shelf/Slope front and the Gulf Stream were located, on average, at about the same locations as in 2001, which was shoreward of its normal position for the Gulf Stream but seaward for the Shelf/Slope front.

Subareas 5 and 6. Temperature and salinity observations from 12 surveys conducted during 2002 by the Northeast Fisheries Science Center in Subareas 5 and 6 during 2002 indicate that the Gulf of Maine and the Middle Atlantic Bight were considerably warmer in 2002 than the long-term means. The 2002 temperatures also were generally warmer than other recent years-particularly for the Middle Atlantic Bight from January through April. The large, positive temperature anomalies were not an artifact of warmer, offshore Slope Water encroaching onto the shelf. The warmer temperatures occurred widely over the Middle Atlantic Bight. During 2002 salinity anomalies generally increased from near zero or negative values at the beginning of the year to be positive by the end of the year. The exception to this pattern was in the southern Middle Atlantic Bight where the salinity anomalies at both the surface and bottom decreased during the second half of 2002. In general temperatures over the region were higher than recent years and higher than a decade-long reference period (1978-87), particularly in the Middle Atlantic Bight during the winter and spring. The salinity generally exhibited an increase through the year relative to the reference period values, continuing a trend that began in 2001.

10. The NAFO Annual Ocean Climate Status Summary (NAOCSS) for 2002

At the June 2002 STACFEN Meeting, it was recommended that beginning in 2003 an annual climate status report be produced to describe environmental conditions during the previous year. This web based annual summary for the NAFO area would include an overview that summarizes the overall general climate changes for the previous year and a regional overview that provided climate indices from each of the Subareas. The 2003 status summary that covered most of the NAFO Convention area based on contributions from Subareas 0-1, West Greenland (M. Stein and E. Buch); Subareas 2 and 3 (E. Colbourne), Subareas 4 and 5 (K. Drinkwater), Subareas 5 and 6 (D. Mountain). This web-based report essentially replaces the traditional much larger environmental overview. It is intended that it be posted on the NAFO website shortly after this STACFEN meeting.

11. Environmental Indices (Implementation in the Assessment Process)

An important role of STACFEN, in addition to providing climate summaries, is to determine the response of fish and invertebrate stocks and the fishery to the changes in the environment, as well as to provide advice on how relationships between climate and marine production may be used to help improve the assessment process. It is felt that a greater emphasis should be placed on these latter two activities within STACFEN and at the June 2002 Meeting STACFEN had **recommended** that *further studies be conducted attempting to link climate and fisheries and to bring forward such studies for review.*

The following presentations were made at this June 2003 Meeting:

- a) *A review of various North Atlantic Oscillation Indices (NAO)* (E. Colbourne). The North Atlantic Oscillation (NAO) is one of the major modes of variability of the Northern Hemisphere atmosphere. It is particularly important in winter, when it exerts a strong control on the climate of the Northern Hemisphere

affecting air temperatures, winds and precipitation. High index years are associated with increased NW winds and a general cooling over the Labrador Sea leading to increased amounts of sea-ice, lower ocean temperatures and salinities and opposite conditions when the index is low. Several different measures of the NAO index were presented including 3 fixed station based indices and the principal component analysis (PCA) or EOF analysis method of gridded sea level pressure (SLP) data. The advantages and disadvantages of each method were also indicated. It was agreed that the Rogers (1984) index using the sea level pressure between Iceland and the Azores during the December to February time period best represents conditions within the NAFO area. It was shown that by using different stations such as Lisbon in Portugal for the southern site, it is possible that the value of the NAO index could differ substantially and even have opposite signs. Therefore researchers using NAO indices to study links between marine resources and variations in climate conditions should be aware of the various measures of the NAO index.

- b) *Overview of the workshop on Strategies for strengthening the link between the AZMP and Stock Assessment* (K. Drinkwater). The principal objectives of the Workshop were to discuss how stock assessment might benefit from ecosystem information and in particular to identify data products from the AZMP that could improve our capability to foresee and to understand the causes of variation in the distribution, abundance, and productivity of fish and shellfish resources. Environmental information is presently used in a qualitative manner for a number of stocks but there is little quantitative use of environmental data in stock assessments. There are several reasons for this. First, although there have been several statistical relationships between the environment and population parameters these usually were obtained through exploratory correlation analysis and often do not hold when further data are obtained. Second, the assessment models have not been designed to easily incorporate environmental information. Third, currently, there are no medium or even short-term projections of the environmental indices. The workshop felt that it is important to continue research directed towards uncovering relationships between the environment and population characteristics and to attempt to understand the mechanisms involved. An important point is to examine, where possible, the relative importance of the environment compared to other potential controlling factors. This can be done progressively but progress might be quicker if a systematic approach was adopted and a sustained collaborative effort that incorporated long-term monitoring (i.e., AZMP) and short-term process studies to test hypotheses. The use of numerical models was recognized as a potentially valuable tool in helping to define key variables or processes and to provide environmental indices for stock assessments. Numerical methods include hydrodynamical/physical models, biophysical models and data assimilation. Biophysical models can provide information on the major components of the food web, i.e. phytoplankton, zooplankton, invertebrates and fishes. Phytoplankton-Zooplankton-Nutrients-Detritus (PZND) models are useful to simulate the lower trophic interactions of the food web. Early Life Stage (ELS) models and Individual Based Models (IBM) are used to better understand the effect of the environment on the growth, drift, mortality, survival and retention of eggs and larvae of fishes and invertebrates. Monitoring programs such as the AZMP provide the necessary information for model initialization and validation. A total of 7 recommendations were made, these are listed in the report "Proceedings of the workshop on strategies for strengthening the link between the AZMP and stock assessment", edited by P. Ouellet. and published by the Canadian Science Advisory Secretariat in Ottawa, CSAS 2003/034 (www.dfo-mpo.gc.ca/CSAS/CSAS/English/Proceedings%20_Years/2002e.htm).
- c) *Oceanographic conditions in Smith Sound during a mass fish kill of April 2003 in comparison to previous years* (E. Colbourne, G. Lilly and J. Bratney). A summary of the extent of the mass fish mortality within Smith Sound, a small embayment in Newfoundland, was presented along with oceanographic conditions within the Sound from two surveys conducted by Canadian Department of Fisheries and Oceans on April 8-11 and on May 1-2, 2003. Historical temperature data collected by researchers at Memorial University of Newfoundland and DFO dating back to March of 1991 were also presented. Temperature conditions within Smith Sound during the early-1990s were very cold, generally $<-1^{\circ}\text{C}$ near bottom throughout the Sound. Since 1995, relatively warmer conditions prevailed, until late January 2003. During the April 2003 survey, the water column had cooled significantly with temperatures ranging from -1.4°C at surface to -1.73°C near 100 m and about -1.6°C near bottom at 200 m. In effect, the entire sound was flooded by very cold water with no temperature observed above -1.4°C except outside the Sound in the deeper water of Trinity Bay where values were $>0.5^{\circ}\text{C}$ below 300 m. In general, temperatures decreased by 1°C at the surface and by about 2°C near bottom from late-January to early-April. During the early May 2003 survey temperatures had warmed to 0.5°C at the surface and to -1°C to -1.5°C at the bottom. Dissolved oxygen

levels throughout Smith Sound were super-saturated in upper layers and ranged from 90-95% in depth range of 100-200 m. Many unanswered questions remain as to the sources of the extremely cold water and the exact causes as to why the fish, cod in particular, but also many redfish, froze to death. For example, was the extremely cold sub-surface water advected into Smith Sound from the Newfoundland Shelf, where intense winter convection normally cools the water column to temperatures below -1.5°C ? Or, was the very cold water mass the result of local air-sea-ice heat exchange due to the extremely cold winter of 2003. From an oceanographic viewpoint, pertaining to the question of why many fish did not survive the cold temperatures, one might consider the question; did the 2°C decrease in bottom temperature in less than 2 months exceed their capacity to produce the required antifreeze protection?

- d) *North Sea helps Baltic Sea* (M. Stein). A brief report was given on an oceanographic event that took place during January 2003 in the Baltic Sea. According to Swedish investigations, an inflow of about 35 km^3 saltwater from the North Sea into the Baltic Sea occurred between 11 and 20 January 2003. This is about one third of the total inflow through the Sound and the Belt Sea. Estimates were that about 100 km^3 of salt-rich water flowed into the southern Baltic Sea. The last such event was in 1993 when about 300 km^3 of North Sea water came into the Baltic Sea. These events are driven by meteorological forcing: In 2003, a very stable high air pressure system over Scandinavia resulting in persistent northeasterly winds in the southern North Sea and the Baltic. When the wind changed to storm force from the west on 11 January, the sea level in the western Baltic sank by 80 cm and a strong inflow from the North Sea began. Biological and oceanographic investigations performed by the Institute for Baltic Sea Fisheries, Rostock/Germany in the Bornholm Basin showed that 85% of female and 92% of potential male spawners had “active” gonads. The hydrographic measurements indicate that in all areas, also in the Bornholm Basin, very good conditions for spawning and survival of eggs were prevalent. This included much higher oxygen levels than in recent years and higher salinities. The preliminary data of the annual maturing process of cod in the Baltic Sea in 2003 showed that conditions for spawning and survival of the eggs in the Bornholm Basin have improved for the first time in 10 years.

12. The Formulation of Recommendations Based on Environmental Conditions

STACFEN made no formal recommendations during this 2003 meeting.

13. Cooperative Research Programs

a) Russian/German Data Evaluation

The Russian/German Project “Assessment of Short-time Climatic Variations in the Labrador Sea” was completed during 2002. As reported during the STACFEN June 2002 Meeting in the Eight Report on this project (NAFO SCR Doc. 02/7) a manuscript for publication in the primary literature was prepared, entitled “Greenland Cod – Modelling Recruitment Variation during the Second Half of the 20th Century”. This manuscript is in press in Fisheries Oceanography.

b) Other Research Programs

There were no other research programs considered by the Committee.

14. National Representatives

The Committee was informed that a new national representative responsible for hydrographic data submissions for Russia would replace F. Troyanovsky during 2003. Other national representatives remained unchanged. They are: E. Valdes (Cuba), S. Narayanan (Canada), E. Buch (Denmark), J.-C. Mahé, (France), F. Nast (Germany), H. Okamura (Japan), H. Sagen (Norway), A. J. Paciorkowski (Poland), J. Pissarra (Portugal), A. I. Boltnev (Russia), L. J. Rickards (United Kingdom), and K. J. Schnebele (USA).

15. Other Matters

The Committee was informed that current meters moored in Flemish Pass by Canada (Bedford Institute of Oceanography) during June 2002 will remain through 2003. One mooring is on the slope of the Grand Bank and the other in the deep section of the Flemish Pass. Their purpose is to gain information on the variability in the strength and position of the Labrador Current. STACFEN requested participants to remind their institutes of this deployment if carrying out assessment surveys on the Grand Bank and in the Flemish Pass and Cap area. In addition, it was indicated that this notice would be posted on the NAFO web site and distributed to Contracting Parties.

16. Acknowledgements

Upon completing the Agenda, the Chair thanked the STACFEN members and invited guest, the NAFO Secretariat and the rapporteur for their support and contributions. The meeting was adjourned.

APPENDIX II. REPORT OF STANDING COMMITTEE ON PUBLICATIONS (STACPUB)

Chair: Manfred Stein

Rapporteur: Margaret A. Treble

The Committee met at the Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, on 9 June 2003, to consider publication-related topics and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Germany, Portugal, Spain, and United Kingdom), Japan, Russian Federation and United States of America. The Executive Secretary and Deputy Executive Secretary were in attendance.

1. Opening

The Chair opened the meeting by welcoming the participants. The agenda as presented in the Provisional Agenda was adopted. Margaret A. Treble (Canada) was appointed rapporteur.

2. Review of Recommendations in 2002

a) Recommendations in June

- i) STACPUB had again recommended that *each member of the Secretariat be given an individual e-mail address.*

Action has been taken on this recommendation under the management of the new Executive Secretary.

- ii) STACPUB had recommended that *the Secretariat provide a copy of the mailing list to each delegation's representatives. Representatives are requested to review the list and provide a list of names that are no longer involved with NAFO and that should be removed from the list.*

Action has been taken on this recommendation by the Secretariat.

- iii) STACPUB had recommended that *the Secretariat maintain the restricted website area for specific Scientific Council business, and that the restricted website name be changed on an annual basis in order to maintain restricted access.*

Action has been taken on this recommendation under the management of the new Executive Secretary.

- iv) STACPUB had recommended that *STACFEN's annual climate status summary report on essential climatic conditions in the NAFO Convention Area be published on the website.*

Action has been taken on this recommendation by the Secretariat.

- v) STACPUB had recommended that *"Informational bulletins" of interest to NAFO Contracting Parties, such as location of mooring of ocean current meters in the Flemish Pass, should also be published on the website.*

Action has been taken on this recommendation by the Secretariat. Regarding a new mooring activity, STACPUB noted that an announcement will be made on the website.

- vi) STACPUB had recommended that *the Secretariat ask the host country to fund a social event during the Elasmobranch symposium.*

Action has been taken on this recommendation by the Secretariat.

- vii) STACPUB had recommended that *conveners of the Deep-sea Fisheries Symposium be asked to remind reviewers and authors of manuscripts to complete their work as soon as possible.*

STACPUB discussed the difficulties which had arisen as a result of other responsibilities of co-editors of papers and publication process of papers has been delayed.

- viii) STACPUB had recommended that *a summary of the Elasmobranch Symposium and a PowerPoint presentation summarizing the symposium be published on the NAFO website.*

Action has been taken on this recommendation by the Secretariat.

- ix) STACPUB had recommended that *an additional agenda item for the 2003 June Meeting should be introduced to review the current requirement of submitting both research document and a manuscript for publication in Symposium Proceedings.*

No action has been taken on this recommendation by the Committee.

3. Status of Scientific Publications (All publications are also placed on the NAFO Website www.nafo.int)

a) Publications

i) Journal of Northwest Atlantic Fishery Science

STACPUB was informed that:

Volume 30 containing 5 papers and 3 notices (91 pages), was published with a publication date of December 2002.

Volume 31 containing papers from the Symposium on "*Deep-sea Fisheries*". A total of 48 papers had been received at the Secretariat and sent to Proceedings co-editors for review. To-date one is still with a co-editor (edited version not received to-date), 2 others which were edited have been sent back to co-editor with comments, 19 including an Abstract are final, 16 have been prepared into galleys, 5 have been rejected and 5 withdrawn. This issue is targeted for publication by mid-2003.

Volume 33 containing papers from the Symposium on "*Elasmobranch Fisheries: Managing for Sustainable Use and Biodiversity Conversation*". A total of 50 papers have been received at the Secretariat and sent during January and February 2003 to proceedings co-editors for review. One paper has been withdrawn by author and 1 has been rejected. To date 4 papers have been received for preparation of galleys. This issue was initially suggested for publication by late-2003, but likely to be much later.

A special Volume containing 9 peer-reviewed articles by members of the *Working Group on Reproductive Potential* is being prepared. This volume is intended to provide state-of-the-art techniques and methods used to estimate reproductive potential of fish stocks. In addition, it reviews and synthesizes published results and provides case studies of various approaches that may be used to integrate knowledge of stock reproductive potential into improving scientific advice for fishery resource management. It is anticipated that this publication will be available mid-2003.

A special Volume containing 8 papers from the *Mini-Symposium on Environmental Conditions* have been received and sent to co-editors for review. Two papers have not been submitted by authors yet. It is anticipated that this publication will be available in late-2003.

In addition, there have been 7 miscellaneous papers received at the Secretariat for publication in the Journal. Three (3) papers have been rejected by the Associate Editors, 2 edited versions have been received from the Associate Editors at Secretariat and one has been published in Journal Volume **32**, and 2 are still in the editorial review process.

ii) **NAFO Scientific Council Studies**

STACPUB was informed that:

Studies Number 35 containing the report of "*The Canada-United States Yellowtail Flounder Age Reading Workshop*" and 2 notices was published with a publication date of December 2002.

Studies Number 36 containing a complete narrative of the proceedings and 9 papers and tutorials presented at the *Workshop on Assessment Methods* held during 13-15 September 2000 in Boston, USA, is in final stage of preparation and scheduled to be published very shortly.

Studies Number 37; the publication on *Availability of Data for Estimating Productive Potential for Selected Stocks in the Northwest Atlantic*. Information was collected on a total of 53 stocks or stock complexes from both the northeast and northwest Atlantic. A series of tables was compiled that provide an overview of the availability of basic information, evaluate the quality of information and provide references to this information. Galley preparations are being finalized for publication shortly.

iii) **NAFO Statistical Bulletin**

STACPUB was informed that:

Catches by country, species and Division are available on the NAFO website as text files for 1960-2002. Information is the most up-to-date available at the Secretariat and is updated as new information become available.

Deadline for submission of STATLANT 21B reports 2000 and 2001 was 30 June of each subsequent year. Data are still for 2000 outstanding from Canada (Central & Arctic), Greenland, Norway and USA. For 2001, data are still outstanding for Canada (Central & Arctic), Cuba, Faroe Islands, Greenland, Lithuania, Norway, USA and Ukraine.

iv) **NAFO Scientific Council Reports**

STACPUB was informed that:

The *NAFO Scientific Council Reports 2002* (Redbook) volume (323 pages) containing reports of the 2002 meetings of the Scientific Council in June, September and November was published and distributed in January 2003 and also placed on the NAFO website.

v) **Index and Lists of Titles**

STACPUB was informed that:

The provisional index and lists of titles of 163 research documents (SCR Doc.) and 23 summary documents (SCS Doc.) which were presented at the Scientific Council Meetings during 2002 were compiled and presented in SCS Doc. 03/9 (excel format) for this June 2003 Meeting.

vi) **Others**

There was no other publication discussed.

4. **NAFO Website**

a) **Web Statistics**

Web site usage was reported for the period January 2001 to March 2003. There was an increase in visits in January 2003 over previous levels and usage has continued to increase in recent months. The redesigning of the website will continue and usage is expected to increase.

b) **Design of NAFO Website**

The Secretariat staff has been involved in the redesign of the NAFO website and has worked closely with the Executive Secretary over the past 6 months to improve the design and add new features. STACPUB viewed a presentation of the key features and pages of the website. A second presentation covered more specific information on the publication section of the website. This redesign project will continue in the future with possible new additions to include a section on press clippings and a searchable database of documents.

5. **Promotion and Distribution of Scientific Publications**

a) **Invitational Papers**

There have been no requests or suggestions for invitational papers in 2002.

b) **CD-ROM Version of Reports, Documents**

All Journal issues are now on CD. The Secretariat is close to completing the process of scanning back issues of Scientific Council Studies and the entire series will be available on CD. The Secretariat staff has continued the process of burning CDs for reports and documents and are able to distribute these CDs as requested.

c) **New Initiatives for Publications.**

In recent years the Journal has received papers primarily for Symposium proceedings while the Secretariat has received few individual papers for the regular publication in the Journal. Various reasons for this were discussed during the meeting but STACPUB has no new initiatives to address this concern at this time.

6. **Editorial Matters Regarding Scientific Publications**

a) **Review of Editorial Board**

STACPUB received a letter from the Associate Editor Dr. Volker Siegel, Institute for Seafisheries, Hamburg, Germany who indicated that he could no longer serve as a member of the Editorial Board and tendered his resignation. While the number of papers submitted for review in any given year is not large he did note that there are often delays in completing reviews and having revisions made. STACPUB discussed several options to shorten the review and revision periods in order to improve the process but did not make any recommendations at this time. STACPUB Chair requested Committee members to propose a replacement to the position of Associate Editor for Invertebrates.

b) **Progress Report of Publications of Reproductive Potential WG (Journal and Studies)**

The Reproductive Potential Working Group currently has nine papers submitted; most are reviews and applications of methods. There were eight papers completed and one is almost finished. The documents were submitted in July 2002 and returned to the editor between December 2002 and June 2003, less than a year to complete the external review process. The Secretariat will now prepare the galleys and return them to the authors for final corrections in the coming months.

c) **Progress Report of Publication of 2001 Deep-Sea Fisheries Symposium Proceedings**

Further to what was reported under agenda item 3, there was no new information on this topic.

d) **Progress Report of Publication on 2002 STACFEN Mini-Symposium on Decadal Trends**

The special volume containing papers from the 2002 STACFEN Mini-Symposium on Decadal Trends identified eight papers for consideration, six have been submitted and two more are expected to be submitted by the end of June. Of the six received to date, four have been reviewed and are being edited. The reviews of the other two are still pending. It is anticipated that all papers will be ready for publication in late-2003.

e) **Progress Report of Publication of 2002 Elasmobranch Symposium Proceedings**

The Symposium on "*Elasmobranch Fisheries: Managing for Sustainable Use and Biodiversity Conversation*" held in September 2002 in Santiago de Compostela, Spain with 119 participants from 22 countries. Papers from that Symposium will be published in Volume 33 of the NAFO Journal. A total of 50 papers have been received at the Secretariat and sent during January and February 2003 to proceedings co-editors D. W. Kulka, M. Pawson, J. Musick and T. Walker for review. This compares with 48 papers received for review for the previous NAFO Symposium on "*Deep-sea Fisheries*". To date, out of the 50 submissions, one paper has been withdrawn by the author and 3 have been rejected. The Secretariat has received 4 papers for preparation of galleys and the remaining are under various stages of review. This issue was initially suggested for publication by late-2003, but likely will be later.

7. **Papers for Possible Publication**

a) **Review of Proposals Resulting from 2002 Meetings**

i) **Papers nominated by STACPUB**

STACPUB Chair reminded the Committee to review the research documents submitted to the June 2003 Meeting and make proposals for publication of papers.

ii) **Up-date since June 2002**

At its meetings since 1980, STACPUB has nominated a total of 802 research documents. This includes 50 documents from the Symposium on "*Elasmobranchs*" in September 2002 and 8 papers nominated at the Mini-Symposium on Environment Conditions. Since 1980, a total of 630 papers have been published in the Journal (317) and Studies (313).

In addition, 7 papers from outside of the STACPUB nomination process were submitted for the Journal since June 2002.

8. **Other Matters**

There being no other matters, the Chair closed the meeting by thanking the participants for their contributions and co-operation, the rapporteur for taking the minutes, and the NAFO Secretariat for their assistance.

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

Chair: M. Joanne Morgan

Rapporteur: David Cross

The Committee met at the Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, during 5-19 June 2003, to discuss matters pertaining to statistics and research referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Germany, Portugal, Spain, and United Kingdom), Japan, Russian Federation and United States of America. The Deputy Executive Secretary was in attendance.

1. Opening

The Chair opened the meeting by welcoming the participants. David Cross was appointed rapporteur.

2. Review of Recommendations in 2002

a) From the June 2002 Meeting

STACREC noted the recommendations would be addressed under the relevant Agenda items and reported appropriately below.

3. Fishery Statistics

a) Progress Report on Secretariat Activities in 2002/2003

Acquisition of STATLANT 21A and 21B reports for recent years

The Deputy Executive Secretary outlined the status of the STATLANT data submissions for recent years. The following table 1 shows the dates when STATLANT 21A and 21B submissions were received at the Secretariat through June 2003.

STACREC noted that a number of countries were failing to report the absence of fishing activities but that such reports were essential for a complete record of NW Atlantic catches. Accordingly STACREC **recommended** that *the Notes for Completion of STATLANT 21A and 21B questionnaires be revised to include the requirement for national authorities to report the absence of fishing activities.*

It was further noted there was a renewed risk of non-reporting or double reporting of chartering activities. It was agreed that a full documentation of these activities was required from both parties in such activities and the Secretariat was requested to review the Notes for Completion of the STATLANT 21A and 21B questionnaires to be sure that the instructions were clear as to the information required.

The Deputy Executive Secretary reported that, following the recommendation at the June 2002 meeting, the Contracting Parties had been informed of the request for the reporting of wolffish catches by species. The catch reports for 2002 were still largely of wolffishes ns but it was hoped that the reporting by species would be improved with the data for 2003.

STATLANT 21A data were used for the compilation of SCS Doc. 03/13 on "Historical Nominal Catches for Selected Stocks". In accordance with the recommendation of the Scientific Council to update reported catches, this document was expanded to include all stocks assessed by the Scientific Council. Data was updated to include data for 2002.

The STATLANT 21B data constitute the final catch and effort data for the compilation of the annual publication of *NAFO Statistical Bulletin*.

Statistical Bulletins for the year 1995-99 were completed in the same manner as the Bulletin for 1994. The *Stat. Bull.* Tables 1, 2 and 3 were compiled in the usual manner, and for USA incomplete data were available to incorporate total catch by species (giving total catch by species with no Divisional breakdown); however, Tables 4 and 5 excluded USA STATLANT 21B data which were not available.

Table 1. Dates of receipt of STATLANT 21A and 21B reports for 2000-2002 at the Secretariat up to June 2003.

Country/ Component	STATLANT 21A (deadline, 15 May)			STATLANT 21B (deadline, 30 June)		
	2000	2001	2002	2000	2001	2002
BGR*	No fishing	No fishing	No fishing	No fishing	No fishing	No fishing
CAN-CA**	-	17 May 02	26 May 03	-	-	-
CAN-M	17 May 01	15 May 02	01 May 03	14 Feb 02	29 Jun 03	-
CAN-N	15 May 01	15 May 02	15 May 03	05 Mar 02	21 Jan 03	-
CAN-Q	22 May 01	09 Apr 02	22 Apr 03	09 Apr 02	22 May 03	-
CUB	31 May 01	-	-	31 May 01	-	-
EST	08 May 01	30 Apr 02	09 May 03	27 Jun 01	27 Jun 02	-
E/DNK	No fishing	14 May 02	14 May 03	No fishing	27 Jun 02	-
E/FRA-M	No fishing	No fishing	No fishing	No fishing	No fishing	No fishing
E/DEU	10 May 01	25 Jul 02	12 May 03	31 Aug 01	25 Jul 02	13 Jun 03
E/NLD	No fishing	No fishing	No fishing	No fishing	No fishing	-
E/PRT	14 May 01	15 May 02	30 May 03	04 Apr 02	30 Aug 02	-
E/ESP	31 May 01	22 May 02	29 May 03	04 Apr 02	11 Jun 03	29 May 03
E/GBR	No fishing	No fishing	No fishing	No fishing	No fishing	No fishing
FRO	07 Jun 01	01 May 03	01 May 03	07 Jun 01	-	-
GRL	07 Nov 02	06 Nov 02	11 Jun 03	-	-	-
ISL	04 Jan 02	23 May 02	10 Apr 03	14 Jan 02	23 May 02	10 Apr 03
JPN	11 Apr 01	21 May 02	27 May 03	11 Apr 01	21 May 02	-
KOR	No fishing	No fishing	No fishing	No fishing	No fishing	No fishing
LVA	22 May 01	27 May 02	22 May 03	22 May 01	27 May 02	-
LTU	16 May 01	-	12 May 03	18 Apr 02	-	-
NOR	28 May 01	13 Jun 02	20 May 03	-	-	-
POL	15 Apr 02	24 May 02	09 May 03	15 Apr 02	19 Jun 02	13 May 03
RUS	06 Jun 01	07 Jun 02	14 May 03	10 Sep 01	25 Jun 02	03 Jun 03
USA	-	-	-	-	-	-
FRA-SP	26 Jan 01	17 Apr 02	31 Mar 03	16 May 01	23 Oct 02	31 Mar 03
UKR	-	27 Jun 02	-	-	-	-

* Note Bulgaria has not reported in recent years but records indicate there was no fishing.

** Canada Central and Arctic began reporting in 2000 (note: in 1989-98 inshore catches only).

Table 2. List of countries that have not submitted STATLANT 21A and 21B data through 2000-2002. (N.B. Bulgaria has not reported in recent years and USA data from 1994- present are not available).

STATLANT 21A			STATLANT 21B		
2000	2001	2002	2000	2001	2002
	Cuba	Cuba	Canada (Central & Arctic)	Canada (Central & Arctic)	Canada (Central & Arctic)
	Lithuania	Ukraine	Greenland	Cuba	Canada (Maritimes)
			Norway	Faroe Islands	Canada (Newfoundland)
			Ukraine	Greenland	Canada (Quebec)
				Lithuania	Cuba
				Norway	Estonia
				Ukraine	EU/Denmark
					EU/Netherlands
					EU/Portugal
					Faroe Islands
					Greenland
					Japan
					Latvia
					Lithuania
					Norway
					Ukraine

b) **CWP Sessions 2003/2004**

i) **Report on the 20th CWP Session, IOTC Headquarters, 21-24 January 2003**

The Vice Chair of Scientific Council and the Deputy Executive Secretary attended the 20th session of the Coordinating Working Party on Fisheries Statistics held at Indian Ocean Tuna Commission (IOTC) headquarters, Victoria, Seychelles. A summary of this meeting was presented and some of the issues of interest to NAFO were highlighted.

The CWP Meeting included a discussion of Elasmobranch and by-catch species statistics. Although there are still many problems with the compilation of statistics in this area, there does appear to have been some improvements. The CWP Meeting agreed that there is a need for practical field guides to allow the at-sea identification of sharks based on fins and other body parts, which are often the only parts landed.

STACREC was informed that the CWP noted that several general purpose fishery data systems are used or under development by different Regional Fisheries bodies (RFB) or individual countries. The CWP decided that characteristics of such information systems should be compared and evaluated in a workshop organized by FAO that should be convened before CWP-21 which could consider the outcome.

A separate meeting devoted to the discussion of the FAO program on FIGIS/FIRMS was held on January 20th prior to the CWP session. It was decided at that meeting that in the first instance only regional fisheries bodies would be invited to sign partnership agreements to join this initiative. National bodies might be asked to join at a later date. In addition progress was made on the wording of the partnership agreements.

ii) **CWP Intersessional Meeting, 2004**

Continuing the usual practice, STACREC **recommended** that *the Deputy Executive Secretary attend the CWP Intersessional Meeting to be held in 2004.*

c) **Reporting of Catch Statistics in Scientific Council Summary Sheets**

STACREC noted that, following the recommendation at the June 2002 meeting, the STACFIS tables and the Scientific Council Summary Sheets include both catch data used by STACFIS in the stock assessments and the officially reported STATLANT 21A data.

4. **Research Activities**

a) **Biological Sampling**

i) **Report on activities in 2002/2003**

STACREC noted and reviewed the listings of Biological Sampling Data prepared by the NAFO Secretariat. These listings (SCS Doc. 03/14) include biological sampling data for 2002 reported to the Secretariat prior to the present meeting.

ii) **Report by National Representatives on commercial sampling conducted**

Canada-Central and Arctic. Data on catch rates, length and otolith samples for age determination were obtained from trawl catches of Greenland halibut from the Div. 0A fishery. Catch rates and length frequency data were also collected for Atlantic cod, spotted wolffish, Grenadier sp. and Arctic skate.

EU-Portugal (NAFO SCS Doc. 03/7): Data on catch rates and length composition were obtained from trawl catches for Greenland halibut (Div. 3LMNO). Data on length and age composition of the catch were obtained for redfish (Div. 3M) and American plaice (Div. 3M). Data on length composition of the catch were obtained for cod (Div.3NO), redfish (Div. 3LNO), American plaice (Div. 3LNO), yellowtail flounder (Div. 3N), roughhead grenadier (Div. 3LMNO), witch flounder (Div. 3LMNO), Atlantic halibut (Div. 3NO), white hake (Div. 3NO), thorny skate (Div. 3NO), spinytail skate (Div. 3NO) and monkfish (Div. 3O).

EU-Spain: Spanish catches in 2002 by species and Division in NAFO Area was presented. Data on length and age composition of the trawl catches were obtained for Greenland halibut (Div. 3LMNO) and roughhead grenadier (Div. 3LMN). Data on length composition of the trawl catches were obtained for witch flounder (Div. 3LMNO), American plaice (Div. 3LNO), yellowtail flounder (Div. 3N), cod (Div. 3NO), skate (Div. 3LMN) and redfish (Div. 3LMNO). Information can be found in SCS Doc. 03/11.

Russia. Data on catch rates, length and age composition were taken from trawl catches of Greenland halibut in Div. 1AD. Data on catch rates and length, age composition from pelagic trawl catches of redfish in Div. 1F, 2J were also available. Data on catch rates, length, age composition, maturity were obtained from trawl catches of Greenland halibut (Div. 3LMNO), partially of redfish (Div. 3LMNO), roughhead grenadier (Div. 3LMNO), American plaice (Div. 3LMNO), witch flounder (Div. 3LMNO), yellowtail flounder (Div. 3NO), cod (Div. 3LMNO), red hake (Divs. 3LMNO), white hake (Div. 3O), thorny and spinytail skates (Div. 3LMNO).

Greenland. CPUE based on logbook data and length frequency data were available from the offshore fishery. Length frequency and age data were available from the inshore fishery in Div. 1A

iii) **Report on data availability for stock assessments** (by Designated Experts)

Available data from commercial fisheries relevant for stock assessment on a stock-by-stock basis were prepared from inputs from Designated Experts. These will be compiled into an SCS document and reviewed for accuracy and updated prior to the September 2003 Meeting.

b) **Biological Surveys**

i) **Review of survey activities in 2002** (by National Representatives and Designated Experts)

On March 20th 2003 representatives from fisheries research institutes in the Northwest Atlantic (Institut Maurice Lamontagne (IML), Bedford Institute of Oceanography (BIO), Northwest Atlantic Fisheries Centre (NWAFC), and Northeast Fisheries Center (NEFC)) meet at (BIO) in Dartmouth to plan creation of a Northwest Atlantic Groundfish Survey database (NWAGS). This database would in essence be an updated version of data provided the East Coast of North America Strategic Assessment Project (ECNASAP)

All labs agreed to release trawl standardized catch data using a metadata transformation suitable for input to the NWAGS data model. It was determined that the most appropriate measurement unit to report would be the numbers and weights standardized to normal tow parameters for the gear used in a particular survey series. These common format data would be placed in an accessible storage location and be updated by the site on a regular basis as new data became available. BIO will then pull the data from each of the sites and make it available on an internet site.

The intention is to make survey catch data available within a reasonable time frame after completion of surveys. This could mean updating survey data several times a year.

ii) **Surveys planned for 2003 and early-2004**

An inventory of biological surveys planned for 2002 and early-2003 as submitted by National Representatives and Designated Experts was prepared by the Secretariat. These will be compiled into an SCS document and reviewed for accuracy and updated prior to the September 2003 Meeting.

5. **FAO Fisheries Global Information System (FIRMS/FIGIS)**

A presentation on the Fisheries Resource Monitoring System (FIRMS) of FIGIS was made by Marc Taconet, (FAO), Information Officer and Manager of the FIGIS project. Fishery Resources Monitoring System (FIRMS) is an information network of partner agencies reporting on fisheries and willing to share information in order to ease access and to facilitate interpretation of the status and trends of global fisheries. FIRMS initiative can be considered as a step ahead of the FAO Strategy on improving information for the understanding of fisheries status and trends, recently approved by the FAO Committee on Fisheries (COFI).

FIRMS, essentially, consists of three components. The inventory of world stocks and fisheries constitutes its backbone and is already well advanced as far as monitored stocks are concerned. FIGIS, the mechanical part, is a web-based tool, designed to allow integration of different domains of information relevant to fisheries, and a distributed input of information under the control of data owner partners (i.e. a partnership between FAO and Regional Fisheries Bodies). The FIRMS Partnership Arrangement, which has been under discussion since the last three years with a core group of RFB agencies, and which is expected to be launched officially by early-2004, will provide the governing framework.

Following an overview of the progress on the inventory of stocks and fisheries, the presentation focussed on the inventory (aimed at 23 NAFO stocks) and case studies achieved on behalf of NAFO while highlighting some of the FIGIS system features. For these case studies, 2 different approaches for including the information on the system were shown.

At its 2002 meeting STACREC was concerned about possible workload issues with this initiative, with the possibility of changes to text agreed to by Scientific Council, and also the proposed inclusion of national data sources in addition to data from RFBs in the FIRMS. At this review, STACREC noted the options for adding information to the system, as well as increased expertise in the Secretariat alleviated most concerns about work load. All text that is placed on the website will be put there by the Secretariat and a system could be in place for review by Scientific Council before the information was published. In terms of the inclusion of national fisheries bodies in the FIRMS agreement, STACREC noted this part of the initiative will only move ahead after agreement has been reached with a number of Regional Fisheries Bodies. Any disagreements would be settled between the bodies before information was placed on the web.

STACREC agreed that this was a worthwhile initiative and that discussions between FAO and Secretariat and among Scientific Council should continue.

6. **NAFO Observer Program**

STACREC noted that the recommendation from the June 2002 meeting that the Conservation and Enforcement Measures Part VI, Program for Observers and Satellite Tracking, be amended to formally incorporate the Scientific Council protocols as specified in NAFO SCS Doc. 00/23 and as adopted by the Fisheries Commission in September 2000 has yet to be implemented. However, STACREC noted that discussions of the Observer Program are ongoing in STACTIC.

STACREC further noted that the agenda of the 2002 STACTIC Meeting had not included the development of a training and operation manual for the collection of scientific data in the Program for Observers and Satellite Tracking and thus that representation by the Scientific Council had not been deemed necessary.

STACREC noted that in accordance with the 2002 recommendations the Secretariat had determined the resource requirements for producing an electronic data base of observer data and that they had begun the process of developing an ACCESS data base tailored to their specific needs. The submission of the observer

information in electronic format to the Secretariat would mean that the data base could be set up and maintained with existing resources.

STACREC considered a proposal to make set by set observer information available without identifiers as to country and vessel name. While it was recognized that this may cause difficulties with some types of analyses and even render some investigations impossible it was agreed that some worthwhile information might be gained in this manner. The Committee strongly felt that if the data are made available in such a way that the actual data base, maintained and controlled by the Secretariat, must contain all identifiers including vessel name and country. STACREC **recommended** that *the observer data be collected and archived on a set by set basis in a format consistent with SCS Doc. 00/23 as adopted by the Fisheries Commission; including all identifiers but that the data be made available to users without any identification of vessel name or country. Rather a unique identifier will be associated with each vessel and country and the user will not have access to the key to this code.* STACREC notes that as a cost saving measure this information could be electronically submitted via VMS.

7. Review of SCR and SCS Documents

STACREC reviewed 9 SCR and SCS documents as summarized below.

- a) The attempt to reveal the compliance of TAC values adopted in ICNAF-NAFO area in 1973-2000 for the stock units of Subarea 2 + Div. 3KLMNO Greenland halibut, Div. 3LNO American plaice, Div. 3LNO yellowtail flounder, Div. 3M beaked redfish, Div. 2J+3KL, Div. 3M, Div. 3NO cod and Div. 4VWX silver hake has been made in SCR Doc. 03/02. The introduction of stock state categories became the methodical basis of the analysis. The plots of the relationship between the values considered and correlation coefficients were allowed to conclude that in most cases TACs adopted were not adequate to the actual stock state. The limits of “improved” TACs were estimated for each category. The results obtained became the basis of so-called conservative approach (CA) to assessment of a stock state and allowable catches for a year ahead.
- b) In May 2001, a comparative Fishing Trial was conducted by EU-Spain between the old research vessel C/V *Playa de Mendiña* and the new research vessel R/V *Vizconde de Eza* in order to calibrate the new ship (SCR Doc. 03/05). The corresponding Factor Power Correction (FPC) and its confidence interval were calculated by six analytical methods proposed in the fisheries literature for American plaice: ratio of mean CPUE, linear regression model, generalized linear regression model by haul, generalized linear regression model by stratum, Kappenman’s ratio of scale parameters and a length conversion method. The results of these calculations are presented with the transformed biomass from the old vessel data by all the methods. The old vessel catches were in the order of three times more than the new vessel catches. The model proposed by Kappenman gave FPC values with the least variation, although his FPC estimation is lower than the rest of the models, so the transformed biomass is lower, too.

STACREC noted that while model choice based on precision is laudable, the proposed approach will result in two separate and different estimates of abundance and biomass. STACREC further noted that the converted length frequencies will be an important data set for future work. STACREC **recommended** that *in 2004 the summed abundance and biomass based on conversion of the length frequencies be presented for American plaice, cod, Greenland halibut and yellowtail flounder in the Div. 3NO survey conducted by EU-Spain and compared to the estimates from the method used to convert the CPUE.*

- c) Spatial and temporal changes in condition were examined for American plaice (*Hippoglossoides platessoides*) in Div. 3L, 3N and 3O (SCR Doc. 03/11). Data were available from spring and autumn Canadian research vessel surveys from 1993 to 2002 (2001 for autumn). Data were available for males and females for both total body and liver weight. There was a clear seasonal difference in condition of American plaice with condition being higher in the autumn. Relative body condition tended to be highest in Div. 3N in both spring and autumn. Relative liver condition was highest in Div. 3L and lowest in Div. 3O in both seasons. There were no significant correlations between condition and abundance in a NAFO Division. There was significant annual variability in condition but no consistent pattern over time.

- d) A study on comparative otolith-based age readings of golden redfish (*Sebastes marinus*) from Iceland and demersal as well as pelagic deep-sea redfish (*Sebastes mentella*) from East Greenland and the Irminger Sea was presented (SCR Doc. 03/16). The results are based on an otolith exchange program between institutes in Germany, Iceland, Norway and Spain. A total of 571 otoliths were thin-sectioned and read independently in the participating labs. Age reading results were compared between readers in terms of bias and precision, using a set of statistical tests and graphical methods. Significant bias was observed between readers, mainly caused by deviations between age scores in the higher ages (>20 years). Percent agreement was poor (<30%) for a tolerance level of ± 0 years, particularly for the age range 21-40 years, which represents the major fraction of the fished stock. A tolerance level of ± 5 years, however, lead to up to 95% agreement for the age ranges up to 20 years. Precision and bias were generally better for *S. marinus* than they were for *S. mentella*, pointing to greater difficulties in the interpretation of growth structures for the latter species. The mean age of *S. mentella* with total lengths of 25-30 cm, which were observed to have recruited from the East Greenland shelf into the Irminger Sea during 1998/99, was determined to be 9-10 years.
- e) As part of an ongoing EU project on redfish, otolith shape analysis and otolith trace element assays were conducted to test for differences between distribution areas (SCR Doc. 03/17). Otolith morphometry and shape (Fourier) descriptors were compared between sampling areas of golden redfish (*Sebastes marinus*) and deep-sea redfish (*Sebastes mentella*) in the North Atlantic. A first series of trace element assays was performed using laser-ablation inductively coupled plasma mass spectrometry (LA-ICPMS) on cross-sections of *S. mentella* otoliths. Geographical separation by these methods appeared to be weak, although some distinction of western, central and eastern areas was apparent for otolith shapes of *S. marinus*. Trace element concentrations in *S. mentella* otoliths differed between three otolith zones (core, 3-year annulus and edge), giving first hints to physiological effects and/or migration. Differences in elemental concentrations between areas showed repeated patterns for some elements, indicating area-specific signatures. Multivariate analysis of these signatures, however, revealed no clear discrimination of distribution areas.
- f) A brief review of Russian investigations conducted by PINRO in NAFO Subareas 0, 2 and 3 in the recent forty years has been presented in SCR Doc. 03/22. The methods of carrying out trawl surveys and studying the environment and fishing gear selectivity, as well as the ways of their change and improvement were given. The main goal of this research was to study the status of fishery resources, the effect of environment on them and the influence of fishing gears on main commercial fish species.
- g) Food and feeding of 5 592 individuals of American plaice (*Hippoglossoides platessoides*, Fabricius) was examined from Grand Bank (NAFO Div. 3NO), Flemish Cap (NAFO Div. 3M) and Svalbard Area (ICES Div. IIb) (SCR Doc. 03/23). Differences in diet composition were observed by areas. Feeding intensity was higher on Flemish Cap (77.6%) and lower in the Svalbard (4.7%). There was significant seasonal feeding variation in the Svalbard, with higher feeding intensity in summer. The main groups of prey were Pisces (46%), Echinodermata (20%), Crustacea (16%) and Mollusca (10%). The prey spectrum was larger in the south of the Grand Bank, the main prey being Pisces (64%), while both on Flemish Cap and in Svalbard the main prey was Ophiuroidea (39%). Feeding pattern indicated that American plaice is a daytime feeder, and no marked differences were noted over a 24 hour period. Low cannibalism intensity was observed on Grand Bank. A greater similitude was present between the diets on Flemish Cap and in Svalbard. Composition and overlapping diet, by length classes, were also analyzed.
- h) Distribution of redfish catch (%) as well as other groundfish in Div. 3O by 100 m depth range has been analyzed for 2000-2002 (SCR Doc. 03/26). In catches at 300-700 m depth redfish completely prevailed and the by-catch of the other fish species was negligible. At shallower depths, the bulk of catches was made up by such non-regulated species as skates and hakes. The main Russian fishery for redfish takes place at 350-550 m depth.
- i) The results of estimating the comparative selectivity of the trawl codends with 130 mm, 135 mm, 136 mm, 145 mm and 150 mm mesh size for the Greenland halibut and some objects of by-catch in its specialized fishery were represented in SCR Doc. 03/28. The investigations were conducted in April-May and in June-September 2002. In experiments the selectivity coefficient for the trawl codends with 130-150 mm mesh size for Greenland halibut varied from 2.9 to 3.3, the selectivity range – from 6.0 to 10.0 cm and the fish

length corresponding to 25% retention – from 35.9 to 45.1 cm. The data analysis showed that 130-150 mm increase in the mesh size when fishing Greenland halibut led to the essential instantaneous losses and the long-term profits of the fishery were negligible

8. Other Matters

a) Tagging Activities

STACREC reviewed the list of tagging activities carried out in 2002 (SCS Doc. 03/4) compiled by the Secretariat, and requested national representatives to update the list during the meeting. Also reviewed were outstanding data from 2001.

b) Conversion Factors

The EU(EUROSTAT) representative reported that there had been no developments in the work on conversion factors.

c) Comparative Fishing between Canada and EU-Spain

Comparative fishing between Canada and EU-Spain continued during the spring surveys of 2003. About 10 pairs of comparative tows were completed. Further work is planned for future surveys in order to develop a time-series of comparative fishing data for several species.

d) Research Activities

Canada. Research Report-Part A. Central and Arctic (SCS Doc. 03/10) contains information on Greenland halibut, Arctic charr and shellfish fisheries conducted in SA0 including information on total weight of common by-catch species in the Greenland halibut fishery. An overview of biological studies covering Greenland halibut shellfish and marine mammal stocks is also given. Length frequency and catch and effort data for the Greenland halibut fishery are reported in SCR Doc. 03/50.

Denmark/Greenland: Research Report (SCS Doc. 03/16) presents information on preliminary catch statistics from the commercial Greenland fishery in 2002. Furthermore, the report gives a brief overview over the research carried out in 2002 by the Greenland Institute of Natural Resources.

EU-Spain survey in Div. 3NO. The bottom trawl survey of NAFO Regulatory area in Div. 3NO was conducted in April and May 2002 on board R/V *Vizconde de Eza* using a Campelen gear with a stratified design. A total of 120 hauls were carry out up to a depth of 1 450 m. Sixteen of those hauls were made in parallel with the Canadian R/V *Wilfred Templeman*, using also a Campelen gear. The results of the Spanish 3NO bottom trawl survey for all the period studied (1995-2002), including abundance and biomass indices, with their errors, and length distributions of American plaice, yellowtail flounder and Greenland halibut are presented in SCR Doc. 03/07, SCR Doc. 03/06, and SCR Doc. 03/08, respectively. In 2001 the R/V *Vizconde de Eza* using a Campelen gear replaced the C/V *Playa de Menguíña*, using a gear type Pedreira, as the research vessel of the survey. A catchability comparison experiment was carried out with 92 paired hauls between both vessels. Six different methods to convert the C/V *Playa de Menguíña* abundance and biomass indices (1995-2000) into the R/V *Vizconde de Eza* indices were considered. Results are presented in SCR Doc. 03/05.

EU-Spain and EU-Portugal survey in Div. 3M. The EU bottom trawl survey on Flemish Cap (Div. 3M) was carried out in July 2002. A total of 120 valid hauls with the usual survey gear (Lofoten) were made up to 730 m depth. Survey results including abundance indices of the main commercial species and age distributions for cod, redfish, American plaice and Greenland halibut are presented in the SCR Doc. 03/42, and for Roughhead grenadier in SCR Doc. 03/13. Data on shrimp from this survey was presented in SCR Doc. 02/150. The results regarding the hydrographic conditions during the survey are presented in SCR Doc. 03/32. Feeding studies on the main species were continued, and samples for histological assessment of sexual maturity of cod, redfish, Greenland halibut and Roughhead grenadier have been also taken.

EU-Germany. Research Report (SCS Doc. 03/8) presents information on demersal fishing in Div. 1D. While the demersal fishery for Greenland halibut is a normal activity, the fishery for pelagic redfish (*Sebastes mentella*) occurred for the first time off West Greenland in 1999. In 2002, the fishery was conducted only in Div. 1F from July to September at depths above 500 m and targeted almost exclusively mature redfish with almost no discard and no by-catch of other species.

During the German groundfish survey off Greenland in October/November 2002, fishery oceanographic measurements were performed at 33 fishing stations off West Greenland. Additionally, temperature and salinity at stations of 2 NAFO standard oceanographic sections off West Greenland was obtained. During this cruise, as done since 1982, a stratified random survey covered shelf areas and the continental slope off West Greenland (Div. 1B-1F). 32 valid hauls were carried out. The total survey catch of 8 144 specimens was classified to 49 taxonomic units. Based on the survey information, assessments of the stock status for demersal redfish (*Sebastes marinus*, *S. mentella*), American plaice (*Hippoglossoides platessoides*), Atlantic wolffish (*Anarhichas lupus*), and thorny skate (*Raja radiata*) are documented. The size compositions of the catches in 2000-2002 are almost identical with mean fish sizes ranging about 35 cm. There is indication of good recruitment of pelagic redfish below 30 cm length in all three years.

Russian survey in Div. 3M. In the period from 31 May to 10 June 2002, the multispecies trawl research survey was conducted aboard RV "Remøyffjord" in Div. 3M (SCR Doc. 03/09). The survey covered the depth range of 127-1 280 m and area of 15.8×10^3 miles². The investigations were carried out by random-stratified method. Hauls were made 24 hours a day. In the conventional research bottom trawl (type 1625A) a small size mesh insertion ($a = 10-12$ mm) in the codend was used, 94 trawlings of half an hour duration were performed. Biological information on 13 fish species, collected by observers in Subareas 1-3 was presented in SCS Doc. 03/06.

US Research Report. The status of 25 finfish and shellfish stocks in US waters of the NAFO Convention Area was updated. Summaries of environmental research were given including hydrographic work, the GLOBEC program, benthic studies, and habitat projects. Projects studying biological aspects of several important commercial and recreational species including winter flounder, summer flounder, bluefish, and goosefish were highlighted. Information about other biological studies on food web dynamics, age and growth and by-catch was presented. Finally, brief summaries were presented on three areas of population dynamics research in 2002: (1) Atlantic salmon research; (2) Cooperative research with the fishing industry including a pilot study for collecting electronic tow-based catch information; and (3) Stock assessment methods development. The last item included information on the new version of analytical software from NOAA Fisheries, FT. This is now available for download at: <http://nft.nefsc.noaa.gov>(usrid:nft; Password:nifty).

e) **Other Business**

The Chair thanked the participants for their valuable contributions to the Committee. Special thanks were extended to the rapporteur and to the Deputy Executive Secretary and staff of the NAFO Secretariat for their invaluable assistance in preparation and distribution of documents. There being no other business. The Chair closed the June 2003 STACREC Meeting.

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

Chair: Don E. Stansbury

Rapporteurs: Various

I. OPENING

The Committee met at the Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, during 5-19 June 2003, to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on certain fish stocks. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (France, Germany, Portugal, Spain and United Kingdom), Japan, Russian Federation and United States of America. Various scientists assisted in the preparation of the reports considered by the Committee.

The Chair, Don E. Stansbury (Canada), opened the meeting by welcoming participants. The agenda was reviewed and a plan of work developed for the meeting. The Chair noted that there were deletions to agenda items, *viz* moving Fisheries Commission request (Annex 1 Item 8) for advice on pelagic *S. mentella* redfish in NAFO Subareas 1-3 to Scientific Council. The provisional agenda with this modification was accordingly **adopted**.

II. GENERAL REVIEW

1. Review of Recommendations in 2002

STACFIS reviewed the recommendations from 2002 during considerations of each relevant stock.

2. General Review of Catches and Fishing Activity

As in previous years STACFIS conducted a general review of catches in the NAFO Regulatory Area of Subarea 3 in 2001. Data from various sources were considered along with catches reported (available to date) in STATLANT 21A reports and national research reports, in order to derive the most appropriate estimates of catches for the various stocks in Subarea 3.

STACFIS noted that there is an increasing trend in reporting of some catches as Flatfish NS, Finfish NS and Groundfish NS in the STATLANT 21A data. For 2002, this amounted to a total of 814 tons. Given the present reduced catches, these have the potential to represent a significant portion of the overall catch of a particular stock and species and the inability to assign these catches could impact the assessments. As such, STACFIS **recommended** that *the NAFO Secretariat write Contracting Parties to remind them that all catches should be apportioned as to species and area where caught*.

Since 1995 there has been an Observer Program in effect, with total coverage of all ships in NAFO areas operating under the flags of Contracting Parties. In addition landings by EU ships in NAFO area were inspected at their landing sites in 2001. These provided other sources of catch data.

STACFIS agreed to continue documenting the preliminary tabulations of catch data from SATLANT 21A reports and the catches determined by STACFIS for this year's assessments in the introductory catch table for each stock.

Structure of STACFIS Report. The present STACFIS report, as in recent years, is based on four geographic regions. The region-based structure of the report enables a quick comparison of the status and trends of biomass and exploitation of resources inhabiting the same or adjacent areas.

III. STOCK ASSESSMENTS

A. STOCKS OFF GREENLAND AND IN DAVIS STRAIT

1. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 0 and Division 1A Offshore and Divisions 1B-1F (SCR Doc. 03/20, 29, 33, 41, 50, 53, 54, SCS Doc. 03/6, 8, 10, 12, 16)

a) Introduction

The annual catches in Subarea 0 and Div. 1A offshore and Div. 1B-1F were below 2 600 tons from 1984 to 1988. From 1989 to 1990 catches increased from 2 200 tons to 10 500 tons, remained at that level in 1991 and then increased to 18 100 tons in 1992. During 1993-2000 catches fluctuated between 8 300 and 11 400 tons. The catches increased to 13 400 tons in 2001 and further to 15 100 tons in 2002 (Fig. 1.1).

In Subarea 0 catches peaked in 1992 at 12 400 tons, declined to 4 300 tons in 1994 then stayed at that level until 2000 when they increased to 5 500 tons. Catches increased further to 7 600 tons in 2001, primarily due to an increase in effort in Div. 0A. Catches remained at that level in 2002 (7 800 tons). Catches in Div. 0A increased from a level around 300 tons in the late-1990s and 2000 to 2 600 tons in 2001 and further to 3 800 tons in 2002.

Catches in Div. 1A offshore and Div. 1B-1F fluctuated between 900 and 2 400 tons during the period 1987-92. After that catches have fluctuated between 3 900 and 5 900 tons. Catches increased from 5 500 tons in 2001 to 7 400 tons in 2002, primarily due to increased effort in Div. 1A. Catches from offshore in Div. 1AB have been low but increased from 150 tons in 2000 to 600 tons in 2001 and further to 2 000 tons in 2002.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995 ¹	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC ¹	25	25	11	11	11	11	11	15 ²	15 ²	19 ³
SA 0	4	3	5	4	4	5	5	8	8	
SA 1 excluding Div. 1A inshore	6	5	4	5	5	5	5	6	7	
Total STATLANT 21A	10	8	9	9	9	17 ⁴	7 ⁵	13 ⁵	12 ⁵	
Total STACFIS	10	8	9	9	9	10	11	13	15	

¹ In the period 1991-95 the TAC included Div. 1A inshore..

² Including a TAC of 4 000 tons allocated specifically to Div. 0A and 1A.

³ Including a TAC of 8 000 tons allocated specifically to Div. 0A and 1A.

⁴ Including 7 603 tons reported by error from Subarea 1.

⁵ Provisional.

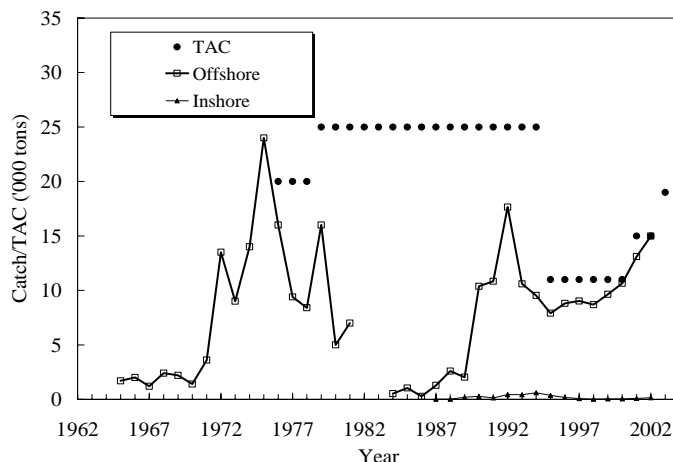


Fig. 1.1. Greenland halibut in Subareas 0+1 (excluding Div. 1A inshore): catches and TACs.

The fishery in Subarea 0. Before 1984, USSR and GDR conducted trawl fisheries in the offshore part of Div. 0B. In the late-1980s catches were low and mainly taken by the Faroe Islands and Norway. In the beginning of the 1990s catches taken by these two countries increased and Canada, Russia and Japan entered the fishery. In 1995 a Canadian gillnet fishery began. During 1998-2002 Canada was the only country fishing in the area. In 2002, 449 tons were taken by longlines, 1 572 tons by gill net and 1 841 tons by trawlers in Div. 0B.

Besides Canadian trawlers, trawlers from a number of different countries chartered by Canada participated in the fishery in Div. 0A in 2001 and 2002. About 30% of the catches in Div. 0A were taken by longliners (1 140 tons) while trawlers took 2 660 tons of which twin trawlers took 70% (1 862 tons).

A longline fishery in Cumberland Sound started in 1987. The catches gradually increased to 400 tons in 1992 where they remained until 1994. Catches decreased to 285 tons in 1995. During 1996-2001 catches have been below 100 tons. The decrease in catches in recent years has been due to decrease in effort as a result of poor ice conditions. Catches amounted to 106 tons in Cumberland Sound in 2002.

The fishery in Div. 1A offshore + Div. 1B-1F. Traditionally the fishery in SA 1 has been taken place in Div. 1D and to a minor extent Div. 1C. Catches have mainly been taken by trawlers from Japan, Greenland, Norway, Russia, Faroe Islands and EU (mainly Germany). These countries, except Japan, were also engaged in the fishery in the area in 2002 together with two longliners from Greenland and Russia and two gill netters from Greenland. The offshore longline fishery in Div. 1CD was started in 1994 and the gillnet fishery was started by Greenland in 2000.

During the years there have been a number of research fisheries offshore in Div. 1A but the catches have always been less than 200 tons annually. The catches have increased gradually during 2000-2002 to 2 000 tons in 2002. Most of the catches were taken by trawlers but gill netters and longliners also participated in the fishery. The main part of the fishery in SA1 takes place during autumn and winter at depths between 1 000 and 1 500 m.

b) **Input Data**

i) **Commercial fishery data**

Information on length distribution was available from the fishery in Div. 0A+B. Thirty-eight percent (38%) of the fish caught by trawl in Div. 0A were <45 cm compared to 21% in Div. 0B, while 21% of the fish caught on longlines in Div.0A were <45 cm (SCR Doc. 03/50).

Catch-at-age and weight-at-age data were available from the fisheries in Div. 0B. The age data from Div. 0B were combined with length frequency data from Div. 0A to estimate catch-at-age for this area (SCR Doc. 03/50).

Information on length distribution of catches from SA1 was available from trawlers from Russia (SCS Doc. 03/6) and Faeroes Islands fishing in Div. 1A and 1D together with length distributions from a German trawler and a Greenlandic gill netter fishing in Div. 1D and 1C, respectively (SCR Doc. 03/53). These length distributions (trawlers combined) were combined with age-length keys from the Greenland deep-sea survey in Div. 1CD in order to estimate catch-at-age and weight-at-age in Div. 1AB and 1CD.

Age 7 fish dominated the catches in Div. 0A + 1AB and Div. 0B + 1CD (all gears combined). There was a tendency towards more fish age 8+ in Div. 0B + 1CD (SCR Doc. 03/53).

Unstandardized catch-rates from the trawl fishery in Div. 0A showed an increase between 2001 and 2002 for both single and twin trawl from 494kg/hr to 842 kg/hr and 882kg/hr 1224kg/hr, respectively (SCR Doc. 03/50) while the catch rate was stable in Div.1A between 2001 and 2002 (1 140 kg/hr) (SCS Doc. 03/16).

Standardized annual catch rates were calculated for the trawl fishery in Div. 1CD for 1988-2002 based on available logbooks and the EU-Germany fishery in Div. 1D (SCR Doc. 03/53 SCS Doc. 03/8). The catch rates decreased slightly between 2001 and 2002 but have been stable during the period 1990-2002 (Fig. 1.2).

Combined standardized annual catch rates were calculated for the trawl fishery in SA 0 for 1990-2000 and from Div. 1CD for 1988-2000 based on available logbooks and the EU-Germany fishery in Div. 1D (SCR Doc. 01/48, SCS Doc. 01/13). The combined catch rates showed a decrease from 1988-89 (one large vessel with high catch rates) to 1990, but have remained stable since (Fig. 1.2). Due to the frequency of fleet changes in the fishery both in SA 0 and Div. 1CD, the indices of CPUE should, however, be treated with caution. The catch rates series has not been updated in the recent years due to lack of data from SA. 0.

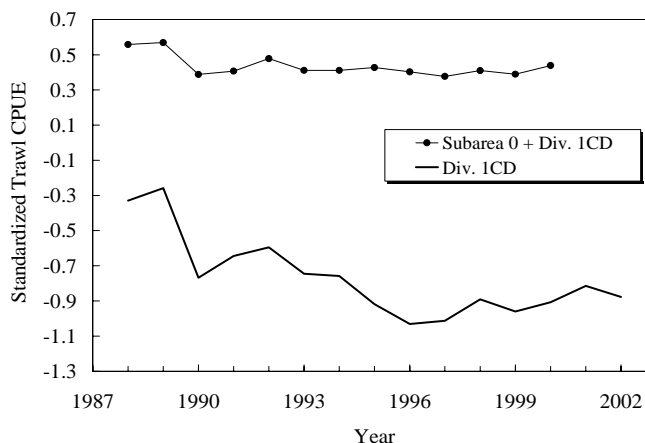


Fig. 1.2. Greenland halibut in Subareas 0+1 (excluding Div. 1A inshore): combined standardized trawl CPUE from SA 0 and Div. 1CD and from Div. 1CD with \pm S.E.

ii) Research survey data

Deep-sea surveys. During the period 1987-95 bottom-trawl surveys were conducted in Subarea 1 jointly by Japan and Greenland (the survey area was re-stratified and the biomass estimates were recalculated in 1997 (SCR Doc. 97/21)). In 1997 Greenland initiated a new survey series covering Div. 1CD. The survey is conducted as a stratified-random bottom trawl survey covering depths between 400 and 1 500 m. The trawlable biomass in Div. 1CD was estimated to be 72 000 tons in 2002, which is the second largest estimate in the time series (56 000-78 000 tons) (Fig. 1.3) (SCR Doc. 03/30).

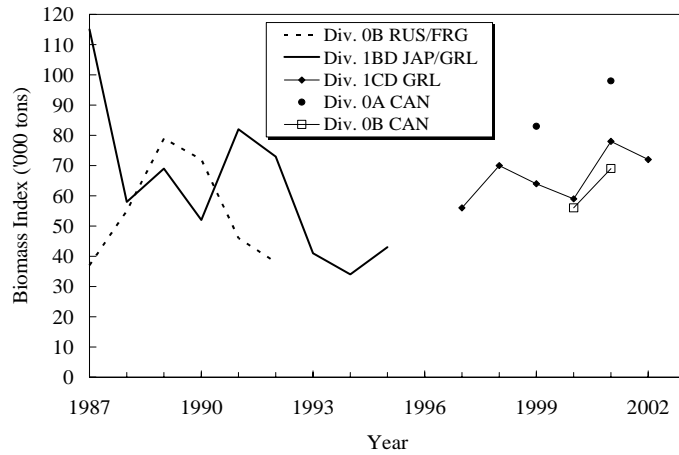


Fig. 1.3. Greenland halibut in Subareas 0+1 (excluding Div. 1A inshore): biomass estimates from surveys. The biomass estimates are given in Scientific Council Reports 2002.

Greenland shrimp survey. Since 1988 annual surveys have been conducted with a shrimp trawl off West Greenland between 59°N and 72°30'N from the 3-mile boundary to the 600 m depth contour line. The number of one-year-old fish in the total survey area including Disko Bay has been increasing gradually from 1996 to a peak of 450 million in 2001. The estimate was 196 million one-year-old specimens in 2002, which is above the recruitment of the 89-94 year-classes but below the recruitment levels since then, except the 1996 and 1997 year-classes (SCR Doc. 03/53)(Fig. 1.4).

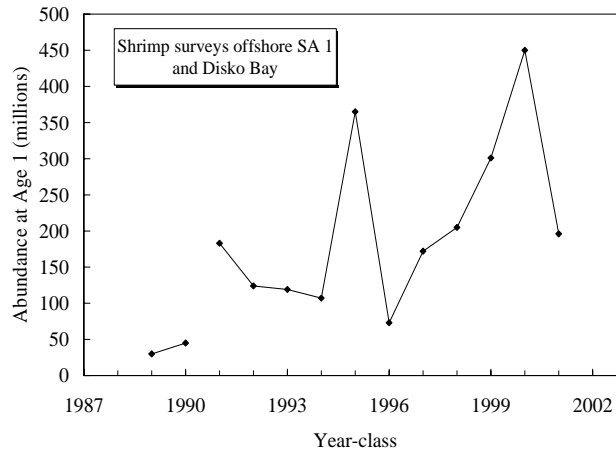


Fig. 1.4. Greenland halibut in Subareas 0+1: recruitment index at age 1 in Subarea 1 derived from the Greenland shrimp trawl surveys. Note that the survey coverage was not complete in 1989 and 1990.

c) **Estimation of Parameters**

An Extended Survivors Analysis (XSA) stock assessment model was fitted to the stock data from SA 0+1. The model was calibrated with trawl survey data (ages 5-15) from Div. 1CD for the years 1997-2002. The analysis was considered to be provisional due to problems with the catch-at-age data and the short time series, but the outcome is considered to reflect the dynamics of the stock. The rate of exploitation seems to have been relatively stable in recent years (SCR Doc. 03/54).

d) **Assessment Results**

The survey biomass index in Div. 1CD was estimated as 72 000 tons in 2002, which is the second highest in the six year time series (56 000-78 000 tons).

Although the survey series from 1987-95 is not directly comparable with the series from 1997-2002, the decline in the stock observed in Subarea 1 until 1994 has stopped and the stock seems to be back at the level of the late-1980s and early-1990s.

Estimation of trawlable one-year-olds has been steadily increasing since 1996 and the 2000 year-class was the largest in the time series. The 2001 year-class is considered to be a little below average. It was noted, that the 1995 year-classes was estimated to be a very strong year-class at age one but it has not shown up in the fishery as a particularly strong year-class.

Unstandardized trawl CPUE indices showed an increase between 2001 and 2002 in Div. 0A but were stable in Div. 1A

A combined standardized trawl CPUE index from SA 0 and Div. 1CD was stable during 1990-2000 and a standardized trawl CPUE index from Div. 1CD has been stable during 1990-2002.

It was noted that 38% of the fish were <45 cm in the commercial trawl fishery in Div. 0A in 2002 compared to 21% in the trawl fishery in Div. 0B.

e) **Precautionary Reference Points**

There was no new information available to allow determination of precautionary reference points.

f) **Research Recommendation**

STACFIS **recommended** that *the investigations of the by-catch of Greenland halibut in the shrimp fishery in Subareas 0 and 1 should be continued and the results should be made available before the assessment in 2004.*

STACFIS **recommended** that *the CPUE series from Div. 0B should be updated.*

STACFIS **recommended** that *a survey be carried out in the northern part of the Baffin Bay (north of the areas which were surveyed in 2001) in order to investigate the distribution of Greenland halibut in the area.*

2. **Greenland Halibut (*Reinhardtius hippoglossoides*) in Division 1A Inshore** (SCR Doc. 03/29, 49; SCS Doc. 03/16)

a) **Introduction**

The main fishing grounds for Greenland halibut in Div. 1A are located inshore. The inshore landings in Div. 1A were around 7 000 tons in the late-1980s then increased until 1998 when the landings were almost 25 000 tons. Since 2000 landings have declined and were 16 900 tons in 2001 but increased again to 20 000 tons in 2002 (Fig. 2.1).

Recruitment to the inshore stock is dependent on immigration from the offshore nursery grounds and the spawning stock in Davis Strait. Only sporadic spawning seems to occur in the fjords, hence the stock is not considered self-sustainable. Based on tagging data the fish remain in the fjords, and do not appear to contribute back to the offshore spawning stock. This connection between the offshore and inshore stocks implies that reproductive failure in the offshore spawning stock for any reason will have severe implications on the recruitment to the inshore stocks.

Catches ('000 tons) in Div. 1A inshore are as follows:

	1994	1995	1996	1997	1998	1999	2000 ¹	2001 ¹	2002 ¹	2003
Recommended TAC							7.9	7.9	7.9	7.9
Disko Bay ²	5.2	7.4	7.8	8.6	10.7	10.6	7.6	7.1	11.7	
Recommended TAC							6.0	6.0	6.0	6.0
Uummannaq	4.0	7.2	4.6	6.3	6.9	8.4	7.6	6.6	5.4	
Recommended TAC							4.3	4.3	4.3	2.4
Upernavik	4.8	3.3	4.8	4.9	7.0	5.3	3.8	3.2	3.0	
Unknown ³	-	-	-	-	-	-	2.2			
STATLANT 21A	14.1	17.0	17.3	20.8	19.7	24.3	21.1 ⁴	17.1 ⁴		
STACFIS	14.0	17.9	17.3	19.8	24.6	24.3	21.0	16.9	20.1	

¹ Provisional. Landing data from 2000 are likely to be underestimated by 2 000 tons.

² Formerly named Ilulissat.

³ Landings from unknown areas within Div. 1A.

⁴ Includes catches from the off shore area.

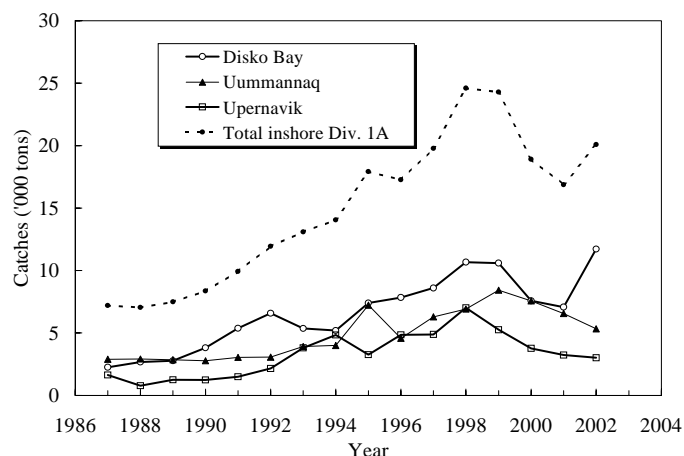


Fig. 2.1. Greenland halibut in Div. 1A: landings by area.

This fishery takes place in the inner parts of the ice fjords at depths between 500 to 800 m. Longlines are set from small boats, or in winter through the ice. Since the mid-1980s gillnets were used in the fishery, but a combination of lower price of gillnet caught fish and local bans on this gear caused this fishery to decrease during the last decade. A total ban on gillnets has been in force since 2000, although dispensation is presently given to a gillnet fishery at Ilulissat in Disko Bay. Dispensations were also given to a gillnet fishery in the outer parts of the fjords in Uummannaq and Upernavik in 2002. The minimum mesh size allowed is 110 mm (half meshes).

There are no regulations on landings, but from 1998 a fishery licence has been required to land Greenland halibut. The total number of licenses is around 1 200.

The inshore fishery in Div. 1A is mainly located in three areas: Disko Bay (69°30'N-70°N), Uummannaq (70°30'N-72°N) and Upernavik (72°30'N-75°N), which are dealt with separately in the following:

Disko Bay. The Greenland halibut fishery is conducted in, and in front of an ice fjord in the immediate vicinity of Ilulissat town, and in an ice fjord, Torssukattaq, north of Ilulissat.

The catches in Disko Bay increased from about 2 300 tons in 1987 to a high level of about 10 500 tons in 1998. Thereafter landings declined to 700 tons in 2001. In 2002 landings increased by 66% to record high 11 700 tons.

Uummannaq. The area consists of a large system of ice fjords where the fishery is conducted. The main fishing ground is in the southwestern part of the fjord system. During earlier times Qarajaqs Ice fjord was the main fishing area but during the last decade the fishery spread further north to include Sermilik and Itividup ice fjords.

Landings increased from a level of 2 000 tons before 1987 to a record high in 1999 of 8 425 tons. The landings declined to 6 600 tons in 2001 and further to 5 300 tons in 2002.

Upernavik. The northernmost area consists of a large number of ice fjords. The main fishing grounds are Upernavik and Giesecke ice fjords (up to 73°45'N). New fishing grounds around Kullorsuaq in the northern part of the area have been exploited recently.

The landings in the Upernavik area increased steadily from about 1 000 tons in the late-1980s to about 3 000 to 4 000 tons in 1993 to 1995 and reached the highest on record in 1998 at 7 000 tons (Fig. 2.1). Landings gradually decreased since then to 3 200 tons in 2001 and 3 019 tons in 2002.

b) **Input Data**

i) **Commercial fishery data**

Landing data available at the time of the assessment were preliminary, however, considered reliable. Length distributions were available from longlines and gill nets from the summer and winter fisheries in most areas, including data from the 2003 winter fishery in Disko Bay and Uummannaq. Catch-at-age could not, however, be calculated because landings have not been reported by gear.

In recent years the age composition has changed towards fewer and younger age groups especially in Upernavik. In Disko Bay and Uummannaq age composition has stabilized (no 2002 data).

Length measurements of the commercial longline landings from 1993 to 2002 in Disko Bay, Uummannaq and Upernavik indicated that the fisheries take place on smaller sub-components of the stock, as size distribution differs substantially between summer and winter.

Mean length in Disko Bay has been relatively stable in the summer fishery since 1993 while the trend in the winter fishery was increasing overall until 2001, except for winter 2000 when weather conditions prevented the traditional fishery. Mean length decreased again in 2002 and 2003, but is still at the average level for the period 1993-2002. In Uummannaq, a decreasing trend in mean length was observed until 1999 for the summer fishery, but this has stabilized since then. In the winter fishery mean length was relatively stable up to 2001. In the winter of 2002 mean length increased sharply but decreased in 2003 again to the previous level. In Upernavik, the mean length has varied but an overall negative trend was observed until 1999, especially in the winter fishery where the reduction was statistically significant. Since 2000 the mean length has been stable around 62 cm in both the winter and summer fisheries.

Logbooks are not mandatory. However, in 1999 logbooks were introduced on a voluntary basis. Available logbooks constitute an insignificant part of the fishery (<1%), and data are thus too scarce to be used in the assessment. Earlier attempts to estimate fishing effort showed a significant correlation between effort (expressed as fishing days) and landings.

ii) **Research survey data**

In 1993 a longline survey program for Greenland halibut was initiated for the inshore areas, Disko Bay, Uummannaq and Upernavik. The surveys have been conducted annually covering two of the three areas in rotation, with approximately 30 fixed stations in each area. Results from these surveys were presented in the 2002 assessment. No survey was conducted in 2002.

Since 1988 annual trawl surveys have been conducted with a shrimp trawl off West Greenland between 59°N and 72°30'N from the 3-mile offshore line to the 600 m depth contour line. Since 1991 the area inshore of the 3-mile line in Disko Bay has been included. Standardized recruitment indices based on the survey were presented as catch-in-numbers per age per hour, for both the offshore and inshore nursery areas (Fig. 2.2). The index was recalculated in 2003 using hauls from depths >250 m only. The recalculations resulted in an increased the absolute values, but not the overall trends in the series. Both offshore and in Disko Bay the numbers of one-year-olds from the 2001 year-class were about average.

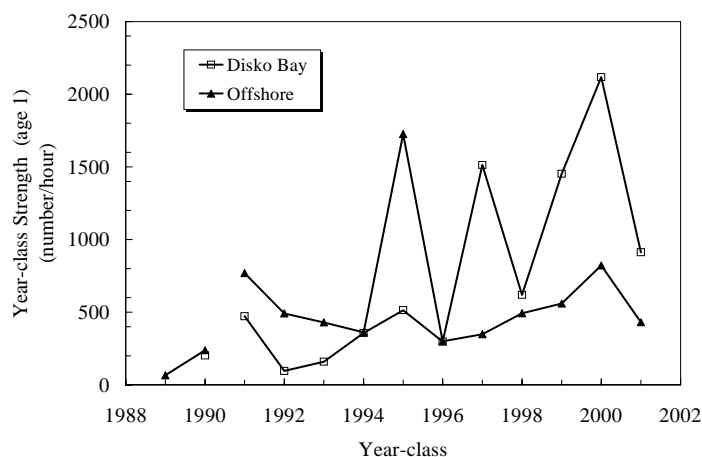


Fig. 2.2. Greenland halibut in Div. 1A: recruitment at age 1 on nursery grounds.

iii) Biological studies

A review of the tagging experiments in West Greenland in the period 1986-98 was given in the 1999 assessment (SCR Doc. 99/25). Tagging of inshore Greenland halibut in Div. 1A has continued since 1999. There have been few tag-returns since then thus no new analysis has been carried out.

c) Assessment Results

General comment. Data deficiencies for 2002, both for commercial and survey data, in combination with preliminary landing statistics, impedes an updated assessment of the populations. The abrupt decline in landings in the most recent years that raised concern by NAFO in 2002, reversed and increased for Disko Bay in 2002. The lack of information on fishing effort makes it difficult to evaluate trends in landings relative to stock biomass or fishing effort.

Disko Bay. In the commercial fishery the mean length in the summer fishery has been relatively stable. The mean length in the winter fishery has fluctuated with an increasing tendency until 2001. The mean length has been decreasing in 2002 and 2003 and is now about average for the period 1993-2002. The increase in landings (66%) in the Disko Bay area in 2002 raises concern. Information from fishermen indicates that the increase, at least to some extent, was the result of an increase in effort.

Ummannaq. Catch composition in the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has recently stabilized. No data from 2002.

The mean length in both the summer and the winter fishery has been relatively stable during the period 1993-2002.

Upernavik. Mean length compositions in commercial catches have decreased, most significantly in the winter fishery. The mean length distribution seems, however, to have stabilized both in the winter and the

summer fishery during 1999-2002 around 62 cm. Fishing grounds in the northern part of the district have been exploited for some years. Little information exists from these areas

Information from fishermen and the industry about the fishery in 2002 suggests that: The increase in landings in Disko Bay in 2002 is a result of a rise in effort. Gillnet boats from Uummannaq participates in a fishery in Torssukattaq in Disko Bay and thus shifted effort from Uummannaq to Disko Bay. In Upernavik several 25-35 ft boats were lost in a fire and 4 of the bigger vessels were involved in a new fishery for snow-crab. Thus effort was reduced in Upernavik in 2002.

d) **Reference Points**

Precautionary reference points could not be given.

e) **Research Recommendations**

It was noted that in 2001 an annual gill net survey with small mesh net was started in the Disko Bay in order to estimate relative year-class strength of pre recruits to the fishery. STACFIS **recommended** that *results from the gill net survey for Greenland halibut Div. 1A be presented for review in June 2004.*

Voluntary logbooks were introduced in 1999 but have only covered a small proportion of the landings due to poor return rates. STACFIS **recommended** that *authorities consider means to ensure a higher return rate of inshore logbooks from the Greenland halibut commercial fishery in Div. 1A.*

STACFIS **recommended** that *investigations of by-catch of juvenile Greenland halibut in the commercial shrimp fishery in Subareas 0+1 be continued.*

STACFIS **recommended** that *the discard rate of 'small Greenland halibut' in Div. 1A be investigated.*

3. **Roundnose Grenadier (*Coryphaenoides rupestris*) in Subareas 0 and 1** (SCR Doc. 03/20, SCS Doc. 03/8, 12, 16)

a) **Interim Monitoring Report**

A total catch of 34 tons, taken as by-catch in the fishery for Greenland halibut, was reported from 2002 compared to 61 tons in 2001 (Fig. 3.1).

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	8.0	8.0	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	0.12 ²	0.31 ³	0.12 ⁴	0.15 ⁵	0.03 ⁶	0.04	0.10 ¹	0.06 ¹	0.01 ¹	
STACFIS	0.12 ²	0.31 ³	0.12 ⁴	0.15 ⁵	0.03 ⁶	0.04	0.10 ¹	0.06 ¹	0.03 ¹	

¹ Provisional.

²⁻⁶ Includes roughhead grenadier from Div. 1A misreported as roundnose grenadier: 14² tons, 24³ tons, 30⁴ tons, 28⁵ tons, 3⁶ tons.

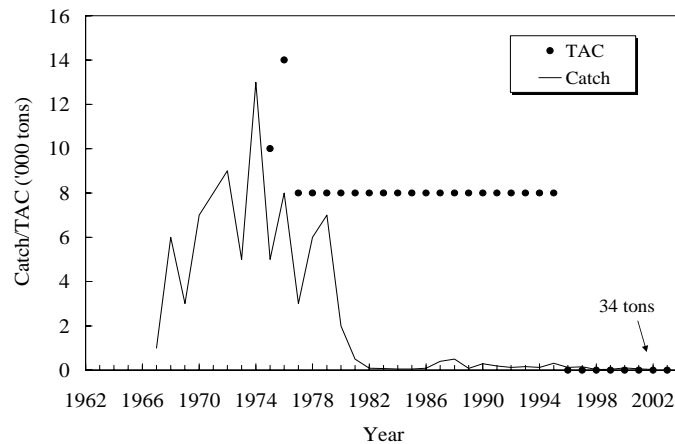


Fig. 3.1. Roundnose grenadier in Subareas 0+1: catches and TACs
In the Greenland survey in 2002 the biomass in Div. 1CD was estimated at 1 563 tons, which is the second lowest on record (Fig. 3.2).

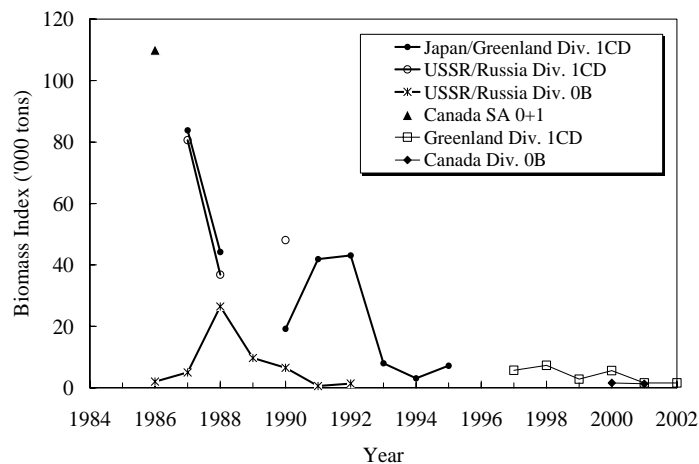


Fig. 3.2. Roundnose grenadier in Subareas 0+1: biomass estimates from USSR/Russian, Japan/Greenland, Greenland and Canadian surveys in Div. 0B and Div. 1CD.

The stock of roundnose grenadier is still at a very low level observed since 1993.

Exploitation level is considered to be low in recent years.

4. Demersal Redfish (*Sebastes* spp.) in Subarea 1 (SCR Doc. 03/15, 20, 29, 33, 35; SCS Doc. 03/8, 16)

a) Introduction

Historically, redfish were taken mainly as by-catch in the trawl fisheries for cod and shrimp. However, occasionally during 1984-86, a directed fishery on redfish was observed for German and Japanese trawlers. With the collapse of the Greenland cod stock during the early-1990s, resulting in a termination of that fishery, catches of commercial sized redfish were taken inshore by long lining or jigging and offshore by shrimp fisheries only. There are also substantial numbers of juveniles discarded in the shrimp fishery. Since 1 October 2000, however, sorting grids are mandatory, probably reducing the amount of by-catches.

Both redfish species, golden redfish (*Sebastes marinus* L.) and deep-sea redfish (*Sebastes mentella* Travin), are included in the catch statistics since no species-specific data are available. Other data suggest that until 1986, landings were composed almost exclusively of golden redfish. Subsequently, the proportion of deep-sea redfish represented in the catches increased, and since 1991, the majority of catches are believed to be deep-sea redfish.

In 1977, total reported catches peaked at 31 000 tons (Fig. 4.1). During the period 1978-83, reported catches of redfish varied between 6 000 and 9 000 tons. From 1984 to 1986, catches declined to an average level of 5 000 tons due to a reduction of effort directed to cod by trawlers of the EU-Germany fleet. With the closure of this offshore fishery in 1987, catches decreased further to 1 200 tons, and remained at that low level. The estimated catch figure in 2001 and 2002 of demersal redfish in Subarea 1 is 332 tons and 487 tons, respectively.

Recent and historical catch figures do not include the weight of substantial numbers of small redfish discarded by the trawl fisheries directed to shrimp.

Recent catches ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	19	19	19	19	19	19	19	19	19	8
Catch	1	0.9	0.9	1	0.9	0.8	0.7 ¹	0.3 ^{1,2}	0.5 ^{1,2}	

¹ Provisional.

² Estimated.

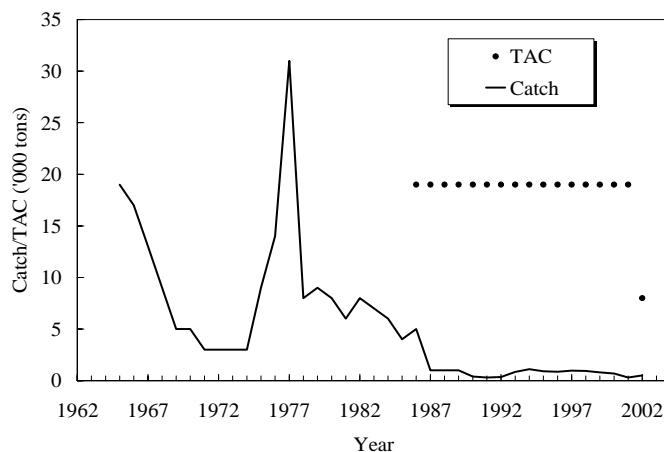


Fig. 4.1. Redfish in Subarea 1: catches and TAC.

b) Input Data

i) Commercial fishery data

No data on CPUE were available. Information on historical length composition was derived from sampling of German commercial catches of golden redfish during 1962-90 covering fresh fish landings as well as catches taken by freezer trawlers. Samples were quarterly aggregated and mean length was calculated. These data revealed significant size reductions of fish caught from 45 to 35 cm, with the biggest reductions occurring during the 1970s. There are no data available to estimate the size composition of historical catches of deep-sea redfish.

Reliable information on by-catch in the shrimp fishery has not been available since 2000.

ii) **Research survey data**

EU-Germany groundfish survey. Annual abundance and biomass indices were derived from stratified-random bottom trawl surveys commencing in 1982. These surveys covered the areas from the 3-mile limit to the 400 m isobath of Div. 1B to 1F and were primarily designed for cod as target species. Therefore, the high interannual variation in the estimates for redfish could have been caused as a result of the incomplete survey coverage in terms of depth range and pelagic occurrence of redfish. Nonetheless, the survey results indicated that both abundance and biomass estimates of golden redfish (≥ 17 cm) decreased by more than 90% until 1990 and remained at that low level since then (Fig. 4.2). Estimates for deep-sea redfish (≥ 17 cm) varied without a clear trend but have frequently been extremely low since 1989 (Fig. 4.3). However, the 1997, 2000 and 2001 estimates indicated a significant biomass increase due to recruitment (Fig. 4.3). Unspecified redfish < 17 cm were found to be very abundant, especially in 1986, 1991, and 1996-98 (Fig. 4.4). The abundance index of these small redfish decreased in 1999 and continued to decrease there after. Reappearing peaks at 6, 10-12 and 15-16 cm might indicate annual growth increments and represent the age groups 0, 1 and 2 years.

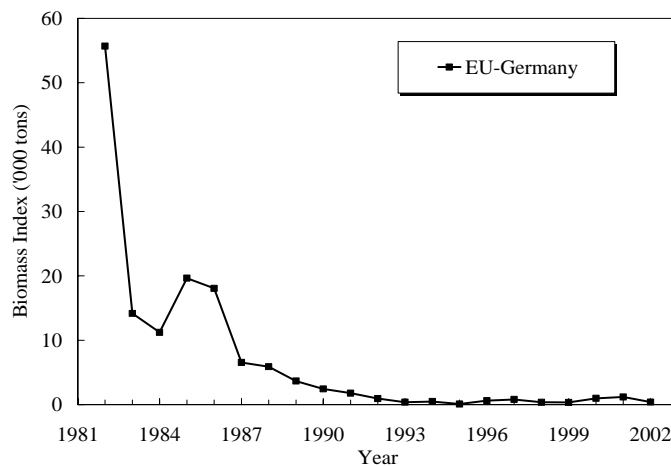


Fig. 4.2. Golden redfish in Subarea 1: survey biomass index.

Greenland-Japan and Greenland deep-sea surveys. During 1987-95, cooperative trawl surveys directed to Greenland halibut and roundnose grenadier have been conducted on the continental slope in Div. 1A-1D at depths between 400 and 1 500 m. This Greenland-Japan deep-sea survey was discontinued in 1996 but conducted again since 1997 by Greenland with another vessel and changed gear. Deep-sea redfish were mainly caught at depths less than 800 m. Despite the technical changes, the increase in stock abundance and biomass from lowest level in 1995 is consistent with other survey information (Fig. 4.3). From 1997 to 1999 and in 2001, the biomass has been stable at about 2 000-2 500 tons (Fig. 4.3). In 2000 and 2002, the survey did not cover the shallow areas (< 800 m) sufficiently. Therefore, no abundance and biomass indices were calculated. Length measurements revealed that the size composition of the stock is presently dominated by individuals < 30 cm. From the 2002 survey 30 redfish (between 18-39 cm) were examined for maturity. None of the fish showed any sign on maturity.

Greenland bottom trawl survey using a shrimp gear. Since 1988, a shrimp survey was conducted by Greenland covering the Div. 1A to 1F down to 600 m depth. Due to changes in survey strategy and sampling of fish, determinations of abundance and biomass indices and length composition were considered comparable only since 1992. Redfish was found to be most abundant in the northern Div. 1B and 1C. In the period 1992-97 abundance and biomass indices varied without a clear trend but indicated juvenile redfish to be very abundant, especially in 1994 and 1996 (Fig. 4.4). In 1997, the

survey indicated a substantial decrease. In 1998 a further decrease was observed, and have remained at a very low level since. During the entire survey series, catches were composed almost exclusively of redfish being smaller than 20 cm.

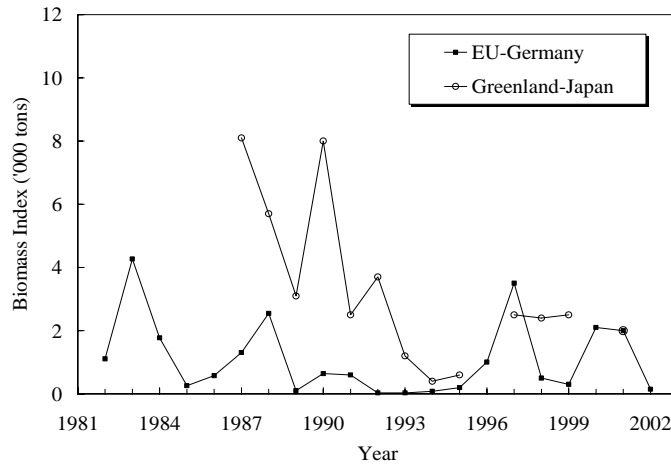


Fig. 4.3. Deep-sea redfish in Subarea 1: survey biomass indices.

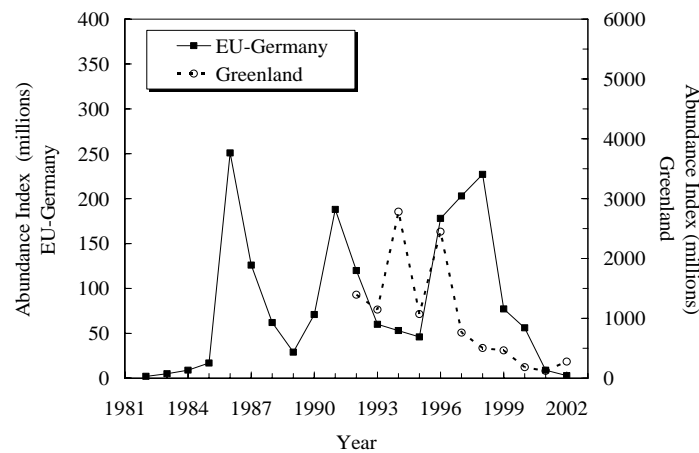


Fig. 4.4. Juvenile redfish (deep-sea redfish and golden redfish combined) in Subarea 1: survey abundance indices.

c) **Estimation of Parameters**

The golden redfish SSB was assessed assuming knife-edge maturity at 35 cm as observed in East Greenland applied to the length disaggregated abundance indices derived from the EU-Germany groundfish survey. The length groups 17-20 cm was chosen as recruitment indices. SSB and recruitment indices decreased drastically from 1982 and have remained significantly below the average level since 1989 (Fig. 4.5). Taking into account the recent very low SSB and the recruitment failure together with the absence of golden redfish in the Greenland surveys, the stock of golden redfish in Subarea 1 is considered to be severely depleted with no signs of recovery.

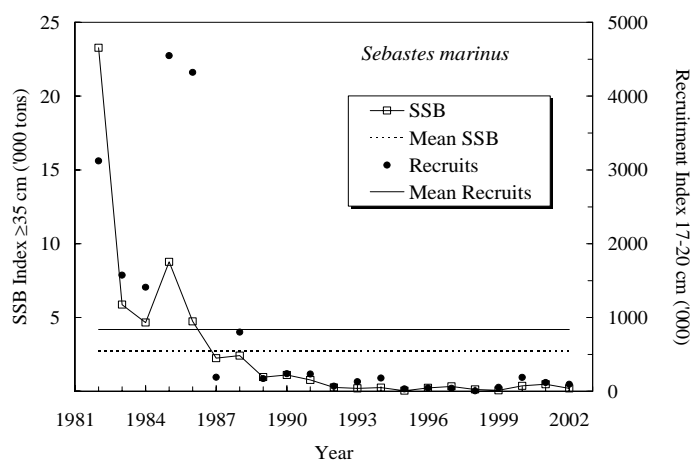


Fig. 4.5. Golden redfish Subarea 1: SSB and recruitment indices as derived from the EU-Germany groundfish survey in the given years.

The German survey biomass of fish ≥ 35 cm and the abundance of length groups 17-20 cm were taken as proxies for deep sea redfish SSB and recruitment, respectively. No clear trend can be derived from these estimates but SSB has been below average since 1989 (Fig. 4.6). The recently depleted status of the SSB is confirmed by the lack of adult fish in the Greenland deepwater survey. Recruitment variation for deep-sea redfish is high, although there is indication of recent improvement (1997, 2000 and 2001).

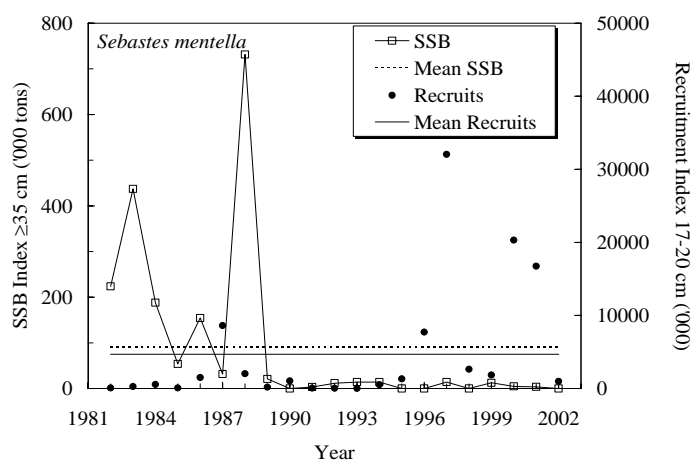


Fig. 4.6 Deep-sea redfish in Subarea 1: SSB and recruitment indices as derived from the Germany groundfish survey in the given years.

d) Assessment Results

In view of dramatic declines in survey biomass indices of golden and deep sea redfish (≥ 17 cm) to an extremely low level along with significant reduction in fish sizes, it is concluded that the stocks of golden and deep sea redfish in Subarea 1 remain severely depleted and there are no signs of any short term recovery.

Substantial numbers of redfish caught are caught and discarded by the shrimp fishery, and concern must be expressed about the continuing failure of the juveniles to rebuild the pre-mature and mature stock components. Considering the depleted SSBs, the recruitment potential of the very abundant early life stages at an

age of 0-2 years to the Subarea 1 stocks remains unclear. Recruitment indices for golden redfish have been extremely poor while those for deep-sea redfish indicate some recent improvement (1997, 2000 and 2001). The probability of recovery of the redfish stocks in Subarea 1 should increase if the by-catches taken by the shrimp fishery is reduced to the lowest level possible. The application of obligatory sorting grids since 1 October 2000 should help to reduce by-catches of young redfish.

e) **Reference Points**

Given the lack of long enough time-series of spawning stock and recruitment data and the uncertainties regarding reproduction and maturation of redfish in this area, STACFIS was unable to propose any limit or target reference points for fishing mortality or spawning stock biomass for the stocks of golden and deep sea redfish stocks in Subarea 1.

f) **Research Recommendation**

STACFIS **recommended** that *the quantity of redfish discarded in the shrimp fishery in Subarea 1 be quantified.*

STACFIS **recommended** that *determination of maturity of redfish caught during surveys in Subareas 1 be carried out.*

5. **Other Finfish in Subarea 1** (03/15, 20, 29; SCS Doc. 03/8, 16)

a) **Introduction**

Historically, catches of Greenland cod (*Gadus ogac*), American plaice (*Hippoglossoides platessoides*), Atlantic wolffish (*Anarhichas lupus*), spotted wolffish (*A. minor*), thorny skate (*Raja radiata*), lumpfish, Atlantic halibut (*Hippoglossus hippoglossus*) and sharks are mainly taken by offshore trawl fisheries directed to shrimp, cod, redfish and Greenland halibut. Since 1 October 2000, however, sorting grids in the shrimp fisheries are mandatory, and will probably reduce the amount of by-catches. Fisheries have also been prosecuted by long liners operating both inshore and offshore, and by pound net and gillnet fisheries. Estimated catches of other finfish in 2002 amounted to 7 437 tons, representing an increase of about 2 400 tons compared to the 2001 catch. This was mainly caused by an increase in catch of lumpfish by 56%, amounting to 5 800 tons in 2002. Catches of wolffish increased by 63 % from 2001 to 2002; amounting to 118 tons in 2002. Atlantic halibut catches decrease from 45 tons in 1999 to only 1 tons in 2001 and 2002.

The catch figures do not include the weight of fish discarded by the trawl fisheries directed to shrimp.

Nominal reported catches (tons) are as follows:

Species	1994	1995	1996	1997	1998	1999	2000	2001 ¹	2002 ¹
Greenland cod	1 854	2 526	2 117	1 729	1 717	1 899	931	1 152	939
Wolffish	100	51	47	68	30	33	59	75	118
Atlantic halibut	38	23	34	22	22	45	9	1	1
Lumpfish	607	447	425	1 158	2 143	3 058	1 211	3 216	5 795
Sharks	34	46	135	nd	nd	nd	nd	nd	nd
Non-specified finfish	643	618	609	1 269	588	nd	769	589	584
Sum	3 276	3 711	3 367	4 246	4 500	5 035	2 979	5 033	7 437

¹ Estimated
nd No data.

b) Input Data

i) Commercial fishery data

No data on CPUE, length and age composition of the catches were available. Length frequencies derived from the Greenland shrimp survey revealed that the shrimp trawl was capable of catching all predominant fish sizes. There was no new information on by-catch in the shrimp fishery available.

ii) Research survey data

EU-German groundfish survey. Annual abundance and biomass indices were derived from stratified-random bottom trawl surveys commencing in 1982. These surveys covered the areas from the 3-mile limit to the 400 m isobath of Div. 1B to 1F, and were primarily designed for cod as target species. Biomass estimates for American plaice, Atlantic wolffish, spotted wolffish and thorny skate remained severely depleted after severe declines in 1991. Recently, Atlantic wolffish showed increased recruitment, which did not, yet resulted in a significant increase in the mature biomass (Fig. 5.1).

Greenland-Japan and Greenland groundfish surveys. During 1987-95, cooperative trawl surveys directed to Greenland halibut and roundnose grenadier were conducted on the continental slope in Div. 1A-1D at depths between 400 and 1 500 m. This Greenland-Japan deep-water survey was discontinued in 1996. From 1997, a Greenland survey was initiated with another vessel and different gear. In 1999, estimates of biomass indices for American plaice were very low and amounted to 135 tons. Very few American plaice have been recorded in the survey since 1999. Therefore, no biomass estimated is available from this survey.

Greenland groundfish/shrimp survey. Since 1988, a shrimp survey has been conducted by Greenland covering the Div. 1A to 1F down to 600 m depth. Due to changes in survey strategy and sampling of fish, determinations of abundance and biomass indices and length composition were considered comparable since 1992. Abundance and biomass indices of American plaice, Atlantic wolffish, spotted wolffish and thorny skate were very low (Fig. 5.1). Juveniles as derived from length measurements dominated all stocks mentioned.

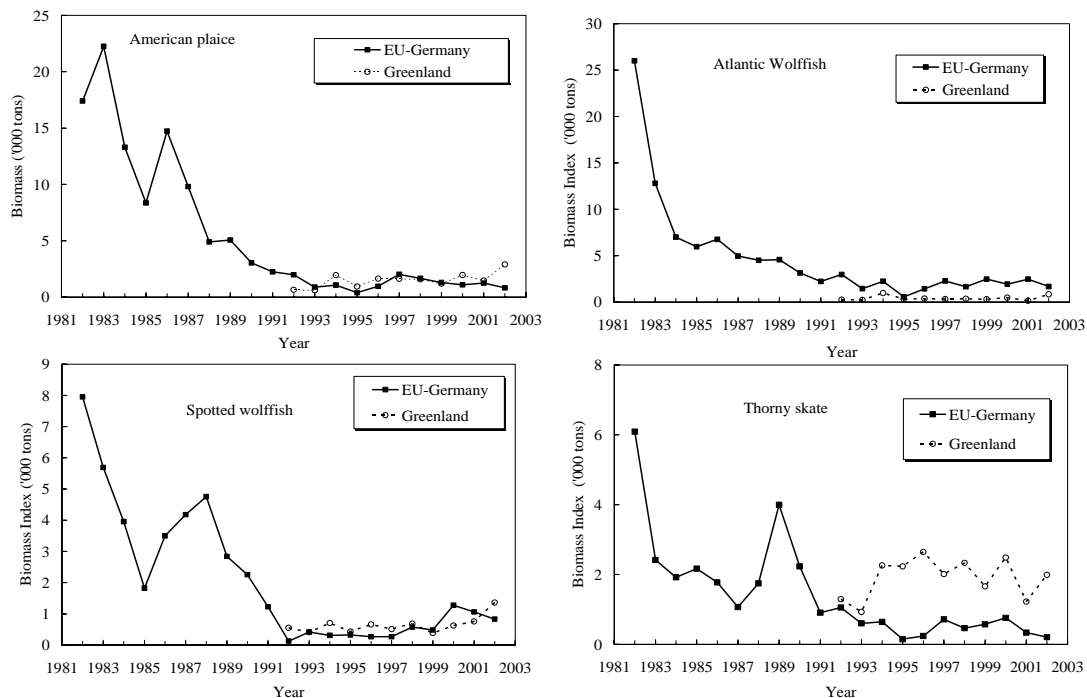


Fig. 5.1. Finfish in Subarea 1: survey biomass indices of various finfish species.

c) Estimation of Parameters

American plaice SSB was derived from German length disaggregated abundance indices to which a length-maturity ogive was applied. During 1982-91, the SSB decreased drastically to depletion without a significant increase since then (Fig. 5.2). Recruitment is presented as abundance of small fish 15-20 cm representing age group 5 and indicates a general higher level before 1991 compared to recent years.

The estimation of Atlantic wolffish SSB and recruitment was performed in the same manner as for American plaice, i.e. using a length-maturity ogive and fish of 15-20 cm representing 3 year old recruits. Since 1982, the SSB decreased drastically and remains severely depleted since the early-1990s (Fig. 5.3). In contrast, until 1994 recruitment increased almost continuously. Recruitment was at a very low level in 1995, increased again in the late-1990s, although it varied considerably. In the last two years (2001 and 2002) recruitment decreased again to the 1995-1996 levels. However, the abundant recruitment has not contributed significantly to the SSB.

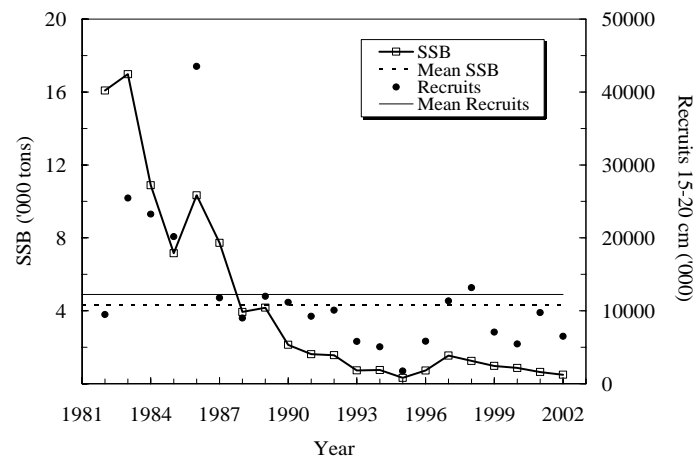


Fig. 5.2. American plaice in Subarea 1: SSB and recruitment indices as derived from the EU-Germany groundfish survey.

Biomass indices for spotted wolffish derived from the Greenland shrimp/groundfish survey, show a weak increase since 1999 (Fig. 5.1). However the German groundfish survey shows a decrease since 2000. For thorny skate the German groundfish survey biomass indices show a decrease since 2000, but data derived from the Greenland shrimp/groundfish survey fluctuated without trend since 1995.

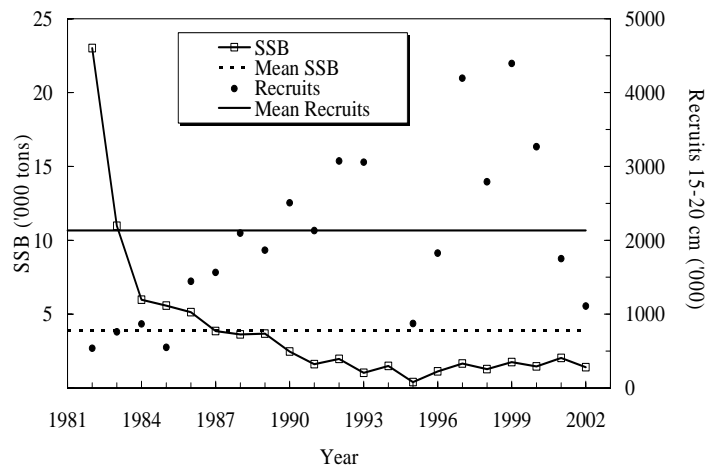


Fig. 5.3. Atlantic wolffish in Subarea 1. SSB and recruitment indices as derived from the EU-Germany groundfish survey.

d) **Assessment results**

Despite gradually increasing recruitment since the 1980s, no increase in Atlantic wolffish SSB has been observed. Recruitment of American plaice remains below average. Both spotted wolffish and thorny skates have exhibited declines since the 1980s and the biomass indices remained at very low levels in 2002. Based on the above STACFIS has concluded that the status of these stocks remains severely depleted.

Taking the poor stock status of American plaice, Atlantic wolffish, spotted wolffish and thorny skate into account, even low amounts of fish taken and discarded by the shrimp fishery might be sufficient to retard the recovery potential of these stocks. The continued failure of the recruits to rebuild the spawning stocks indicates high mortality rates in excess of the sustainable level. The probability of stock recovery would be enhanced by minimizing the by-catch of finfish in SA1 to the lowest possible level. The application of obligatory sorting grids since 1 October 2000 should help to reduce these by-catches.

e) **Reference Points**

Due to a lack of appropriate data, STACFIS was unable to propose any limit or target reference points for fishing mortality or spawning stock biomass for American plaice, Atlantic wolffish, spotted wolffish and thorny skate in Subarea 1. Nevertheless, the current spawning stock biomass levels as derived from survey results are considered far below appropriate levels of B_{lim} .

f) **Research Recommendation**

STACFIS **recommended** that *the species composition and quantity of other finfish discarded in the shrimp fishery in Subarea 1 be quantified.*

B. STOCKS ON THE FLEMISH CAP

6. Cod (*Gadus morhua*) in Division 3M (SCR Doc. 03/38, 03/42; SCS Doc. 03/6, 03/7)

a) Interim Monitoring Report

The fishery has been under moratorium since 1999. Catches in 2002 were estimated to be 33 tons, about the same level as catches in the two previous years.

Recent TACs and catches ('000 tons) are as follows (see also Fig. 6.1):

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	0	0	11	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	6.9	3.2	2.3	1.5	0.5	0.0	0.0 ¹	0.1 ¹	0.0 ¹	
STACFIS	29.9	10.4	2.6	2.9	0.7	0.4	0.1	0.0	0.0	

¹ Provisional.

ndf No directed fishery.

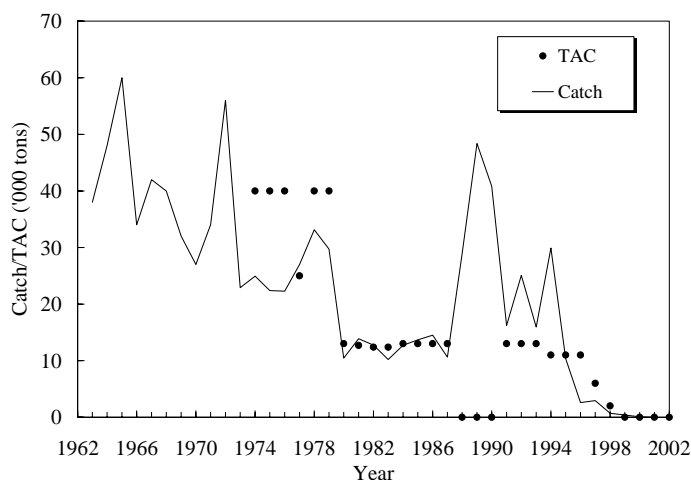


Fig. 6. 1. Cod in Div. 3M: catches and TACs.

Survey results from 2002 indicate that total biomass remain at the same low level as in 2002 (Fig. 6.2), and confirm the weakness of recruitment for the 1992 and subsequent year-classes at all observed ages.

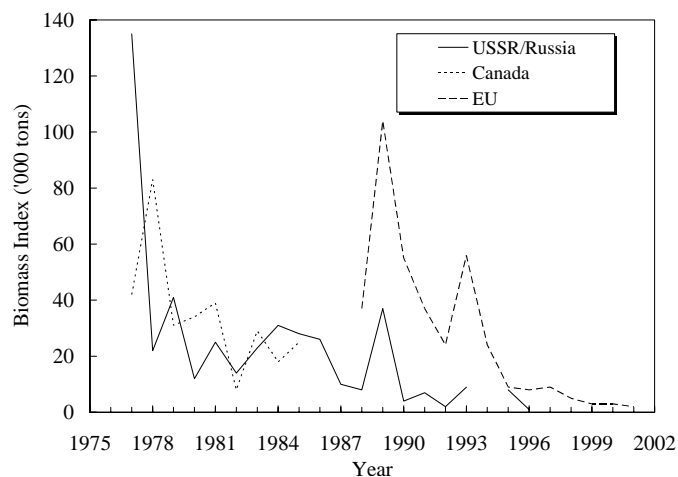


Fig. 6.2. Cod in Div. 3M: total biomass estimates from surveys.

7. **Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 3M** (SCR Doc. 03/9, 25, 42, 45; SCS Doc. 03/06 (Part 2), 7, 11.

a) **Introduction**

There are three species of redfish that are commercially fished on Flemish Cap; deep-sea redfish (*Sebastes mentella*), golden redfish (*Sebastes marinus*) and Acadian redfish (*Sebastes fasciatus*). The term beaked redfish is used for *S. mentella* and *S. fasciatus* combined. Because of difficulties with identification and separation, all three species are reported together as 'redfish' in the commercial fishery. All stocks have both pelagic and demersal concentrations as well as a long recruitment process to the bottom, extending to lengths up to 30-32 cm. All redfish species are long lived with slow and very similar growth. Female sexual maturity is reached at a median length of 26.5 cm for Acadian redfish, 30.1 cm for deep-sea redfish and 33.8 cm for golden redfish.

i) **Description of the fishery**

The redfish fishery in Div. 3M increased from 20 000 tons in 1985 to 81 000 tons in 1990, falling continuously since then until 1998-99, when a minimum catch around 1 000 tons was recorded mostly as by-catch of the Greenland halibut fishery. There was an overall increase in the redfish catches to 3 700 tons in 2000. In 2001-2002 the provisional catch was at a somewhat lower level around 2 900 tons.

The drop in the Div. 3M redfish catches from 1990 until 1999 was related both to the decline of the stock biomass and the abrupt decline of fishing effort deployed in this fishery by the fleets responsible for the high level of catches in the late-1980s to early-1990s (former USSR, former GDR and Korean crewed non-Contracting Party vessels). However in 1999 Russian vessels appeared again on Flemish Cap and their nominal catch increased from 108 tons to 1 864 tons in 2000. The EU catches increased from 365 tons in 1999 to 1 226 tons in 2000 due to an increase in the catches of EU-Portugal from 96 tons to 916 tons. As in 2001, the 2002 directed fishery was primarily prosecuted by EU-Portugal and Russia with 1 512 tons and 1 55 tons, respectively.

The start in 1993 and further development of a shrimp fishery on Flemish Cap led to high levels of redfish by-catch in 1993-94. Since 1995 this by-catch in weight fell to apparent low levels but in 2001-2002 redfish by-catch increased significantly to 750 tons, the highest observed since 1994. Translated to numbers this represented an increase from the recent by-catch level of 3.4 million redfish (1999-2000) to 22.1 million in 2001-2002, representing 71% of the total 2001-2002 catch numbers.

Recent TACs, catches and by-catch ('000 tons) are as follows (Fig. 7.1):

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	20	20	20	20	20	10	5	5	5	5
STATLANT 21A	9.9	6.7	1.1	0.4	1.0	0.8	3.8 ²	3.2 ²	3.0 ²	
STACFIS Catch ¹	11.3	13.5	5.8	1.3	1.0	1.1	3.7	3.2	2.9	
By-catch ³	5.90	0.37	0.55	0.16	0.19	0.10	0.10	0.74	0.77	
Total catch ⁴	17.2	13.9	6.4	1.5	1.2	1.2	3.8	3.9	3.7	

¹ Includes estimates of non-reported catches from various sources.

² Provisional.

³ In shrimp fishery (Kulka, D., pers. comm., 2000-2003).

⁴ Total STACFIS + by-catch.

The Div. 3M redfish stocks have been exploited in the past by both pelagic and bottom trawls. The majority of the bottom commercial catches were composed of beaked redfish. The species composition of the pelagic redfish catches, which dominated the fishery in the early-1990s, remains

unknown. However, based on bottom survey results, on average *S. mentella* and *S. fasciatus* together represent most of the abundance and biomass of Div. 3M redfish. It is therefore assumed that the pelagic catches in the commercial fishery were also dominated by beaked redfish.

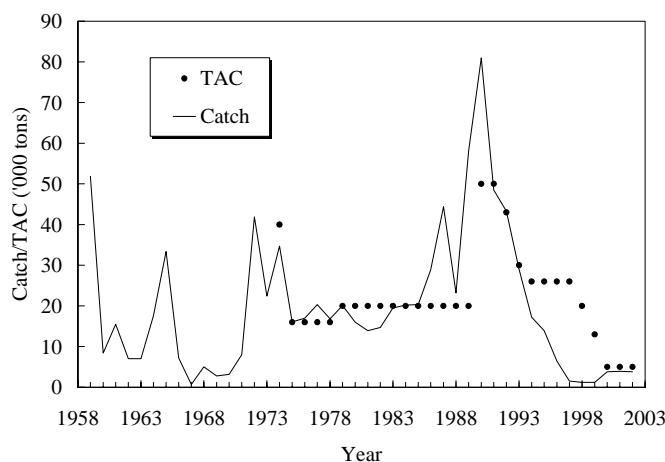


Fig. 7.1. Redfish in Div. 3M: catches and TACs.

b) Input Data

The present assessment evaluates the status of the Div. 3M beaked redfish stock, regarded as a management unit composed of populations of two very similar species. The reasons for this approach were the dominance of this group in the Div. 3M redfish commercial catches and respective CPUE series, corresponding also to the bulk of all redfish bottom biomass survey indices available for the Flemish Cap bank. Any further recovery of the Div. 3M redfish fishery from its present status will be basically supported by the *S. mentella* plus *S. fasciatus* biomass.

i) Commercial fishery and by-catch data

Sampling data. Most of the commercial sampling data available for the Div. 3M redfish stocks since 1989 are from the Portuguese fisheries. Length sampling data from Russia (1989-91, 1995, 1998-2002) and from the Japan (1996 and 1998) were used to estimate the length composition of the commercial catches for those fleets and time periods. The 1989-2002 length composition of the Portuguese trawl catch was applied to the rest of the commercial catches. These length compositions have been combined with the Div. 3M beaked redfish length-weight relationships from 1989-2002 EU surveys, to estimate the catch in numbers at length of the Div. 3M redfish commercial catch for the same period.

Redfish by-catch in numbers at length for the Div. 3M shrimp fishery were available for 1993-2002 based on data collected on board of Canadian and Norwegian vessels. These numbers at length were recalculated in order to fit by-catch in weight with the annual length weight relationships derived from EU survey data.

The commercial and by-catch length frequencies were then summed to establish the total removals at length. These were converted to removals at age using the *S. mentella* age-length keys from the 1990-2002 EU surveys. The 1990 year-class continued to dominate catches in 2002, followed by the 1998 and 1994 year-classes. Annual length weight relationships derived from EU survey data were used for determination of mean weights-at-age

CPUE data. A CPUE series incorporating catch and effort data from the STATLANT 21B database for most of the components of the fishery (1959-93) was used in a surplus production analysis carried out in this assessment.

ii) Research survey data

Survey bottom biomass and survey female spawning biomass of Div. 3M beaked (*S. mentella* plus *S. fasciatus*) redfish were calculated based on the abundance at length from Canadian and EU bottom trawl surveys for the periods 1979-85 and 1988-2002 respectively, and based on the Div. 3M beaked redfish length weight relationships from 1989-2001 EU survey data. Female spawning biomass was calculated applying length maturity ogives derived from data collected during the 1992-94 and 1999 surveys.

Age compositions for Div. 3M beaked redfish EU survey stock and mature female stock in 1989-2002 were obtained using the *S. mentella* age length keys from the 1990-2002 EU surveys with both sexes combined. Mean weights-at-age were determined using the EU survey annual length weight relationships.

Survey results. Biomass indices (swept area method) from EU surveys are presented in the following table ('000 tons):

Year	Beaked redfish	<i>S. Mentella</i>	<i>S. fasciatus</i>	Juveniles
1988	143.0	-	-	-
1989	113.7	-	-	-
1990	87.6	-	-	14.7
1991	59.3	50.1	5.7	3.5
1992	97.6	71.8	5.3	20.5
1993	55.0	25.1	4.4	25.6
1994	87.0	35.7	7.8	43.5
1995	64.6	59.3	5.0	0.2
1996	89.2	77.9	11.0	0.3
1997	74.3	56.1	17.5	0.7
1998	52.8	45.4	6.4	1.0
1999	73.4	65.3	8.0	0.2
2000	102.3	89.4	12.9	1.8
2001	55.3	38.6	11.5	5.1
2002	103.6	51.0	28.7	23.9

Total survey biomass, spawning biomass and abundance. During the earlier period (1979-85), covered by the Canadian surveys, both total survey biomass and female spawning biomass of beaked redfish were stable (Fig. 7.2). The more recent period of 1988-2002, covered by EU surveys, started with a continuous decline of bottom biomass until 1991 followed by a period of biomass fluctuation with no apparent trend from 1992 until 1996. A further decline occurred in 1997 and 1998, when the second lowest biomass was recorded (Fig.7.2). Survey bottom biomass increased in 1999 and 2000 to 102 300 tons, the highest observed since 1989. In 2001 biomass dropped to 55 000 tons before increasing again in 2002 to a level similar to that of 2000. In 2001-2002 the spawning biomass index remained similar to that of 2001 at 7 000-8 000 tons, a decline from an estimate of 18 000 tons in year 2000. It is difficult to associate these drastic year-to-year changes with actual changes in stock status.

From the Canadian survey series female spawning biomass (SSB) of beaked redfish was stable and represented on average more than 40% of the survey bottom biomass. Survey spawning biomass declined through the first years of EU survey series, oscillating within 9% and 12% for most of the following years between 1994 and 2002.

Beaked redfish abundance increased continuously from 1998 onwards despite the fluctuations in biomass and spawning biomass. This recent increase in stock abundance was the result of increases

in the pre-recruited age groups (1-4) over consecutive years. The 2000 year-class is the most abundant year class at age 1 and the second largest at age 2 of the EU survey series.

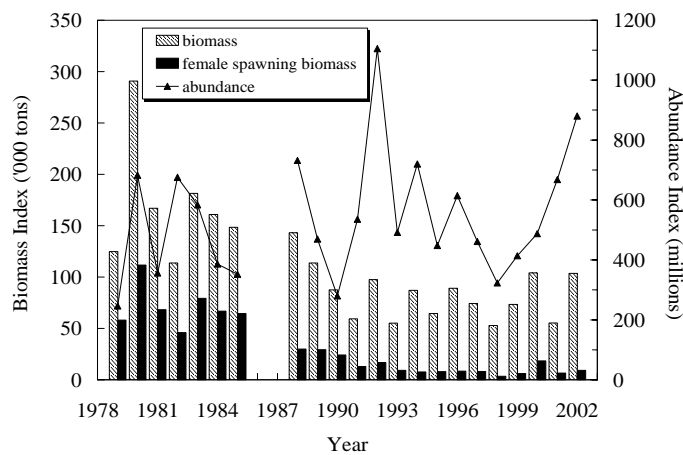


Fig. 7.2. Beaked redfish in Div. 3M: survey biomass, female spawning biomass and abundance from Canadian (1979-85) and EU (1988-2002) surveys.

c) Estimation of Parameters

The expected proportion of mature females found at each age for Div. 3M beaked redfish was calculated using the mean proportion of mature females found in survey stock abundance-at-age and fitting a general logistic curve to the observed data. This female “maturity ogive” was incorporated in the yield-per-recruit analysis.

A partial recruitment vector for Div. 3M beaked redfish was derived assuming flat topped partial recruitment and adjusting a relative mean index-at-age to a general logistic curve. This index was derived by determining the ratio between the 1989-2002 age composition of the total catch, including redfish by-catch in the shrimp fishery, and beaked redfish survey abundance. Both data sets were standardized to numbers-per-thousand prior to analysis.

An Extended Survival Analysis (XSA) (Shepherd, 1999)¹ for the period 1989-2002 was run. Natural mortality was assumed constant at 0.1. The input catch-at-age was as described above as was the observed female mature proportion at age. The month of peak spawning (larval extrusion) for *S. mentella* in Div. 3M, February, was used for the estimate of the proportion of fishing mortality and natural mortality before spawning. The first age group considered was age 4 and a plus group was set at age 19. EU survey abundance at age was used for calibration.

A logistic surplus production model which does not use the equilibrium assumption (ASPIC) was applied using the 1959-2002 STACFIS catch estimates with the standardized commercial catch rate data (1959-93) and the age 4+ EU bottom biomass (1988-2002). The selection of these series was made because of their higher correlation, compared with the negative or very low correlation between any other combination of the CPUE and survey series available for Div. 3M redfish. A starting estimate for the intrinsic rate of biomass increase was derived from $F_{0.1}$ determined by the yield-per-recruit analysis. Catchability (q) of the EU survey was fixed based on mean age 4 + survey bottom biomass/XSA stock biomass ratio for the 1989-2002 period.

¹ SHEPHERD, J. G., 1999. Extended survivors analysis: an improved method for the analysis of catch-at-age data and abundance indices. *ICES J. Mar. Sci.*, **56**(5): 584-591.

ASPIC was first run to fit for estimates of parameters, together with effort and survey patterns of unweighted residuals as well as the biomass and fishing mortality trends expressed as ratios to B_{msy} and F_{msy} . Effort and survey residuals were finally run through bootstrap analysis in order to derive bias corrected estimates and probability distribution of the parameters.

d) Assessment Results

The XSA and ASPIC results were used for illustrative purposes only to indicate trends in the resource over time.

Both VPA and ASPIC analysis indicate that the Div. 3M beaked redfish stock experienced a steep decline from the second half of the eighties until 1996 (Fig. 7.3). Fishing mortality was relatively high from 1988-94 (Fig. 7.4), due to increasing commercial catches since the mid-1980s that peaked in 1989 and 1993. From 1995 onwards fishing mortality declined and since 1997 has been well below the assumed natural mortality of 0.1, allowing the survival and growth of the population. Despite recent fluctuations, biomass and female spawning biomass appear to have increased marginally since 1997 but, are still well below the SSB that produced the pulse of strong recruitment in 1990 (Fig. 7.5). At the same time abundance has only increased in 2002, with the entry of the above average 1998 year-class to the exploitable stock. (Fig. 7.3).

The recruits per SSB have increased through the 1990s (Fig. 7.6), compensating for the SSB decline. Based on XSA, the 1998 year-class is relatively abundant. From 1988-2002 EU survey results the 2000 year-class is the most abundant cohort at age 1 and the second largest at age 2.

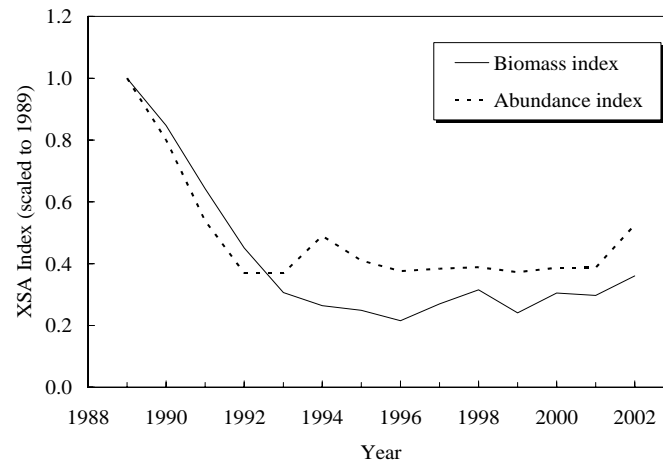


Fig. 7.3. Beaked redfish in Div. 3M: age 4+ biomass and Age 4+abundance trends from XSA.

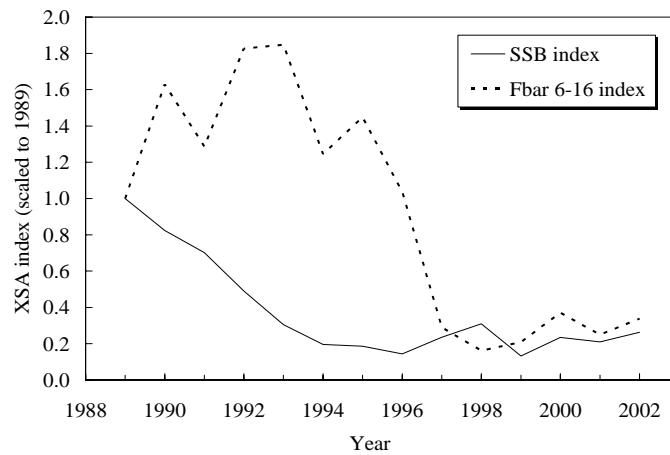


Fig. 7.4. Beaked redfish in Div. 3M: female spawning biomass and fishing mortality trends from XSA.

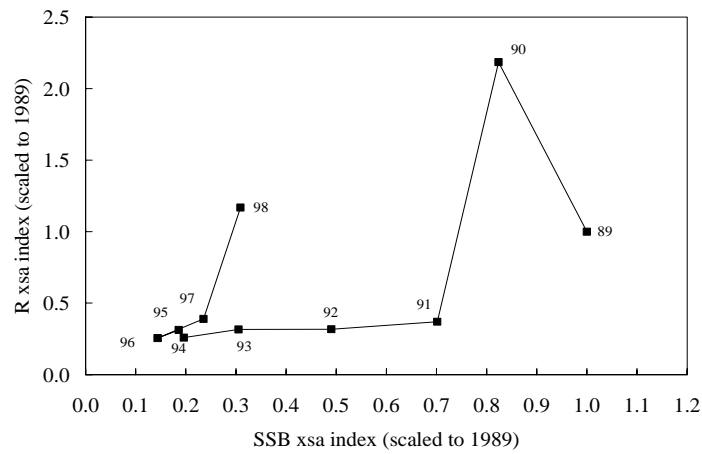


Fig. 7.5. Beaked redfish in Div. 3M: relative recruitment from XSA (year-classes indicated)

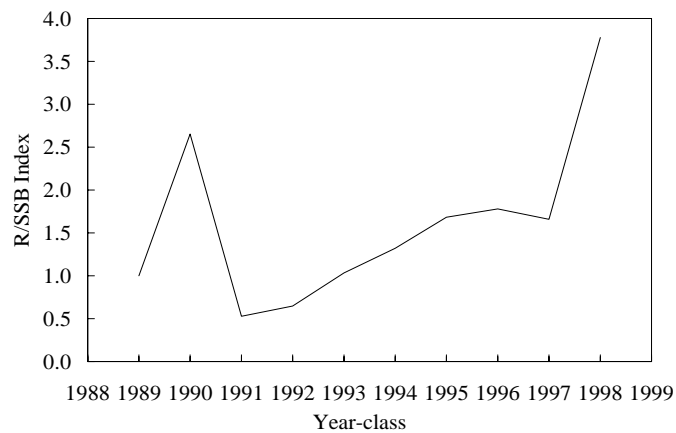


Fig. 7.6. Beaked redfish in Div. 3M: recruitment per thousand tons of SSB trend from XSA (recruits at age 4 four years later than SSB).

The ASPIC results, with regard to biomass and fishing mortality trends are comparable to those from the XSA model, but with biomass declining to a lesser extent and increasing at faster rate through the second half of the 1988-2002 period (Fig. 7.7).

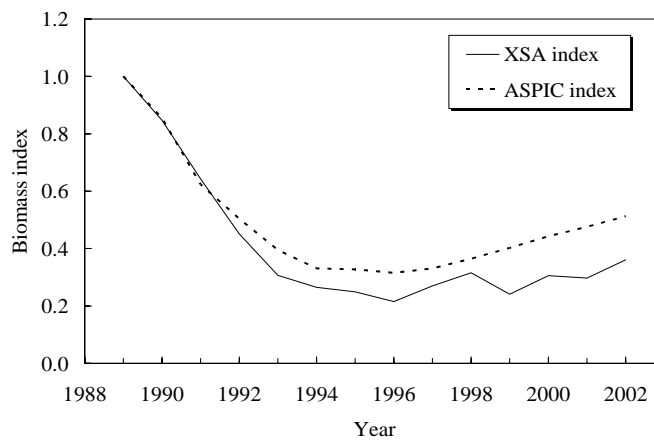


Fig. 7.7. Beaked redfish in Div. 3M: XSA and ASPIC total biomass trends.

STACFIS concluded that while the decline in stock biomass appears to have halted, it is still unclear as to whether there has been any actual increase. The total stock and spawning stock are currently at a low level compared to the earlier period in the time series. At the low fishing mortalities of the most recent years, with growth of the relatively strong 1990 year-class followed by the promising 1998 and 2000 year-classes, spawning biomass should gradually increase.

At present the stock growth in biomass and in abundance is dependent upon the appearance and survival of cohorts past their early life stage so they recruit to the SSB and commercial fishery. As such it is important to keep catch and fishing mortality at a low level by ensuring that by-catch of very small redfish is kept to a minimum. In this regard, STACFIS has concerns regarding the sharp increases seen in by-catch of small redfish in 2001 and 2002.

STACFIS noted that measures must be taken to reduce significantly the actual proportion of very small redfish (<12cm) in the by-catch of the Div. 3M shrimp fishery. In order to assist in developing possible approaches to achieve this, STACFIS **recommended** that *information on the distribution on shrimp and small redfish (<12 cm) in Div. 3M be compiled for review during the June 2004 meeting of Scientific Council.*

STACFIS **recommended** that *an update of the Div. 3M redfish by-catch information be compiled on an annual basis, including the estimated weights and numbers of redfish caught annually in the Div. 3M shrimp fishery as well as tables showing their size distribution.*

e) **Reference Points**

No updated information on biological reference points was available.

8. **American Plaice (*Hippoglossoides platessoides*) in Division 3M** (SCR Doc. 02/62, 03/9, 42, 44; SCS Doc. 03/06, 7, 11)

a) **Interim Monitoring Report**

A total catch of 128 tons was estimated for 2002 (Fig. 8.1).

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	1	1	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	0.3	0.2	0.1	0.1	0.2	0.2	0.3 ¹	0.2 ¹	0.2 ¹	
STACFIS	0.7	1.3	0.3	0.2	0.3	0.3	0.1	0.1	0.1	

¹ Provisional.
 ndf No directed fishing.

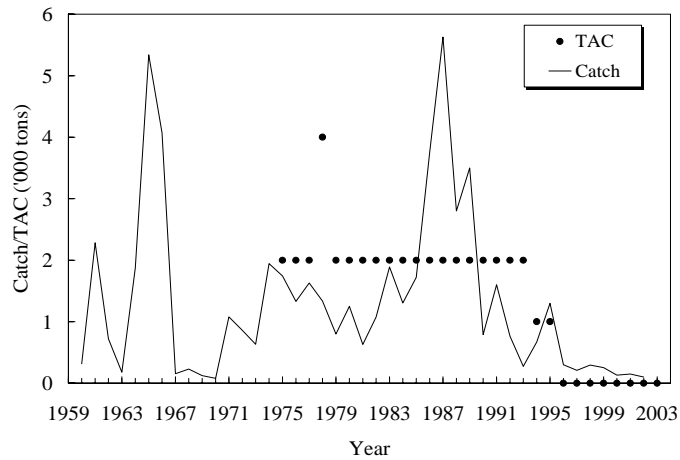


Fig. 8.1. American plaice in Div. 3M: nominal catches and agreed TACs.

The Russian and EU bottom trawl surveys on Flemish Cap were conducted during 2002. The survey estimates did not alter the perception of the stock status by STACFIS (Fig. 8.2 and 8.3).

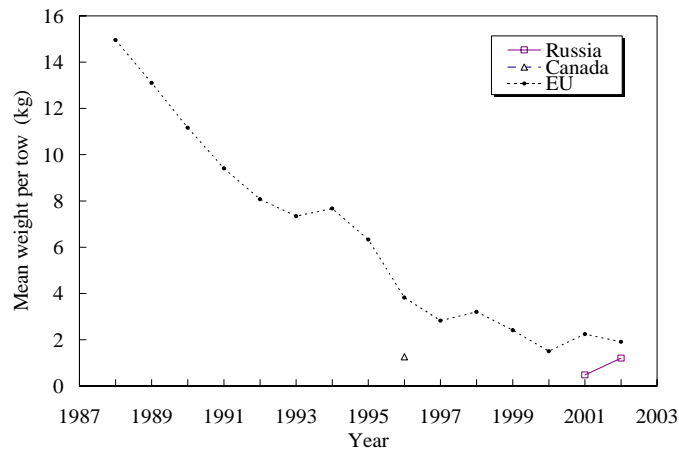


Fig. 8.2. American plaice in Div. 3M: mean weight per tow in the surveys.

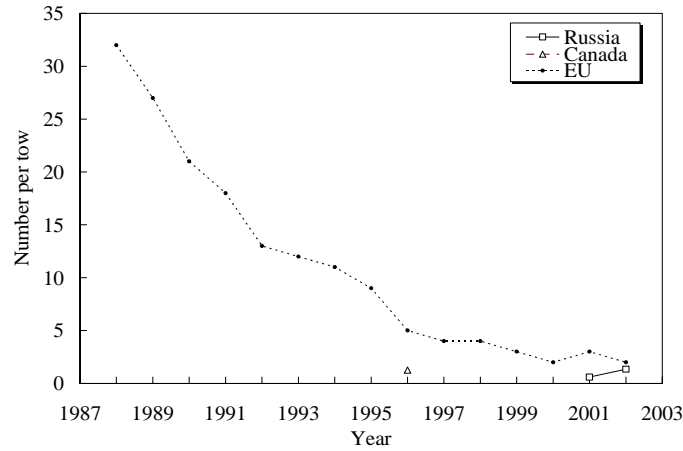


Fig. 8.3. American plaice in Div. 3M: mean number per tow in the surveys.

Recruitment has been poor since the 1990 year-class. STACFIS noted that this stock continues to be in a very poor condition, with only poor year-classes expected to be recruit to the SSB for at least five years. Although the level of catches and fishing mortality since 1992 appear to be relatively low, survey data indicate that the stock biomass and the SSB are at a very low level. Due to the consistent year to year recruitment failure since the beginning of the 1990s there is no sign of recovery of this stock.

b) **Future Studies**

STACFIS **recommended** that *for American plaice in Div. 3M current initiatives aiming at reconciling age determination from different age readers be continued.*

C. **STOCKS ON THE GRAND BANK**

9. **Cod (*Gadus morhua*) in Divisions 3N and 3O** (SCR. Doc. 03/2, 14, 18, 19, 21, 26, 30 ,59; SCS Doc. 03/6, 7, 10, 11, 12)

a) **Introduction**

Nominal catches increased during the late-1950s and early-1960s, reaching a peak of about 227 000 tons in 1967. During the period from 1979 to 1991, catches ranged from 20 000 to 50 000 tons. The continued reduction in recommended TAC levels contributed to reduced catches to a level of about 10 000 tons in 1993 (Fig. 9.1). Directed fisheries on this stock ceased about mid-year 1994. This stock has been under moratorium to all directed fishing both inside and outside the Regulatory Area since February 1994. Since the moratorium was instituted, catches have increased steadily, from 172 tons in 1995 to 2 194 tons in 2002 (Fig. 9.1).

Recent TACs and catches ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	6	nf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	1.9	0.1	0.1	0.4	0.5	0.9	0.5 ¹	0.9 ¹	1.2 ¹	
STACFIS	2.7	0.2	0.2	0.4	0.5	0.5	1.1	1.3	2.2	

¹ Provisional.

nf No fishing.

ndf No directed fishery and by-catches of cod in fisheries targeting other species should be kept at the lowest possible level.

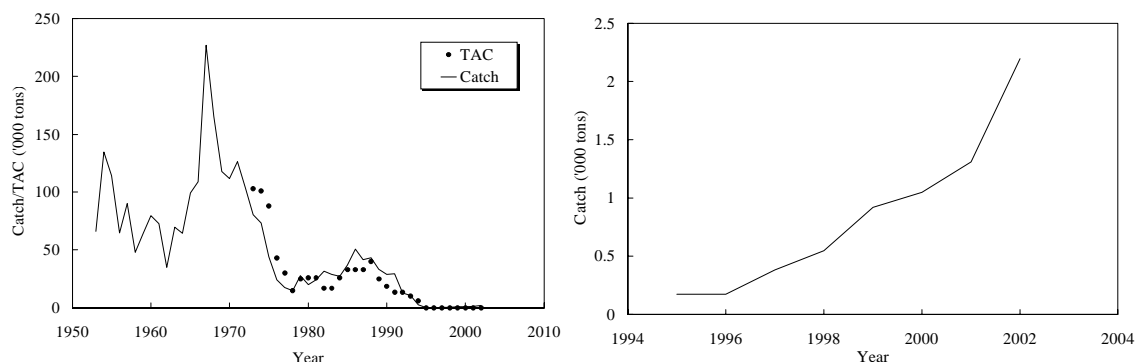


Fig. 9.1. Cod in Div. 3NO: total catches and TACs. Panel at right highlights catches during the moratorium on directed fishing.

b) Input Data

i) Commercial fishery data

Catch rates. There was no catch rate information in 2001 or 2002 since there were no directed fisheries for cod.

Catch-at-age. There was age sampling of the 2001 by-catch in Russian fishery and for 2001 and 2002 cod by-catch in the Canadian fishery. There was length sampling only in the Portuguese and Spanish fisheries in 2001 and 2002. In the Portuguese catch in Div. 3NO modal catch lengths were 45 cm (Div. 3N), 45 cm (Div. 3O) in 2001 and 54 cm (Div. 3N), 45 cm (Div. 3O) in 2002. The Spanish catch in 2001 had modal lengths of 52 cm (Div. 3N) and 55 cm (Div. 3O) cm and a mode of 58 cm in 2002 (one sample in Div. 3N). Catch-at-age from 2001 and 2002 was produced by applying Canadian survey age length keys to length frequencies collected each year by EU-Spain and EU-Portugal. The catch in 2001 was dominated by ages 3 and 4 while in 2002 it was dominated by ages 4 and 5.

ii) Research survey data

Canadian spring surveys. Stratified-random research vessel surveys have been conducted in spring by Canada in Div. 3N during the 1971-2002 period, with the exception of 1983, and in Div. 3O for the years 1973-2002 with the exception of 1974 and 1983.

A new survey trawl (Campelen 1800) was introduced to the Canadian survey starting with the autumn 1995 survey. The survey time series was converted to Campelen equivalents from 1984 to spring 1995. Consequently, comparisons of data from assessments prior to the conversion should be approached with caution.

The Canadian spring mean numbers per tow series declined from 1984 to 1989, with the exception of 1987, when the largest value in the time series was observed. The 1991 and 1993 spring surveys indicated increased catches of cod. Since 1994, the Canadian spring index has been extremely low, yet showed improvement from 1994 to 2000. However, the spring surveys in 2001 and 2002 have declined from the 2000 levels; with the 2002 value being the second lowest in the entire time series. (Fig. 9.2).

Canadian autumn surveys. Additional stratified-random surveys have been conducted by Canada during autumn since 1990. Results from 1990 to 1992 surveys were the largest in the time series (Fig 9.2). Mean numbers per tow declined dramatically in 1993, and have remained low. Similar to the spring series, the index increased over 1996 to 2000, but has since declined.

Canadian juvenile surveys. Canadian autumn juvenile survey data were available for the period 1989-94. The index increased from 1989 to 1991, and declined steadily from 1992 to 1994 (Fig 9.2).

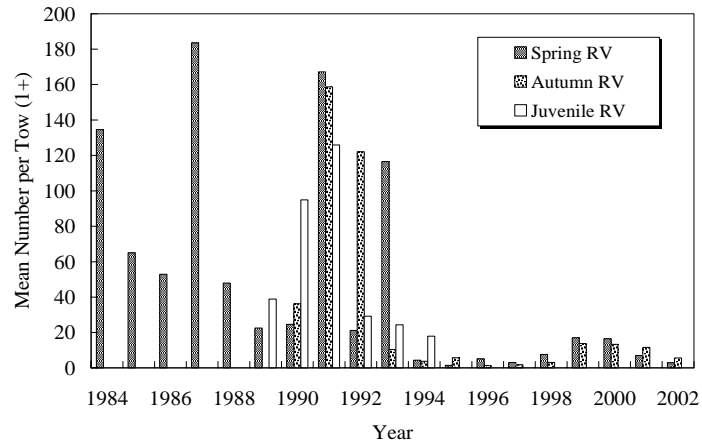


Fig. 9.2. Cod in Div. 3NO: mean numbers per tow from Canadian spring, autumn and juvenile surveys.

iii) **Biological studies**

Year-class strength. A multiplicative model was used to estimate the year-class strength based upon Canadian survey data at ages 2 and 3. Results (Fig 9.3) indicate that the 1989 and 1990 were the last good year-classes produced, and that all recent year-classes are poor relative to historic recruitment.

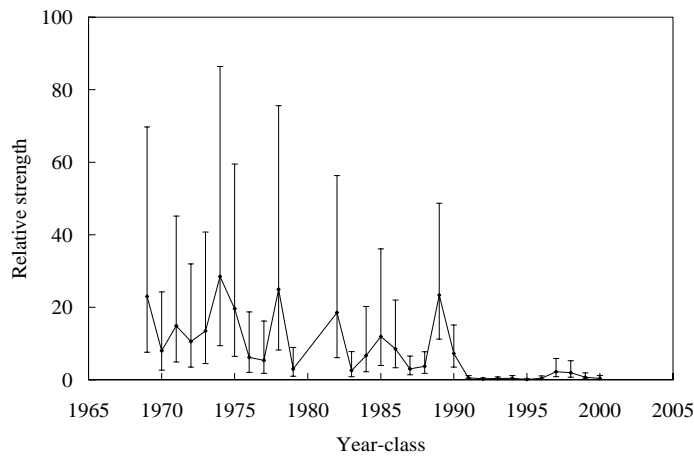


Fig 9.3. Cod in Div. 3NO: estimated year-class strength.

c) **Estimation of Parameters**

i) **Sequential population analysis (SPA)**

An ADAPT was applied to catch-at-age calibrated with the Canadian spring, autumn and juvenile survey data (ages 2-10) to estimate population numbers in 2003. Numbers at age 12 were also estimated from 1994-2002. An F-constraint was used in the estimation, such that fishing mortality at age 12 was assumed to equal the average fishing mortality over ages 6-9 from 1959-93. Natural mortality was assumed fixed at 0.2 for all years and ages.

d) Assessment Results

The SPA results indicate that the stock is estimated to be at an extremely low level. The estimated spawner biomass for 2003 is 4 500 tons (Fig. 9.4).

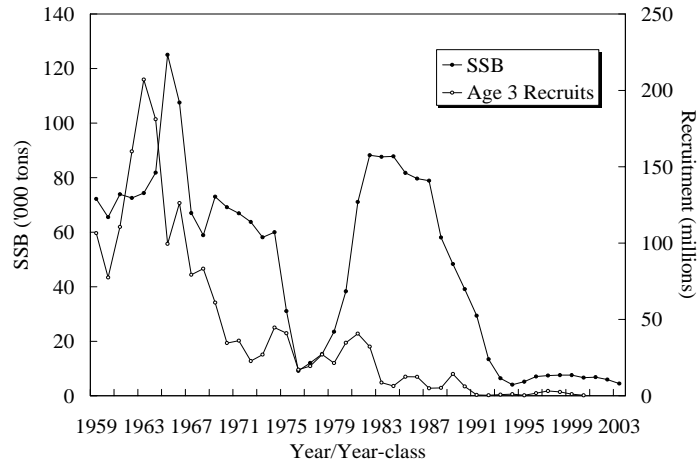


Fig. 9.4. Cod in Div. 3NO: time trend of spawner stock biomass (SSB) and corresponding recruitment from the SPA.

Historically, fishing mortality on the fully recruited age groups (age >5) has been higher on older ages than on younger ages. In recent years there has been a considerable increase in fishing mortality on younger fish (Fig. 9.5). The fishing mortality averaged over 2000 to 2002 for ages 4 to 6 is 0.32. This level of fishing mortality is comparable to that in earlier time periods during which substantial fisheries existed. Estimates of recent year-class size indicate that recruitment has been very low since the 1990 year-class. Low spawner biomass, low recruitment and high fishing mortality point to poor prospects for this stock in the future. Recovery will require a number of relatively strong year-classes that survive to maturity, rebuilding the spawner biomass.

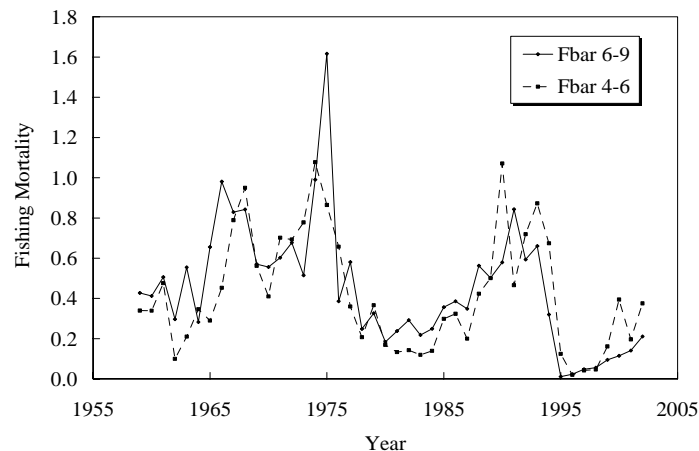


Fig. 9.5. Cod in Div. 3NO: time trend of average fishing mortalities from the SPA.

e) Reference Points

In April 2003 the Scientific Council re-iterated that 60 000 tons is the current best estimate of B_{lim} . In the recent period of low productivity (since 1982), there is an indication of even further reduction in recruitment at about half the B_{lim} level. In view of the difficulty in determining if the current low

productivity will persist in the immediate future, it was **recommended** that *for cod in Div. 3NO the Scientific Council review in detail the biological reference points in the context of the PA framework when the SSB has reached half the current estimate of B_{lim} .*

Medium-term considerations. Previous assessment of this stock have used stochastic simulations including uncertainty in the survivors from the SPA representing the starting population for the projection and uncertainty in future recruitment to explore the prospects for stock rebuilding under different levels of fishing mortality. Uncertainty in future recruitment is the major source of variation in population size 5 to 10 years after the start of the simulation. In many cases data on recruitment variation may provide useful information about the probability of outcomes under alternative management options. However, data accumulated on recruitment variation as a stock declines may not be very informative about recruitment probabilities when unprecedented low spawner stock biomass is reached for two reasons. Firstly, even though recruitment rates (R/S) is supposedly maximized at lowest stock size, recruitment models fitted to a range of stock-recruit data quite often over-predict recruitment at low stock size. Secondly, the error distribution around the fitted model, most often assumed to be lognormal, may have the upper tail of the distribution influenced by a large range of recruitment values observed at intermediate spawner stock size, and may not appropriately reflect the expected distribution of recruit values at low stock size. Under such circumstances, deterministic projections may be more informative about the prospects of, for example stock recovery, under different conditions. In addition, limiting the time frame of such projections to 5 years decreases the impact of uncertainties in recruitment rate, as longer term projections are increasingly driven on assumptions about recruitment.

Deterministic projections were carried out to project spawning stock biomass over 5 years assuming fixed recruits-per-spawner rate, weight-at-age, natural mortality, and fishing mortality (all averages over final three years of SPA). Input data for the projections are tabled below. The partial recruitment vector was computed by averaging the PR vector over the last three years, then re-scaling this vector by the mean values over ages 4 to 6.

Table 9.1. Cod in Div. 3NO: Input data for Deterministic Projections.

	Age	3	4	5	6	7	8	9	10	11	12
M		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Average wt (3yrs)		0.52	0.77	1.17	1.77	2.86	4.20	4.54	4.86	6.03	7.41
Maturity-at-age	1998	0.02	0.11	0.58	0.86	0.99	1.00	1.00	1.00	1.00	1.00
	1999	0.00	0.10	0.52	0.92	0.98	1.00	1.00	1.00	1.00	1.00
	2000	0.00	0.00	0.43	0.91	0.99	1.00	1.00	1.00	1.00	1.00
	2001	0.01	0.03	0.14	0.84	0.99	1.00	1.00	1.00	1.00	1.00
	2002	0.01	0.04	0.43	0.88	0.97	1.00	1.00	1.00	1.00	1.00
	2003	0.01	0.04	0.34	0.95	1.00	1.00	1.00	1.00	1.00	1.00
	2004	0.01	0.04	0.34	0.89	1.00	1.00	1.00	1.00	1.00	1.00
	2005	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
	2006	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
	2007	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
	2008	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
	2009	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
	2010	0.01	0.04	0.34	0.89	0.99	1.00	1.00	1.00	1.00	1.00
Projection PR		0.49	0.91	1.27	0.82	0.55	0.47	0.33	0.17	0.12	0.12
$F_{current}$ (3 yrs)		0.32									
Average R/S (3 yrs)		0.18									

The projections indicate that even under the scenario of no-fishing, stock size increases are minimal over the next 5 years (Fig. 9.6). If the stock continues to be fished at current rates, spawner biomass will continue to decrease.

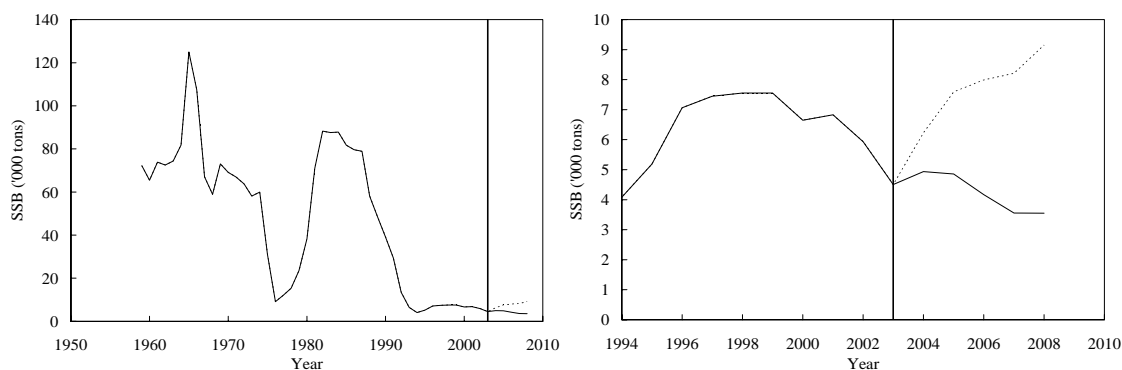


Fig. 9.6. Cod in Div. 3NO: deterministic projections under $F = 0$ (dashed line) and $F_{current}$. Panel at right highlight trends since 1994.

10. **Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Divisions 3L and 3N** (SCR Doc. 03/55, 60; SCS Doc. 03/6, 7, 11)

a) **Introduction**

There are two species of redfish that have been commercially fished in Div. 3LN; the deep-sea redfish (*Sebastes mentella*) and the Acadian redfish (*Sebastes fasciatus*). The external characteristics are very similar, making them difficult to distinguish, and as a consequence they are reported collectively as "redfish" in the commercial fishery statistics.

The average reported catch from Div. 3LN from 1959 to 1985 was about 22 000 tons ranging between 10 000 tons and 45 000 tons. Catches increased sharply from about 21 000 tons in 1985, peaked at an historical high of 79 000 tons in 1987 then declined steadily to about 600 tons in 1996. Catch increased to 850 tons in 1998, the first year under a moratorium on directed fishing, with a further increase to 2 300 tons in 1999 and declined to 1 200 tons in 2002.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	14	14	11	11	ndf ¹	ndf ¹	ndf ¹	ndf ¹	ndf ¹	ndf ¹
STATLANT 21A	2.7	2.0	0.5	0.6	0.9	1.8	1.5 ²	0.9 ²	1.0 ²	
STACFIS	6 ³	2	0.5	0.6	0.9	2.3	1.7	1.4	1.2	

¹ No directed fishing.

² Provisional.

³ STACFIS could not precisely estimate the catch. Figures are midpoint of range of estimates.

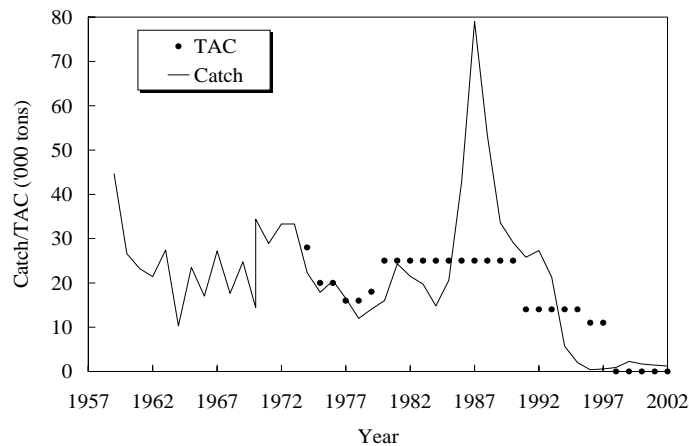


Fig. 10.1. Redfish in Div. 3LN: catches and TACs.

b) Input Data

i) Commercial fishery data

Sampling of redfish as by-catch was conducted by EU-Portugal, Russia and EU-Spain in Div. 3LN from the 2002 trawl fisheries primarily for Greenland halibut. The compilation of annual catch at length suggested catches in Div. 3L were dominated by lengths between 27-32 cm for the Portuguese and Spanish fleets and between 31-33 cm for the Russian fleet. In Div. 3N, catches sampled from Portuguese and Spanish fleets were dominated by lengths between 27-32 cm while those sampled from the Russian fleet were dominated by lengths between 33-35 cm. Sampling, over the past number of years, has consistently shown that the dominant lengths in the samples have ranged between 27-33 cm.

ii) Research survey data

Stratified-random surveys have been conducted by Canada in Div. 3L in various years and seasons from 1978 to 2002 during which strata down to a maximum depth of 732 m (400 fathoms) were sampled. Until the autumn of 1995 these surveys were conducted with an Engels 145 high lift otter trawl. Starting in the autumn 1995 survey, a Campelen 1800 survey trawl was used. The Engel data were converted into Campelen equivalent units in the 1998 assessment (*NAFO Sci. Coun. Rep.*, 1998, p. 76).

Results of bottom trawl surveys for redfish in Div. 3L indicated a considerable amount of variability. This occurred between both seasons and years. Although it is difficult to interpret year to year changes in the estimates, in general, the spring survey index (Fig. 10.2) from 1992 to 1995 suggests the stock was at its lowest level relative to the time period prior to 1986 for surveys conducted in the first half of the year. A similar contrast occurs in the autumn survey index from 1992 to 1995 relative to a time period prior to 1986 for surveys conducted in the second half of the year. Since 1996 the spring index has fluctuated around a higher level compared to the 1992-95 period. The autumn index also shows a similar increase from 1996 to 2000 as compared to 1992-95.

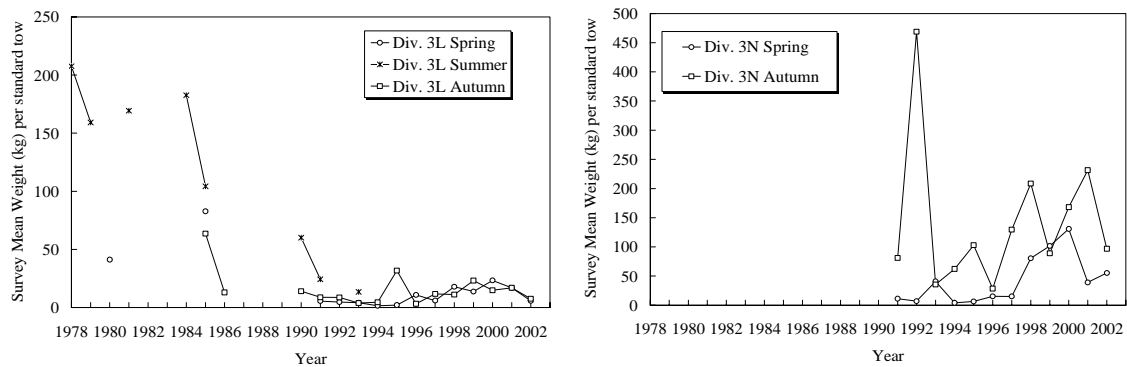


Fig. 10.2. Redfish in Div. 3LN: survey biomass indices from Canadian surveys in Div. 3L and Div. 3N in Campelen equivalent units for surveys prior to autumn 1995.

Canadian surveys have also been conducted in Div. 3N in spring and autumn from 1991-2002 and in summer in 1991 and 1993. These surveys also utilized the Campelen survey trawl beginning in the autumn of 1995. The Engel data prior to autumn 1995 were also converted into Campelen equivalents. Survey biomass and abundance estimates were generally higher in Div. 3N than in Div. 3L, but there was greater between survey variability than in Div. 3L. The source of this variability is unclear but is likely due to availability to the trawl gear or possible migrations between Div. 3N and Div. 3O rather than real changes in population abundance. In any case, abundance in the surveys is higher during the autumn surveys than in the spring.

The survey index for the spring and autumn surveys although variable appear to have increased since 1996.

iii) Recruitment

Length distributions from Canadian surveys in various seasons in Div. 3L indicated there has been relatively poor recruitment since the mid-1970s. A pulse of recruitment detected at 7 cm in the 2001 spring survey, corresponding to the 2000 year-class has progressed in each survey to autumn 2002. However, abundance averaged less than three fish per tow in the 2002 spring and autumn surveys (Fig. 10.3). Therefore recruitment continues to be poor in Div. 3L.

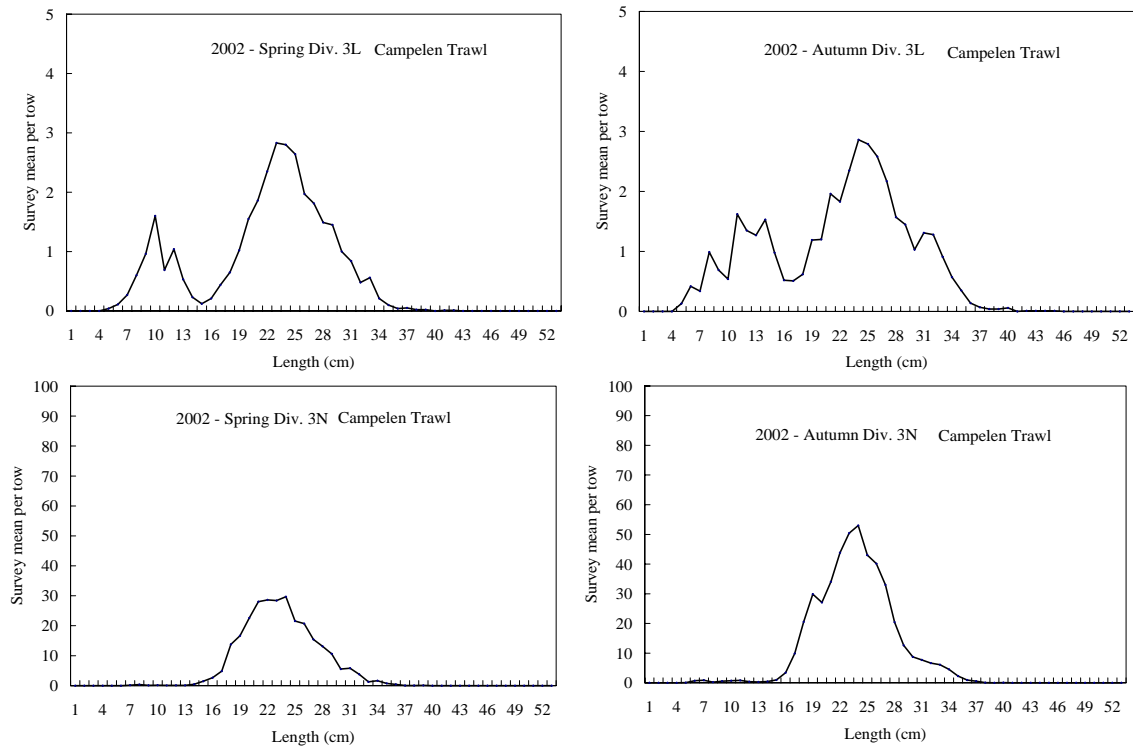


Fig. 10.3 Redfish in Div. 3LN: Size distribution (stratified mean per tow) from Canadian surveys in Div. 3L and Div. 3N for 2002.

Length distributions from spring and autumn Canadian surveys in Div. 3N from 1991-2002 generally showed smaller fish compared with Div. 3L. There was a relatively good pulse of recruitment picked up in the 1991 autumn survey in the range of 12-14 cm (1986-87 year-classes) that could be tracked through to 2002 at about 24 cm. There is no sign of any good year-classes since then.

d) Estimation of Stock Parameters

i) Relative exploitation

Ratios of catch to Canadian survey biomass index were calculated for Div. 3L and Div. 3N separately. Biomass was averaged over all seasonal surveys conducted in any given year. The results (Fig. 10.4) indicate that exploitation in Div. 3L was relatively low from 1978 to 1985. There is no survey information to relate to the period of high catches from 1987 to 1989. Exploitation increased from 1990 to 1991, peaked in 1992 and declined sharply by 1995 and has remained low to 2002.

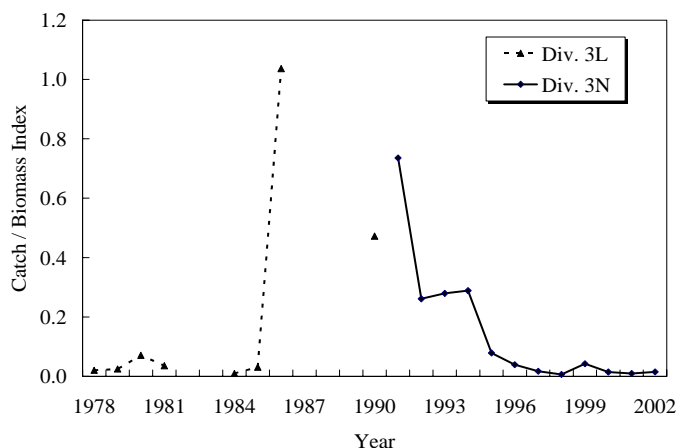


Fig. 10.4. Redfish in Div. 3LN: catch/biomass ratios for Div. 3L and Div. 3N.

ii) **Size at maturity**

Maturity ogives indicate L_{50} for females in Div. 3L is 30.5 cm and in Div. 3N is 30.2 cm. Males mature at a much smaller size than females and there are differences between Div. 3L ($L_{50} = 23.9$) and Div. 3N ($L_{50} = 20.3$ cm).

c) **Assessment Results**

Interpretation of available data remains difficult for this stock. The surveys demonstrate considerable inter-annual variability, the changes frequently being the result of single large catches being taken in different years. Nonetheless, estimates from recent surveys are considerably lower than those from the 1980s indicating a reduced and low stock size. The improvement in the stock in both Div. 3L and Div. 3N, particularly since 1996, is due to growth increases from existing year-classes and not through improved recruitment. It is possible that some of the observed increase could be due to migration from Div. 3O to Div. 3N. Exploitation is indicated to be low in the most recent period since 1995.

Poor recruitment has persisted in Div. 3L since the late-1970s. The last good recruitment in Div. 3N was from the 1986-87 year-classes. Prior to the moratorium on directed fishing in 1998, these year-classes were available to the commercial fleets but did not result in a turn around in catch levels, which remained below the TAC level. This is interpreted as another sign of low overall stock sizes.

Based on the above, STACFIS considers that the stock remains at a very low level and recruitment has been poor for more than a decade.

e) **Reference Points**

At present, it is not possible to determine limit or other reference points for either fishing mortality or biomass for redfish in Div. 3LN.

f) **Stock Structure**

Information on survey catch and length distribution was available to address a recommendation concerning the relationship between redfish in Div. 3LN and Div. 3O. The information suggests that redfish in Div. 3N is more similar to those in Div. 3O than those in Div. 3L with regard to size composition. STACFIS noted that most recent studies on this issue have suggested a closer connection between Div. 3N and Div. 3O redfish. If redfish in these divisions constitute a biological stock, managing them separately may not be harmful. STACFIS is more concerned about the relationship with redfish in Div. 3L, given that they have

experienced poor recruitment since the early-1980s while those in Div. 3N and Div. 3O have experienced improved recruitment from year-classes born in the 1986-88 period. One major disadvantage to addressing this issue is the inability to use conventional tagging because of the high mortality caused in bringing redfish to the surface. Recent improvements in tagging technology where fish are tagged on bottom may be a useful tool in future to unraveling this long-standing issue.

STACFIS regards this stock issue to be important as the continuing uncertainties regarding the relationship between redfish in Div. 3LN and Div. 3O have important impacts on interpretations of available data. STACFIS **recommended** that (1) redfish data in Div. 3LN and Div. 3O be analyzed further to determine if a relationship exists between Div. 3LN and Div. 3O that may help in the interpretation of the indices of abundance; and (2) data be examined to evaluate the appropriateness of Div. 3LN and Div. 3O as management units for redfish.

11. American Plaice (*Hippoglossoides platessoides*) in Divisions 3L, 3N and 3O (SCR Doc. 03/2, 5, 7, 11, 18, 39, 56; SCS Doc. 03/5, 6, 7, 11)

a) Introduction

This fishery was under moratorium in 2002. Total catch in 2002 was 4 800 tons, mainly taken in the Regulatory Area (Fig. 11.1), and as by-catch in the Canadian yellowtail flounder fishery. There was an increase in catch each year from 1995 to 2001, but catch declined in 2002.

Recent nominal catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	4.8 ¹	nf	nf	nf	nf	nf	ndf	ndf	ndf	ndf
STATLANT 21A	0.6	0.5	0.9	1.4	1.6	2.4	2.7 ²	2.8 ²	3.1 ²	
STACFIS	7	0.6	0.9	1.4	1.6	2.6	5.2	5.7	4.8	

¹ No directed fishing.

² Provisional.

nf No fishing.

ndf No directed fishing.

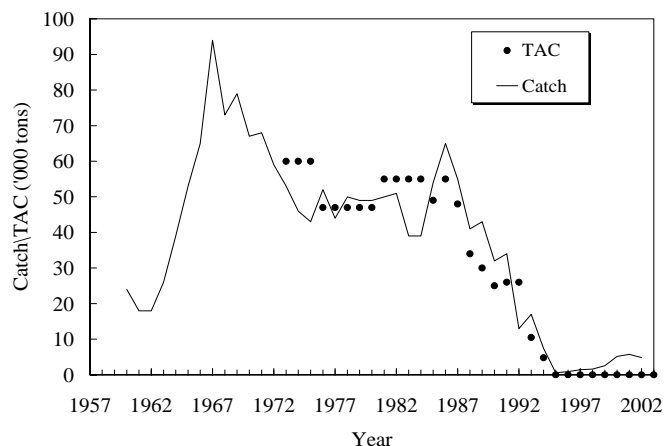


Fig. 11.1. American plaice in Div. 3LNO: catches and TACs.

b) Input Data

i) Commercial fishery data

Catch and effort. There were no recent catch and effort data available.

Catch-at-age. There was age sampling of the 2002 by-catches in the Canadian fishery and length sampling of by-catch in the Portuguese, Spanish and Russian fisheries. Catch-at-age in the Canadian by-catch was mainly age 7 to 11 with a peak at age 8. For the Spanish by-catch the peak in Div. 3L was 34-43 cm, while in Div. 3O it was 34-53 cm. In Div. 3N the catch was composed of smaller fish with a peak at 24-31 cm (SCS Doc. 03/11). For EU-Spain 44% of the by-catch in Div. 3N and 77% of the by-catch in Div. 3O was taken in the first half of the year, but sampling was only from the second half of the year. For the Portuguese fleets most of the by-catch in Div. 3L was between 34 and 42 cm with a clear mode at 38 cm. In Div. 3N lengths between 36 and 44 cm dominated the catches with a mode at 36-38 cm, while in Div. 3O the main lengths were 34-44 cm (SCS Doc. 03/7). In the Russian by-catch the bulk of the catch was made up of fish 38-39 cm in length in Div. 3L, the mode was 42 cm in Div. 3N and 42-43 cm in Div. 3O (SCS Doc. 03/6). Total catch-at-age for 2002 was produced by applying Canadian survey age-length keys to length frequencies collected each year by EU-Spain, EU-Portugal and Russia and adding it to the catch-at-age calculated for Canada. This total was adjusted to include catch for which there were no sampling data. Overall, ages 8 to 11 dominated the 2002 catch.

ii) Research survey data

Canadian stratified-random bottom trawl surveys. Data from **spring surveys** in Div. 3L, 3N and 3O were available from 1985 to 2002. Surveys prior to 1991 generally had a maximum depth of 366 m. From 1991 to 2002, the depth range has been extended to at least 731 m in each survey.

The biomass (mean weight per tow) from the spring survey showed a large decline followed by a slight increase since 1996. The average mean weight per tow in the last 3 years is 22% of the average of the mid-1980s (SCR Doc. 03/56; Fig. 11.2). The decrease in mean weight per tow has been greatest in Div. 3L.

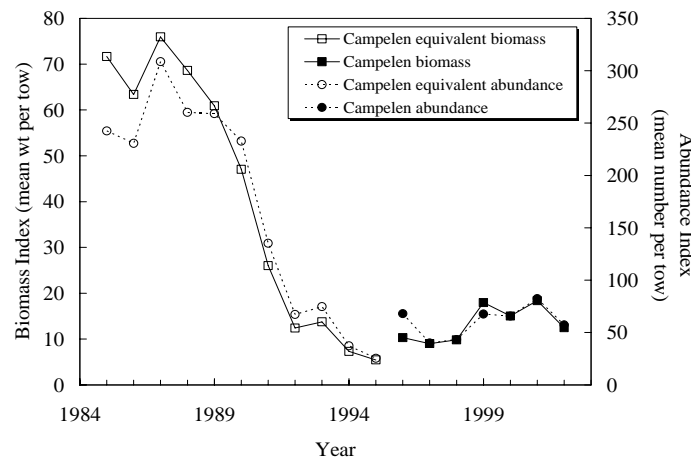


Fig. 11.2. American plaice in Div. 3LNO: biomass and abundance indices from Canadian spring surveys.

Abundance (mean number per tow) for Div. 3LNO declined during the late 1980s-early 1990s. Abundance has fluctuated since 1996 with perhaps a slight increase over the period (Fig. 11.2). As with the biomass estimate, mean number per tow has shown the greatest decline in Div. 3L. The proportion

of fish that are ages 0 to 5 are among the highest in the time series in 2000-2002, but these ages are probably 'under converted' in the 1985 to 1995 data.

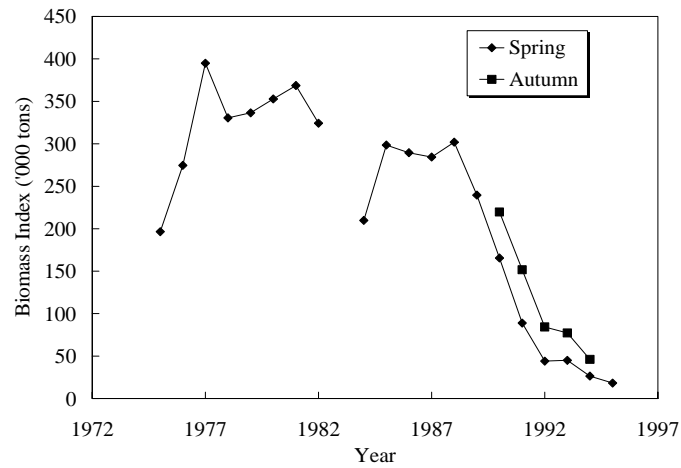


Fig 11.3. American plaice in Div. 3LNO: biomass index as swept area estimates from Canadian spring and autumn surveys using the Engel groundfish trawl.

Canadian spring and autumn surveys conducted prior to autumn 1995 were conducted using an Engel bottom trawl. There is no conversion of the data series prior to 1985. However, the index from the spring survey using the Engel indicates that the biomass level in the mid-1980s was slightly lower than that in the late-1970s (Fig. 11.3).

From Canadian **autumn surveys** the biomass (mean weight per tow) index for Div. 3LNO in the autumn has shown a slight increasing trend since 1995 but remains well below the level of the early-1990s with the average of the last 3 years being 32% of the level of 1990 (11.4). Mean weight-per-tow has shown the largest decline in Div. 3L and has been increasing since 1997 in Div. 3N.

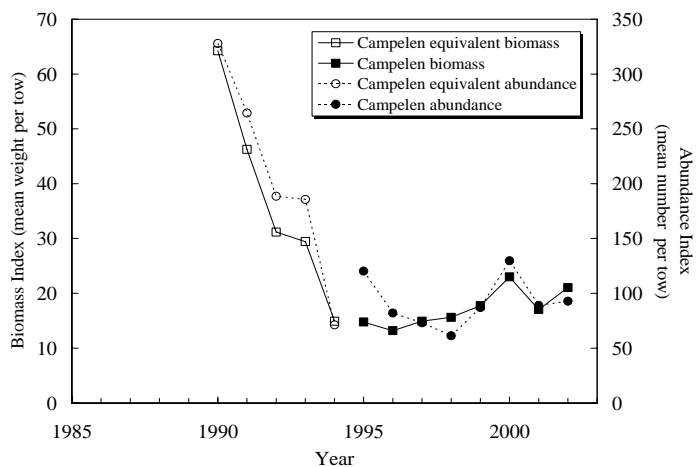


Fig. 11.4. American plaice in Div. 3LNO: biomass and abundance indices from autumn surveys.

Abundance showed a substantial decline from 1990 to 1998 but has been somewhat higher since 1998 (Fig. 11.4). The largest decline was once again in Div. 3L. Ageing was not available for 2002. The age composition has been rather stable over the 1990-2001 time period.

Survey by EU-Spain. Surveys have been conducted annually from 1995 to 2002 by EU-Spain in the Regulatory Area in Div. 3NO to a maximum depth of 1 462 m (since 1998). Starting in 2001 the survey gear changed to a Campelen net and the data prior to that time have been converted to Campelen equivalent (SCR Doc. 03/5, 7). Both the biomass and abundance indices from this survey peaked in 2000 and then declined in 2001 and 2002 (Fig. 11.5).

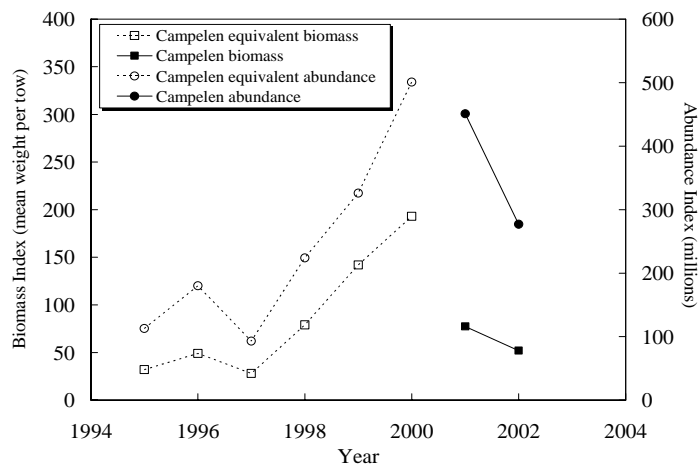


Fig. 11.5 American plaice in Div. 3LNO: biomass and abundance indices from the survey by EU-Spain.

Joint DFO-Industry surveys. Since 1996 grid surveys directed at yellowtail flounder have been conducted jointly by the Canadian Department of Fisheries and Oceans and the fishing industry in Div. 3NO. Information has also been collected on American plaice. Data collected from common grids in July (the most frequent time of the survey) showed an increase from 1996 to 1997 and then no trend over the remainder of the period (SCR Doc. 03/18). The grid was expanded in 2000. Catch rates of American plaice in the expanded grid declined slightly from 2000 to 2002.

iii) Biological studies

Maturity. Age (A_{50}) and length (L_{50}) at 50% maturity were produced from spring research vessel data. For males, A_{50} declined and then showed an increase in both the estimates, although the most recent two cohorts have shown a decline. For females, estimates of A_{50} have been declining since the beginning of the time series. The A_{50} for males in recent cohorts is about 4 years compared to 6 years at the beginning of the time series. For females the A_{50} for recent cohorts is about 8 years compared to 11 years for cohorts at the beginning of the time series. L_{50} has declined for both sexes but recovered in recent cohorts. The current L_{50} for males of about 20 cm is similar to the earliest cohorts estimated. The L_{50} of most recent cohorts for females is in the range of 34-35 cm, lower than the 38 cm of the earliest cohorts.

Size-at-age. Mean weights-at-age were calculated for male and female American plaice for Div. 3LNO using spring survey data from 1990 to 2002 and mean lengths-at-age using data from 1985-2002. Means were calculated accounting for the length stratified sampling design. There is little indication of any trend over the time period in either mean length or weight-at-age.

Recruitment studies. A multiplicative model incorporating data from Canadian spring and autumn surveys was used to estimate the relative year-class strength produced by the spawning stock.

Predicted year-class strength generally declines over time; the estimates indicate no substantial recruitment since 1989. However, the model estimate of the 1998 year-class strength shows marginal improvement over the seven previous cohorts (Fig. 11.6).

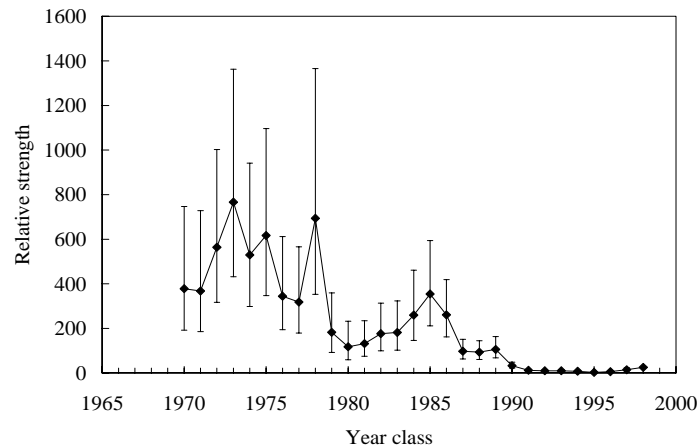


Fig. 11.6 American plaice in Div. 3LNO: estimates of relative cohort strength from Canadian surveys

Mortality from surveys. Estimates of total mortality (Z) from the Campelen or equivalent, spring and autumn survey data were calculated for ages 1 to 16. Both surveys indicate an increase in mortality up to the mid-1990s. Since that time, mortality has declined. The estimates of total mortality from the spring and autumn surveys indicate that mortality was very high after the moratorium on fishing was introduced. The average Z for ages 5 to 10 in 1995 and 1996 was approximately 0.6. The estimates of total mortality were very high from 1989 through 1996 but decreased substantially after that period. Estimates of mortality on ages greater than 6 have increased over the last few years.

Condition. Spatial and temporal variability in condition was examined using data from Canadian spring and autumn surveys (SCR Doc. 03/11). American plaice were found to have higher liver and body condition in the autumn than in the spring. Condition was lower for fish in Div. 3O but the relationship between Div. 3L and Div. 3N depended on which index of condition was examined. There was no relationship between condition and population abundance.

c) Estimation of Parameters

Virtual population analysis (VPA) was conducted using the ADAPTive framework with catch-at-age and survey information up to 2002 (SCR Doc. 03/56). The same formulation of the model was used as in the last assessment. Canadian spring (1975-2002) and autumn (1990-2001) survey data for ages 5 to 14 were used. There was a plus group at age 15 in the catch-at-age and the ratio of F on the plus group to F on the last true age was set at 1.0. M was assumed to be 0.2 on all ages except 0.53 on all ages from 1989 to 1996.

d) Assessment Results

The VPA analyses showed that population abundance and biomass declined fairly steadily from the mid-1970s to 1995. Biomass and abundance have been relatively stable over the last number of years (Fig 11.7). Average F on ages 9 to 14 and ages 11 to 14 showed an increasing trend from about 1965 to 1985. There was a large peak in F in 1993, which may be an artifact. F since 1995 has been generally lower than in the earlier period but increased steadily to 2001 when average F on ages 9-14 and on ages 11-14 was well above 0.2 (Fig. 11.8). F declined somewhat in 2002, consistent with the decreased catch in that year.

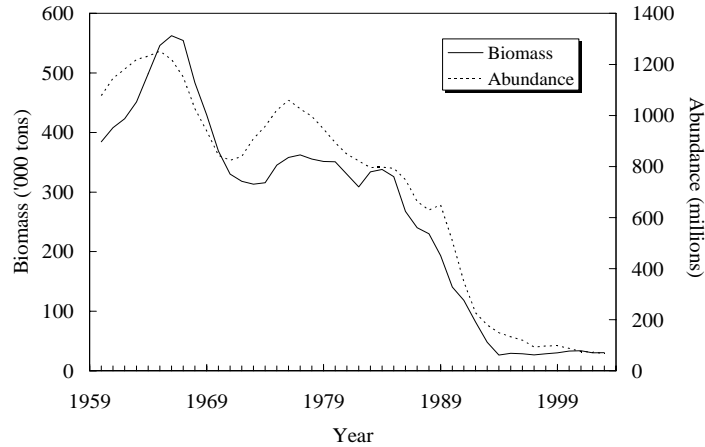


Fig. 11.7. American plaice in Div. 3LNO: population abundance and biomass from VPA

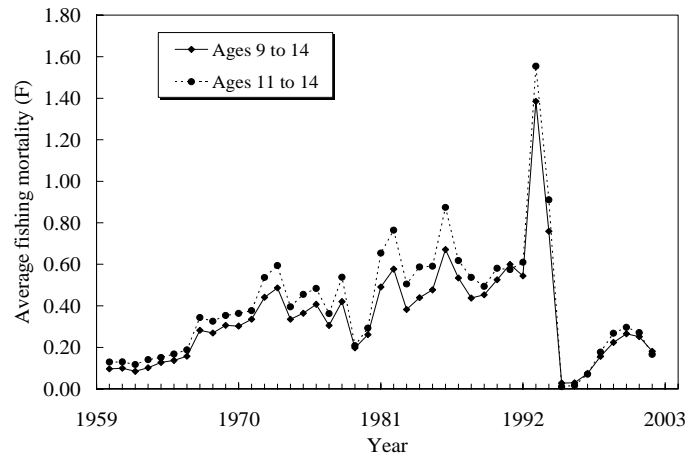


Fig. 11.8. American plaice in Div. 3LNO: average fishing mortality from VPA.

Spawning stock biomass has shown 2 peaks, one in the mid-1960s and another in the early- to mid-1980s. Since then it declined to a very low level (less than 10 000 tons) in 1994 and 1995 (Fig. 11.9). It has increased since then but still remains at a very low level at just over 20 000 tons. This is only 10% of the level in the mid-1960s and 16% of the level in the mid-1980s. Recruitment has been steadily declining since the 1986 year-class and there have been no good recruitment since then (Fig. 11.9). No good recruitment has been seen below an SSB of 50 000 tons.

Biomass: The biomass is very low compared to historic levels.

Spawning stock biomass: SSB declined to the lowest observed levels in 1994 and 1995. It has increased since then but remains very low at just over 20 000 tons.

Recruitment: There has been no good recruitment since the mid-1980s.

Fishing mortality: The average fishing mortality on ages 9 to 14 was above 0.2 from 1999-2001 and decreased to 0.18 in 2002.

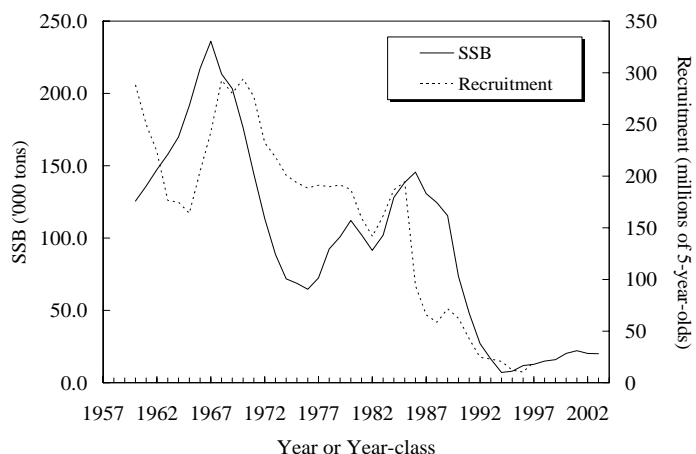


Fig. 11.9. American plaice in Div. 3LNO: spawning stock biomass and recruitment from VPA.

e) Precautionary Reference Points

An examination of the stock recruit scatter shows that there has been only good recruitment observed above 155 000 tons and no good recruitment observed at SSB below 50 000 tons (Fig. 11.10). 50 000 tons of SSB is the current best estimate of B_{lim} for this stock (SCS Doc. 03/05). There is also an indication that since the mid-1980s recruitment has been depressed at SSB above this level, which may indicate that the stock has been in a period of low productivity.

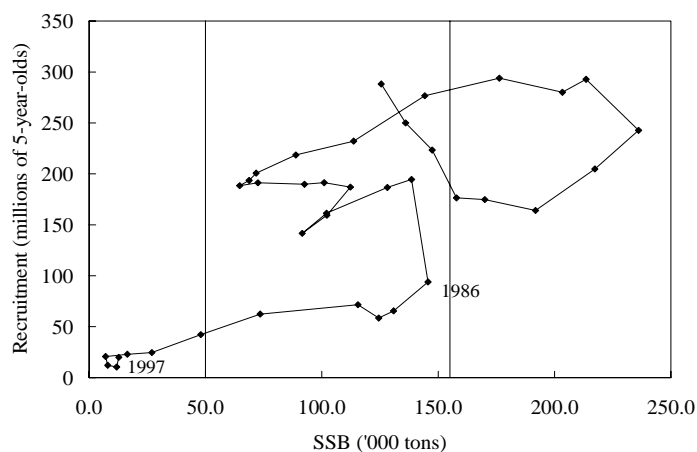


Fig. 11.10. American plaice in Div. 3LNO: spawning stock biomass recruitment relationship from VPA.

f) Medium Term Considerations

Previous assessments of this stock have used stochastic simulations including uncertainty in the survivors from the SPA representing the starting population for the projection and uncertainty in future recruitment to explore the prospects for stock rebuilding under different levels of fishing mortality. Uncertainty in future recruitment is the major source of variation in population size 5 to 10 years after the start of the simulation. In many cases, data on recruitment variation may provide useful information about the probability of outcomes under alternative management options. However, data accumulated on recruitment variation as a stock declines may not be very informative about recruitment probabilities when unprecedented low spawner stock biomass is reached for two reasons. Firstly, even though recruitment

rate (R/S) is supposedly maximized at lowest stock size, recruitment models fitted to a range of stock-recruit data quite often over-predict recruitment at low stock size. Secondly, the error distribution around the fitted model, most often assumed to be lognormal, may have the upper tail of the distribution influenced by a large range of recruitment values observed at intermediate spawner stock size, and may not appropriately reflect the expected distribution of recruit values at low stock size. Under such circumstances, deterministic projections may be more informative about the prospects of, for example stock recovery, under different conditions. In addition, limiting the time frame of such projections to 5 years decreases the impact of uncertainties in recruitment rate, as longer term projections are increasingly driven on assumptions about recruitment.

Projections were carried out for 5 years to examine the trajectory of the spawning stock biomass under 2 scenarios of fishing mortality: $F = 0$, $F = F_{\text{current}}$. For these deterministic projections the results of the VPA were used. F_{current} was set as the average F on age 13 (the fully recruited age in the VPA) over the last 3 years and was 0.26. PR and weights were averaged over the last 3 years. Recruitment was the average R/S for the last 3 year-classes and was equal to 1.85. In addition the following values were used:

Age	5	6	7	8	9	10	11	12	13	14	15+
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
PR	0.04	0.13	0.34	0.58	0.77	0.84	1	0.98	0.91	0.73	0.73
Weight	0.19	0.24	0.32	0.39	0.45	0.57	0.73	0.92	1.14	1.38	1.78
Maturities											
2004	0.02	0.07	0.20	0.47	0.68	0.93	0.98	1.0	1.0	1.0	1.0
2005	0.02	0.07	0.20	0.47	0.75	0.87	0.98	1.0	1.0	1.0	1.0
2006	0.02	0.07	0.20	0.47	0.75	0.91	0.96	0.99	1.0	1.0	1.0
2007	0.02	0.07	0.20	0.47	0.75	0.91	0.97	0.99	1.0	1.0	1.0
2008	0.02	0.07	0.20	0.47	0.75	0.91	0.97	0.99	1.0	1.0	1.0

The stock is estimated to increase under both $F = F_{\text{current}}$ and $F = 0$. However, the increase under current conditions of F is only about 5 000 tons over the 5 year period. The spawning stock does not reach the B_{lim} of 50 000 tons by 2008 even with $F = 0$ (Fig. 11.11).

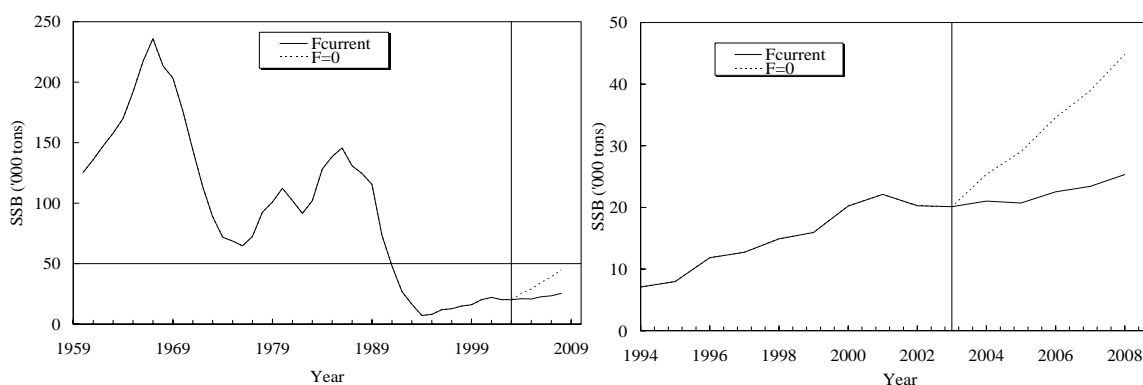


Fig. 11.11. American plaice in Div. 3LNO: projected spawning stock biomass at F_{current} and $F=0$.

12. Yellowtail Flounder (*Limanda ferruginea*) in Divisions 3L, 3N and 3O (SCR Doc. 03/6, 18, 39, 52, 61; SCS Doc. 03/6, 7, 11)

a) Interim Monitoring Report

Since the fishery re-opened in 1998, catches increased from 4 400 tons to 14 100 tons in 2001 (Fig 12.1). Catches in 2002 declined to about 10 800 tons, due mainly to decreased catches by Canada and EU-Spain.

Canadian catches were lower due mainly to by-catch problems with American plaice, and Spanish catches were lower likely because of an increase in the minimum mesh size introduced in 2002 in the skate fishery.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	7 ¹	ndf	ndf	ndf	4	6	10	13	13	14.5 ³
STATLANT 21A	0.2	0.1	0.2	0.7	4.4	7.0	10.6 ²	12.8 ²	10.4 ²	
STACFIS	2	0.1	0.3	0.8	4	7	11	14.1	10.8	

¹ No directed fishing.

² Provisional.

³ Recommended by SC in 2002 as TAC in 2004.

ndf No directed fishing.

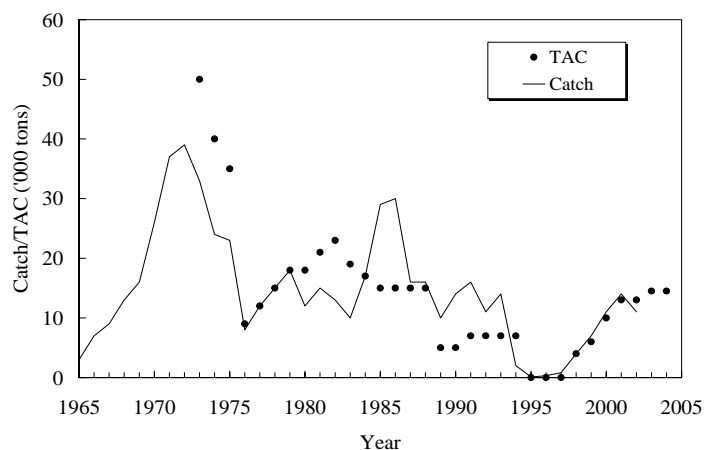


Fig. 12.1. Yellowtail flounder in Div. 3LNO: catches and TACs.

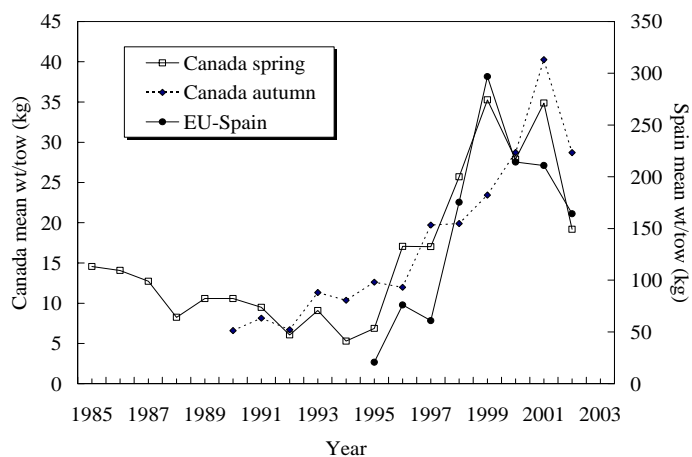


Fig. 12.2. Yellowtail flounder in Div. 3LNO: indices of biomass from Canadian and Spanish surveys.

Canadian stratified-random survey results indicated that in 2002, most of the biomass of this stock continued to be found in Div. 3N. The index of biomass from the spring survey in 2001 was similar to the high value in 1999, but declined in 2002. The index of biomass for Div. 3LNO increased steadily from 1990 to a peak in 2001, then declined in 2002 to about the 2000 level (Fig. 12.2).

Data from the Spanish stratified-random spring surveys in the Regulatory Area of Div. 3NO in 1995-2000 were converted to be comparable to the surveys from 2001 onward, which were done with a different vessel and gear. The abundance and biomass indices showed an increasing trend between 1995 and 1999, before declining thereafter (Fig. 12.2). The 2002 values were the lowest since 1997, but were not significantly different from those in 2000 or 2001.

The ASPIC model results accepted in 2002 indicated that stock size has increased, and was projected to stabilize in the medium term. Those projections, on which the TACs for 2003 and 2004 were based, assumed a catch in 2002 of 14 300 tons (current TAC + 10%). STACFIS observed that the TAC was not taken in 2002 due to by-catch constraints, but was not able to predict whether the same situation would exist into the future. Most indices of abundance showed a decline in 2002, although many were at or close to peak levels in 2001. Although there were some concerns expressed about the decline in the survey results in 2002, STACFIS did not consider the declines to be of sufficient concern to alter the perception of stock status.

b) **ASPIC modeling** (SCR Doc. 03/61).

In 2002, STACFIS **recommended** that *further exploration of the ASPIC model with yellowtail flounder data be conducted for 2003, including sensitivity of the model to various indices and to convergence criteria. Several formulations of the ASPIC model, using numerous survey and CPUE indices, showed that the Russian and Spanish surveys, along with the Canadian CPUE data, had strong residual patterns in the model fit.* The model results were sensitive to excluding the Russian survey data. A good model fit, giving very similar results to the accepted formulation, was obtained by including only the Canadian survey time series and setting the initial biomass to B_{MSY} ratio at 2.0. Exploration of the convergence criteria in the ASPIC model showed that model results were neither sensitive to varying the input criteria, nor to using 3 different versions of ASPIC which use different criteria for model convergence.

13. **Witch Flounder (*Glyptocephalus cynoglossus*) in Divisions 3N and 3O** (SCR Doc. 02/46; SCS Doc. 03/6, 7, 11)

a) **Interim monitoring report**

Reported catches in the period 1972-84 ranged from a low of about 2 400 tons in 1980 and 1981 to a high of about 9 200 tons in 1972 (Fig. 13.1). With increased effort, mainly by EU-Spain and EU-Portugal, catches rose rapidly to 8 800 and 9 100 tons in 1985 and 1986, respectively. This increased effort was concentrated mainly in the Regulatory Area of Div. 3N.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	3	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	0.3	0.3	0.3	0.5	0.6	0.9	0.7 ¹	0.5 ¹	0.7 ¹	
STACFIS	1.0	0.3	0.3	0.5	0.6	0.8	0.5	0.7	0.4	

¹ Provisional.

ndf No directed fishery.

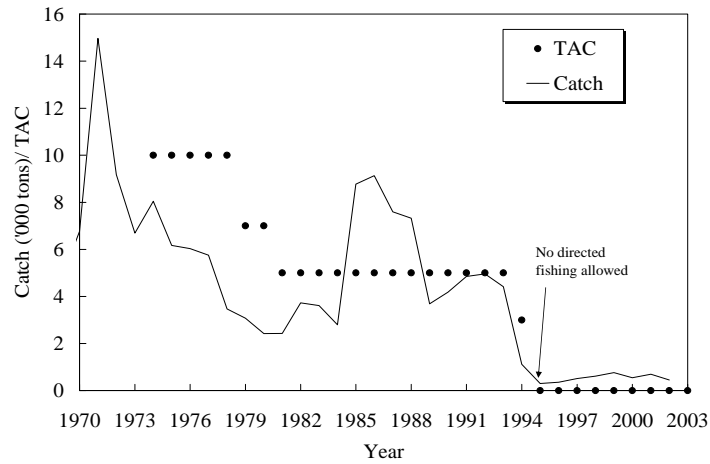


Fig. 13.1. Witch flounder in Div. 3NO: catches and TACs.

The mean weight (kg) per tow index from the Canadian spring survey series, starting in 1984, has shown a decline to a minimum in 1998 (Fig. 13.2). Although variable, recent surveys indicate some improvement in the stock since 1998. There has been no appreciable change from last year.

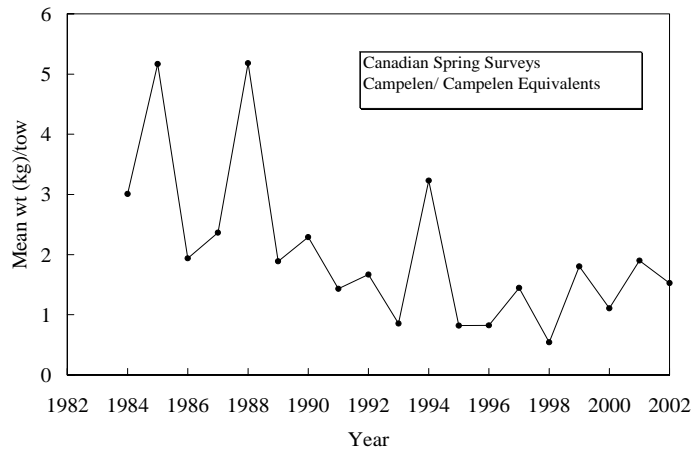


Fig. 13.2. Witch flounder in Div. 3NO: survey mean weight (kg) per tow.

14. **Capelin (*Mallotus villosus*) in Divisions 3N and 3O (SCR Doc. 03/37)**

a) **Introduction**

The directed fishery was closed in 1992 and the closure has continued through 2003 (Fig. 14.1).

No catches have been reported from this stock since 1993:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Recommended TAC	ndf	ndf	ndf	na	na	na	na	na	na	na
Catch ¹	0	0	0	0	0	0	0	0	0	0

¹ No catch reported or estimated for this stock.

ndf No directed fishing.

na No advice possible.

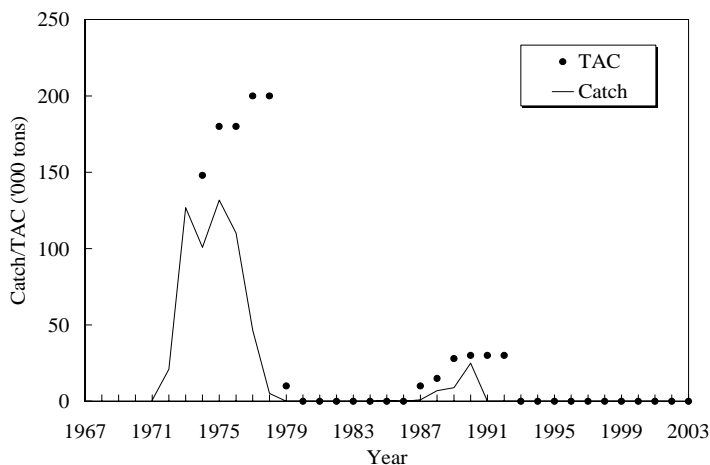


Fig. 14.1. Capelin in Div. 3N and 3O: catches and TACs.

b) Input Data

Trawl acoustic surveys of capelin on the Grand Bank previously conducted by Russia and Canada on a regular basis have not been undertaken since 1995. The only indicator of stock dynamics presently available may be capelin biomass indices obtained during Canadian stratified-random bottom trawl surveys. Trawlable biomass of capelin in Div. 3LNO and 3NO for 1977-2002 was converted into absolute values on the basis of the relationship between trawl and acoustic estimates of the capelin biomass in Div. 3LNO in spring 1977-94. Data on catches of capelin reflect the availability of its aggregations in the 5 m near-bottom layer for research trawls rather than actual capelin biomass in all layers. It is not clear how the data reflects the real stock distribution and stock status. The correlation between biomass estimates derived by the acoustic and the trawl methods was relatively weak; with an R^2 of 0.36. Assuming the existence of a linear or power relationship, it may be concluded that in 1990-1994, both the calculated and the trawlable biomass of capelin in Div. 3LNO fluctuated within a wide range, tending to decrease. Since 1995 the biomass of capelin on the Grand Bank has remained at a low level. In 2002 the biomass was estimated in Divs. 3LNO as maximum as 0.988 million tons (Fig. 14.2). Length groups of 14-16 cm predominated in capelin by-catches.

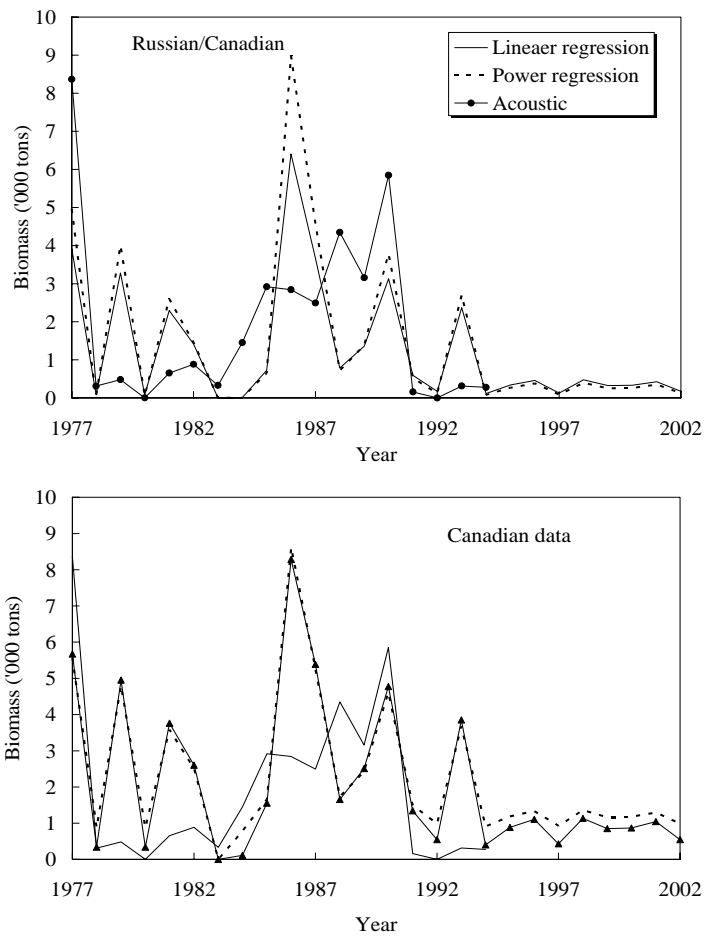


Fig. 14.2. Capelin in Div. 3LNO: biomass estimates in 1977-2002.

c) **Assessment Results**

STACFIS considered that the stock is still at a low level relative to that of the late-1980s.

d) **Precautionary Reference Points**

It is not possible to determine biological reference points for capelin in Div. 3NO at this time.

e) **Research Recommendation**

STACFIS **recommended** that *initial investigations to evaluate the status of capelin in Div. 3NO utilize trawl acoustic surveys to allow comparison with the historical time series.*

15. **Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 30** (SCR Doc. 03/12, 26, 60, 63; SCS Doc. 03/6, 7, 11)

a) **Introduction**

There are two species of redfish that have been commercially fished in Div. 30; the deep-sea redfish (*Sebastes mentella*) and the Acadian redfish (*Sebastes fasciatus*). The external characteristics are very similar, making them difficult to distinguish, and as a consequence they are reported collectively as "redfish" in the commercial fishery statistics.

Nominal catches have ranged between 3 000 tons and 35 000 tons since 1960 (Fig. 15.1). Up to 1986 catches averaged 13 000 tons, increased to 27 000 tons in 1987 with a further increase to 35 000 tons in 1988. Catches declined to 13 000 tons in 1989, increased gradually to about 16 000 tons in 1993 and declined further to about 3 000 tons in 1995, partly due to reductions in foreign allocations within the Canadian zone since 1993. Catches increased to 14 000 tons by 1998, declined to 10 000 tons in 2000 and increased to 20 000 in 2001. The 2002 catch was at 17 000 tons.

The large catches in 1987 and 1988 were due mainly to increased activity in the NAFO Regulatory Area NRA by South Korea and non-Contracting Parties (NCPs), primarily by Panama. There hasn't been any activity in the NRA by NCPs since 1994. Estimates of under-reported catch have ranged from 200 tons to 23 500 tons. There have also been estimates of over-reported catch in recent years. These have ranged from 1 800 tons to 2 800 tons.

Russia predominated in this fishery up until 1993. From 1987 to 1993 Russian catches ranged from 3 800 tons to 7 200 tons. Russia and Cuba, impacted by the reduction and eventual elimination of foreign allocations by Canada, ceased directed fishing in 1994. Russia resumed directed fishing in 2000 rapidly increasing their catch from 2 200 tons to about 11 000 tons in 2001 and 2002. EU-Portugal began fishing in 1992 and averaged about 1 800 tons between 1992 to 1998. Catches escalated to 5 500 tons in 1999 and have averaged about 4 200 tons to 2002. EU-Spain, who had taken less than 50 tons before 1995, increased catches from 1 200 tons in 1997 to a peak of 4 500 tons in 1999 with a subsequent decline to 700 tons in 2002.

Canada has had limited interest in a fishery in Div. 30 because of small sizes of redfish encountered in areas suitable for trawling. Canadian landings were less than 200 tons annually from 1983-1991. In 1994, Canada took 1 600 tons due to improved markets, but declined to about 200 tons in 1995. Between 1996 and 1999 Canadian catches have alternated between levels of about 8 000 tons and 2 500 tons based on acceptable markets for redfish near the 22 cm Canadian size limit. From 2000-2002 Canada has averaged about 3 400 tons.

In general, the fishery has occurred primarily from May to October since 1990. The prominent means of capture from the mid-1970s to the early-1980s was the bottom otter trawl. The use of mid-water trawls from 1990 to 1993 was primarily by Russia and Cuba. Canadian, Portuguese and Spanish fleets primarily use bottom trawling.

Nominal catches and TACs ('000 tons) for redfish in the recent period are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC (Canada Only)	10	10	10	10	10	10	10	10	10	10
STATLANT 21A	4.6	2.8	10	5	13	13	13 ¹	22 ¹	19 ¹	
STACFIS	5.4	3.2	10	5	14	13	10	20	17	

¹ Provisional.

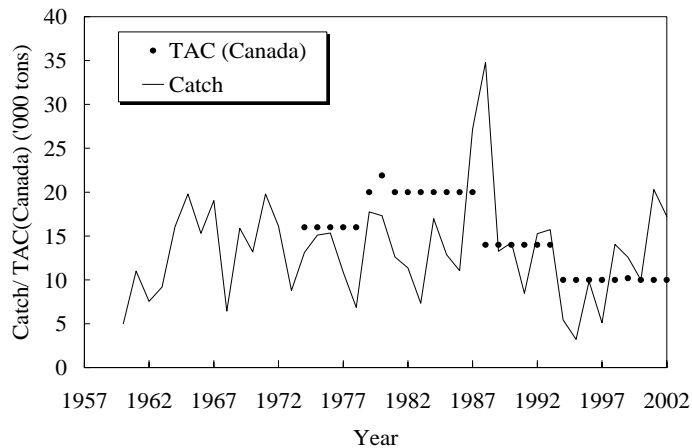


Fig. 15.1. Redfish in Div. 3O: catches and Canadian TACs.

b) Input Data

i) Commercial fishery data

A catch-rate database with effort measured in hours fished and another with effort measured in days fished were standardized using a multiplicative model. Previous catch rate analyses suggested different trends in the catch rate series derived for Canada only and for countries that have only fished outside the EEZ. Accordingly, separate standardizations of available catch-rate data were conducted as follows: (i) All fleets, (ii) Canada only, (iii) countries which have fished both inside and outside the EEZ (Russia, Cuba and Japan), and (iv) countries, which have only fished outside the EEZ (Poland, EU-Portugal, South Korea, EU-Spain and Russia and Japan since 1994).

The analysis of catch rates separately by fleet category (Fig. 15.2) suggests different trends over the time period from 1960 to 1990, particularly since the mid-1970s in both hours fished and days fished models. The Canadian fleet generally shows an increase over the period while the fleets that fished both in the Canadian zone and the NRA show a decrease. The trends in both are generally in agreement since 1993 indicating an increase. STACFIS concluded that the catch rate indices are not considered indicative of overall trends in the resource but may simply indicate fishing success of these fleets within their areas of operation. Canada has not accounted for a major portion of the reported catches from Div. 3O and has only fished within the 200-mile EEZ. The recent dramatic fluctuations cannot be accounted for by the biology of redfish. The catch rate index of the fleets that have fished outside covers an area of about 8% of the stock area.

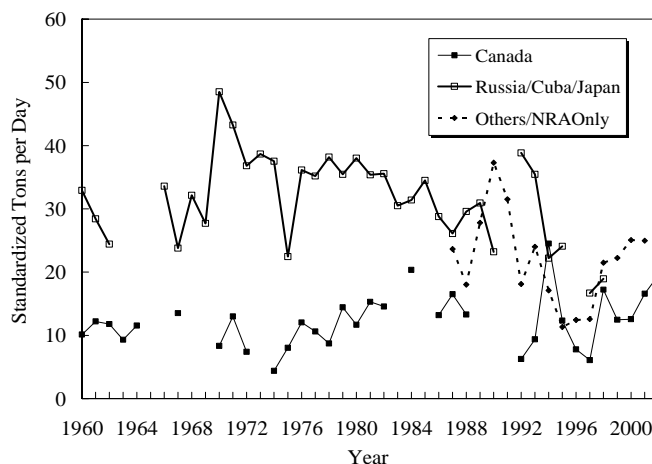


Fig. 15.2. Redfish in Div. 3O: standardized CPUE by fleet.

Sampling of redfish was conducted by Canada, EU-Portugal, Russia and EU-Spain from the 2002 trawl fishery. The Portuguese fleet fished between 200-300 m. The Canadian and Russian fleets fished from 300-600 m. The compilation of annual catch-at-length as number per thousand suggested fish between 21-25 cm generally dominated the catches. Lengths between 21-24 cm (range 15-43 cm) dominated the Portuguese catch. The dominant mode in the Spanish catch was between 19-21 cm (range 14-31 cm) and the Russian fleet modal catch occurred between 23-25 cm (range 11-52 cm). Fish between 22-25 cm from a length range between 17-37 cm, dominated the Canadian catch. Catch at length from various fleets from 1995 to 2002 suggests that the size composition has changed over the time period with fleets catching a larger portion of fish >25 cm prior to 1998.

ii) Research survey data

Stratified-random surveys have been conducted by Canada in Div. 3O in spring and autumn from 1991 to spring 2003. The surveys cover to depths of 732 m (400 fathoms) in spring and to 1 464 m (800 fathoms) in autumn. Until the autumn of 1995 these surveys were conducted with an Engels 145 high lift otter trawl. Starting in the autumn 1995 survey, a Campelen 1800 survey trawl was used. The Engel data were converted into Campelen equivalent units.

Results of bottom trawl surveys for redfish in Div. 3O indicated a considerable amount of variability. This occurred between seasons and years. Although it is difficult to interpret year to year changes in the estimates, in general, the spring survey index (Fig. 15.3) suggests the stock may have increased from an average of 19 kg/tow in 1991-1992 to an average of 205 kg/tow between 1994-96 and subsequently declined to an average of 31 kg/ tow between 2002-2003. The autumn surveys, while more stable in the early-1990s, generally supports this pattern. Research vessel surveys do not appear to adequately sample fish greater than 25 cm which up to 1997 have generally comprised the main portion of the fishery.

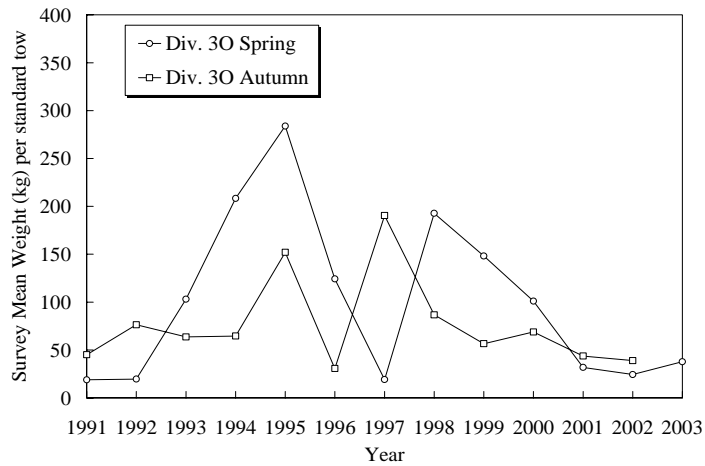


Fig. 15.3. Redfish in Div. 3O: survey biomass indices from Canadian surveys in Div. 3O in Campelen equivalent units for surveys prior to autumn 1995.

Stratified random surveys were conducted by USSR/Russia in Div. 3O from 1983 to 1993. These surveys also demonstrate large fluctuation and within year variability with the estimates sometimes highly influenced by large sets. The survey index of biomass declined from 40 000 tons in 1983 to 806 tons in 1989 and remained relatively low to 1993.

iii) **Recruitment**

Size distribution from the Canadian spring and autumn surveys in terms of mean number-per-tow at length indicates a bimodal distribution in 1991 corresponding to the 1988 and 1984 year-classes. The 1984 year-class progressed at about one cm per year up to 1994 and cannot be traced any further. The 1988 year-class remains dominant at 22-23 cm from 2001-2003 surveys. Recruitment pulses were detected in both surveys in 1999, were greatly diminished by 2002 (Fig. 15.4). There is no prospect of good recruitment in the surveys since the 1988 year-class.

Size distribution from the USSR/Russian spring/summer surveys from 1983 to 1993 indicated pulses of recruitment that first appeared in the surveys of 1983, 1988 and 1991 between 10-13 cm. These correspond to the year-classes of 1978, 1984 and 1988, respectively. The relative strength of these in the surveys suggests 1978 was the strongest of these year-classes.

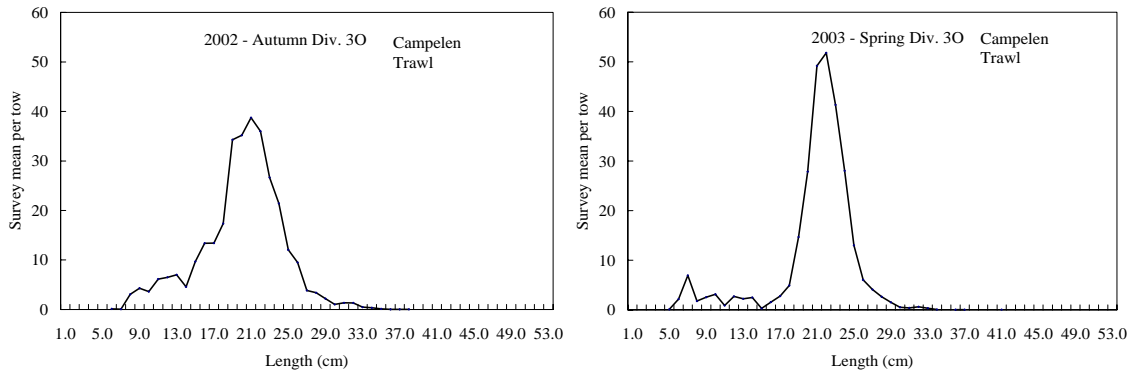


Fig. 15.4 Redfish in Div. 3O: size distribution (stratified mean per tow) from Canadian spring and autumn surveys for 2002.

c) Estimation of Stock Parameters

i) Non-Equilibrium Surplus Production Model (ASPIC)

The catch and the days fished standardized CPUE series were utilized in a non-equilibrium surplus production model (ASPIC). Indices used as covariates were the 1991-2002 Canadian spring and autumn survey indices and the Russian Spring/Summer survey index. Model diagnostics suggest the results are not consistent with a long lived species like redfish. STACFIS did not accept the results as indicative of the stock dynamics.

ii) Relative exploitation

A fishing mortality proxy was derived from catch to biomass ratios. As most of the catch of the 1990s was taken in the last three quarters of the year, the catch in year “n” was divided by the average of the Canadian Spring (year = n) and Autumn (year = n-1) survey biomass estimates to better represent the relative biomass at the time of the year before the catch was taken. Survey catchability (q) for redfish is not known but assumed less than one. Prior to 1998 the catch was composed of fish greater than 25 cm which are not well represented in the survey catch. From 1998 to 2002, the fishery size composition more resembled the survey size composition. Accordingly, catch/biomass ratios were only calculated for the surveys from 1998-2002. The results (Fig. 15.5) suggest that relative fishing mortality increased steadily from 1998 to 2002.

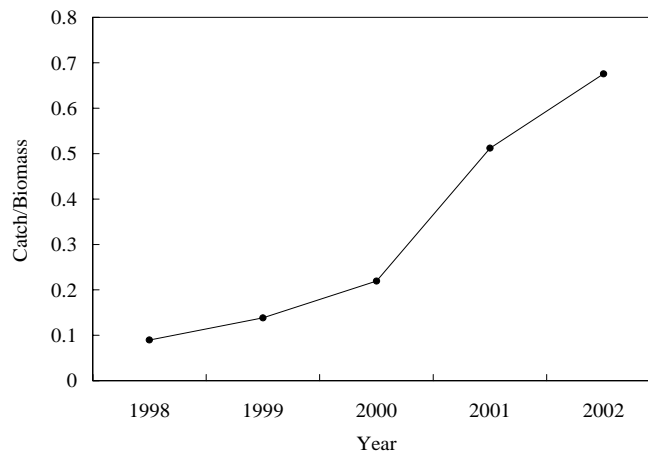


Fig. 15.5. Redfish in Div. 3O: catch/survey biomass ratios for Div. 3O.

iii) Size at maturity

Size at maturity data for redfish suggests L_{50} is about 28 cm for females and 21 cm for males.

d) Assessment Results

It is not possible to determine current fishing mortality rate or absolute size of the stock. Accepting that the surveys may indicate general trends over the time period, the Canadian spring and autumn survey estimates did not increase in the last few years. Therefore, the increase in catches in Div. 3O in recent years, particularly in 2001 and 2002 at about 20 000 tons, suggests that fishing mortality has been increasing since 2001. STACFIS is concerned that there has been poor recruitment since the relatively strong 1988 year-class. Given that the bulk of the catches in recent years are comprised of fish less than 25 cm, these fisheries are targeting predominantly immature fish.

e) **Reference Points**

At present it is not possible to determine limit or other reference points for either fishing mortality or biomass for redfish in Div. 3O.

f) **Stock Structure**

Information on survey catch and length distribution was available to address an outstanding recommendation concerning the relationship between redfish in Div. 3LN and Div. 3O. The information suggests that Div. 3N is more similar to Div. 3O than Div. 3L with regard to size composition. STACFIS noted that although most recent studies on this issue have suggested a closer connection between Div. 3N and Div. 3O. If these divisions constitute a biological stock, managing these separately may not be harmful. STACFIS is more concerned of the relationship with Div. 3L, given that it has experienced poor recruitment since the early-1980s while Div. 3N and Div. 3O have experienced improved recruitment from the year classes born in the 1986-88 period. One major disadvantage to addressing this puzzle is the inability to use conventional tagging because of the high mortality caused in bringing redfish to the surface. Recent improvements in tagging technology where fish are tagged on bottom may be a useful tool in future to unraveling this long-standing issue.

STACFIS regards this stock issue to be important as the continuing uncertainties regarding the relationship between redfish in Div. 3LN and Div. 3O have important impacts on interpretations of available data. STACFIS again **recommended** that (1) *redfish data in Div. 3LN and Div. 3O be analyzed further to determine if a relationship exists between Div. 3LN and Div. 3O that may help in the interpretation of the indices of abundance; and (2) data be examined to evaluate the appropriateness of Div. 3LN and Div. 3O as management units for redfish.*

D. WIDELY DISTRIBUTED STOCKS

16. **Roughhead Grenadier (*Macrourus berglax*) in Subareas 2 and 3** (SCR Doc. 03/9, 13, 42; SCS Doc. 03/6, 7, 13)

a) **Introduction**

i) **Description of the fisheries**

It has been recognised that a substantial part of the recent grenadier catches in Subarea 3, previously reported as roundnose grenadier correspond to roughhead grenadier (SCR Doc. 98/28). The misreporting has not yet been resolved in the official statistics before 1996, but the species are reported correctly since 1997. Roughhead grenadier is taken as by-catch in the Greenland halibut fishery, mainly in Div. 3LMN in the Regulatory Area (Fig. 16.1). This stock is not regulated.

The revised recent catches ('000 tons) are as follow:

	1994	1995	1996	1997	1998	1999	2000	2001	2002
STATLANT 21A	2.3	1.5	4.1	4.7	7.2	7.1	2.7 ¹	1.6 ¹	1.9 ¹
STACFIS	4.0	3.9	4.1	4.7	7.2	7.2	4.8	3.2	3.7

¹ Provisional.

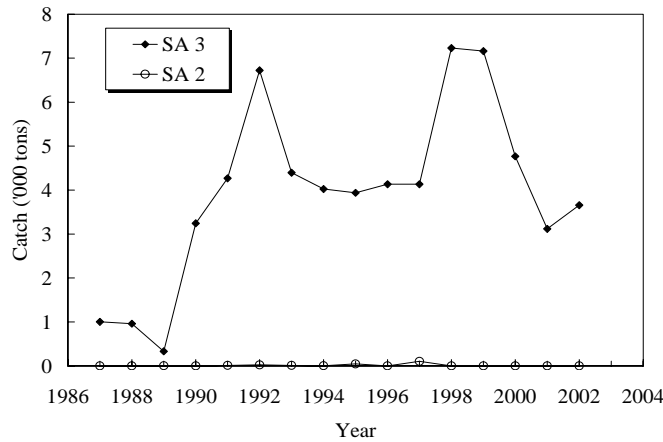


Fig. 16.1 Roughhead grenadier in Subareas 2+3: catches in Subareas 2+3

b) Input Data

i) Commercial fishery data

Length frequencies from the Spanish, Russian and Portuguese trawl catches in Div. 3LMNO are available since 1995 (SCS Doc. 03/6, 7, 13). In the commercial fishery females attain larger lengths than males. Catch-at-age data from the total catches determined by applying the annually the age-length keys from Spanish commercial catches, in Div. 3LMNO are available since 1997.

ii) Research survey data

Canadian autumn surveys. Stratified random bottom trawl surveys have been conducted in Div. 2GHJ and Div. 3KL in autumn since 1978. Since 1990 the survey also covered Div. 3NO. Until 1994 an Engel trawl was used but this was changed since then to a Campelen 1800. Survey depth was up to 1 000 m in Div. 2GHJ and 3K and to 730 m in Div. 3LNO and was extended to 1 463 m after 1995.

The roughhead biomass indices from this series of surveys are not directly comparable over time because of the change in the survey gear and variations in the depth coverage. However, the survey provides information on the stock distribution. It seems that the main part of the stock has shifted from the northern Divisions (Div. 2GJ and Div. 3K) to the southern ones (Div. 3LN) and to greater depths (beyond 1 000 m.) since the early-1990s. At present, most of the survey biomass is caught in Div. 3L. In Fig. 16.2 are presented the biomass indices for the period 1996-02.

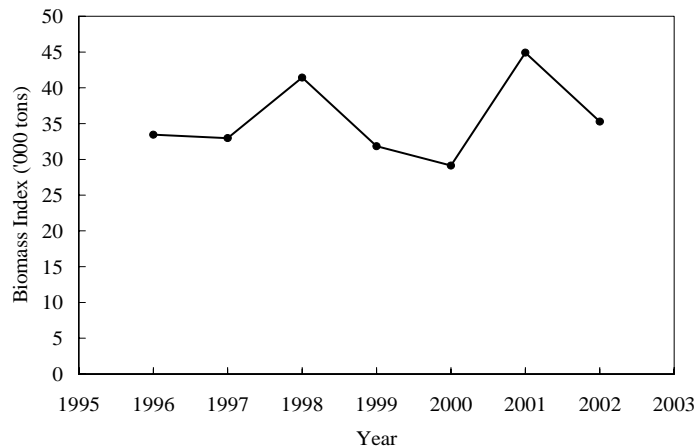


Fig. 16.2. Roughhead grenadier in Subareas 2+3: biomass indices from the Canadian autumn surveys.

Canadian spring surveys. Stratified random bottom trawl surveys have been conducted in Div. 3L and Div. 3N in spring since 1971. Until 1995 an Engel trawl was used but this was changed to a Campelen 1800 since then. The depth range of the surveys is down to 730 m. Again in this case a direct comparison of the biomass index through the whole time series is not possible because of the changes in the survey gear. Biomass estimates from the spring survey series are considerably lower than the ones obtained in the autumn series. The first surveys cover only the southern Divisions and the shallower depths, where according to the other results this species is less abundant. Presently the main part of the stock could be distributed beyond 1 000 m depth, especially in the southern Divisions. The biomass indices for the period 1996-02 are presented in Fig. 16.3.

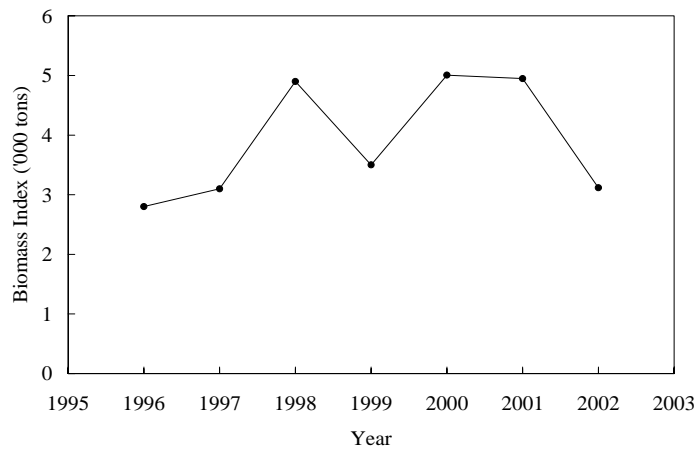


Fig. 16.3 Roughhead grenadier in Subareas 2+3: biomass indices from the Canadian spring surveys.

Canadian deepwater surveys. Stratified deepwater bottom trawl surveys (750-1 500 m) in 1991, 1994 and in 1995 in Div. 3KLMN were carried out. The biomass estimates increased from 16 215 tons in 1991 to 46 668 tons in 1995. Most of the biomass was taken in Div. 3L and Div. 3M, at depths beyond 1 000 m. However the increase could be related in part to the increased survey coverage.

EU (Spain-Portugal) longline deepwater survey. A deepwater longline survey was conducted in 1995 in Div. 3LMN, at depths between 562 and 3 028 m. (SCR Doc. 96/34). This survey does not provide a quantitative biomass index for roughhead grenadier, but gives information on the species depth distribution. Roughhead was the most abundant species, accounting for 32% of the total catch. This species occurred mostly beyond 1 000 m, with maximum yields between 1 000-1 599 m. Below 2 000 m, roughhead grenadier became progressively less abundant and disappeared completely at 2 200 m, where they were replaced by another Macrouridae species (*Nematonurus armatus*).

EU (Spain and Portugal) summer survey. Stratified bottom trawl surveys in Div. 3M, up to depths of 730 m, have been carried out since 1988. The roughhead grenadier mean catch per tow (\pm S.E.) from this survey series is presented in Fig. 16.4. Significant biomass was only found at depths beyond 500 m every year, although this survey does not cover the whole depth range of this species.

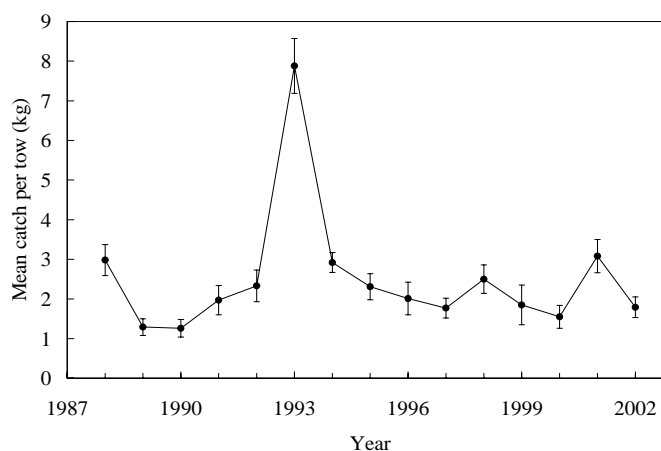


Fig. 16.4 Roughhead grenadier in Subareas 2+3: mean catch per tow (\pm S.E.) from the EU-summer survey in Div. 3M.

iii) Biological studies

SCR 03/13 provides information on age and length structure in Div. 3M based on results from the summer EU survey series. Age and length composition of the catches showed clear differences between sexes. The proportion of males in the catches decreases progressively, as length increases and there are sexual differences in growth. Male growth rates declines when reaching a pre-anal fin length of 18 cm, around 9 years old, while female growth rate does not slow until reaching 34-35 cm, around 20 years old.

c) Assessment Results

Based on commercial catch-at-age data, full recruitment to the fishery occurs at age 8; a catch curve analysis gives a total mortality estimate of 0.39. The estimated catch / biomass (C/B), based on the Canadian autumn survey biomass index, is 0.1, and it is at the same level in 2001 ($C/B_{2001} = 0.07$) (Fig. 16.5)

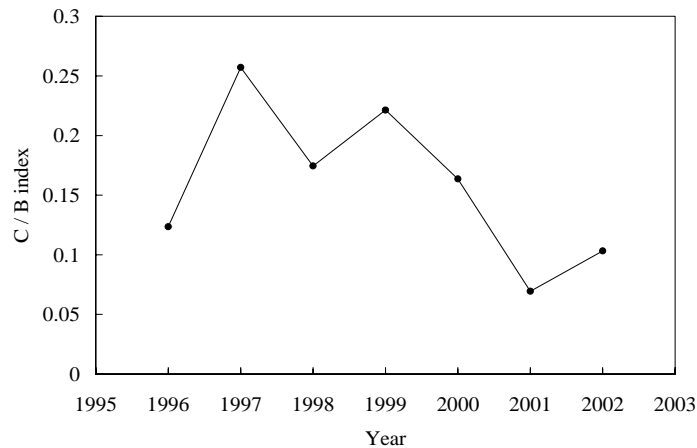


Fig. 16.5. Roughhead grenadier in Subareas 2+3: catch/biomass index based upon Canadian autumn survey.

The mean lengths have been rather stable since 1995. The available time series of catches at age is too short to analyse trends in the SSB, however it can be noted that only 4% in abundance and 20% in weight of the 2002 catches were older than the female age at 50% maturity (15 years).

d) **Reference Points**

STACFIS is not in the position to provide reference points at this time.

e) **Research Recommendation**

STACFIS **recommended** that *further investigations into yield-per-recruit analysis by sex be carried out for roughhead grenadier in SA 2 and 3.*

17. **Cod (*Gadus morhua*) in Divisions 2J, 3K and 3L** (SCR Doc. 03/62)

a) **Introduction**

This stock was placed under moratorium in 1992. Catches during 1993-97 came from by-catches, food/recreational fisheries, and the DFO-industry sentinel surveys that started in 1995. A small Canadian index/commercial fishery limited to fixed gear deployed inshore from small (<65 feet) vessels commenced in 1998. Catches from 1998 to 2002/2003 came from directed cod fisheries, by-catches, sentinel surveys and food/recreational fisheries. A Canadian inshore fixed gear TAC of 5 600 tons was put in place for each of 3 years commencing in 2001/2002 (1 April-31 March) that was to include all catches, including those from the food/recreational fishery. Reported landings by Canada were approximately 3 500 tons from the index fishery, 100 tons from the sentinel surveys, and 600 tons from the food/recreational fishery, for a total of 4 200 tons. Non-Canadian removals in 2002 are reported to have totaled 54 tons, 50 by EU-Portugal, 1 by EU-Spain and 3 tons by Russia in Div. 3L. The limited Canadian index and recreational fisheries were again closed beginning on 1 April 2003.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	0 ¹	0 ¹	0 ¹	0 ¹	4 ¹	9 ²	7 ²	5.6 ²	5.6 ²	0 ²
Total Catch	1.4	0.3	1.5	0.5	4.5	8.5	5.4	6.9 ³	4.2 ³	

¹ Moratorium on Canadian fishing became effective in July 1992, and ended in 1998.

² Inshore Fixed Gear Canada Only

³ Provisional.

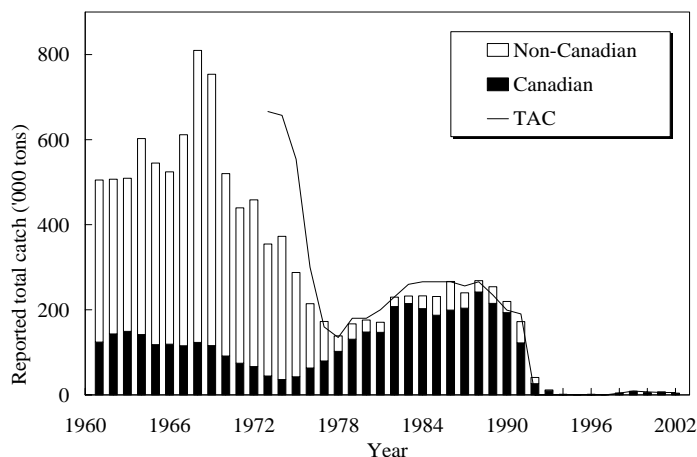


Fig. 17.1. Cod in Div. 2J+3KL: landings and TACs.

b) Input Data

i) Commercial fishery data

Catch and effort. Median catch rates for the Canadian commercial index fishery (Fig. 17.2) were calculated from catch and effort data recorded in logbooks from 1998-2002. The overall spatial pattern for gillnets, the predominant gear, has been similar among years. Catch rates have been consistently low in Div. 2J (not illustrated) and northern 3K. During 1998-2002 catch rates declined in both southern Div. 3K and southern 3L, and have remained high only in northern 3L, most notably in southern Bonavista Bay and northern Trinity Bay (Statistical Areas 13 and 14). The area in which high catch rates can be obtained has declined considerably since 1998.

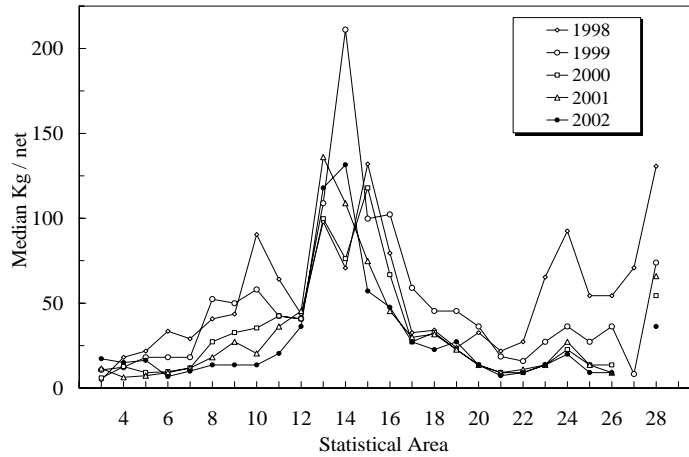


Fig. 17.2. Cod in Div. 2J+3KL: median gillnet catch rates from the commercial fishery for the years 1998-2002.

The catch rates from logbooks were standardized to remove site and seasonal effects and to produce an annual estimate of total catch rate for Div. 3K and 3L combined. Gillnet catch rates declined from 1998 to 2002 (Fig. 17.3).

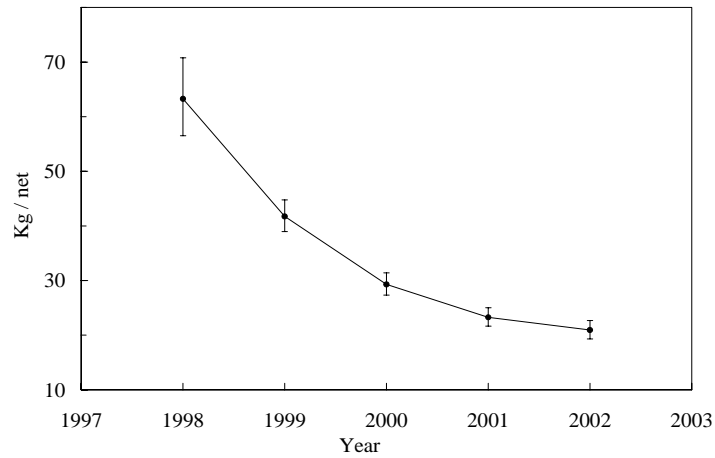


Fig. 17.3. Cod in Div. 2J+3KL: Standardized catch rates from the gillnet fisheries for cod by vessels < 35 feet in Div. 3KL.

Catch-at-age. No sampling of the recreational catch was carried out in 2002. Sampling of the commercial catch was insufficient in some area-time blocks and was augmented by sentinel survey data. The total catch-at-age comprised a range of ages, with ages 3-12 being important contributors and age 5 being most prominent. Ages 5-7 were most prominent in gillnets and ages 4-5 were most prominent in handlines.

ii) **Research survey data**

Canadian stratified-random bottom trawl surveys. The biomass index from the Canadian autumn bottom-trawl survey in 2002 remained extremely low at only 2% of the average in the 1980s (Fig. 17.4).

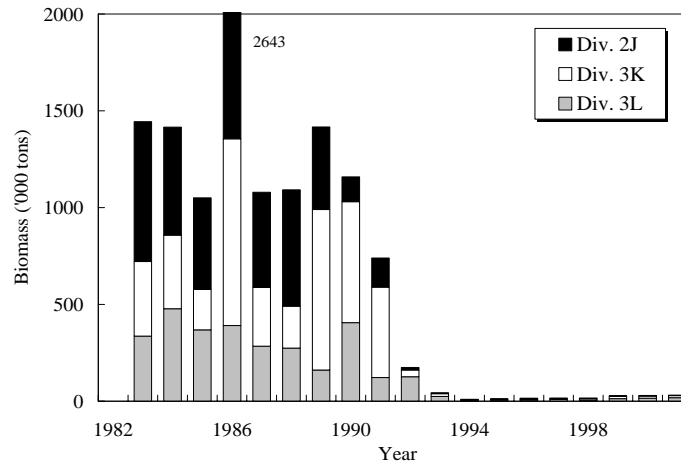


Fig. 17.4. Cod in Div. 2J+3KL: biomass indices from autumn surveys.

The spawner biomass index from these surveys remained at less than 2% of the average in the 1980s. The biomass index from the Canadian spring bottom-trawl survey in Div. 3L in 2002 also remained extremely low, at about 1% of the average in the 1980s.

Industry-DFO fixed gear surveys. Fixed gear (sentinel) surveys were initiated in 1995 to provide catch rates on traditional inshore fishing grounds during the moratorium, but the surveys continued during the period when commercial fishing recommenced on a small scale (1998-2002). The sentinel survey data were standardized to remove site and seasonal effects and produce annual indices of total catch rate and catch rate at age for Div. 3K and 3L combined. Gillnets and line trawls were treated separately (Fig. 17.5). Gillnet catch rates increased from 1995 to 1998 but then declined to 2002. Line trawl catch rates showed relatively little change from 1995 to 1996, increased in 1997, and then declined to 2002, with a small increase in 2001.

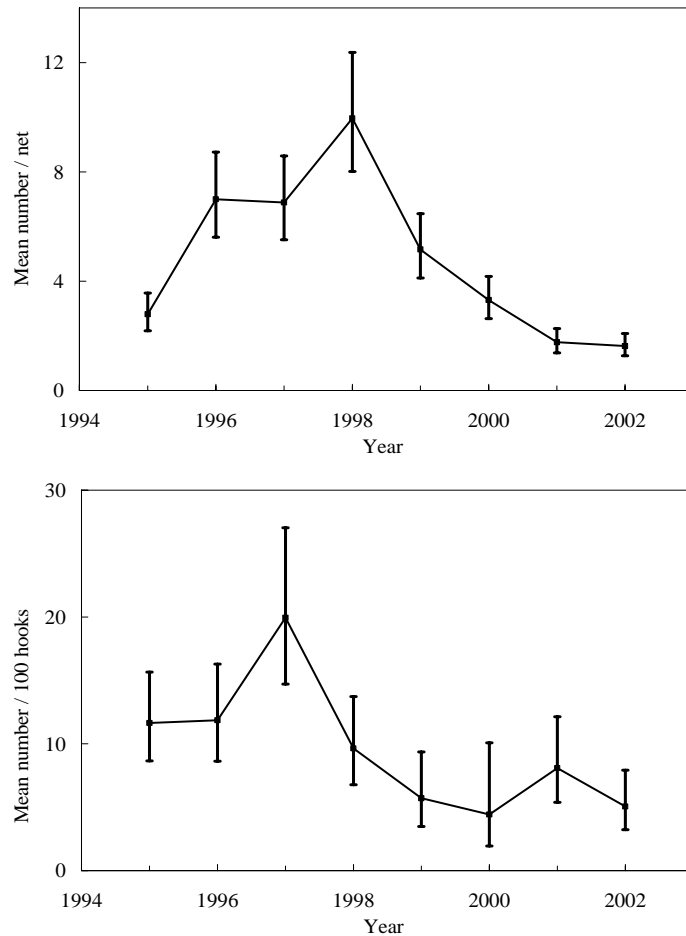


Fig. 17.5. Cod in Div. 2J+3KL: standardized catch rates from sentinel surveys in Div. 3KL; gillnets above and line trawls below.

Hydroacoustic studies. Hydroacoustic studies have been conducted in Smith Sound in western Trinity Bay (Div. 3L) at various times since spring 1995. Surveys in January provided average indices of biomass that increased from 1999 to a peak of about 26 000 tons in 2001 and then declined to 23 000 tons in 2002 and 20 000 tons in 2003. Hydroacoustic estimates within two regions of the offshore (Hawke Saddle (Div. 2J) and the saddle along the Div. 3K/3L boundary) were considered uncertain but suggest a combined biomass of less than 20 000 tons.

iii) **Biological studies**

Maturity. The proportion of young female cod mature at age, as determined from observations during autumn bottom-trawl surveys, increased during the early-1990s and has fluctuated since.

Size-at-age and condition. Size-at-age of cod sampled during the autumn surveys declined during 1983-85 and again in the early-1990s, especially in Div. 2J. Size-at-age has increased in recent years but is below peak values observed in the late-1970s. Condition of cod, as measured by both gutted body weight and liver weight relative to fish length, declined in the offshore during the early-1990s, especially in Div. 2J. Since the mid-1990s, condition levels have been similar to those measured in the mid-1980s.

Recruitment. A recruitment index was derived from catch rates of juvenile (ages 0-3) cod during various studies that have been conducted since the early-1990s. These data were combined to produce a single index of relative year-class strength (Fig. 17.6). This index was low through much of the 1990s, but shows a pulse of better recruitment starting toward the end of the decade, with the 2000 year-class higher than any other in this short series. The 2001 and 2002 year-classes appear weak. The 2002 year-class is estimated with low precision.

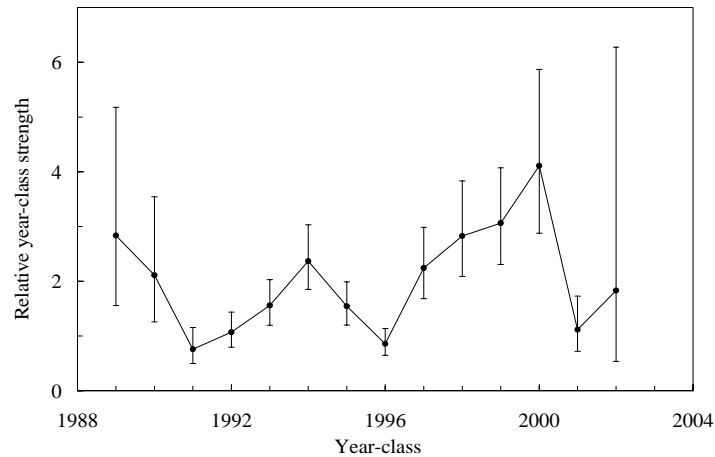


Fig. 17.6. Cod in Div. 2J+3KL: standardized year-class strength.

Mortality calculated from surveys. Age specific mortality rates (proportion of population dying in a year) were calculated from catch rates during the autumn Div. 2J+3KL bottom-trawl survey. The rates for all ages rose to very high levels by the early-1990s, and remained extremely high for a few years after the start of the moratorium in 1992. The paucity of older fish (7+) in the survey since the early-1990s prevents estimating total mortality on these older ages. For younger ages (Fig. 17.7), mortality has remained very high (40-60% per year at age 4 and 60-80% per year at age 6).

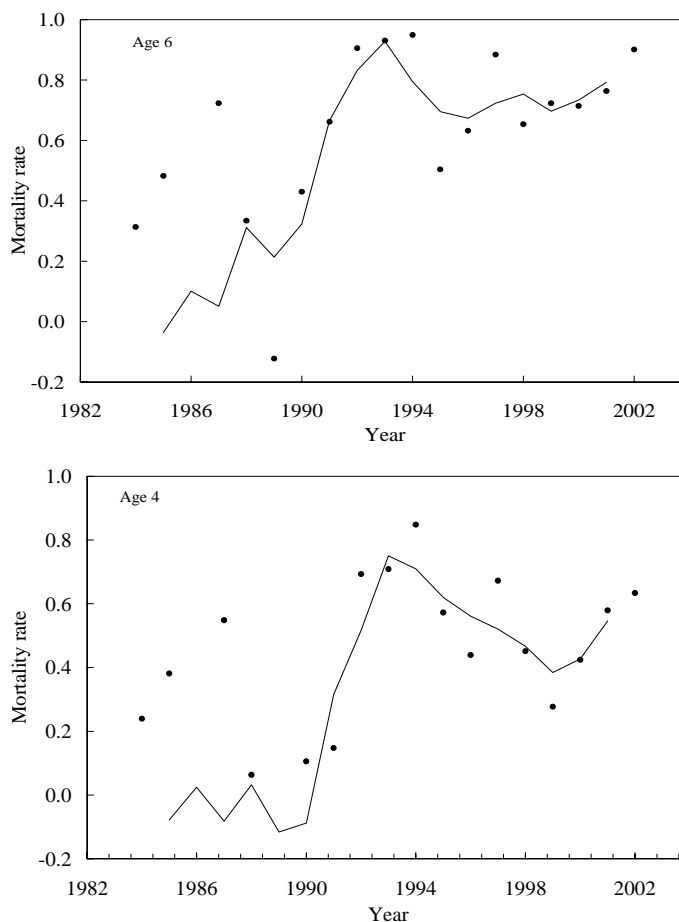


Fig. 17.7. Cod in Div. 2J+3KL: age specific mortality calculated from catch per tow at age during the autumn bottom-trawl surveys in Div. 2J+3KL. As an example, in the age 4 panel, the value of 0.85 in 1994 is the mortality experienced by the 1990 year-class from age 3 in 1993 to age 4 in 1994. The line is a 3-year moving average. Data points less than -0.2, which occurred only before 1990, are not shown.

Predation by harp seals. Consumption of cod by harp seals in 2000 is estimated from diet studies to have been about 37 000 tons (95% confidence interval of 14 000-62 000 tons). Most cod represented in such studies are small. Harp seals also prey on large cod by consuming only soft parts, and such predation has been frequently observed. Predation by hooded seals on cod has not been measured but is potentially large. The information on feeding by seals and trends in the harp seal population indicate that predation by seals is a factor contributing to the high total mortality of cod in the offshore and the high natural mortality of adult cod in the inshore.

c) **Assessment results**

Inshore biomass from tagging studies. Results of tagging experiments indicate an exploitation rate close to 20% in the inshore in 2002 associated with a reported catch of 4 200 tons. This harvest rate is in percent of exploitable biomass (approximately ages 4+), which was estimated to be 22 000 tons in the inshore regions of Div. 3KL. The exploitable biomass estimates increased during 1999-2001, but declined sharply in 2002. The tagging studies provided evidence of natural mortality of 55% in Div. 3K and 33% in Div. 3L. These estimates are considered to be independent of unreported catch.

Inshore population size from VPA. A virtual population analysis using the ADAPTive framework was applied to those cod in the inshore since the mid-1990s. The analysis incorporated catches during 1995-2002 and indices from the sentinel surveys and research vessel inshore strata. VPA estimates indicate that spawner biomass in the inshore increased from 1995 to 41 000 tons in 1998, but has subsequently declined to only 14 000 tons at the beginning of 2003 (Fig. 17.8). The estimate of 4+ biomass at the beginning of 2003 is about 30 000 tons. Fishing pressure on older age classes has been increasing and the exploitation rate is currently at approximately 35% (17.9), a level comparable to levels estimated during the stock collapse in the late-1980s and early-1990s.

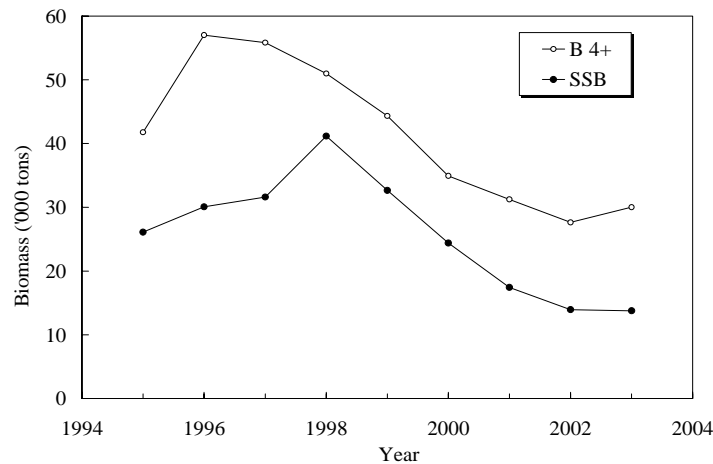


Fig. 17.8. Cod in Div. 2J+3KL: VPA estimates of spawner biomass and exploitable (ages 4+) biomass for the inshore.

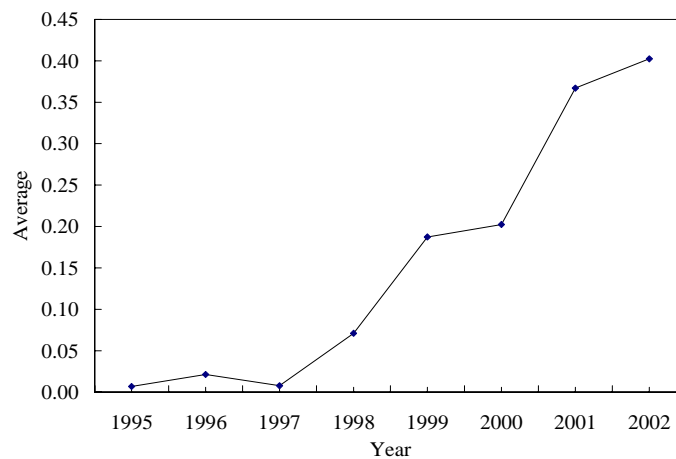


Fig 17.9. Cod in Div 2J+3KL: average F of ages 5+ for the inshore.

18. **Witch Flounder (*Glyptocephalus cynoglossus*) in Divisions 2J, 3K and 3L** (SCR Doc. 03/47; SCS Doc. 03/6, 7, 11)

a) **Introduction**

The fishery for witch flounder in this area began in the early-1960s and increased steadily from about 1 000 tons in 1963 to a peak of over 24 000 tons in 1973 (Fig. 18.1). Catches declined rapidly to 2 800 tons by 1980 and subsequently fluctuated between 3 000 and 4 500 tons to 1991. The catch in 1992 declined to about 2 700 tons, the lowest since 1964; and further declined to around 400 tons by 1993. Until the late-1980s, the fishery was conducted by Poland, USSR and Canada mainly in Div. 3K. Since then, the regulated fishery had been mainly Canadian although EU (Portugal and Spain) has taken increased catches in the Regulatory Area of Div. 3L since the mid-1980s. Although only 12 tons were reported for 1994, a catch of 491 tons was indicated for EU-Spain in the Spanish Research Report (SCS Doc. 95/15) for the Regulatory Area of Div. 3L. Although a moratorium on directed fishing was implemented in 1995, the catches in 1995 and 1996 were estimated to be about 780 and 1 370 tons, respectively. However, it is believed that these catches could be overestimated by 15-20% because of misreported Greenland halibut. The catches in 1997 and 1998 were estimated to be about 850 and 1 100 tons, respectively, most of which was reported from the Regulatory Area of Div. 3L. From 1999 to 2001 catches were estimated to be between 300 and 800 tons, and in 2002 catch was estimated at about 450 tons.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	1	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21A	0.1	0.8	1.4	0.9	0.4	0.4	0.5 ¹	0.6 ¹	0.7 ¹	
STACFIS	0.5	0.7	1.4	0.8	1.1	0.3	0.7	0.8	0.4	

¹ Provisional.

ndf no directed fishing.

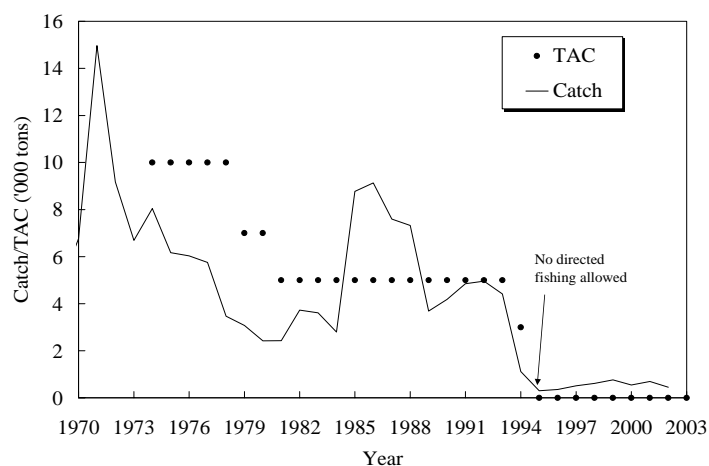


Fig. 18.1. Witch flounder in Div. 2J, 3K and 3L: catches and TAC.

b) **Input Data**

i) **Research survey data**

Mean weight (kg) per tow. For Div. 2J, mean weights (kg) per tow ranged from as high as 1.82 kg per tow in 1986 to a low of 0.06 kg per tow in 2001 and a marginal increase to 0.12 kg per tow in 2002 (Fig 18.2). In Div. 3K, during 1979-85, there was a period of relative stability where most

survey sets averaged 7-13 kg. Since that time estimates have declined considerably to less than 0.09 kg per tow in 1995. Values increased slightly after 1995 ranging from 0.17 to 0.28 kg per tow between 1996-2001, but declined in 2002 to 0.09 kg per tow, the lowest value in the series. For Div. 3L, mean weights per tow varied generally between 2.5 and 1.31 kg per tow from 1983 to 1990 but declined rapidly since then to a low of 0.08 kg per tow in 1995. Values have remained low since then.

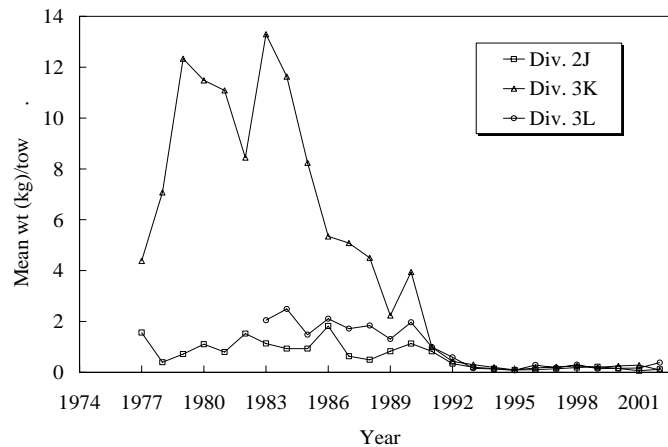


Fig. 18.2. Witch flounder in Div. 2J, 3K and 3L: mean weights (kg) per tow from Canadian autumn surveys.

Distribution. Survey distribution data from the late-1970s and early-1980s indicated that witch flounder were widely distributed throughout the shelf area in deeper channels around the fishing banks primarily in Div. 3K. By the mid-1980s, however, they were rapidly disappearing and by the early-1990s had virtually disappeared from the area entirely except for some very small catches along the slope and more to the southern area. They now appear to be located only along the deep continental slope area, especially in Div. 3L both inside and outside the Canadian 200-mile fishery zone (Fig. 18.3).

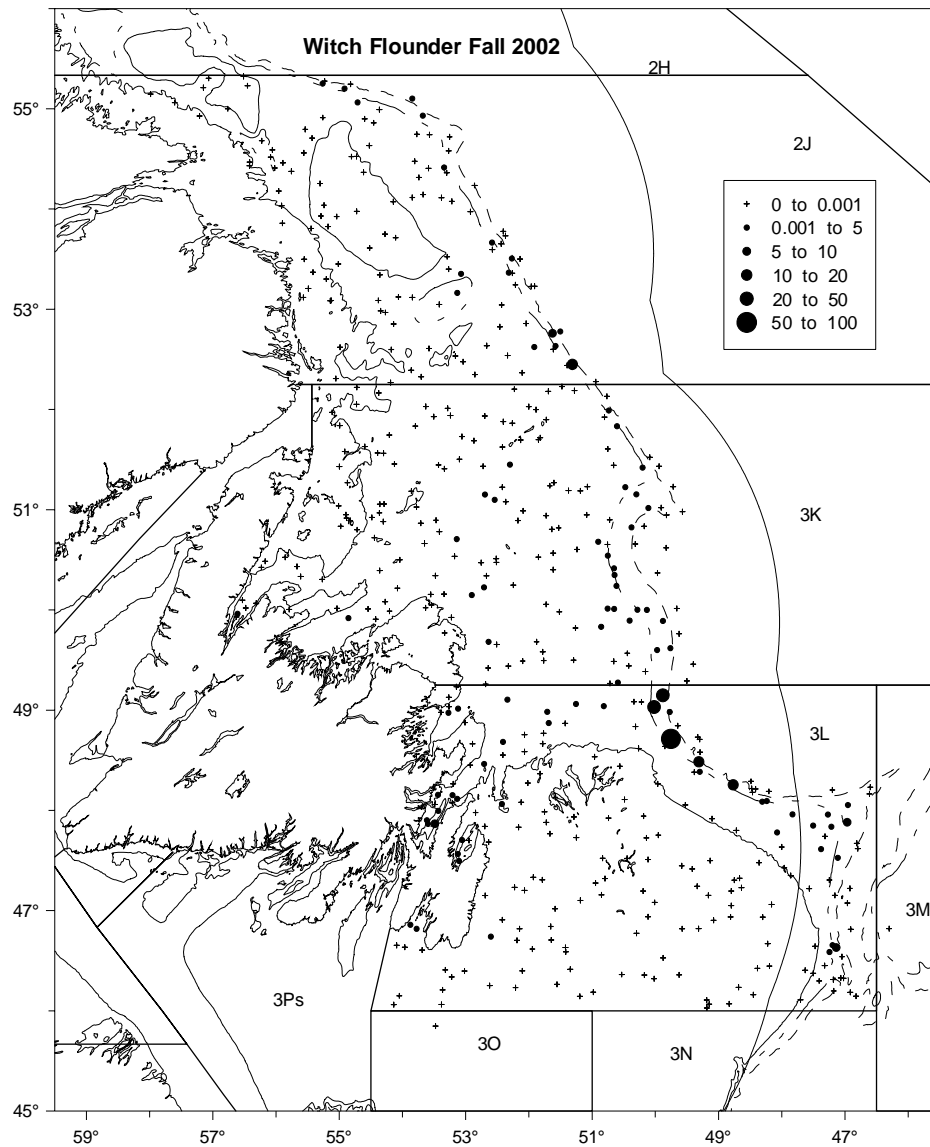


Fig. 18.3. Witch flounder in Div. 2J, 3K and 3L: weight (kg) per set from Canadian surveys during autumn 2002.

c) Assessment Results

Based on the most recent data, STACFIS considers that the overall stock remains at a low level.

19. **Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 2 and Divisions 3KLMNO** (SCR Doc. 03/8, 9, 24, 36, 40, 42, 51, 64; SCS Doc. 03/3, 06, 07, 11)

a) **Introduction**

Catches increased from low levels in the early-1960s to over 36 000 tons in 1969, and ranged from less than 20 000 tons to 39 000 tons until 1990 (Fig. 19.1). In 1990, an extensive fishery developed in the deep water (down to at least 1 500 m) in the Regulatory Area, around the boundary of Div. 3L and 3M and by 1991 extended into Div. 3N. The total catch estimated by STACFIS for 1990-94 was in the range of 47 000 to 63 000 tons annually, although estimates in some years were as high as 75 000 tons. Beginning in 1995, TACs for the resource were established by the Fisheries Commission, and the catch declined to just over 15 000 tons in 1995, a reduction of about 75% compared to the average annual catch of the previous 5 years. The catch from 1996-98 was around 20 000 tons per year. Catches have been increasing since then and by 2001 had reached 38 000 tons before declining to 34 000 tons in 2002. The major participants in the fishery in the Regulatory Area in 2002 were EU-Spain (15 900 tons), EU-Portugal (4 200 tons), Russia (3 500 tons) and Japan (2 800 tons).

Canadian catches peaked in 1980 at just over 31 000 tons, while the largest non-Canadian catches before 1990 occurred in 1969-70. USSR/Russia, Denmark (Faroe Islands), Poland and EU-Germany (GDR before 1989) had taken catches from this stock in most years, but catches by the latter two countries have been negligible since 1991. Canadian catches ranged from 8 200 to 13 500 tons from 1985-91, then declined to between 2 300 and 6 200 tons per year from 1995 to 1999. Catches increased to 10 600 tons in 2000 but declined again to 8 000 tons in 2001 and 6 300 tons in 2002. Most of the Canadian catch in recent years is taken by gillnets.

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC ¹	25	27	27	27	27	33	35	40	44	42
STATLANT 21A	21	16	19	20	20	23	32 ²	29 ²	29 ²	
STACFIS	51	15	19	20	20	24	34	38	34	

¹ Set autonomously by Canada 1985-94 and by the Fisheries Commission since 1995.

² Provisional.

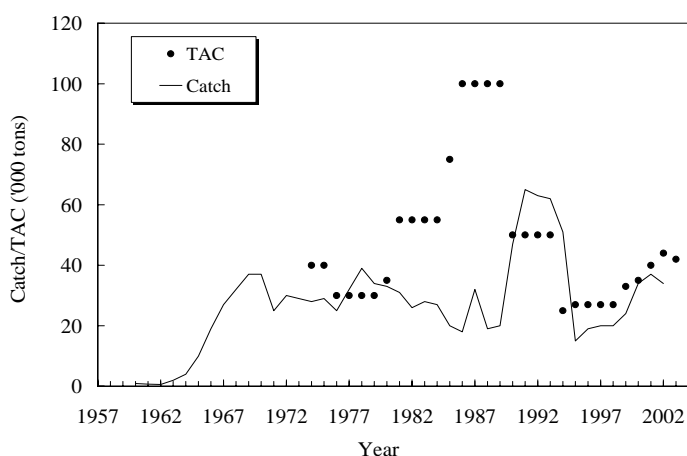


Fig. 19.1. Greenland halibut in Subarea 2 + Div. 3KLMNO: catches and TACs.

b) **Input Data**i) **Commercial fishery data**

Catch and effort. Analyses of otter trawl catch rates from many fleets (Fig. 19.2), but mostly from Canadian vessels, using both hours fished and days fished indicated a declining trend since about the mid-1980s, stabilizing at a low level during the mid-1990s. The standardized catch rate increased from 1997-2000 in both the hours fished analysis and in the days fished analysis then declined in the mean value for 2001 and 2002 (SCR Doc. 03/24).

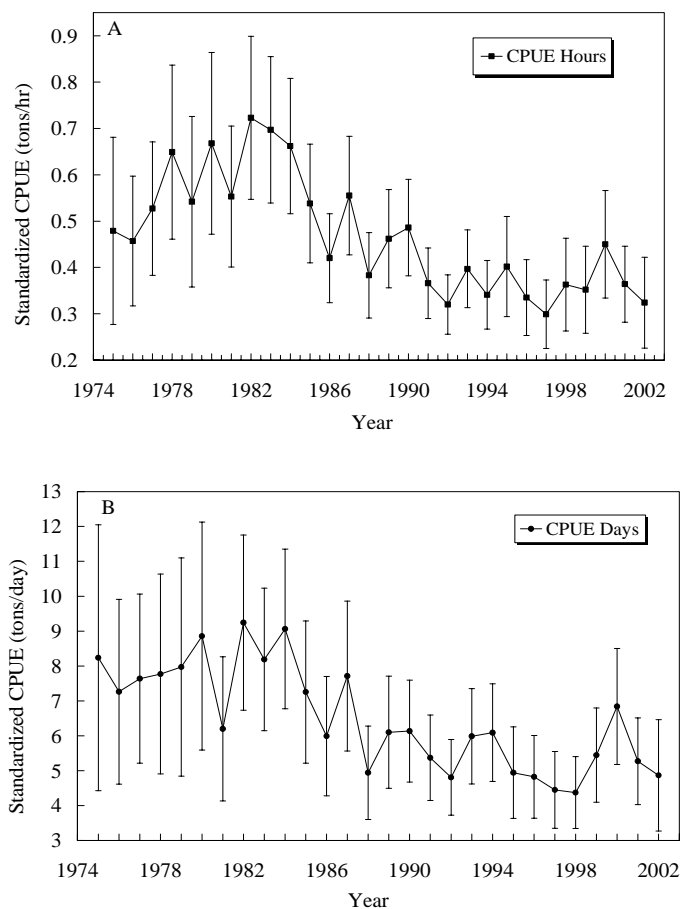


Fig. 19.2 Greenland halibut in Subarea 2 + Div. 3KLMNO: standardized CPUE (± 2 S.E.) based on A) hours fished and B) days fished from the international fishery.

Catch-rates of Portuguese otter trawlers fishing in the NAFO Regulatory Area (NRA) of Div. 3LMN from 1988-2002 (Fig. 19.3) declined sharply from 1988 to 1991, and remained around this low level until 1994 (SCS Doc. 03/07). CPUE gradually increased since then, until 1999-2000 when it was almost double the low values in 1991-94, but still below the CPUE in 1988-90. The CPUE declined in 2001 and remained at about the same level in 2002. Directed effort on Greenland halibut was present in Div. 3L in all years from 1988-2002, in Div. 3N since 1990 but only since 1995 in Div. 3M.

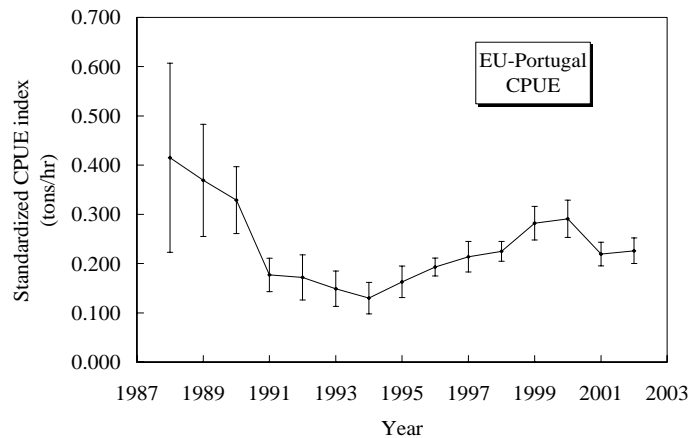


Fig. 19.3 Greenland halibut in Subarea 2 + Div. 3KLMNO: standardized CPUE (± 2 S.E.) from the EU-Portugal trawlers with scientific observers in Div. 3LMN.

Catch-at-age and mean weights-at-age. Catch-at-age and mean weights-at-age (kg) from 1975-2000 fisheries were used from the previous assessment as described in detail in SCR Doc. 00/24. The catch-at-age data from the Canadian fisheries in 2001 and 2002 were provided as calculated in the usual fashion (SCR Doc. 02/39, 03/36).

At the June 2002 Meeting, for countries fishing in the NRA, age-length keys from EU-Spain and Russia were used to calculate the catch-at-age data for 2001. The method differed from the previous approach in which a Canadian age-length key was used to calculate all catches in the NRA. Concerns were raised about the inconsistency of the age reading information (SCR Doc. 02/81) therefore at the current meeting the data for NRA catches in 2001 were re-calculated using the Canadian key. A comparison of results from the two methods is shown in Fig. 19.4. The new 2001 catch-at-age data have significantly greater proportions of fish in at age 7. In the current assessment, a Canadian age-length key was again used to calculate catch-at-age for NRA catches in 2002. The mean weights-at-age (kg) were computed by applying a standard length-weight relationship to the mean lengths-at-age (cm) from the adjusted age-length keys as done previously.

Ages 6-8 dominated the catch throughout the entire time period; with ages 12+ contributing less than 15% on average to the annual catch biomass. Mean weights (kg) show peculiar patterns in the earliest period likely due to poor sampling and lack of individual weights. Mean weights-at-age for age groups 5-9 during the recent period were relatively stable. For older fish they were variable but with a declining trend since 1998 (SCR Doc. 03/64).

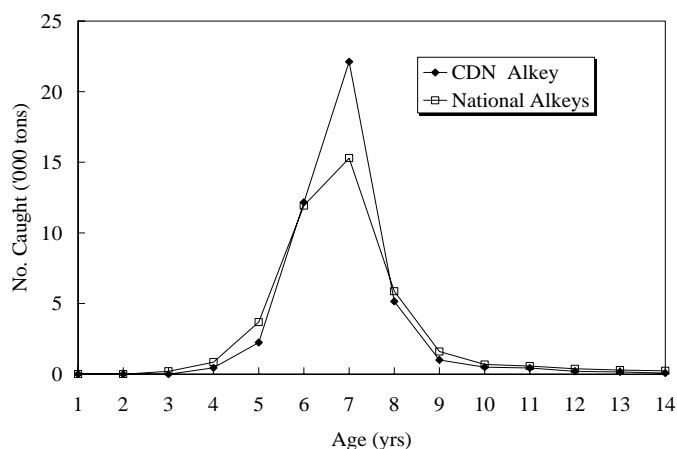


Fig. 19.4. Greenland halibut in Subarea 2 + Div. 3KLMNO: comparison of catch-at-age for 2001 using National age-length keys vs a Canadian age-length key.

ii) Research survey data

STACFIS reiterated that most research vessel survey series providing information on the abundance of Greenland halibut are deficient in various ways and to varying degrees. Lack of divisional and depth coverage creates problems in the comparability of results from different years. However, in the autumn of 1996-99 the Canadian survey included all Divisions in the geographical range of the Greenland halibut stock in Subarea 2 and Div. 3KLMNO. No surveys were conducted in Div. 2GH during 2000 and 2002, however, Div. 2H was surveyed in 2001. Nevertheless, the extent of coverage varied from year-to-year in all Divisions except for Div. 2H, 2J and 3K (SCR Doc. 02/24).

Canadian stratified-random surveys in Div. 2J and 3K (SCR Doc. 03/51) (Fig. 19.5). These surveys are conducted in the autumn. Length-weight relationships were applied to estimate mean weight (kg) per tow-at-length for this survey series.

In Div. 2J the biomass index (mean weight (kg) per tow) was relatively stable from 1978-84 at an average level of about 36 kg. It then began to decline to reach an all time low in 1992 at about 6 kg and only increased marginally until 1995 after which it began to increase more rapidly. By 1999 the index had reached a level of around 25 kg, the highest since 1986 but subsequently declined again and by 2002 was 15 kg, the lowest index value since 1995. In Div. 3K there was a rather long period of apparent stability from 1978-89 at an average annual mean weight per tow of 32 kg. It then declined to a low of 10.3 kg in 1992 with an average of 14.6 kg between 1991-94. After 1994 the index increased rapidly and steadily until 1999, when it reached a mean weight per tow of 38 kg, near the highest in the time series. The index has been declining since then and by 2002 was 13 kg per tow, the lowest since 1994. The value declined by nearly 50% between 2001 and 2002.

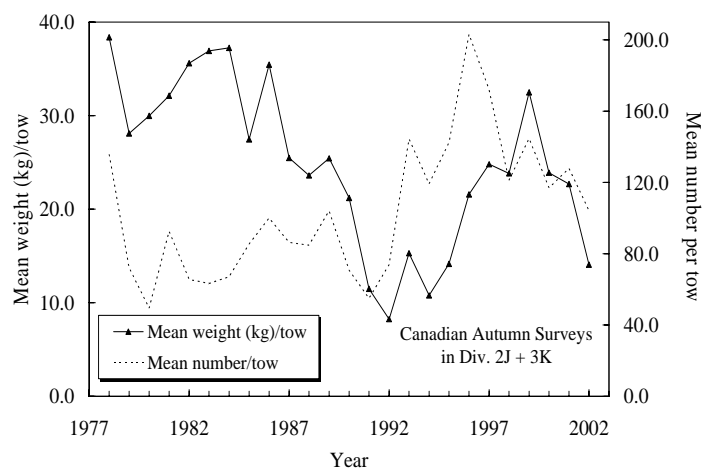


Fig. 19.5. Greenland halibut in Subarea 2 + Div. 3KLMNO: biomass and abundance indices (mean catch-per-tow) from Canadian autumn surveys in Div. 2J and 3K.

Mean weight-per-tow in Div. 2J and 3K combined of fish greater than 30 cm (minimum size limit) was lowest in 1992; remained the same until 1995 after which it increased steadily until 1999 when it approached levels of the late-1980s (SCR Doc. 03/51) (Fig. 19.6). The index has declined since then and by 2002 was about the same level as 1994-95. During the late-1970s and early-1980s Greenland halibut greater than 70 cm (approximate length at M_{50}) contributed almost 20% to the estimated biomass. However, after 1984 this size category declined to the point that by 1991 virtually no Greenland halibut in this size range contributed to the estimates of stock size (Fig. 19.6). Since then, the contribution to the stock from this size group has remained extremely low (SCR Doc. 03/51).

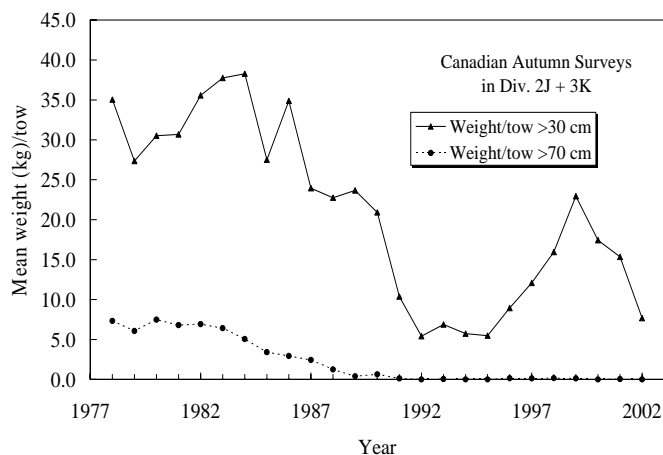


Fig. 19.6 Greenland halibut in Subarea 2 + Div. 3KLMNO: biomass indices (mean weight (kg) per tow) for fish >30 cm and >70 cm from Canadian surveys in Div. 2J and 3K.

An examination of the age structure indicated that the ages 5+ abundance index declined by about 80% from the peak values of the mid-1980s to the lowest point observed in 1993 (SCR Doc. 03/51). The index increased steadily at these ages from 1993 and peaked in 1999. Since then it has declined once again and by 2002 was near the lowest in the time series. The index at ages 1-4 was variable without trend during the 1980s but increased substantially during the early-1990s. It generally

remained above the long-term average since 1992 and reached a maximum in 1996 beyond which it declined but nevertheless remained relatively high.

Canadian stratified-random surveys in Div. 3LNO and 3M (SCR Doc. 03/51). The biomass index (mean weight (kg) per tow) from the Canadian spring surveys in Div. 3LNO using the Campelen trawl increased from 2 kg per tow in 1996 and peaked at 5 kg per tow in 1998. Since then the index has declined to 1 kg per tow in 2002, the lowest in the time series (Fig. 19.7). The Canadian autumn surveys in Div. 3L and 3N showed a similar trend whereas in Div. 3O no clear trend was observed. However, autumn survey coverage in Div. 3N and 3O was highly variable from year to year. Canadian autumn surveys in Div. 3M since 1996 indicated a decline from a high of 16.4 kg per tow in 1996 to 4 kg per tow in 2002 (Fig. 198).

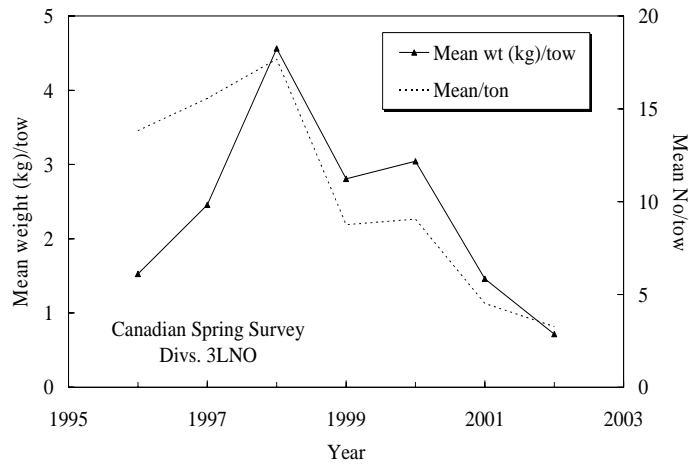


Fig. 19.7. Greenland halibut in Subarea 2 + Div. 3KLMNO: biomass and abundance indices (mean catch per tow) from Canadian spring surveys in Div. 3LNO.

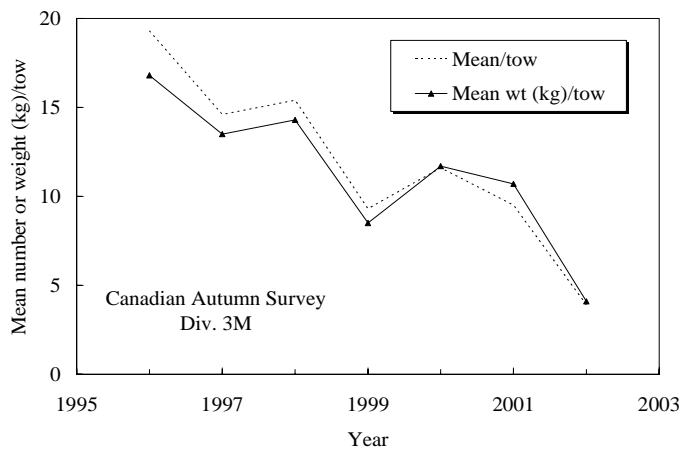


Fig. 19.8. Greenland halibut in Subarea 2 + Div. 3KLMNO: biomass and abundance indices (mean catch per tow) from Canadian autumn surveys in Div. 3M.

EU stratified-random surveys in Div. 3M (SCR Doc. 03/42). These surveys indicated that the Greenland halibut biomass index (mean weight (kg) per tow) on Flemish Cap in July in depths to 730 m, ranged from 6 kg to 11 kg in the 1988 to 1994 period (Fig. 19.9). The index increased in each year since then, to reach a maximum value of 30 kg tons in 1998. The age composition data indicated that an increase in recruitment (1993-95 year-classes) was mainly responsible for the relatively high index in 1997-98. The biomass index has been declining since then and by 2002 was

about 15 kg, near the level observed in 1996. The 1993, 1994 and 1995 year-classes were represented by relatively high values at all ages with the estimate of the 1994 year-class at age 6 in 2000 the highest in the series. The estimate for age 1 in the 2001 survey (2000 year-class) was the second highest in the series and still above average at age 2 in 2002. The 2001 year-class at age 1 is about average. Few fish older than age 10 were encountered in any of these surveys, probably because no depths greater than 730 m were fished.

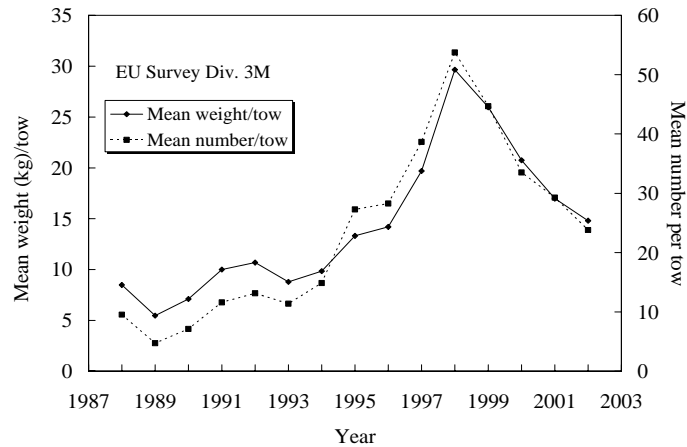


Fig. 19.9. Greenland halibut in Subarea 2 + Div. 3M: biomass and abundance indices (mean catch per tow) from EU summer surveys in Div. 3M.

EU-Spain stratified-random surveys in Div. 3NO Regulatory Area (SCR Doc. 03/08). The biomass index (converted to Campelen trawl equivalents) increased from about 3 200 tons in 1996 to 13 700 tons in 1998, but declined since then to about 2 300 tons in 2002, the lowest in the time series (Fig. 19.10). In 2001, the size composition was dominated by fish in the 42 to 48 cm range although modes also occurred at 14 cm and 24 cm. The size range in 2002 was rather similar but at generally lower abundance. Few fish above 60 cm were caught in any of the surveys.

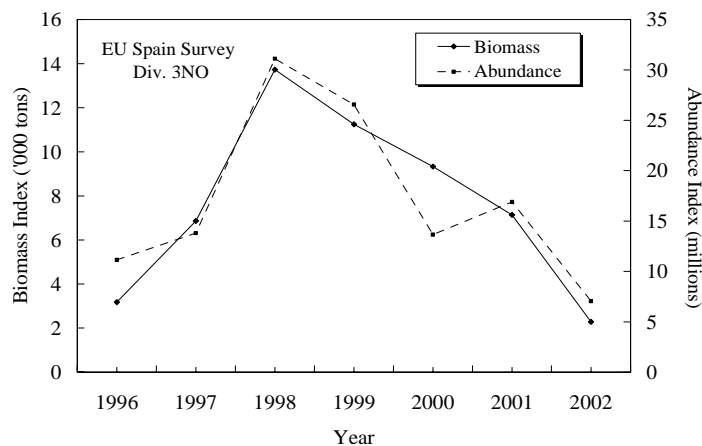


Fig. 19.10. Greenland halibut in Subarea 2 + Div. 3M: biomass and abundance indices from EU-Spain spring surveys in Div. 3NO.

Russian stratified-random surveys in Div. 3M (SCR Doc. 03/09). Greenland halibut directed surveys were carried out to a depth of 1 280 m during the spring of 2001 and 2002. Estimated abundance and biomass of Greenland halibut declined from about 14 million to 10 million fish (30% reduction) and 12 700 tons to 9 800 tons (23% reduction), respectively between 2001 and 2002. The 1995 year-class appears to have dominated the index in both years (40% in 2001 and 50% in 2002 by number).

iii) Recruitment indices

At the June 2002 meeting, a mixed linear (multiplicative) model was applied to provide an index of year-class strength from several research vessel survey data sets (SCR Doc. 03/40). For all survey series, stratified mean numbers per tow at ages 1-4 were selected for the modelling exercise, as these are ages at which fishing mortality would be minimal. Only those year-classes having more than three observations were included in the analysis. In the current analysis, five independent data series (SCR Doc. 03/40) were used as follows: EU 3M (1991-2002), Canadian Autumn 2J+3K (1978-2002), Canadian Autumn 3L (1995-2002), Canadian 3NO (1997-2002) and Canadian Spring 3LNO (1996-2002) (SCR Doc. 03/40). All Canadian data were from surveys using Campelen survey gear.

Results indicated that strengths of the 1975-90 year-classes were relatively stable but below the long term average (Fig. 19.11). The 1993-95 year-classes were estimated to be well above average despite wide confidence intervals similar to the previous analysis. The subsequent year-classes (1996-99) are similar to those prior to 1993. The 2000 and 2001 year-classes appear to be better than average, however, the confidence intervals are large due in part to the low number of observations. Nevertheless, they are well below the estimates for the 1993-95 year-classes.

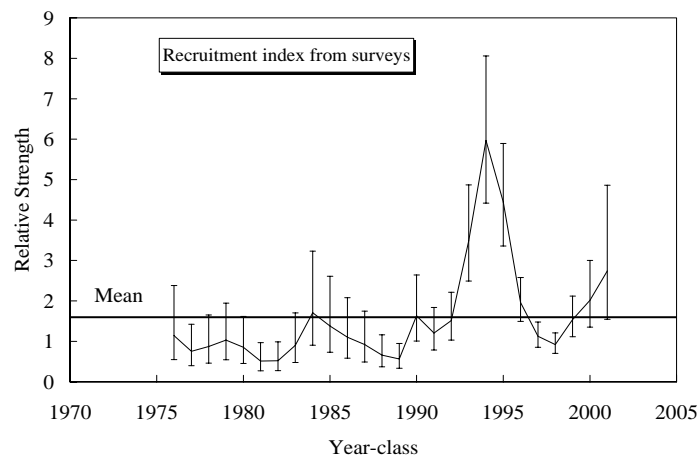


Fig. 19.11. Greenland halibut in Subarea 2 + Div. 3KLMNO: recruitment index from five research vessel survey series.

c) Estimation of Parameters

At the 2002 Scientific Council meeting, a VPA based assessment of this stock was presented (SCR Doc. 02/78). Biomass was estimated to be increasing, in contrast with recent catch rates obtained from most of the commercial fishery and survey series, which were declining. STACFIS considered that the assessment estimated biomasses were inconsistent with the fishery and survey information and the assessment was rejected.

Commercial catch-at-age data were available for the period 1975-2002. The catch-at-age data for 2001 was recalculated from that presented in 2002. The fishery independent surveys with catch-at-age data suitable for calibrating a VPA are:

- i) an EU summer survey in Div. 3M from 1991-2002, ages 1-12 (SCR Doc. 03/42),
- ii) a Canadian autumn survey in Div. 2J and 3K from 1978-2002, ages 1-13 (available as either a single time series from 1978-2002 using a conversion factor for the change in gear type from Engel to Campelen trawl in 1995, or as separate Engel (1978-1994) and Campelen (1995-2002). In 2003 the CPUE data for the series were revised to stratified mean numbers per tow and including a new series for Div. 2J+3KL (1995-2002) (SCR Doc. 03/51).
- iii) a Canadian spring survey in Div. 3LNO from 1996-2002, ages 1-8 (SCR Doc. 03/51).

Sensitivity analysis of the 2002 XSA model

An XSA model was fitted to the catch-at-age and survey data using the same model formulation as fitted in 2002 (SCR Doc. 03/64). The estimated time series of age 5+ exploitable biomass recruitment and fishing mortality gave a very different perception of the dynamics of the stock to the 2002 assessment (Fig. 19.12-19.13). Fishing mortality was estimated to be higher and biomass lower. However, the model estimates are more consistent with the perception of the stock dynamics derived from the survey and commercial catch rates; the main reason for the rejection of the 2002 XSA results. A major contributor to the change in the estimated biomass dynamics is the estimated abundance of the 1993-97 year-classes (Fig. 19.14).

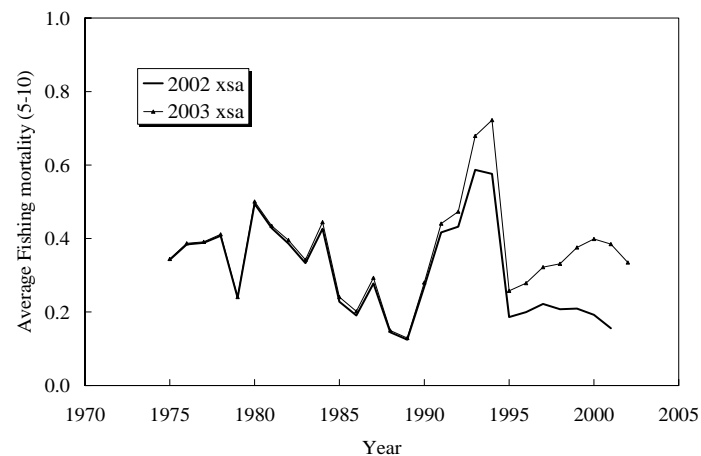


Fig. 19.12. Greenland halibut in Subarea 2 and Div. 3KLMNO : a comparison of the estimated fishing mortality time series from XSA model fits to the data set constructed for the 2002 and 2003 assessments.

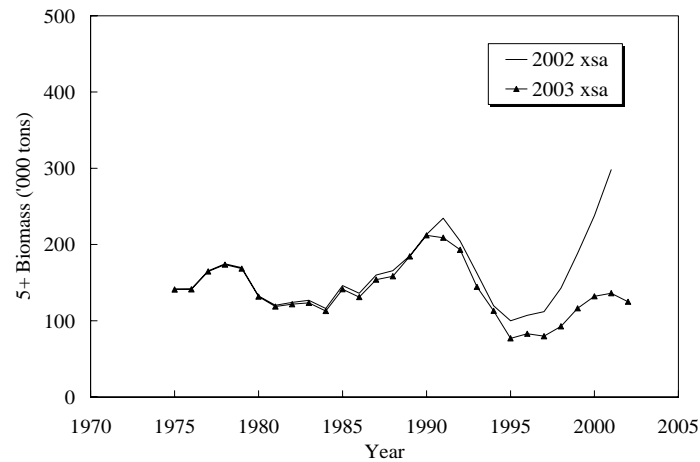


Fig. 19.13. Greenland halibut in Subarea 2 and Div. 3KLMNO : a comparison of the estimated 5+ exploitable biomass time series from XSA model fits to the data sets constructed for the 2002 and 2003 assessments.

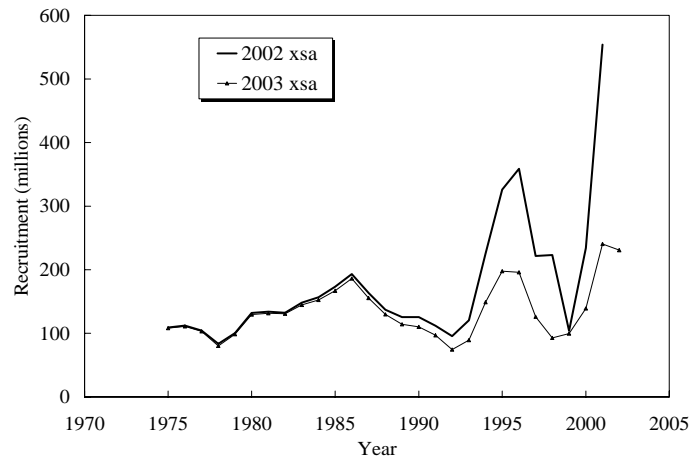


Fig. 19.14. Greenland halibut in Subarea 2 and Div. 3KLMNO: a comparison of the estimated time series of recruitment at age 1 from XSA models fitted to the assessment data collated for 2002 and 2003.

A series of XSA models were fitted to the full time series of available data in order to examine potential causes for the difference between the model fitted to the 2003 data set and the model rejected by Scientific Council in 2002. The runs examined:

- the effect of the revision to the Canadian CPUE survey series
- the effect of the revision of the catch-at-age data for 2001 and the Canadian CPUE survey series on the 2002 model estimates
- adding the 2002 catch and revised survey data to the time series with the original 2001 data
- adding the 2002 catch and revised survey data to the time series with revised 2001 data

Figures 19.15-19.17 present the results of the sensitivity analysis for the estimates of 5+ exploitable biomass, fishing mortality and recruitment.

The revision to the survey data (run a) re-scales the estimates derived from the 2002 XSA formulation but does not alter the recent trends in the time series of estimates. The peak of fishing mortality in 1994 is estimated to be marginally higher and the low point of the biomass series in 1995 slightly lower.

Revising the catch data for 2001 (run b) had an additive effect with the revision of the Canadian survey series, raising estimates of fishing mortality for recent years and lowering the biomass estimates, but as with the survey revision, recent trends are largely unaffected.

The major changes to the estimated dynamic history of the stock result from the addition of the 2002 catch and survey data to the assessed time series (runs c and d). Fishing mortality in 2001 is revised upwards by a factor of three compared to estimate from the rejected 2002 XSA formulation. The biomass estimate for 2001 is reduced by a factor of 2. This results from a marked downwards revision of the estimated strength of the 1993-1997 year-classes. The comparison is not sensitive to the structure of the catch-at-age data recorded in 2001.

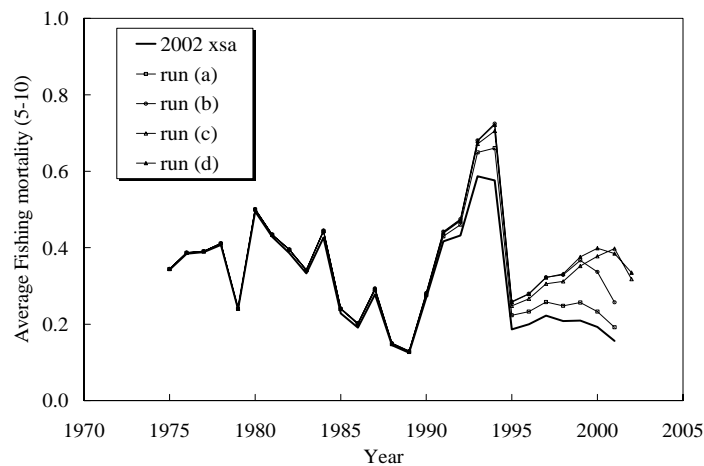


Fig. 19.15. Greenland halibut in Subarea 2 and Div. 3KLMNO : a comparison of the estimated average fishing mortality time series from XSA models fitted to the data collated in 2002 and 2003. Refer to the text for the run keys.

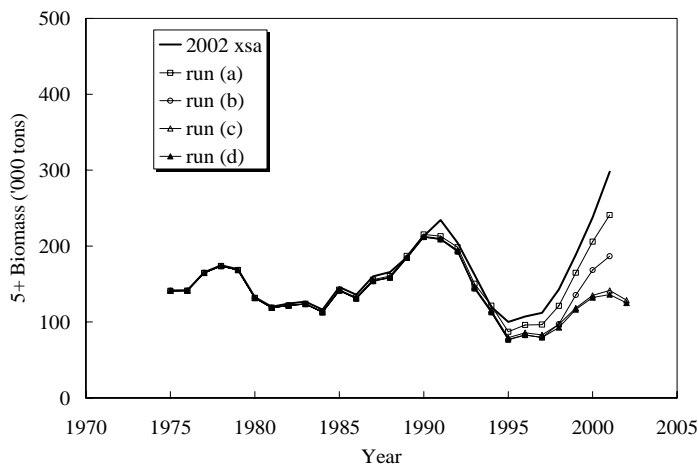


Fig. 19.16. Greenland halibut in Subarea 2 and Div. 3KLMNO : a comparison of the estimated 5+ exploitable biomass time series from XSA models fitted to the data collated in 2002 and 2003. Refer to the text for the run keys.

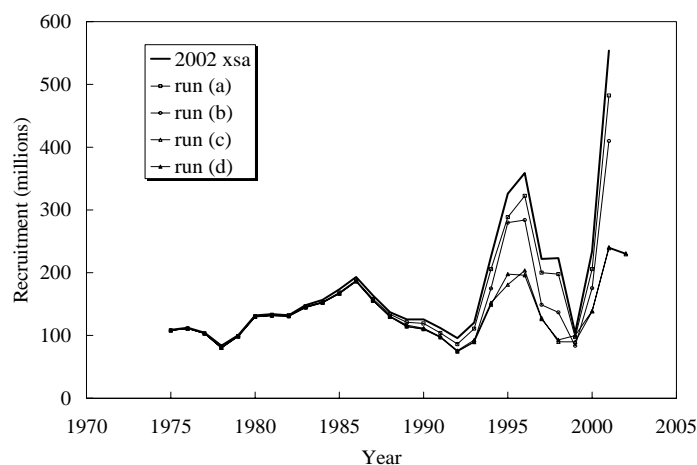


Fig. 19.17. Greenland halibut in Subarea 2 and Div. 3KLMNO: a comparison of the estimated time series of recruitment at age 1 from XSA models fitted to the data for 2002 and 2003. Refer to the text for the run keys.

The sensitivity analysis of the XSA formulation has shown that the revision of the catch-at-age data for 2001 and the changes to the Canadian survey indices only have a minor effect on the level of estimates derived from an XSA analysis of this stock. The major contribution to the change in the perception of the stock trends in recent years is the cumulative effect of new years of data. This applies to both the surveys and catches. The data has provided more information on the abundance of the large 1993-97 year-classes. This is an example of retrospective uncertainty in the assessment estimates. This uncertainty has been identified in many studies and is an active area of assessment research (e.g. Sinclair *et al.*, 1991, ICES 2002).

An XSA retrospective analysis was run with the new stock data series and the time series of estimated fishing mortality, 5+ exploitable biomass and recruitment plotted to evaluate consistency of the series. The results are plotted in Figure 19.18-19.20, they indicate that there is a strong retrospective pattern in the model estimates when the 2002 XSA formulation is used. Estimated fishing mortality is revised upwards each year and biomass downwards. As data has been added to the assessment series, estimated abundance of the above average 1993-95 year-classes has been reduced by 44%.

Retrospective uncertainty is generally introduced into assessment model estimates as a result of model misspecification, usually an assumption of constancy in a parameter that in reality exhibits a trend or step to a new level. Retrospective patterns can be induced by changes in the level of mis-reporting, natural mortality or catchability (ICES, 1991; Mohn, 1999). Retrospective uncertainty can be reduced by changes to model structure, that is adding extra parameters or by down-weighting (removing) sections of the data that do not conform to the model structure. If this cannot be carried out or if the cause of the uncertainty is uncertain then shrinkage (ICES, 1991, 1993) can be used as a time series constraint to stabilize sequential estimates.

The log catchability residuals from the XSA model fitted to the full range of survey data from Canada, (including the Engels data converted to a Campelen index) and the EU survey series were examined in order to determine whether time series correlation was present. Systematic change in catchability, a trend or step is the most common cause of retrospective patterns. Correlated residual patterns were found for both the EU and the full time series of the Canadian surveys. The largest change occurred concurrently in the surveys during 1990-1995. Large negative residuals are estimated with a decreasing trend in time. Catchability during this period was not constant and the low estimates result in an underestimation bias in the mean value. This induces under-estimation bias to fishing mortality and over-estimation of population abundance and therefore biomass.

Catchability is the link between survey catches and population abundance as estimated from the catch-at-age data. The model residuals indicate departures of either the survey indices or the population abundance from the correlation. In the case of the survey indices, the correlated residuals could result from environmental changes such as the cold temperatures recorded in the NAFO Divisions during the early-1990s (SCR Doc. 02/41) or from changes in gear such as occurred in 1995/6 with the change from Engels to Campelen trawls. Departures of the population abundance from the survey series may result from bias in the catch-at-age data. It is notable that the low residuals occur during the period of high recorded landings from the fishery, a time when the actual levels of landings are considered to be in doubt (SCR Doc. 00/24).

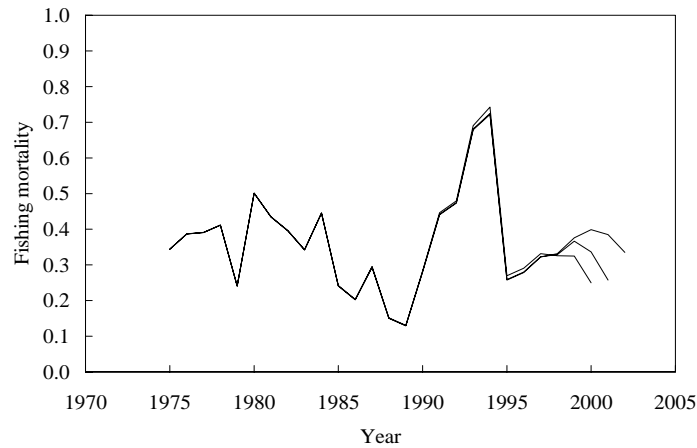


Fig. 19.18. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of XSA estimated average fishing mortality (ages 5-10). 2002 XSA model formulation.

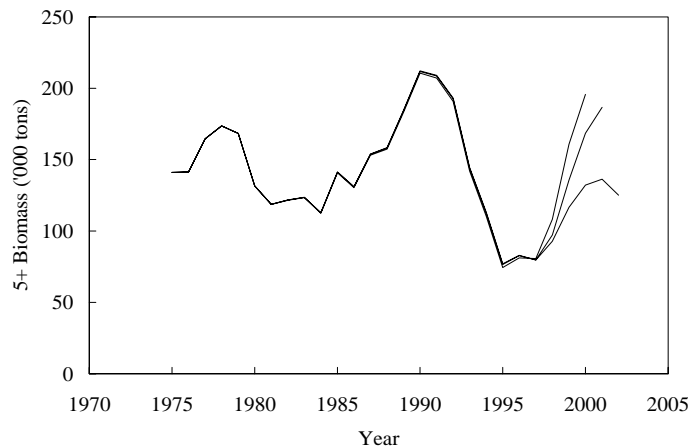


Fig. 19.19. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of XSA estimated 5+ exploitable biomass. 2002 XSA model formulation.

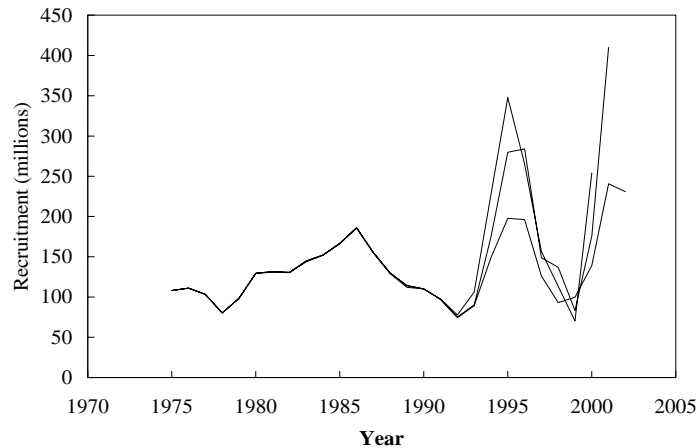


Fig. 19.20. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of XSA estimated recruitment at age 1. 2002 XSA model formulation.

The 2003 assessment model

In an attempt to reduce the retrospective pattern in the estimates from the XSA model, the survey series were shortened to include only the years 1995–2002. This is the period when the gear used in the Canadian survey was the Campelen trawl and is after the period of high/uncertain landings data. Recent survey indices are consistent between ages and between survey series (SCR Doc.03/64) giving greater assurance as to their reliability.

In addition to the EU survey series from Div. 3M and the Canadian autumn survey series in Div. 3KLMO, the Canadian spring survey series in Div. 3LNO was also included in the assessment model formulation.

Figures 19.21-19.23 present the retrospective series of estimates from the model fits to the shortened survey series. While not curing the problem completely, shortening the survey series has reduced the retrospective bias in the series of assessment results to an acceptable level. The individual assessment results are consistent with other sources of information from the fishery.

An analysis of the consistency in the estimates from each of the survey series was carried out by fitting single fleet calibrations of XSA. The estimated stock and exploitation trends were consistent across surveys and showed similar trends to those of the combined assessment results. Figure 19.24 presents an illustration of the consistency in the estimates.

STACFIS accepted the modified model formulation as an assessment of the 5+ exploitable biomass, level of exploitation and recruitment to the stock. The accepted XSA assessment model structure used catch data for ages 4-14+ and was calibrated using Canadian spring (Div. 3LNO, ages 1-8) and autumn (Div. 2J, 3K, 3L ages 1-13) and the EU (Div. 3M, ages 1-12) survey data for the years 1995-2002. Natural mortality was assumed to be 0.2 at all ages. In order to estimate uncertainty in the XSA parameter estimates, a non-parametric bootstrap procedure was used to generate percentile distributions.

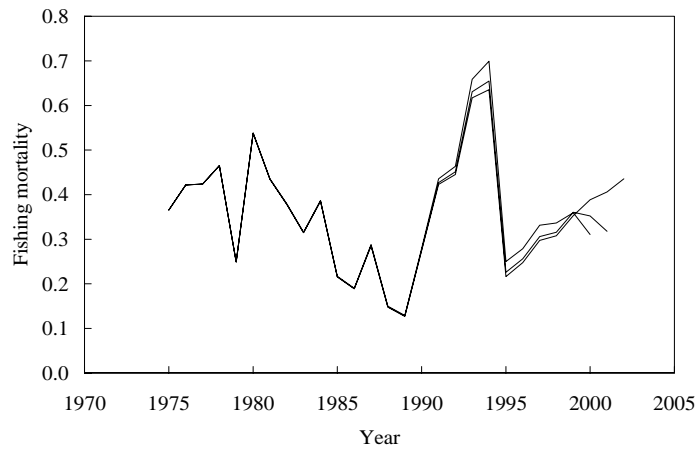


Fig. 19.21. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of estimated average fishing mortality (ages 5-10) computed using the 2003 XSA formulation.

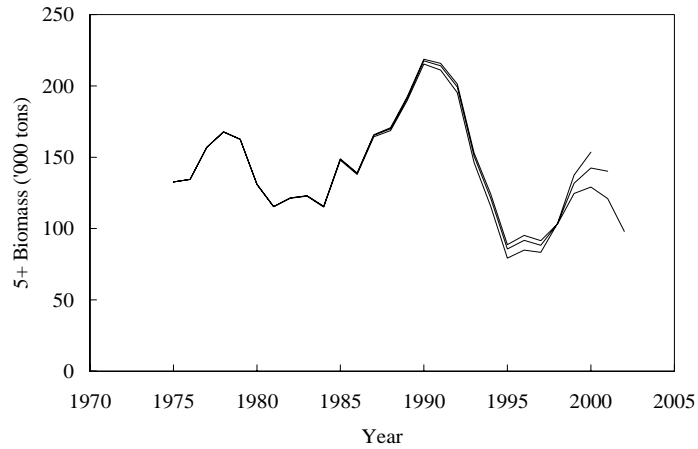


Fig. 19.22. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of estimated 5+ exploitable biomass computed using the 2003 XSA formulation.

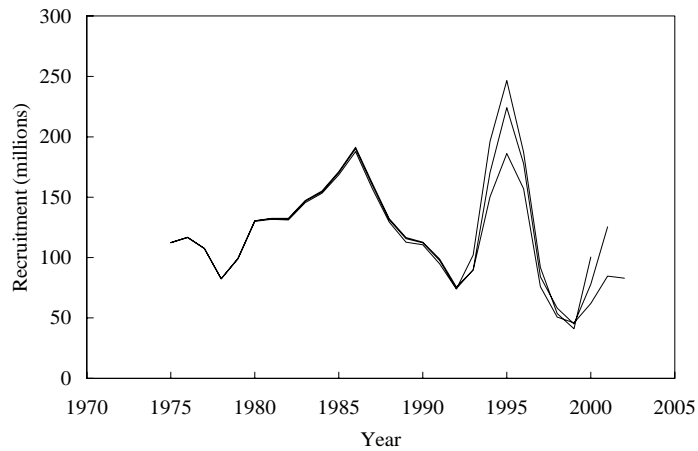


Fig. 19.23. Greenland halibut in Subarea 2 and Div. 3KLMNO : a retrospective plot of the time series of estimated recruitment at age 1 computed using the 2003 XSA formulation.

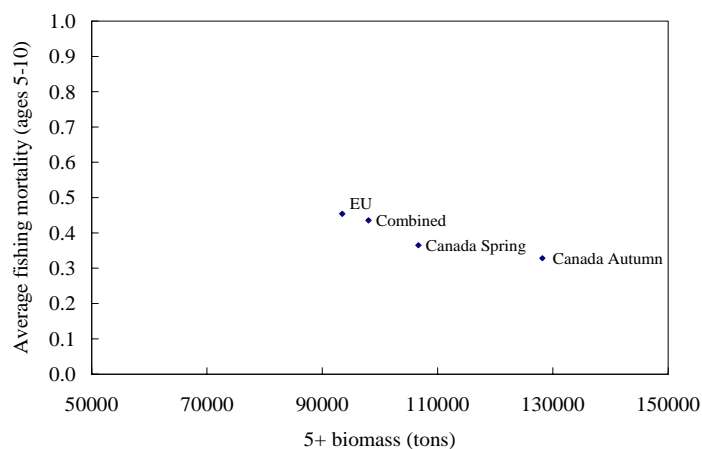


Fig. 19.24. Greenland halibut in Subarea 2 and Div. 3KLMNO: estimates of 2002, beginning of the year, 5+ exploitable biomass and average fishing mortality at ages 5-10 from XSA assessment fitted to the individual survey series available for tuning, and the estimates from the combined assessment.

d) Assessment Results

The VPA analysis indicates that fishing mortality (Fig. 19.25) has generally followed the landings (Fig. 19.1) from the fishery. After a decline during the 1970s and 1980s, the high landings removed during 1990-94 resulted in fishing mortality reaching levels exceeding $F = 0.50$. The reduction in landings in 1995 resulted in a sharp reduction in fishing mortality to values close to $F = 0.2$; subsequently landings and fishing mortality have increased and are now estimated to be at the average of the time series.

Figures 19.26 and 19.27 illustrate the estimated recruitment at age 1 and the stock biomass for ages 5 and older, respectively. During 1980-90, a period of sustained good recruitment and relatively low fishing mortality resulted in an increase in stock biomass to a historic high in 1991. The increased landings and high mortality rates during 1991-94 reduced the biomass to a historic low from 1995-97. The stock increased during 1998-2000 following the substantial reduction in landings and the recruitment of three above average year-classes (1993-95). However, subsequent increased landings and the resulting higher mortality rates are estimated to have halted the increase in biomass and the stock is now estimated to currently be in decline. The estimated 5+ exploitable biomass at the beginning of the 2003 is 76 000 tons.

The trend in the VPA estimated stock biomass is consistent with the catch-per-unit effort from the International and Portuguese commercial fisheries and the all of the stock surveys, all of which have declined in the last few years.

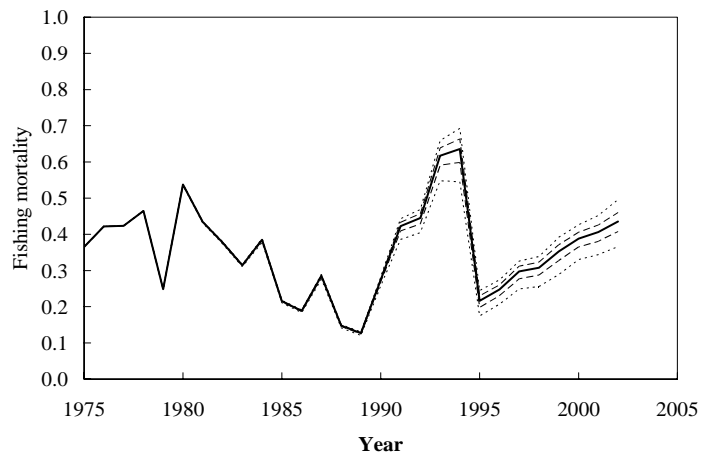


Fig 19.25. Greenland halibut in Subarea 2 and Div. 3KLMNO: average fishing for ages 5-10 (5th, 25th, 50th, 75th and 95th percentiles) computed by non-parametric bootstrap XSA

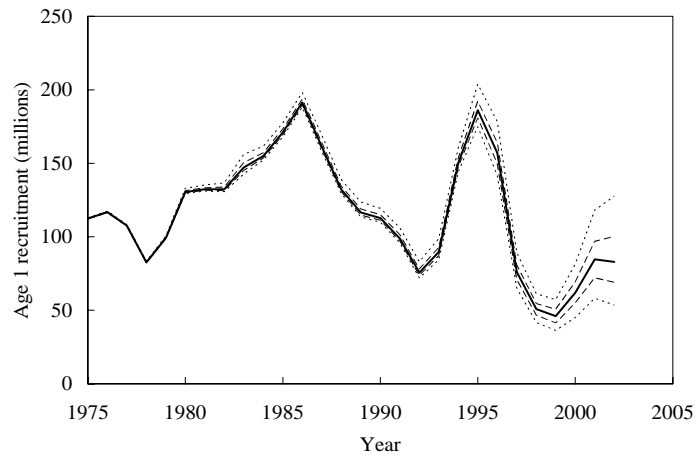


Fig. 19.26. Greenland halibut in Subarea 2 and Div. 3KLMNO: recruitment (5th, 25th, 50th, 75th and 95th percentiles) computed by non-parametric bootstrap of XSA.

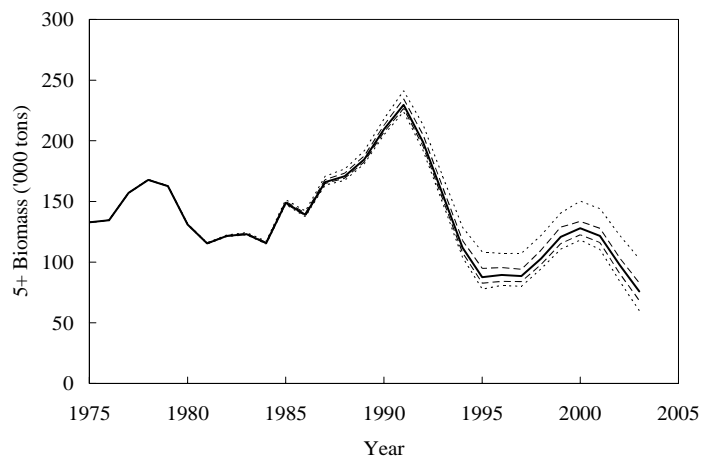


Fig. 19.27 Greenland halibut in Subarea 2 and Div. 3KLMNO: age 5+ exploitable biomass (5th, 25th, 50th, 75th and 95th percentiles) computed by non-parametric bootstrap of XSA.

e) **Reference Points**

Precautionary approach reference points

Precautionary approach reference points have not been defined for this stock.

Biometric reference points

Based on average exploitation patterns and weight-at-age for the years 2000-2002, $F_{0.1}$ is estimated to be 0.16, F_{max} 0.28.

f) **Short-term stock projections**

Short-term projections for 5+ exploitable biomass and landings for the Greenland halibut stock in SA 2 and Div. 3KLMNO are presented in Table 19.1 and Fig. 19.28.

The projections and management options for 2004 are conditioned on a STACFIS estimate of the catch in 2003 of 30 000 tons. The estimate is the mid-point between the catches estimated for 2002 and a *status quo* fishing mortality estimate of catches in 2003, derived from the VPA population numbers and exploitation rate.

If a catch of 30 000 tons is taken in 2003 fishing mortality is projected to increase to $F = 0.61$ and 5+ exploitable biomass at the start of 2004 will decrease to 58 000 tons. Catches greater than 16 000 tons during 2004 will result in a further decline in the biomass in 2005.

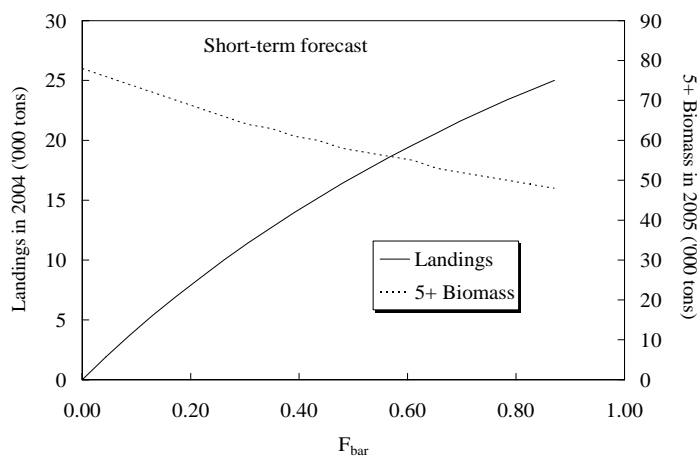


Fig. 19.28. Greenland halibut in Subarea 2 + Div. 3KLMNO: the short-term management options for landings in 2004 and 5+ exploitable biomass in 2005.

Table 19.1. Greenland halibut in Subarea 2 + Div. 3KLMNO: Short-term management options for landings in 2004 and 5+ exploitable biomass in 2005.

2003		
5+ Biomass Tons	FBar (5 - 10)	Landings Tons
76000	0.61	30000

2004			2005
5+ Biomass Tons	FBar	Landings Tons	5+ Biomass Tons
58000	0.00	000	78000
.	0.04	2000	76000
.	0.09	4000	74000
.	0.13	5000	72000
.	0.17	7000	70000
.	0.22	9000	68000
.	0.26	10000	66000
.	0.30	11000	64000
.	0.35	13000	63000
.	0.39	14000	61000
.	0.44	15000	60000
.	0.48	16000	58000
.	0.52	18000	57000
.	0.57	19000	56000
.	0.61	20000	55000
.	0.65	21000	53000
.	0.70	22000	52000
.	0.74	23000	51000
.	0.78	23000	50000
.	0.83	24000	49000
.	0.87	25000	48000

g) **Medium-term considerations**

Stochastic medium-term, stock projections were generated in order to illustrate a series of potential management scenarios for rebuilding 5+ exploitable biomass. Each projection was conditioned on the assumption of a 30 000 tons catch in 2003, with constant landings or exploitation rate in each of the years 2004-2007. Projections were run for 5 years a range sufficient to allow management options to be evaluated for the over the period for which the outcomes are not heavily influenced by the assumption of future recruitment.

Five scenarios are illustrated:

- 1) constant fishing mortality at $F_{0.1}$ (0.16), Fig. 19.29
- 2) constant fishing mortality at F_{max} (0.28), Fig. 19.30
- 3) constant fishing mortality at $F_{status\ quo}$ (0.44), Fig. 19.31
- 4) constant catch of 20 000 tons, Fig. 19.32
- 5) constant catch of 30 000 tons, Fig. 19.33

All of the simulations indicate that if the landings in 2003 reach 30 000 tons, stock biomass in 2004 will be reduced below the historic low of the time series. This is because of the recent high fishing mortality and the relatively low recruitment. The lower fishing mortality scenarios ($F_{0.1}$, F_{max}) result in an increase in 5+ exploitable biomass by 2007, but only to the historic low level observed in 1995-97. *Status quo* fishing mortality (0.44) and constant landings at 20 000 tons stabilize the biomass at the new low point. The stochastic projections indicate that there is a high probability that a constant landings constraint of 20 000 tons or 30 000 tons will result in high mortality rates and low 5+ exploitable biomass.

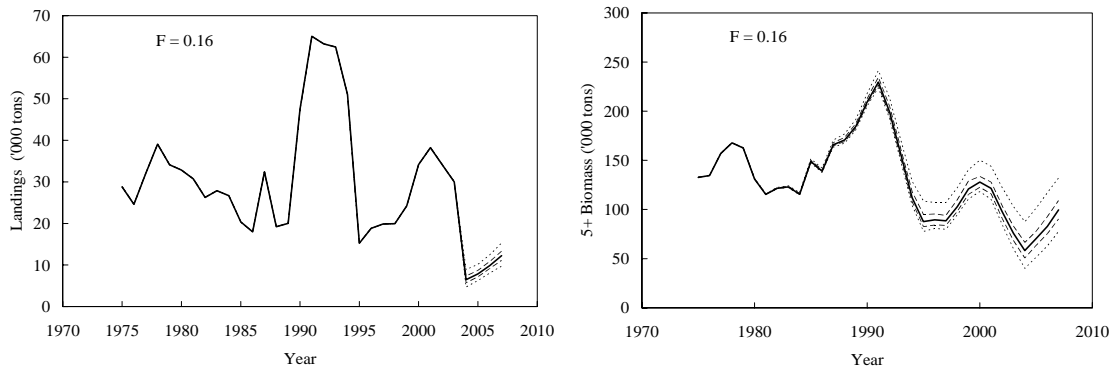


Fig. 19.29. Greenland halibut in Subarea 2 + Div. 3KLMNO: a stochastic projection for landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.16$ ($F_{0.1}$) in the years 2004-2007.

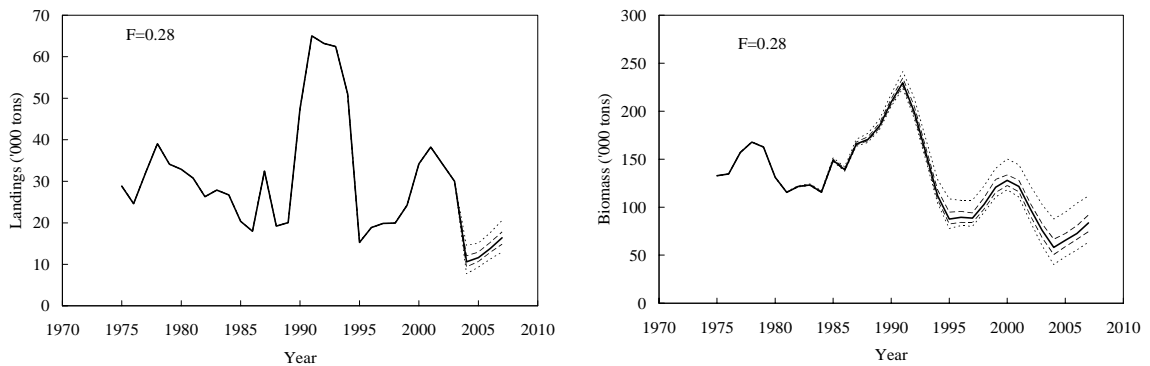


Fig. 19.30. Greenland halibut in Subarea 2 + Div. 3KLMNO: a stochastic projection for landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.28$ (F_{max}) in the years 2004-2007.

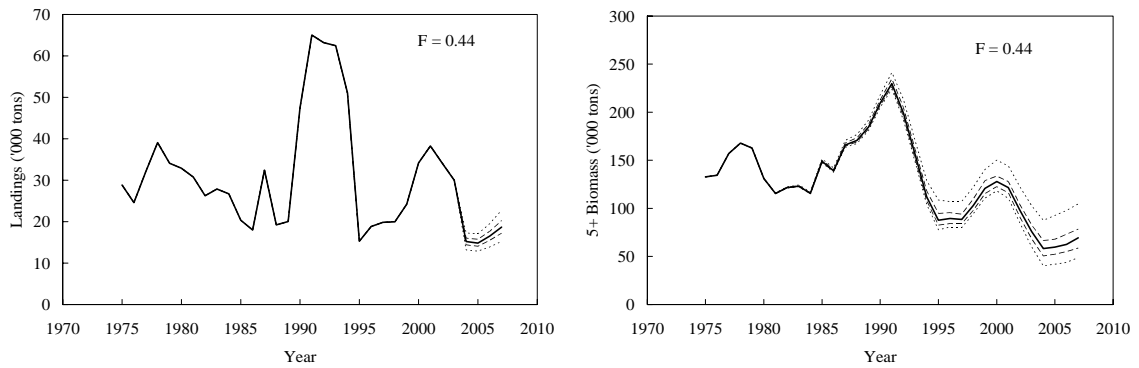


Fig. 19.31. Greenland halibut in Subarea 2 + Div. 3KLMNO: a stochastic projection for landings and ages 5+ exploitable biomass at a constant fishing mortality of $F = 0.44$ (F status quo) in the years 2004-2007.

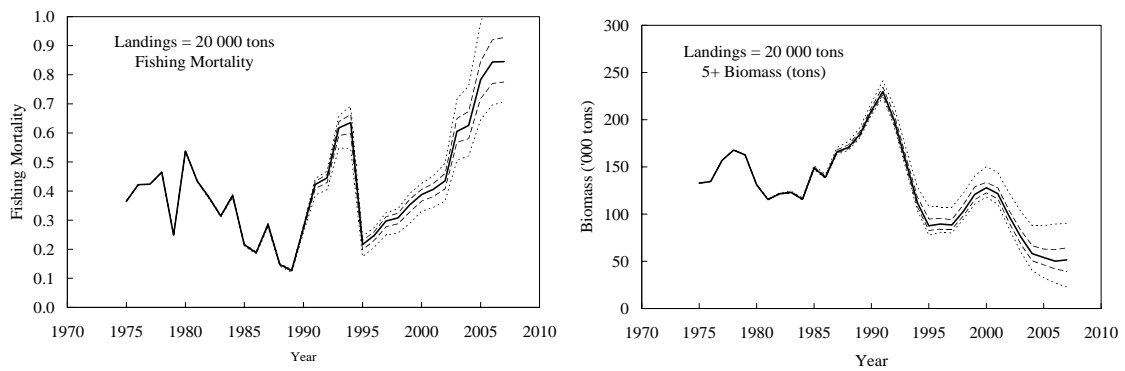


Fig. 19.32. Greenland halibut in Subarea 2 + Div. 3KLMNO: a stochastic projection for fishing mortality and ages 5+ exploitable biomass at a constant catch of 20 000 tons in the years 2004-2007.

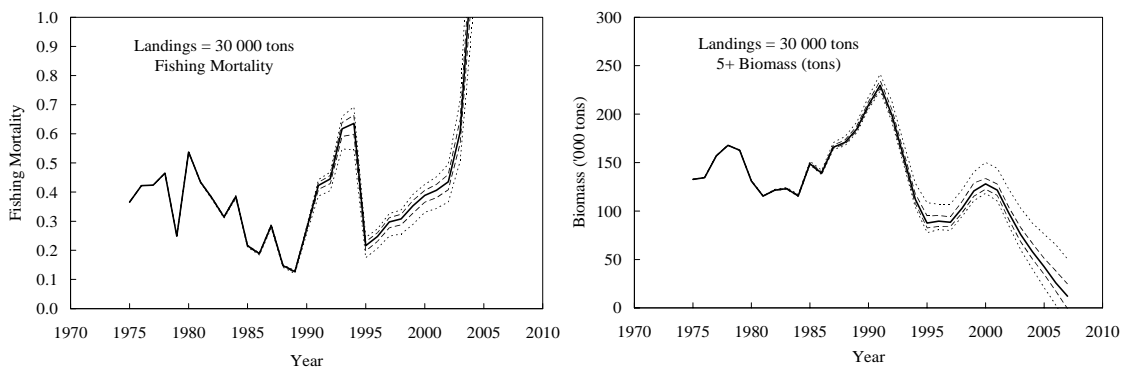


Fig. 19.33. Greenland halibut in Subarea 2 + Div. 3KLMNO: a stochastic projection for fishing mortality and ages 5+ exploitable biomass at a constant catch of 30 000 tons in the years 2004-2007.

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- SINCLAIR, A., D. GASCON, R. O'BOYLE, D. RIVARD, D. and S. GAVARIS. (1991). Consistency of some Northwest Atlantic groundfish stock assessments. *NAFO Sci. Coun. Studies*, **16**: 59-77.

h) Research Recommendation

It is **recommended** that *in future assessments of Greenland halibut in Subarea 2 + Div. 3KLMNO the details of the calculation of the catch at age in the final year be provided for review.*

20. Northern Shortfin Squid (*Illex illecebrosus*) in Subareas 3+4 (SCR Doc. 03/48; SCS Doc. 03/6, 03/12)

a) Interim Monitoring Report

The Subareas 3+4 catch in 2002 (248 tons) was higher than in 2001 (57 tons), but remained well below the 1982-2001 average of 2 355 tons (Fig. 20.1).

Recent catches and TACs ('000 tons) are as follows:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC SA 3+4	150	150	150	150	150	75	34	34	34	34
STATLANT 21A										
SA 3+4	6.0	1.1	8.8	15.7	1.9	0.3	0.3 ¹	<0.1 ¹	0.2 ¹	
SA 5+6	18.3	14.0	17.0	13.6	23.6	7.4	9.0 ¹	3.9 ¹	2.7 ¹	
STACFIS										
SA 3+4	5.9	1.0	8.7	15.6	1.9	0.3	0.4	<0.1	0.2	
SA 5+6	18.3	14.0	17.0	13.6	23.6	7.4	9.0	3.9	2.7	
SA 3-6	24.2	15.0	25.7	29.2	25.5	7.7	9.4	4.0	2.9	

¹ Provisional.

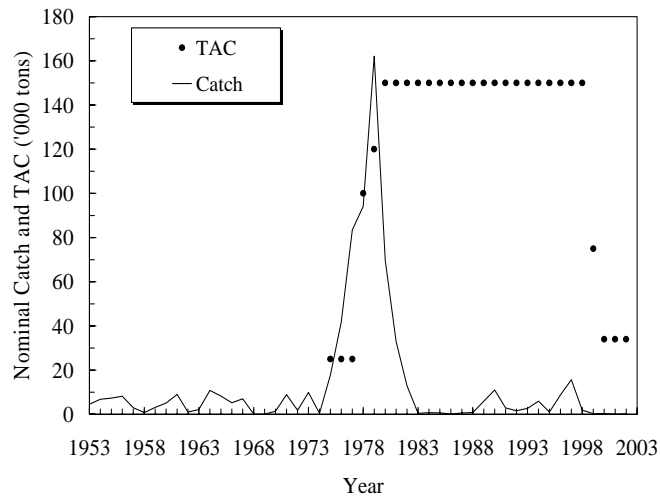


Fig. 20.1. Northern shortfin squid in Subareas 3+4: nominal catches and TACs.

During 2002, biomass indices from the July Div. 4VWX survey were within the range of values observed during the 1982-2001 low productivity period (Fig. 20.2).

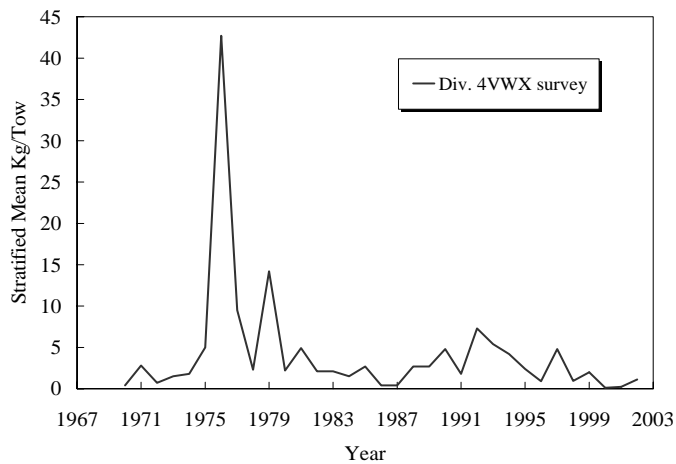


Fig. 20.2. Northern shortfin squid in Subareas 3+4: research survey biomass indices from the July survey in Div. 4VWX.

The average body weight of squid caught in the Div. 4VWX survey increased from 70 g in 2001 to 85 g in 2002 and was slightly above the average (75 g) for the 1982-2001 low productivity period (Fig. 20.3).

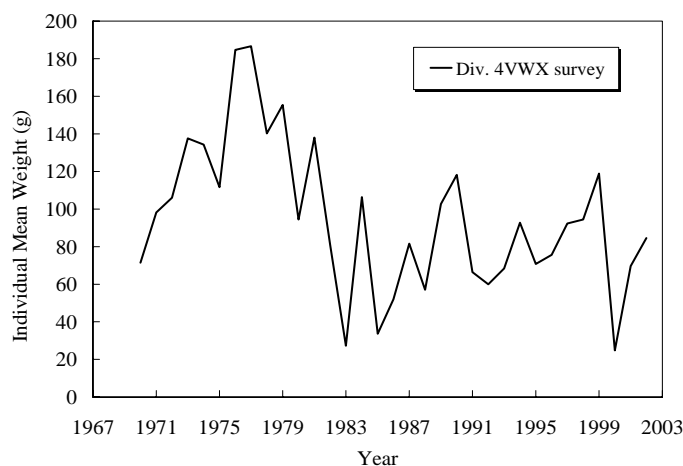


Fig. 20.3. Northern shortfin squid in Subareas 3+4: annual mean body weights from the July survey in Div. 4VWX.

In summary, the 2002 biomass index and average body weight of squid caught in the Div. 4VWX survey were within the range of values observed during the 1982-2001 low productivity period.

E. MISCELLANEOUS TASKS

21. Analyses Pertaining to Other Fisheries Commission Requests (Annex 1 item 9) (SCR Doc. 03/39, 57; SCS Doc. 03/6, 7, 11)

STACFIS noted with respect to thorny skate in Div. 3LNO, the Fisheries Commission with the concurrence of the Coastal State requested Scientific Council, at a meeting in advance of the 2003 Annual Meeting to provide the following:

- a) Information on exploitation rates in recent years, as well as information on by-catches of other groundfish in the Div. 3LNO skate fishery;
- b) Information on abundance indices and the distribution of the stock in relation to groundfish resources, particularly for the stocks which are under moratorium;
- c) Information on the distribution of thorny skate in Div. 3LNO, as well as a description of the relative distribution inside and outside the NAFO Regulatory Area;
- d) Advice on reference points and conservation measures that would allow for exploitation of this resource in a precautionary manner;
- e) Information on annual yield potential for this stock in the context of (d) above;
- f) Identification and delineation of fishery areas and exclusion zones where fishing would not be permitted, with the aim of reducing the impact on the groundfish stocks which are under moratorium, particularly juveniles;
- g) Determination of the appropriate level of research that would be required to monitor the status of this resource on an ongoing basis with the aim of providing catch options that could be used in the context of management by Total Allowable Catch (TAC); and

- h) Information on the size composition in the current catches and comments on these sizes in relation to the size at sexual maturity.

Discussion of this item took place in STACFIS; however, the report as adopted by the Scientific Council is presented as responses from the Scientific Council under Scientific Council section VII.1.c.

VI. OTHER MATTERS

1. New Designated Experts

This matter was deferred to the September 2003 Meeting.

2. Other Business

There being no other business, the Chair thanked the participants for their valuable contributions, and in particular the Designated Experts and the Secretariat for their work and co-operation during the meeting.

PART E

Miscellaneous

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AGENDA III

SCIENTIFIC COUNCIL WORKSHOP ON THE PRECAUTIONARY APPROACH TO FISHERIES MANAGEMENT 31 MAR-4 APR 2003

- I. Opening
 1. Appointment of rapporteur
 2. Adoption of agenda
 3. Terms of reference
- II. Review of Progress on Precautionary Approach
 1. Basis for existing PA reference points for NAFO stocks
 2. Evaluation of existing Scientific Council PA framework
 3. Report of ICES SGPA meeting, 2-6 December 2002
 4. Report of ICES PA meeting, 24-26 February 2003
 5. Recent advances in other regional bodies
 6. Recent advances in Coastal States
 - III. Canada
 - IV. United States of America
- III. Review of Methods for Determining PA Reference Points
- IV. Application to NAFO Stocks
 1. Greenland halibut in Subarea 2 and Div. 3KLMNO
 2. American plaice in Div. 3LNO
 3. Cod in Div. 3NO
 4. Yellowtail flounder in Div. 3LNO
 5. Redfish in Div. 3M
 6. Cod in Div. 3M
 7. Northern shrimp in Subareas 0 and 1
- V. Recommendations
- VI. Other Business
- VII. Adoption of Report
- VIII. Adjournment

Terms of Reference

Terms of Reference for the Workshop agreed at the September 2002 Scientific Council meeting are:

- Review the basis for existing PA reference points.
- Determine appropriate methodology to calculate reference points for data-limited stocks.
- Develop or revise reference points for the following stocks:
 - Greenland halibut in SA 2 and Div. 3KLMNO
 - American plaice in Div. 3LNO
 - Cod in Div. 3NO
 - Yellowtail flounder in Div. 3LNO
 - Redfish in Div. 3M
 - Cod in Div. 3M
 - Shrimp in SA 0 and 1
- Provide guidance to Designated Experts for calculating PA reference points for all remaining stocks for which sufficient data exist

An additional term of reference calls for a re-examination of the framework initially developed by the Scientific Council in 1997.

AGENDA IV**SCIENTIFIC COUNCIL MEETING, 5-19 JUNE 2003**

- I. Opening (Scientific Council Chair: R.K. Mayo)
 1. Appointment of Rapporteur
 2. Adoption of Agenda
 3. Attendance of Observers
 4. Plan of Work
 5. Report of Proxy Votes (by Executive Secretary)
- II. Review of Scientific Council Recommendations in 2002
- III. Fisheries Environment (STACFEN Chair: E. Colbourne)
 1. Opening
 2. Chairman's Introduction, Report on Intersessional Activities
 3. Agenda and Plan of Work, Appointment of Rapporteur
 4. Review of Recommendations in 2002
 5. Progress Report on Publication of Proceedings of the Mini-symposium on Hydrographic Variability in NAFO Waters 1991-2000
 6. Invited Lecture (T. Platt Bedford Institute of Oceanography Dartmouth, Nova Scotia: "Climate, Weather and the Pelagic Ecosystem")
 7. Marine Environmental Data Service (MEDS) Report for 2002
 8. Review of Environmental Studies in 2002
 - a) Physical oceanographic studies
 - b) Interdisciplinary studies
 9. Review of the Physical, Biological and Chemical Environment in the NAFO Convention Area for 2002
 10. The NAFO Annual Ocean Climate Status Summary (NAOCSS) for 2002
 11. Environmental Indices (Implementation in the Assessment Process)
 12. Formulation of Recommendations Based on Environmental Conditions in 2002
 13. Cooperative Research Programs
 - a) Russian/German assessment of short-time climate variations in the Labrador Seas
 - b) Other research programs
 14. National Representatives
 15. Other Matters
 16. Adjournment
- IV. Publications (STACPUB Chair: M. Stein)
 1. Opening
 - a) Appointment of Rapporteur
 2. Review of Recommendations in 2002
 3. Review of Publications
 - a) Journal of Northwest Atlantic Fishery Science
 - b) NAFO Scientific Council Studies
 - c) NAFO Statistical Bulletin
 - d) NAFO Scientific Council Reports

- e) Index and Lists of Titles
 - f) Others
4. NAFO Website
 - a) Web statistics
 - b) Design of NAFO Website
 5. Promotion and Distribution of Scientific Publications
 - a) Invitational papers
 - b) CD-ROM versions of reports, documents
 - c) New initiatives for publications
 6. Editorial Matters Regarding Scientific Publications
 - a) Review of Editorial Board
 - b) Progress report of publications of Reproductive Potential WG (Journal and Studies)
 - c) Progress report of publication of 2001 Deep-sea Fisheries Symposium proceedings
 - d) Progress report of publication on 2002 STACFEN Mini-symposium on Decadal Trends
 - e) Progress report of publication of 2002 Elasmobranch Symposium proceedings
 7. Papers for Possible Publication
 8. Other Matters
- V. Research Coordination (STACREC Chair: M. J. Morgan)
1. Opening
 2. Review of Recommendations in 2002
 3. Fishery Statistics
 - a) Progress report on Secretariat activities in 2002/2003
 - i) Acquisition of STATLANT 21A and 21B reports for recent years
 - b) CWP Sessions 2003/2004
 - i) Report of 20th CWP Meeting, Seychelles, 21-24 January 2003
 - ii) Intersessional CWP Meeting 2004
 4. Research Activities
 - a) Biological sampling
 - i) Report on activities in 2002/2003
 - ii) Report by National Representatives on commercial sampling conducted
 - iii) Report on data availability for stock assessments (by Designated Experts)
 - b) Biological surveys
 - i) Review of survey activities in 2002 (by National Representatives and Designated Experts)
 - ii) Surveys planned for 2003 and early-2004
 5. FAO Fisheries Global Information System (FIGIS)
 6. NAFO Observer Program
 7. Review of SCR and SCS Documents
 8. Other Matters
 - a) Tagging activities
 - b) Conversion factors
 - c) Comparative fishing between Canada and EU-Spain
 - d) Research activities
 - e) Other business
- VI. Fisheries Science (STACFIS Chair: D. Stansbury)
1. Opening
 2. General Review
 - a) Review of recommendations in 2002

- b) General review of catches and fishing activity
3. Stock Assessments
- a) Stocks within or partly within the Regulatory Area, as requested by the Fisheries Commission with the concurrence of the Coastal States (Annex 1) (Northern shrimp in Div. 3M and Div. 3LNO (items 1 and 7) will be undertaken during Scientific Council Meeting October/November, 2003):
 - Cod (Div. 3NO; Div. 3M (monitor))
 - Redfish (Div. 3LN; Div. 3M; Div. 3O)
 - American plaice (Div. 3LNO; Div. 3M (monitor))
 - Witch flounder (Div. 2J and 3KL; Div. 3NO (monitor))
 - Yellowtail flounder (Div. 3LNO (monitor))
 - Northern shortfin squid in Subareas 3 and 4 (monitor)
 - Greenland halibut (Subareas 2 and 3)
 - Capelin (Div. 3NO)
 - b) Analyses pertaining to other Fisheries Commission requests (Annex 1)
 - Thorny skate (Div. 3LNO) (Item 9)
 - c) Stocks within the 200-mile fishery zone in Subareas 0 to 4, as requested by Canada (Annex 2)
 - Greenland halibut in Subareas 2 and 3 (Item 1)
 - Cod in Div. 2J and 3KL (Item 3)
 - d) Request by Denmark (Greenland) (Annex 3)
 - Roundnose grenadier in Subareas 0 and 1 (monitor) (Item 1)
 - Demersal redfish and other finfish in Subarea 1 (Item 2)
 - Greenland halibut in Div. 1A inshore (Item 3)
 - e) Stocks overlapping the fishery zones in Subareas 0 and 1 as requested by Canada and by Denmark (Greenland) (Annexes 2 and 3)
 - Greenland halibut (Subareas 0 + Division 1A Offshore and Divisions 1B-1F) (Annex 2, Item 1; Annex 3, Item 3)
 - f) Assessment of other stocks
 - Roughhead grenadier in Subareas 2 and 3
4. Other Matters
- a) New Designated Experts
 - b) Other business

VII. Management Advice and Responses to Special Requests

1. Fisheries Commission (Annex 1)
- a) Request for advice on TACs and other management measures for the year 2004
 - i) Greenland halibut in Subarea 2 and Div. 3KLMNO
 - b) Request for advice on TACs and other management measures for the years 2004 and 2005
 - i) Cod in Div. 3NO
 - ii) American Plaice in Div. 3LNO
 - iii) Witch flounder in Div. 2J+3KL
 - iv) Redfish in Div. 3M
 - v) Redfish in Div. 3LN
 - vi) Capelin in Div. 3NO
 - c) Special requests for management advice (see Items 3-9)
 - i) Redfish in Div. 3O (see Item 3)
 - ii) Formulation of advice under the precautionary approach (Items 5 and 6) (note: Report of NAFO Scientific Council Workshop on the Precautionary Approach, St. John's Newfoundland, 31 March-4 April, 2003)
 - iii) Pelagic *S. mentella* (redfish) in Subareas 1-3 and adjacent ICES area (see Item 8)
 - iv) Information on thorny skates in Div. 3LNO (see Item 9)

- d) Monitoring of stocks for which multi-year advice was provided in 2002
 - i) Cod in Div. 3M
 - ii) American plaice in Div. 3M
 - iii) Yellowtail flounder in Div. 3LNO
 - iv) Witch flounder in Div. 3NO
 - v) Northern shortfin squid in Subareas 3 and 4
- 2. Coastal States
 - a) Request by Canada for advice (Annex 2)
 - i) Greenland halibut in Subareas 2 and 3 (Item 1)
 - ii) Cod in Div. 2J and 3KL (Item 3)
 - b) Request by Denmark (Greenland) for advice (Annex 3)
 - i) Multi-year advice for demersal redfish and other finfish in Subarea 1 (Item 2)
 - ii) Roundnose grenadier in Subareas 0 and 1 (monitor) (Item 1)
 - iii) Greenland halibut in Div. 1A Inshore (Item 3)
 - c) Request by Canada and Denmark (Greenland) for advice on TACs and other management measures (Annexes 2 and 3)
 - i) Greenland halibut in Subarea 0 + Division 1A Offshore and Divisions 1B-1F
 - ii) Special requests for management advice for Greenland halibut in Subareas 0 and 1
- VIII. Future Scientific Council Meetings 2003 and 2004
 - 1. Scientific Council Meeting and Special Session, September 2003 Dartmouth, Nova Scotia, Canada
 - 2. Scientific Council Meeting, October/November 2003 (assessment of shrimp stocks) Dartmouth, Nova Scotia, Canada
 - 3. Scientific Council Meeting, June 2004
 - 4. Scientific Council Meeting and Special Session, September 2004
 - 5. Scientific Council Meeting, November 2004 (assessment of shrimp stocks)
- IX. Arrangements for Special Sessions
 - 1. Progress Report on Special Session in 2003: Scientific Council Workshop on Geostatistics in Fisheries.
 - 2. Topics for Special Sessions in 2004 and 2005.
- X. Reports of Working Groups
 - 1. Working Group on Reproductive Potential (Chair: E. A. Trippel)
 - 2. Joint NAFO-ICES Working Group on Harp and Hooded Seals
- XI. Nomination and Election of Officers
 - 1. Chairs of all Standing Committees (STACFEN, STACPUB, STACREC, STACFIS)
 - 2. Chair and Vice-Chair of Scientific Council
- XII. Review of Scientific Council Working Procedures/Protocol
 - 1. Implementation of Precautionary Approach
 - a) Report of the March/April 2003 Scientific Council Workshop on PA
 - b) Further development of NAFO Scientific Council PA methodology
 - 2. NAFO Scientific Council Observership at ICES ACFM Meetings
 - 3. Analytical Basis for an Interim Monitoring Evaluation
 - 4. Facilitating Workload of Scientific Council During Annual Meeting in September
 - 5. Facilities and Technological Support

XIII. Other Matters

1. Report of 25th Session of the FAO Committee on Fisheries (COFI) Rome, Italy, 24-28 February 2003
2. Report of Regional Fishery Bodies (RFB) Meeting, Rome, Italy, 3-4 March 2003
3. Meeting Highlights for NAFO Website
4. Other Business

XIV. Adoption of Committee Reports

1. STACFEN
2. STACREC
3. STACPUB
4. STACFIS

XV. Scientific Council Recommendations to General Council and Fisheries Commission

XVI. Adoption of Scientific Council Report

XVII. Adjournment

**ANNEX 1. FISHERIES COMMISSION'S REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT
IN 2004 OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4**

1. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of the following fish and invertebrate stocks or groups of stocks in 2004:

Shrimp (Div. 3M, 3LNO)
Greenland halibut (Subarea 2 and Div. 3KLMNO)
Capelin (Div. 3NO)

2. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of the following fish stocks on an alternating year basis:

Cod (Div. 3NO; Div. 3M)
Redfish (Div. 3M; Div. 3LN)
Yellowtail flounder (Div. 3LNO)
American plaice (Div. 3LNO; Div. 3M)
Witch flounder (Div. 2J3KL; Div. 3NO)
Squid (Subareas 3 and 4)

- In 2002, advice was provided for 2003 and 2004 for cod in 3M, American plaice in 3M, yellowtail flounder in 3LNO, witch flounder in 3NO and squid in SA 3&4. These stocks will next be assessed in 2004.
- In 2003, advice will be provided for 2004 and 2005 for cod in 3NO, American plaice in 3LNO, witch flounder in 2J3KL, redfish in 3M and redfish in 3LN. These stocks will next be assessed in 2005.

The Fisheries Commission requests the Scientific Council to continue to monitor the status of all these stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in by-catches in other fisheries, provide updated advice as appropriate.

3. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of redfish in Div. 3O including recommendations regarding the most appropriate TAC for 2004 and 2005. This stock will be assessed in alternate years thereafter.
4. The Commission and the Coastal State request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above:
 - a) The preferred tool for the presentation of a synthetic view of the past dynamics of an exploited stock and its future development is a stock assessment model, whether age-based or age-aggregated.
 - b) For those stocks subject to analytical-type assessments, the status of the stocks should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. As general reference points, the implications of fishing at $F_{0.1}$ and F_{2002} in 2004 and subsequent years should be evaluated. The present stock size and spawning stock size should be described in relation to those observed historically and those expected in the longer term under this range of options.
 - c) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. In this case, the general reference points should be the level of fishing effort or fishing mortality (F) which is calculated to be required to take the MSY catch in the long term and two-thirds of that effort level.
 - d) For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.
 - e) Spawning stock biomass levels considered necessary for maintenance of sustained recruitment should be recommended for each stock. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing reproductive potential of the stock, management options should be offered that specifically respond to such concerns.

- f) Information should be provided on stock size, spawning stock sizes, recruitment prospects, fishing mortality, catch rates and TACs implied by these management strategies for the short and the long term in the following format:
- I. For stocks for which analytical-type assessments are possible, graphs should be provided of all of the following for the longest time-period possible:
 - historical yield and fishing mortality;
 - spawning stock biomass and recruitment levels;
 - catch options for the year 2004 and subsequent years over a range of fishing mortality rates (F) at least from $F_{0.1}$ to F_{max} ;
 - spawning stock biomass corresponding to each catch option;
 - yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.
 - II. For stocks for which advice is based on general production models, the relevant graph of production as a function of fishing mortality rate or fishing effort should be provided. Age-aggregated assessments should also provide graphs of all of the following for the longest time-period possible:
 - exploitable biomass (both absolute and relative to B_{MSY})
 - yield/biomass ratio as a proxy for fishing mortality (both absolute and relative to F_{MSY})
 - estimates of recruitment from surveys, if available.
 - III. Where analytical methods are not attempted, the following graphs should be presented, for one or several surveys, for the longest time-period possible:
 - time trends of survey abundance estimates, over:
 - an age or size range chosen to represent the spawning population
 - an age or size-range chosen to represent the exploited population
 - recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
 - fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.

For age-structured assessments, yield-per-recruit graphs and associated estimates of yield-per-recruit based reference points should be provided. In particular, the three reference points, actual F, $F_{0.1}$ and F_{max} should be shown.

5. Noting the progress made by the Scientific Council on the development of a framework for implementation of the Precautionary Approach, the Fisheries Commission requests that the Scientific Council provide the following information for the 2003 Annual Meeting of the Fisheries Commission for stocks under its responsibility requiring advice for 2004, or 2004 and 2005:
 - a) the limit and target precautionary reference points as described in Annex II of the UN Fisheries Agreement indicating areas of uncertainty (when precautionary reference points cannot be determined directly, proxies should be provided);
 - b) information including medium term considerations and associated risk or probabilities which will assist the Commission in developing the management strategies described in paragraphs 4 and 5 of Annex II in the Agreement;
 - c) information on the research and monitoring required to evaluate and refine the reference points described in paragraphs 1 and 3 of Annex II of the Agreement; these research requirements should be set out in the order of priority considered appropriate by the Scientific Council;
 - d) any other aspect of Article 6 and Annex II of the Agreement which the Scientific Council considers useful for implementation of the Agreement's provisions regarding the precautionary approach to capture fisheries;
 - e) propose criteria and harvest strategies for re-opening of fisheries and for new and developing fisheries; and
 - f) to work toward the harmonization of the terminology and application of the precautionary approach within relevant advisory bodies.
6. In addition, the following elements should be taken into account by the Scientific Council when considering the precautionary approach:
 - a) Many of the stocks in the NAFO Regulatory Area are well below any reasonable level of B_{lim} or B_{buf} . For these stocks, the most important task for the Scientific Council is to inform on how to rebuild the stocks. In this context and building on previous work of the Scientific Council in this area, the Scientific Council is requested to evaluate various scenarios corresponding to recovery plans with timeframes of 5 to 10 years, or longer as appropriate. This evaluation should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, including information on the consequences and risks of no action at all.

References to "risk" and to "risk analyses" should refer to estimated probabilities of stock population parameters falling outside biological reference points.

- b) Where reference points are proposed by the Scientific Council as indicators of biological risk, they should be accompanied by a description of the nature of the risk incurred if the reference point is crossed (e.g. short-term risk of recruitment overfishing, loss of long-term yield, etc.)
 - c) When a buffer reference point is proposed in order to maintain a low probability that a stock, measured to be at the buffer reference point, may actually be at or beyond the limit reference point, the Scientific Council should explain the assumptions made about the uncertainty with which the stock is measured, and also the level of 'low probability' that is used in the calculation.
 - d) Wherever possible, short and medium term consequences should be identified for various exploitation rates (including no fishing) in terms of yield, stability in yield from year to year, and the risk or probability of moving the stock beyond B_{lim} or B_{buf} . Whenever possible, this information should be cast in terms of risk assessments relating fishing mortality rates to the risks of falling below B_{lim} and B_{buf} , as well as of being above F_{lim} and F_{buf} , the risks of stock collapse and recruitment overfishing, as well as the risks of growth overfishing and the consequences in terms of both short and long term yields.
 - e) When providing risk estimates, it is very important that the time horizon be clearly spelled out. By way of consequence, risks should be expressed in timeframes of 5, 10 and 15 years (or more), or in terms of other appropriate year ranges depending on stock specific dynamics. Furthermore, in order to provide the Fisheries Commission with the information necessary to consider the balance between risks and yield levels, each harvesting strategy or risk scenario should include, for the selected year ranges, the risks and yields associated with various harvesting options in relation to B_{lim} (B_{buf}) and B_{target} , and F_{lim} (F_{buf}) and F_{target} .
7. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting, to consider options available for the provision of annual advice as regards shrimp in Div. 3LNO and 3M in advance of the Annual Meetings.
8. Regarding pelagic *S. mentella* redfish in NAFO Subareas 1-3, the Scientific Council is requested to review the most recent information on the distribution of this resource, as well as on the affinity of this stock to the pelagic redfish resource found in the ICES Sub-area XII, parts of SA Va and XIV and to the shelf stocks of redfish found in ICES Sub-areas V, VI and XIV, and NAFO Subareas 1-3.
9. With respect to thorny skate in Divisions 3LNO, the Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting to provide the following:
- a) Information on exploitation rates in recent years, as well as information on by-catches of other groundfish in the 3LNO skate fishery;
 - b) Information on abundance indices and the distribution of the stock in relation to groundfish resources, particularly for the stocks which are under moratorium;
 - c) Information on the distribution of thorny skate in Divisions 3LNO, as well as a description of the relative distribution inside and outside the NAFO Regulatory Area;
 - d) Advice on reference points and conservation measures that would allow for exploitation of this resource in a precautionary manner;
 - e) Information on annual yield potential for this stock in the context of (d) above;
 - f) Identification and delineation of fishery areas and exclusion zones where fishing would not be permitted, with the aim of reducing the impact on the groundfish stocks which are under moratorium, particularly juveniles;
 - g) Determination of the appropriate level of research that would be required to monitor the status of this resource on an ongoing basis with the aim of providing catch options that could be used in the context of management by Total Allowable Catch (TAC); and
 - h) Information on the size composition in the current catches and comment on these sizes in relation to the size at sexual maturity.
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**ANNEX 2. CANADIAN REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2004
OF CERTAIN STOCKS IN SUBAREAS 0 TO 4**

1. Canada requests that the Scientific Council, at its meeting in advance of the 2003 Annual Meeting of NAFO, subject to the concurrence of Denmark (on behalf of Greenland), provide advice on the scientific basis for management in 2004 of the following stocks:

Shrimp (Subareas 0 and 1)
Greenland halibut (Subareas 0 and 1)

The Scientific Council has noted previously that there is no biological basis for conducting separate assessments for Greenland halibut throughout Subareas 0-3, but has advised that separate TACs be maintained for different areas of the distribution of Greenland halibut. The Council is asked therefore, subject to the concurrence of Denmark (on behalf of Greenland) as regards Subarea 1, to provide an overall assessment of status and trends in the total stock throughout its range and comment on its management in Subareas 0+1 for 2004.

Greenland halibut in the offshore area of Division 0A+1A is currently being managed separately from the remainder of SA 0+1. However, given the bathymetry of Baffin Bay and its proximity to the NAFO boundaries of Divisions 0A, 1A and 1B, the Scientific Council is requested to:

- a) advise on whether it is more appropriate for management purposes to include Division 1B with the current management area of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-F;
- b) advise on appropriate TAC levels for 2004, separately, for Greenland halibut in the offshore area of Divisions 0A+1A (plus Division 1B depending on the result of (a) above) and Divisions 0B+ 1C-F (plus Division 1B depending on the result of (a) above). The Scientific Council is also asked to advise on any other management measures it deems appropriate to ensure the sustainability of these resources;
- c) comment on the Greenland halibut size composition throughout SA0+1 (offshore), the potential relationship between fish in Baffin Bay and Davis Strait and the impact of harvesting on these stock components; and
- d) advise on the most appropriate protocols for the conduct of exploratory fisheries in Division 0A north of 71°30'N including precautionary catch limits.

The Council also is asked to advise on appropriate TAC levels separately – for Greenland halibut in SA 2 + Division 3K and for Divisions 3LMNO.

Scientific Council has, in the past, advised that fishing effort for Greenland halibut in SA2 + 3KLMNO should be distributed in relation to biomass. Scientific Council is requested to comment on:

- a) the current distribution of the resource between SA2 + 3K and 3LMNO and comment on how this compares with the current distribution of quota allocation; and
- b) the appropriate distribution of quota allocation if it was based on the distribution of biomass.

With respect to shrimp, it is recognized that the Council may, at its discretion, delay providing advice until later in the year, taking into account data availability, predictive capability, and the logistics of additional meetings.

2. Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for Shrimp and Greenland halibut in Subareas 0 and 1:

- a) For those stocks subject to analytical-type assessments, the status of the stock should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. The implications of no fishing as well as fishing at $F_{0.1}$, and F_{2002} in 2004 and subsequent years should be evaluated in relation to precautionary reference points of both fishing mortality and spawning stock biomass. The present stock size and spawning stock size should be described in relation to those observed historically and those to be expected in the longer term under this range of fishing mortalities, and any other options Scientific Council feels worthy of consideration under a precautionary framework.

Opinions of the Scientific Council should be expressed in regard to stock size, spawning stock sizes, recruitment prospects, catch rates and catches implied by these management strategies for the short and long term. Values of F corresponding to the reference points should be given. Uncertainties in the assessment should be evaluated and presented in the form of risk analyses related to B_{lim} (B_{buf}) and B_{target} , and F_{lim} (B_{Fuf}) and F_{target} .

- b) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. Management options should be within the precautionary framework.
- c) For those resources for which only general biological advice and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and management options evaluated in the way described above to the extent possible. Management options should be within the precautionary framework.
- d) Presentation of the results should include the following:
 - I. For stocks for which analytical-type assessments are possible:
 - A graph of historical yield and fishing mortality for the longest time period possible;
 - A graph of spawning stock biomass and recruitment levels for the longest time period possible;
 - Graphs and tables of catch options for the year 2004 and subsequent years over a range of fishing mortality rates (F) at least from F=0 to F_{0.1} including risk analyses;
 - Graphs and tables showing spawning stock biomass corresponding to each catch option including risk analyses;
 - Graphs showing the yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.
 - II. For stocks for which advice is based on general production models, the relevant graph of production on fishing mortality rate or fishing effort.

In all cases, the reference points, F=0, actual F, and F_{0.1} should be shown.

3. For the cod stock in Divisions 2J + 3KL, the Scientific Council is requested to report on recent trends in the total and spawning biomass based on the most recent Stock Status Report.

P. S. Chamut
 Assistant Deputy Minister
 Fisheries Management, Department of Fisheries and Oceans
 Ottawa, Canada

ANNEX 3. DENMARK (GREENLAND) REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2004 OF CERTAIN STOCKS IN SUBAREAS 0 AND 1

1. In the Scientific Council report of 2002, scientific advice on management of Roundnose grenadier in Subarea 0+1 was given as a 3-year advice (for 2003, 2004 and 2005). Denmark, on behalf of Greenland, requests the Scientific Council to continue to monitor the status of Roundnose grenadier in Subarea 0+1 annually and, should significant change in stock status be observed (e.g. from surveys), the Scientific Council is requested to provide updated advice as appropriate.
2. Advice for redfish (*Sebastes* spp.) and other finfish in Subarea 1 was in 2001 given for 2002 and 2003. Denmark, on behalf of Greenland, requests that the Scientific Council in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of these stocks in Subarea 1 for 2004 and 2005.
3. Subject to the concurrence of Canada as regards Subarea 0, the Scientific Council is requested to provide advice on the scientific basis for management of Greenland halibut overlapping Subarea 0 and 1 in 2004, and as many years forward as data allow.

Given the bathymetry of the Baffin Bay and Davis Strait, the Scientific Council is asked to advise on whether it is more appropriate for management purposes to include Division 1B with the current management of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-F.

The Scientific Council is asked to advise on the most appropriate protocols for the conduct of exploratory fisheries in Divisions 1A north of 74°N including precautionary catch limits.

Further, for Subarea 1A inshore, the Council is asked to provide advice on allocation of TACs distributed in the areas of Ilulissat, Uummannaq and Upernavik, respectively.

The Council is asked in its advice to assess the impact from the offshore fisheries in Baffin Bay and Davis Strait on the status and trends of the Subarea 1A inshore stock components, and *vice versa*.

4. Subject to the concurrence of Canada as regards Subarea 0, Denmark, on behalf of Greenland, further requests the Scientific Council of NAFO before December 2003 to provide advice on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Subarea 0 and 1 in 2004, and as many years forward as data allow.

The Scientific Council is asked to update the information on the distribution of Northern shrimp (*Pandalus borealis*) and provide advice on allocation of TAC's to Subarea 0 and Subarea 1.

Further, the Council is requested to advise, in co-operation with ICES, on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Denmark Strait and adjacent areas east of southern Greenland in 2004, and as many years forward as data allow.

On behalf of
The Department of Fisheries, Hunting and Agriculture
Sincerely
Amalie Jessen
Deputy Minister (acting)

LIST OF SCIENTIFIC DOCUMENTS

RESEARCH DOCUMENTS (SCR)

January–June 2003

SCR #	Ser. #	Author(s) and Title
03/1 ^a	N4808	SHELTON, P. A. and D. RIVARD. Developing a precautionary approach to fisheries management in Canada – the decade following the cod collapses. (16 pages)
03/2 ^b	N4806	RIKHTER, V. A. On the TAC estimates compliance with some commercial fish stocks in NAFO Area: retrospective analysis and improvement possibilities. (13 pages)
03/3 ^b	N4809	BUCH, E. and M. H. RIBERGAARD. Oceanographic investigations off West Greenland 2002. (13 pages)
03/4 ^b	N4810	STEIN, M. Climatic conditions around Greenland – 2002. (29 pages)
03/5 ^b	N4811	GONZÁLEZ TRONCOSO, D. and X. PAZ. Testing methods for estimating the factor power correction obtained from the comparative fishing trial: <i>C/V Playa de Menduñña versus R/V Vizconde de Eza</i> . (8 pages)
03/6 ^b	N4812	PAZ, X., D. GONZÁLEZ TRONCOSO and E. ROMÁN. New time series for yellowtail flounder from the comparative experience between the <i>C/V Playa de Menduñña</i> and the <i>R/V Vizconde de Eza</i> in the NAFO Regulatory Area of Divisions 3NO, 1995-2002. (15 pages)
03/7 ^b	N4813	GONZÁLEZ TRONCOSO, D., X. PAZ and E. ROMÁN. Data conversions for American plaice from the surveys conducted by Spain in the NAFO Regulatory Area of Division 3NO: 1995-2002. (17 pages)
03/8 ^b	N4814	GONZÁLEZ TRONCOSO, D., E. ROMÁN and X. PAZ. Transformed results for Greenland halibut from the surveys conducted by Spain in the NAFO Regulatory Area of Divisions 3NO, 1996-2002. (15 pages, revised)
03/9 ^b	N4815	VASKOV, A. A. and T. M. IGASHOV. Results from the Russian trawl survey on the Flemish Cap Bank (Division 3M) in 2002. (30 pages)
03/10 ^b	N4816	TAYLOR, M. H., C. BASCUNAN, J. P. MANNING and D. G. MOUNTAIN. Oceanographic conditions in NAFO Subareas 5 and 6 during 2002. (9 pages)
03/11 ^b	N4817	MORGAN, M. J. A preliminary examination of variability in condition of American plaice in NAFO Divisions 3LNO. (14 pages)
03/12 ^b	N4818	VASKOV, A. A. Distribution of redfish in Division 3O based on data from Russian trawl surveys in 1983-1993. (13 pages)
03/13 ^b	N4819	MURUA, H. A review of roughhead grenadier (<i>Macrourus berglax</i>) biology and population structure on Flemish Cap (NAFO Division 3M), 1991-2002 based on EU Flemish Cap bottom survey data. (18 pages)

^a Scientific Council Workshop on the Precautionary Approach to Fisheries Management, 31 Mar-4 Apr 2003

^b Scientific Council Meeting, 5-19 June 2003

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03/14 ^b	N4820	COLBOURNE, E. B. and C. FITZPATRICK. Physical oceanographic conditions in NAFO Subareas 2 and 3 on the Newfoundland and Labrador Shelf during 2002. (25 pages)
03/15 ^b	N4821	RÄTZ, H.-J. and C. STRANSKY. Stock abundance indices and length compositions of demersal redfish and other finfish in NAFO Subarea 1 based on German bottom trawl survey. (28 pages)
03/16 ^b	N4823	STRANSKY, C., S. GUÐMUNDSDÓTTIR, Þ. SIGURÐSSON, S. LEMVIG, K. NEDREAAS and F. SABORIDO-REY. Age readings of <i>Sebastes marinus</i> and <i>S. mentella</i> otoliths: bias and precision between readers. (14 pages)
03/17 ^b	N4824	STRANSKY, C. Shape analysis and microchemistry of redfish otoliths: investigation of geographical differences in the North Atlantic. (10 pages)
03/18 ^b	N4825	MADDOCK-PARSONS, D., W. B. BRODIE and K. DWYER. Update on cooperative surveys of yellowtail flounder in NAFO Divisions 3LNO, 1996-2002. (21 pages, revised)
03/19 ^b	N4826	MAILLET, G. L., P. PEPIN, S. FRASER and D. LANE. Biological oceanographic conditions in NAFO Subareas 2 and 3 on the Newfoundland and Labrador Shelf during 2002. (32 pages)
03/20 ^b	N4829	JORGENSEN, O. Survey for Greenland halibut in NAFO Divisions 1C-1D, 2002. (25 pages)
03/21 ^b	N4830	SIGAEV, I. K. Sea-surface temperature and water mass boundaries in the Northwestern Atlantic Ocean in 2002. (12 pages)
03/22 ^b	N4831	VASKOV, A., S. LISOWSKY and S. LOBODENKO. A brief review of investigations conducted by PINRO in NAFO Subareas 0, 2 and 3. (7 pages)
03/23 ^b	N4832	GONZÁLEZ, C., E. ROMÁN and X. PAZ. Food and feed chronology of American plaice (<i>Hippoglossoides platessoides</i>) in the North Atlantic. (21 pages)
03/24 ^b	N4834	POWER, D. Standardized catch rate index for Greenland halibut in SA 2 + 3LKMNO. (7 pages)
03/25 ^b	N4835	BAKANEV, S. V. and K. V. GORCHINSKY. Assessment of by-catches of young redfish during fishery for shrimp in Division 3M by data of the Russian fishery in 2002. (5 pages)
03/26 ^b	N4836	VASKOV, A. Brief review of Russian fisheries in Division 3O in 2001-2002. (5 pages)
03/27 ^b	N4841	SCHOCK, C. and S. TOMINSON. Marine Environmental Data Service Report for 2002. (43 pages)
03/28 ^b	N4842	LISOVSKY, S. and A. PAVLENKO. Selectivity of the codends with 130-150 mm mesh size in specialized trawl fishery for Greenland halibut in Division 3L of NAFO Regulatory Area. (24 pages)
03/29 ^b	N4843	STORR-PAULSEN, M. Biomass and abundance of demersal fish stocks off West Greenland estimated from the Greenland shrimp survey, 1988-2002. (24 pages)

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03/30 ^b	N4845	DRINKWATER, K. F., B. PETRIE, R. G. PETTIPAS and W. M. PETRIE. An overview of meteorological, sea ice and sea-surface temperature conditions in the Northwest Atlantic during 2002. (32 pages)
03/31 ^b	N4846	DRINKWATER, K. F., B. PETRIE, R. G. PETTIPAS, W. M. PETRIE and V. SOUKHOTSEV. Physical oceanographic conditions on the Scotian Shelf and in the Gulf of Maine during 2002. (32 pages)
03/32 ^b	N4848	CABANAS, J. M. Hydrographic conditions on Flemish Cap in July 2002. (9 pages)
03/33 ^b	N4850	GUNDERSEN A. C. and Å. HØINES. Norwegian Fishery for Greenland Halibut, Grenadiers and Redfish in West-Greenland Waters, 2001-2002. (7 pages)
03/34 ^b	N4851	SIEGSTAD, H., H.-J. RÄTZ and C. STRANSKY. Assessment of other finfish in NAFO Subarea 1. (6 pages)
03/35 ^b	N4853	SIEGSTAD, H., H.-J. RÄTZ and C. STRANSKY. An assessment of demersal redfish in NAFO Subarea 1. (8 pages)
03/36 ^b	N4854	BRODIE, W. B. and D. POWER. The Canadian fishery for Greenland halibut in SA 2 + Divisions 3KLMNO, with emphasis on 2002. (14 pages)
03/37 ^b	N4855	GORCHINSKY, K. V. Using trawlable biomass data from Canadian bottom trawl survey in spring 2002 to estimate capelin state of the stock on the Grand Bank. (6 pages)
03/38 ^b	N4856	CERVIÑO, S. and A. VÁZQUEZ. Re-opening criteria for Flemish Cap cod: a survey-based method. (11 pages)
03/39 ^b	N4857	DEL RIO, J. L., F. GONZALEZ and D. GONZALEZ. The Spanish fishery (1998, 2000-2002) and the Spanish 3NO survey (1995-2002) in relation to the skate fishery in Divisions 3NO. (16 pages)
03/40 ^b	N4858	HEALEY, B. P., R. BOWERING and K. S. DWYER. Estimating year-class strength and total mortality for Greenland halibut from surveys in NAFO Subarea 2 and Divisions 3KLMNO. (14 pages)
03/41 ^b	N4859	TREBLE, M. A. Results of a Greenland Halibut (<i>Reinhardtius hippoglossoides</i>) Tagging Project in Cumberland Sound, NAFO Division 0B, 1997-2000. (7 pages)
03/42 ^b	N4860	SABORIDO, F. and A. VÁZQUEZ. Results from Bottom Trawl Survey on Flemish Cap of July 2002. (41 pages)
03/43 ^b	N4861	MURUA, H. Assessment of roughhead grenadier, <i>Macrourus berglax</i> , in NAFO Subareas 2 and 3. (13 pages)
03/44 ^b	N4862	ALPOIM, R. A stock status update of American plaice (<i>Hippoglossoides platessoides</i>) in NAFO Division 3M. (12 pages)

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03/45 ^b	N4863	AVILA DE MELO, A., R. ALPOIM and F. SABORIDO-REY. An assessment of beaked redfish (<i>Sebastes mentella</i> and <i>S. fasciatus</i>) in NAFO Division 3M. (72 pages)
03/46 ^b	N4864	MADDOCK PARSONS, D. and W. R. BOWERING. Witch flounder in Divisions 3NO: a stock status update. (29 pages)
03/47 ^b	N4865	MADDOCK PARSONS, D. and W. R. BOWERING. Witch flounder population trends in Divisions 2J, 3K and 3L. (22 pages)
03/48 ^b	N4866	HENDRICKSON, L. C., E. G. DAWE and M. A. SHOWELL. Interim monitoring report for the assessment of northern shortfin squid (<i>Illex illecebrosus</i>) in Subareas 3+4 during 2002. (13 pages)
03/49 ^b	N4867	SIMONSEN, C. S. and J. BOJE. An assessment of the Greenland halibut stock component in NAFO Division 1A inshore. (22 pages)
03/50 ^b	N4868	TREBLE, M., W. B. BRODIE and W. R. BOWERING. Summary of data from the offshore Canadian commercial fishery for Greenland halibut in Subarea 0. (18 pages)
03/51 ^b	N4869	DWYER, K. S. and W. R. BOWERING. Greenland halibut (<i>Reinhardtius hippoglossoides</i>) in NAFO Subarea 2 and Divisions 3KLMNO: stock trends based on annual Canadian research vessel survey results during 1978-2002. (57 pages)
03/52 ^b	N4870	BRODIE, W. B., S. J. WALSH, D. POWER, K. S. DWYER and M. F. VEITCH. Divisions 3LNO yellowtail flounder – interim monitoring update. (18 pages)
03/53 ^b	N4871	JØRGENSEN, O. A. Assessment of Greenland halibut stock component in NAFO Subarea 0 + Division 1A offshore + Divisions 1B-1F. (17 pages)
03/54 ^b	N4872	DARBY, C. An extended survivors analyzing (XSA) of Greenland halibut in NAFO Divisions 0+1. (15 pages)
03/55 ^b	N4873	POWER, D. An assessment of the status of the redfish in NAFO Divisions 3LN. (21 pages)
03/56 ^b	N4874	MORGAN, M. J., W. B. BRODIE, D. MADDOCK PARSONS, B. P. HEALEY and D. POWER. An assessment of American plaice in NAFO Divisions 3LNO. (70 pages)
03/57 ^b	N4875	KULKA, D. W. and C. M. MIRI. The status of thorny skate (<i>Amblyraja radiata</i> Donovan, 1808) in NAFO Divisions 3L, 3N, 3O and Subdivisions 3Ps. (80 pages)
03/58 ^b	N4876	SHELTON, P. A., P. M. MACE, W. B. BRODIE and J.-C. MAHÉ. A proposal for a more flexible framework for implementing the Precautionary Approach on NAFO stocks. (25 pages, revised)
03/59 ^b	N4878	HEALEY, B. P., E. F. MURPHY, D. E. STANSBURY and J. BRATTEY. An assessment of the cod stock in NAFO Divisions 3NO. (60 pages)
03/60 ^b	N4879	POWER, D. Distribution of redfish in NAFO Divisions 3LNO based on Canadian research surveys from 1991-2002. (8 pages)

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03/61 ^b	N4880	WALSH, S. J. and W. B. BRODIE. Sensitivity analysis of survey biomass indices used to tuned ASPIC production model for Grand Bank yellowtail flounder. (23 pages)
03/62 ^b	N4881	LILLY, G. R., P. A. SHELTON, J. BRATTEY, N. G. CADIGAN, B. P. HEALEY, E. F. MURPHY, D. E. STANSBURY and N. CHEN. A summary of the February 2003 assessment of the 2J+3KL stock of Atlantic cod (<i>Gadus morhua</i>). (20 pages)
03/63 ^b	N4882	POWER, D. An assessment of the status of the redfish in NAFO Division 3O. (30 pages)
03/64 ^b	N4883	DARBY, C., J. C. MAHÉ and W. R. BOWERING. An assessment of the status of the Greenland halibut resource in NAFO Subarea 2 and Divisions 3KLMNO based on extended survivors analysis with short-and medium- term projections of future stock development. (40 pages, revised)

SUMMARY DOCUMENTS (SCS)

January-August 2003

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03/1 ^b	N4800	FISHERIES COMMISSION. Fisheries Commission's request for scientific advice on management in 2004 of certain stocks in Subareas 2, 3 and 4. (4 pages)
03/2 ^b	N4802	CHAMUT, P. S. Canadian request for scientific advice on management In 2004 of certain stocks in Subareas 0 to 4. (2 pages)
03/3 ^b	N4803	JESSEN, A. Denmark (Greenland) request for scientific advice on management in 2004 of certain stocks in Subareas 0 and 1. (1 page)
03/4 ^b	N4804	NAFO SECRETARIAT (D. AUBY). Tagging activities reported for the Northwest Atlantic in 2002 and early-2003. (9 pages)
03/5 ^b	N4805	NAFO. Report of NAFO Scientific Council Workshop on the Precautionary Approach to Fisheries Management. (60 pages)
03/6 ^b	N4807	RIKHTER, V. A., I. K. SIGAEV, A. VASKOV, K. GORCHINSKY, T. IGASHOV, S. LOBODENKO, S. MELNIKOV and N. SHAKURO. Russian research report for 2002. (31 pages)
03/7 ^b	N4815	VARGAS, J., R. ALPOIM, E. SANTOS, and A. M. AVILA DE MELO. Portuguese research report for 2002. (53 pages)
03/8 ^b	N4822	RÄTZ, H.-J., M. STEIN, and C. STRANSKY. German research report for 2002. (5 pages)
03/9 ^b	N4827	NAFO SECRETARIAT (B. MARSHALL). Provisional index and list of titles of research and summary documents of 2002. (1 page + excel file)

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03/10 ^b	N4833	TREBLE, M., S. COSENS, and D. PARMITER-RICHARDS. Canadian research report for 2002. (25 pages)
03/11 ^b	N4837	GONZALEZ, F., J. L. DEL RIO, A VÁZQUEZ, H. MURUA and E. ROMÁN. Spanish Research Report for 2002. (26 pages)
03/12 ^b	N4838	NAFO SECRETARIAT (G. MOULTON). Historical nominal catches for selected stocks. (7 pages)
03/13 ^b	N4839	NAFO SECRETARIAT (G. MOULTON). Notes on acquisition and publications of statistics since June 2002. (2 pages)
03/14 ^b	N4840	NAFO SECRETARIAT (C. KERR). List of biological sampling data, 2002. (1 page + excel file)
03/15 ^b	N4847	SOSEBEE, K. A. and W. L. GABRIEL. United States research report for 2002. (16 pages)
03/16 ^b	N4849	SIEGSTAD, H. and R. P. FRANDBSEN. Denmark/Greenland research report for 2002. (7 pages)
03/17 ^b	N4851	GONZALEZ, F. and D. POWER. A report on the deliberations of the ICES North-Western Working Group, 2003. (12 pages)
03/18 ^b	N4877	FAO. Report of the Third Meeting of Regional Fishery Bodies. (20 pages)
03/19 ^b	N4884	NAFO. Report of Scientific Council, 5-19 June 2003 Meeting. (194 pages)

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LIST OF REPRESENTATIVES, ADVISERS/EXPERTS AND OBSERVERS

January-June 2003

Meetings**CANADA****Representatives:**

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Meeting*

A Scientific Council Workshop on the Precautionary Approach to Fisheries Management, 31 Mar-4 Apr 2003

B Scientific Council Meeting, 5-19 June 2003

Meetings

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Meeting*

- A Scientific Council Workshop on the Precautionary Approach to Fisheries Management, 31 Mar-4 Apr 2003
 B Scientific Council Meeting, 5-19 June 2003

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A Scientific Council Workshop on the Precautionary Approach to Fisheries Management, 31 Mar-4 Apr 2003
 B Scientific Council Meeting, 5-19 June 2003

LIST OF RECOMMENDATIONS IN 2003

The following are the specific **recommendations made by the Scientific Council** at its meetings through January-June 2003 besides those made with respect to scientific advice on stocks considered. The recommendations with respect to stock advice appear in the stock-by-stock Summary Sheets presented in this publication. Recommendations listed under the Standing Committees were **endorsed** by the Scientific Council.

All recommendations listed here were **adopted** by the Scientific Council and are presented as they appear in this publication under the relevant sections and pages mentioned.

Scientific Council Meeting, 5-19 June 2003 Meeting

SCIENTIFIC COUNCIL

VII. MANAGEMENT ADVICE AND RESPONSES TO SPECIAL REQUESTS

2. Coastal States

- c) **Request by Canada and Denmark (Greenland) for Advice on TACs and Other Management Measures** (Annexes 2 and 3)

Responses Specific to Requests by Canada (page 191)

Given the bathymetry of Baffin Bay and its proximity to the NAFO boundaries of Div. 0A, 1A and 1B it would have been more appropriate to set the TAC for Div. 0A+1AB. Scientific Council therefore **recommended** that Div. 1B be included in the management area with Div. 0A and 1A.

XII. REVIEW OF SCIENTIFIC COUNCIL WORKING PROCEDURES/PROTOCOL

1. Implementation of Precautionary Approach

- a) **Report of the March/April 2003 Scientific Council Workshop on PA** (page 200)

Scientific Council endorsed this proposal and **recommended** that *a Study Group on the estimation of limit reference points be established. Peter Shelton (Canada) was named as a co-Chair with other co-Chairs to be selected from among the 2003 PA Workshop participants, and the Co-Chairs explore with colleagues possible themes for a Study Group working session in 2004.*

- b) **Further Development of NAFO Scientific Council PA Methodology** (page 201)

Having adopted this revised PA framework, the Scientific Council **recommended** that: *a meeting of the Joint Fisheries Commission/Scientific Council Working Group on the Precautionary Approach be held to discuss the implementation of the revised PA framework.*

XIII. OTHER MATTERS

4. Other Business (page 204)

The Council noted these events will ideally have invited experts or speakers, and the Council **recommended** that *the estimated \$10 000 should be allocated from the 2004 budget, to accommodate the costs of the 2 proposed upcoming events of the Scientific Council.*

FISHERIES ENVIRONMENT (STACFEN)

STACFEN made no formal recommendations during this 2003 meeting.

PUBLICATIONS (STACPUB)

STACPUB made no formal recommendations during this 2003 meeting.

RESEARCH COORDINATION (STACREC)

3. Fishery Statistics

a) **Progress Report on Secretariat Activities in 2002/2003** (Page 225)

STACREC noted that a number of countries were failing to report the absence of fishing activities but that such reports were essential for a complete record of NW Atlantic catches. Accordingly STACREC **recommended** that *the Notes for Completion of STATLANT 21A and 21B questionnaires be revised to include the requirement for national authorities to report the absence of fishing activities.*

b) **CWP Sessions 2003/2004**

ii) **CWP Intersessional Meeting, 2004** (page 227)

Continuing the usual practice, STACREC **recommended** that *the Deputy Executive Secretary attend the CWP Intersessional Meeting to be held in 2004.*

6. **NAFO Observer Program** (page 230)

STACREC **recommended** *the observer data be collected and archived on a set by set basis in a format consistent with SCS Doc. 00/23, as adopted by the Fisheries Commission, including all identifiers but that the data be made available to users without any identification of vessel name or country. Rather a unique identifier will be associated with each vessel and country and the user will not have access to the key to this code.*

7. **Review of SCR and SCS Documents** (page 230)

STACREC **recommended** that *in 2004 the summed abundance and biomass based on conversion of the length frequencies be presented for American plaice, cod, Greenland halibut and yellowtail flounder in the Div. 3NO surveys conducted by EU-Spain, and these be compared to the estimates from the method used to convert the CPUE.*

FISHERIES SCIENCE (STACFIS)

2. **General Review of Catches and Fishing Activity** (page 235)

Given the present reduced catches, these have the potential to represent a significant portion of the overall catch of a particular stock and species and the inability to assign these catches could impact the assessments. As such, STACFIS **recommended** that *the NAFO Secretariat write Contracting Parties to remind them that all catches should be apportioned as to species and area where caught.*

A. STOCKS OFF GREENLAND AND IN DAVIS STRAIT

Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 0 and Division 1A Offshore and Divisions 1B-1F

Research Recommendations (page 240)

STACFIS **recommended** that *the investigations of the by-catch of Greenland halibut in the shrimp fishery in Subareas 0 and 1 should be continued and the results should be made available before the assessment in 2003.*

STACFIS **recommended** that *the CPUE series from Div. 0B should be updated.*

STACFIS **recommended** that *a survey is carried out in the northern part of the Baffin Bay (north of the areas which have been surveyed in 2001) in order to investigate the distribution of Greenland halibut in the area.*

Greenland Halibut (*Reinhardtius hippoglossoides*) in Division 1A Inshore

Research Recommendations (page 244)

It was noted that in 2001 an annual gill net survey with small mesh net was started in the Disko Bay in order to estimate relative year-class strength of pre recruits to the fishery. STACFIS **recommended** that *results from the gill net survey for Greenland halibut Div. 1A be presented for review in June 2004.*

Voluntary logbooks were introduced in 1999 but have only covered a small proportion of the landings due to poor return rates. STACFIS **recommended** that *authorities consider means to ensure a higher return rate of inshore logbooks from the Greenland halibut commercial fishery in Div. 1A.*

STACFIS **recommended** that *investigations of by-catch of juvenile Greenland halibut in the commercial shrimp fishery in Subareas 0+1 be continued.*

STACFIS **recommended** that *the discard rate of 'small Greenland halibut' in Div. 1A be investigated.*

Demersal Redfish (*Sebastes* spp.) in Subarea 1

Research Recommendation (page 250)

STACFIS **recommended** that *the species composition and quantity of redfish discarded in the shrimp fishery in Subarea 1 be quantified.*

STACFIS **recommended** that *determination of maturity of redfish caught during surveys in Subareas 1 be carried out.*

Other Finfish in Subarea 1

Research Recommendation (page 253)

STACFIS **recommended** that *the species composition and quantity of other finfish discarded in the shrimp fishery in Subarea 1 be quantified.*

B. STOCKS ON THE FLEMISH CAP**Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 3M****Assessment Results** (page 261)

In order to assist in developing possible approaches to achieve this, STACFIS **recommended** that *information on the distribution on shrimp and small redfish (<12 cm) in Div. 3M be compiled for review during the June 2004 meeting of Scientific Council.*

STACFIS **recommended** that *an update of the Div. 3M redfish by-catch information be compiled on an annual basis, including the estimated weights and numbers of redfish caught annually in the Div. 3M shrimp fishery as well as tables showing their size distribution.*

American Plaice (*Hippoglossoides platessoides*) in Division 3M**Future Studies** (page 263)

STACFIS **recommended** that *for American plaice in Div. 3M current initiatives aiming at reconciling age determination from different age readers be continued.*

C. STOCKS ON THE GRAND BANK**Cod (*Gadus morhua*) in Divisions 3N and 3O****Reference Points** (page 267)

In view of the difficulty in determining if the current low productivity will persist in the immediate future, it was **recommended** that *for cod in Div. 3NO the Scientific Council review in detail the biological reference points in the context of the PA framework when the SSB has reached half the current estimate of B_{lim} .*

Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Divisions 3L and 3N**Stick Structure** (page 273)

STACFIS **recommended** that *(1) redfish data in Div. 3LN and Div. 3O be analyzed further to determine if a relationship exists between Div. 3LN and Div. 3O that may help in the interpretation of the indices of abundance; and (2) data be examined to evaluate the appropriateness of Div. 3LN and Div. 3O as management units for redfish.*

Capelin (*Mallotus villosus*) in Divisions 3N and 3O**Research Recommendation** (page 285)

STACFIS **recommended** that *initial investigations to evaluate the status of capelin in Div. 3NO utilize trawl acoustic surveys to allow comparison with the historical time series.*

Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 3O**Stock Structure** (page 291)

STACFIS again **recommended** that *(1) redfish data in Div. 3LN and Div. 3O be analyzed further to determine if a relationship exists between Div. 3LN and Div. 3O that may help in the interpretation of the indices of abundance; and (2) data be examined to evaluate the appropriateness of Div. 3LN and Div. 3O as management units for redfish.*

D. WIDELY DISTRIBUTED STOCKS**Roughhead Grenadier (*Macrourus berglax*) in Subareas 2 and 3****Research Recommendation** (page 295)

STACFIS **recommended** that *further investigations into yield-per-recruit analysis by sex be carried out for roughhead grenadier in SA 2 and 3.*

Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 2 and Divisions 3KLMNO**Recommendation** (page 327)

It is **recommended** that *in future assessments of Greenland halibut in Subarea 2 + Div. 3KLMNO the details of the calculation of the catch at age in the final year be provided for review.*

PART F

Scientific Council Annual Meeting, 15-19 September 2003

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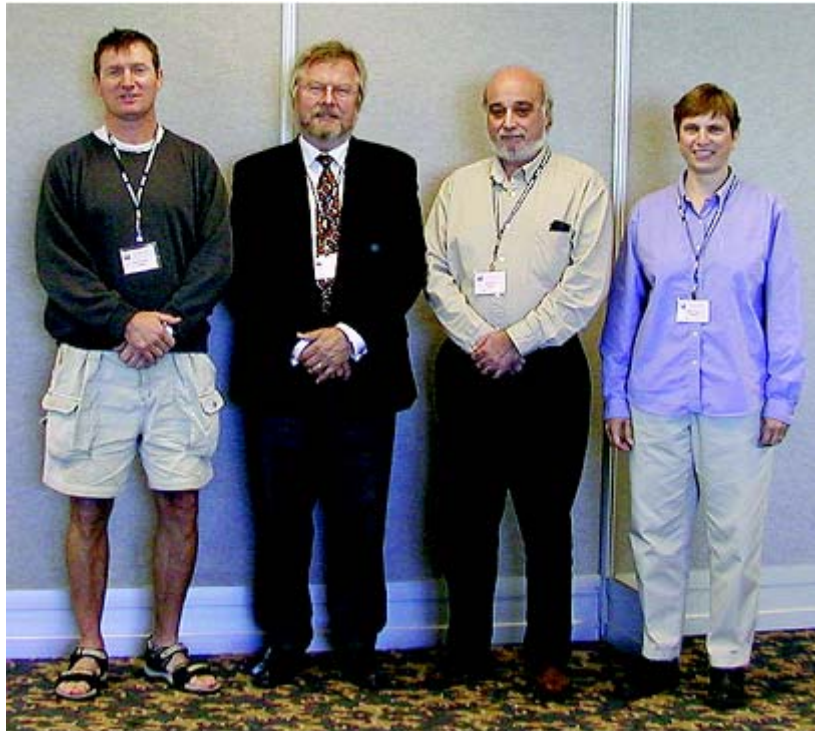
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The Chairs, Scientific Council Meeting, 15-19 September 2003 (left to right): D. E. Stansbury, Chair STACFIS
M. Stein, Chair STACPUB; R. K. Mayo, Chair Scientific Council; M. J. Morgan, Vice-Chair Scientific Council and
Chair STACREC.



Scientific Council in session, 15-19 September 2003.

SCIENTIFIC COUNCIL ANNUAL MEETING, 15-19 SEPTEMBER 2003

Chair: Ralph K. Mayo

Rapporteur: Tissa Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at the Holiday Inn Harbourview, Dartmouth, Nova Scotia, Canada, during 15-19 September 2003. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), Estonia, European Union (France, Germany, Portugal and Spain), Iceland, Japan, Russian Federation, Ukraine and United States of America.

The Executive Committee met prior to the opening session of the Council, and the Provisional Agenda, plan of work and other related matters were discussed. The Council noted the Scientific Council "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment" was successfully conducted during 10-12 September 2003. The Chair extended appreciation to the conveners.

The opening session of the Council was called to order at 1000 hours on 15 September 2003.

The Chair welcomed everyone to Dartmouth, Nova Scotia, Canada, and to this venue for the Meeting. The Deputy Executive Secretary was appointed rapporteur. The Chair thanked the Canadian hosts for the facilities and support offered for the meeting.

The Provisional Agenda was **adopted** as presented, noting some additional items may be addressed subject to Fisheries Commission requests during the course of this meeting.

The Council noted the Provisional Agenda for the Scientific Council Meeting on shrimp during 5-11 November 2003 in Dartmouth, Nova Scotia, Canada, was circulated 3 September 2003.

The Council and its Standing Committees met through 15-18 September 2003 as needed. At its sessions on 18 September 2003, the Council considered and **adopted** the reports of the Standing Committees (STACFIS, STACREC, STACPUB).

The concluding session was called to order at 1030 hours on 19 September 2003 when the Council addressed other outstanding agenda items. The Scientific Council then considered and **adopted** its report of this meeting.

The meeting was adjourned at 1150 hours on 19 September 2003.

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

The Report of the Scientific Council Workshop "Mapping and Geostatistical Methods for Fisheries Stock Assessment" is presented at Annex 1 of this Scientific Council Report.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, List of Representatives and Advisers/Experts of this meeting are given in Part H this volume.

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

II. REVIEW OF SCIENTIFIC COUNCIL RECOMMENDATIONS FROM JUNE 2003

The Council noted that recommendations made by the Scientific Council in 2003 will be addressed as needed under relevant agenda items at this meeting.

The Scientific Council decided that relevant recommendations from each Scientific Council Meeting should be transmitted by mail from the Chair of Scientific Council to the Chairs and Executive Secretary of the other Constituent Bodies for attention and appropriate action.

III. FISHERIES SCIENCE

The Council **adopted** the Report of the Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Don E. Stansbury. The full report of STACFIS is at Appendix I.

IV. RESEARCH COORDINATION

The Council **adopted** the Report of the Standing Committee on Research Coordination (STACREC) as presented by the Chair, M. Joanne Morgan. The full report of STACREC is at Appendix II.

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

1. STACREC reviewed the draft FAO Partnership Arrangement but noted the difficulty in doing so without legal expertise and given the short time period. STACREC **recommended** that *a draft version of Annex 2 (the section most pertinent to NAFO) of the FIRMS Partnership Arrangement should be prepared in advance of the June 2004 Scientific Council Meeting for review at that meeting.*
2. STACREC discussed a proposal to archive data utilized in stock assessments, on a regular basis, in a standardized format and common location. The importance of the ability to reproduce stock assessments was emphasized. STACREC **recommended** that *the Designated Experts would be asked to place electronic versions of their stock assessment data (including time series of catch, survey indices, numbers at age, catch at age, weights at age, and maturity at age) on the server, in formats currently available, at the Scientific Council meetings. The data files provided should be annotated and include all survey indices available and catches in aggregate form. The Secretariat will archive these data following Scientific Council Meetings and make them available to members of the Scientific Council thereafter.*
3. STACREC noted the tuna data were not required for the work of the Scientific Council, and STACREC **recommended** that *the Secretariat need not report tuna catches in the data tabulations prepared at NAFO and that CWP (and FAO) will be informed that tuna catches will no longer be recorded in the STATLANT 21 data.*

V. PUBLICATIONS

The Council **adopted** the Report of the Standing Committee on Publications (STACPUB) as presented by the Chair, Manfred Stein. The full report of STACPUB is at Appendix III.

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

1. STACPUB noted that it is important that papers from the Deep Sea Fisheries Symposium be published as far as possible in advance of another symposium on deep-sea fisheries scheduled for late-2003 in New Zealand. Recognizing the delays to date were as a result of a special situation, STACPUB **recommended** that *the 23 papers currently ready be placed on the NAFO Website by the beginning of October 2003, as part of Volume 31, ensuring a 2003 publication date.*

2. STACPUB **recommended** that *hard copy and web versions of Scientific Council Studies No. 37 be issued shortly.*
3. STACPUB **recommended** that *for the Scientific Council Reports, the Secretariat return to printing its reports on a calendar year basis, and that color printing be used where warranted in Scientific Council Reports. The Scientific Council Reports for calendar year 2003 should therefore be printed as the next "Redbook".*
4. STACPUB was informed that all Journal and Studies issues have been scanned and are available on CD. STACPUB **recommended** that *all scanned versions of the Journal and Studies be placed on the NAFO website as soon as possible, as this is a vital reference tool for users.*
5. Scientific Council Studies contains publications such as workbooks and workshop reports, and STACPUB concluded that this material must be made available in print. Therefore, STACPUB **recommended** that *Scientific Council Studies continue to be produced in printed versions recognizing the number of hard copies has been reduced.*

VI. RESPONSE TO SPECIAL REQUEST FROM FISHERIES COMMISSION

1. Update on advice for northern shrimp in Divisions 3LNO and Division 3M

Scientific Council reviewed the updated information available for Div. 3LNO and Div. 3M shrimp. Based on this review, Scientific Council concluded that there is no basis to change its advice for 2004.

This advice was submitted to the Fisheries Commission during the course of this meeting.

VII. REVIEW OF FUTURE MEETING ARRANGEMENTS

1. Scientific Council Meeting on Shrimp, November 2003

The Scientific Council noted the Provisional Agenda for the meeting of 5 -11 November 2003 was circulated on 3 September 2003 in accordance with the Rules of Procedure. The meeting will be held at NAFO Headquarters in Dartmouth. The Council noted that the meeting will have a LAN System wired to a server.

2. Scientific Council Meeting, 3-17 June 2004

The Scientific Council reconfirmed that its meeting of 3-17 June 2004 will be held at Alderney Landing, Dartmouth, Nova Scotia, Canada. The Council again emphasized that a LAN System, with technical support present throughout the meeting, was required for its work at the meeting.

3. Special Session, 8-10 September, and Annual Meeting, 13-17 September 2004

The NAFO Annual Meeting is scheduled for 13-17 September 2004, when Scientific Council conducts its meeting. The Scientific Council Special Session, the Symposium on "*The Ecosystem of the Flemish Cap*" will be held during 8-10 September 2004. The venue will be Dartmouth, Nova Scotia, Canada. The Council emphasized the space and facilities for this Symposium should be similar to what was used for the "*Pandalid Shrimp Fisheries*" Symposium held in September 1999 at the Holiday Inn, Dartmouth.

The Council again noted a LAN System with technical support is needed for the 13-17 September 2004 Scientific Council Meeting.

4. **Scientific Council Meeting on Shrimp, October/November 2004**

NAFO/ICES Secretariat Discussions on 2004 Shrimp Assessment Meeting

During its meeting of June 2003, the Scientific Council stated the following:

"Taking into account the Council Meeting of November 2004 may include the ICES request to assess northern shrimp stocks in the Northeast Atlantic, the Scientific Council considers it premature to tentatively set dates for the 2004 northern shrimp assessment meeting. The dates and venue of the 2004 meeting will be discussed by the Council at the November 2003 Meeting. In the interim, the Chair of Scientific Council will communicate with the Chair of ACFM to initiate discussion on the roles and responsibilities of both parties and the NAFO Secretariat will communicate with the ICES Secretariat to develop protocols for institutional arrangements. A report of these activities will be discussed by Scientific Council at the September 2003 Meeting."

Following NAFO and ICES Secretariat discussions, Scientific Council agreed to the following.

It is proposed that ICES participants of Working Groups assessing Pandalid shrimp stocks will come to the October/November 2004 NAFO Scientific Council Meeting on northern shrimp assessments. The NAFO and ICES shrimp stocks will be assessed during the course of the STACFIS sessions. The ICES assessment reports will be incorporated by stock in the STACFIS Report (e.g. in a special section titled "Shrimp Stocks for which ICES-ACFM provides advice").

The NAFO Scientific Council will conduct its business as usual, and provide management advice only on the usual NAFO stocks (i.e. those requested by Fisheries Commission and NAFO Coastal States). ICES participants who are from NAFO Contracting Parties will be welcome to participate in the Scientific Council discussions.

The relevant ICES section from the STACFIS report will be forwarded to ACFM to develop scientific advice, with the understanding that ICES experts addressed all issues regarding the ICES stocks, and were supported in the assessments by the NAFO experts present at the meeting. Should there be any additional data considered by ACFM after the Scientific Council shrimp meeting (e.g. new survey results), these data should be transmitted to STACFIS in a timely manner.

It is proposed that a formal request for STACFIS to do these ICES assessments can be sent by ACFM to Scientific Council, in the same manner that Scientific Council conversely employs for requests on harp and hooded seals.

As proposed at previous discussions, the NAFO and ICES Secretariats find the dates 27 October to 5 November 2004, \pm one or two days, to be most acceptable for the 2004 shrimp assessment meeting. Considering the NAFO practice of alternating shrimp meeting venues between NAFO Headquarters one year and away the next, the 2004 meeting is proposed to be held at ICES Headquarters. The NAFO Secretariat would provide the services as usual for conducting this Scientific Council Meeting, and preparing its report.

5. **Scientific Council Meeting, June 2005**

The Council agreed to the tentative date 2-16 June 2005 for this meeting to be held at the Alderney Landing, Dartmouth, Nova Scotia, Canada.

VIII. FUTURE SPECIAL SESSIONS

1. **Proposal for Special Session 2004**

The co-convenors Antonio Vazquez and Joanne Morgan reported significant progress in planning a session on "The Ecosystem of the Flemish Cap" to be held 8-10 September 2004, in advance of the 13-17 September 2004 Annual Meeting. A search of the literature indicates that substantial research activity has been devoted to the study of the Flemish Cap. Since 1972 more than 400 papers have been published in the scientific literature on

the topic. These papers have encompassed such diverse areas as oceanography, plankton, general biology and life history.

The co-convenors propose the following topics for inclusion in the Symposium: a) oceanography of the Flemish Cap, including description of any trends, the interactions between species and their environment, and oceanographic linkages with other areas, b) the isolation of the Flemish Cap or its connection to surrounding areas including studies on tagging, genetics, parasites and comparisons of biological parameters, c) general biology of species on the Flemish Cap, d) ecology of species on the Flemish Cap including studies of niche overlap, species assemblages and diet studies, e) the development of fisheries for species on the Flemish Cap and their effect on the system.

The Council was informed an announcement of the Symposium and Call for Papers should be ready by the end of September 2003. The participation of keynote speakers will be actively pursued. It is anticipated that papers from the Symposium will be published in a special volume of the *Journal of Northwest Atlantic Fishery Science*. A progress report for preparation for this Symposium will be presented at the June 2004 Meeting of Scientific Council.

2. **Topics for Special Session in 2005**

The Council reviewed a detailed outline for a proposed Symposium on "*The Incorporation of Environmental Information into Marine Stock Assessments*" presented by Eugene Colbourne (Chair, STACFEN). The Council noted the concern expressed by the STACFEN Chair that there were other Symposia with similar or related topics taking place elsewhere, and that further consideration was necessary on whether this may limit the available information and likely contributions for this Symposium.

Recognizing the progress made within the Working Group on Reproductive Potential (see also the Studies Issue No. 37 and the forthcoming NAFO Journal issue on the subject), the Council also considered the possibilities of developing a Symposium on the Reproductive Potential of Fish.

The Council agreed that a Symposium on either subject would be premature for September 2005. However, it was agreed further discussion on both subjects, as well as other topics, should take place during the June 2004 Scientific Council Meeting for a Scientific Council Symposium to be held in 2006.

IX. NAFO WORKING GROUPS OR WORKSHOPS

1. **Update on Activities of NAFO WG on Reproductive Potential**

The Council was pleased to note the NAFO Journal issue with 9 papers proposed by the Working Group on Reproductive Potential would be published shortly with a publication date of 2003. It was noted that the Studies No. 37 containing information on the Reproductive Potential databases was published on CD. The hard copy and web versions of both these publications will be ready soon.

The Chair of the NAFO Working Group on Reproductive Potential, Ed A. Trippel, conveyed to the Council that the activities since June 2003 primarily focused on making arrangements for the next meeting planned for 15-18 October 2003 at Woods Hole, Massachusetts, USA. The agenda has been circulated to address the ToR as discussed at the Scientific Council Meeting of June 2003.

2. **ICES/NAFO WG on Harp and Hooded Seals**

The Council noted a complete update on the "*Workshop to Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice*" sponsored by the joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP), hosted by the US National Marine Fisheries Service in Woods Hole, MA, USA, 11-13 February 2003, will be presented at the June 2004 Scientific Council Meeting.

X. SCIENTIFIC COUNCIL WORKING PROCEDURES AND PROTOCOL

1. Timetable and Frequency of Assessments

The following schedule of Scientific Council assessments reflects decisions that some stocks should be reviewed on a multi-year basis, with monitoring during the interim years.

Since 1999, the Scientific Council has agreed to the following overall schedule (+ is assessment year, *i* is interim monitor, 0 is no assessment) subject to the Fisheries Commission and Coastal State requests for advice and concurrence:

Stock	1999	2000	2001	2002	2003	2004	2005
<i>Current schedule</i>							
MULTI-YEAR ASSESSMENTS							
American plaice in Div. 3LNO	+	<i>i</i>	+	+	+	<i>i</i>	+
Cod in Div. 3NO	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>	+
Redfish in Div. 3LN	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>	+
Witch flounder in Div. 2J3KL	+	+	+	<i>i</i>	+	<i>i</i>	+
Redfish in Div. 3M	+	+	+	+	+	<i>i</i>	+
Roughhead grenadier in SA 2+3	+	+	<i>i</i>	0	+	<i>i</i>	+
Redfish in SA 1	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>	+
Other fish in SA 1	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>	+
Cod in Div. 3M	+	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>
American plaice in Div. 3M	+	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>
Witch flounder in Div. 3NO	+	+	<i>i</i>	+	<i>i</i>	+	<i>i</i>
Yellowtail flounder in Div. 3LNO	+	+	+	+	<i>i</i>	+	<i>i</i>
<i>Illex</i> Squid in Subareas 3 and 4	+	+	+	+	<i>i</i>	+	<i>i</i>
Roundnose grenadier in SA 0+1	+	<i>i</i>	<i>i</i>	+	<i>i</i>	<i>i</i>	+
Capelin in Div. 3NO	+	+	+	+	+	<i>i</i>	+
ANNUAL ASSESSMENTS							
Greenland halibut in SA2 and Div 3KLMNO	+	+	+	+	+	+	+
Northern Shrimp in Div. 3M	+	+	+	+	+	+	+
Northern Shrimp in Div. 3LNO	+	+	+	+	+	+	+
Northern Shrimp in SA 0+1	+	+	+	+	+	+	+
Northern Shrimp in Denmark Strait	+	+	+	+	+	+	+

Scientific Council reviewed the timetable and, noting that most of the multi-year assessments covered a 2-year period, discussed the possibility of extending the assessment period for some stocks. Discussions on specific stocks will take place at the June 2004 Scientific Council Meeting.

2. Revised Precautionary Approach Framework

A revised framework was developed at the NAFO Scientific Council Workshop on the Precautionary Approach to Fisheries Management during 31 March-4 April 2003 as described in SCS Doc. 03/05. The framework proposed at the Workshop was subsequently reviewed at the June and September 2003 Scientific Council meetings and was adopted by Scientific Council after some revisions. The framework includes a more flexible set of management strategies and courses of action as well as reference point definitions that take account of the agreed roles and responsibilities of the Scientific Council and the Fisheries Commission as given in FC Doc. 98/2.

a) **Proposed NAFO Precautionary Approach Framework**

The following is the proposed revised NAFO Precautionary Approach Framework developed at the 2003 Scientific Council Workshop on the Precautionary Approach to Fisheries Management as modified by the Council at the June and September 2003 Meetings. For stocks where the Scientific Council can conduct risk analyses, the security margins (F_{buf} and B_{buf}) will be based on the risk levels specified by the Fisheries Commission. For stocks where risk analyses are not possible, the Fisheries Commission will specify the security margins.

The Council agreed that this complete revised version should be issued as NAFO SCS Doc 03/23 shortly.

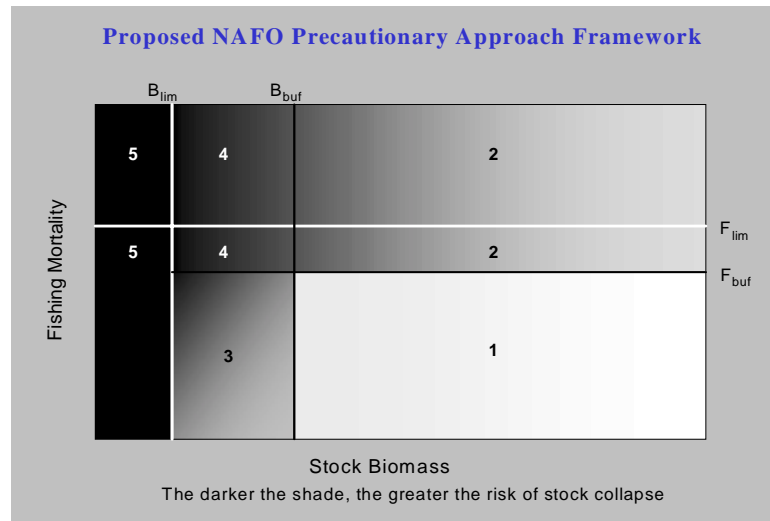


Fig. 1. Schematic depicting a revision to the proposed NAFO PA framework adopted by the Scientific Council in September 2003.

Fishing Mortality Reference Points

F_{lim} = A fishing mortality rate that should only have a low probability¹ of being exceeded. F_{lim} cannot be greater than F_{msy} . If F_{msy} cannot be estimated, then an appropriate surrogate may be used instead.

F_{buf} = A fishing mortality rate below F_{lim} that is required in the absence of analyses of the probability that current or projected fishing mortality exceeds F_{lim} . In the absence of such analyses, F_{buf} should be specified by managers and should satisfy the requirement that there is a low probability¹ that any fishing mortality rate estimated to be below F_{buf} will actually be above F_{lim} . The more uncertain the stock assessment, the greater the buffer zone should be. In all cases, a buffer is required to signify the need for more restrictive measures.

When the stock is above B_{buf} and fishing mortality is below F_{buf} , a flexible fishing mortality rate will be selected by managers to achieve desired management objectives, subject only to the constraints defined by the limit and buffer reference points. In particular, a target F should be chosen to ensure that there is a low probability¹ that F exceeds F_{lim} , and a very low probability² that biomass will decline below B_{lim} within the foreseeable future³.

¹ low probability might be defined as # 20%, but the actual level should be specified by managers

² very low probability might be defined as # 5-10%, but the actual level should be specified by managers

³ foreseeable future might be defined as 5-10 years, but the actual time horizon should be specified by managers

Stock Biomass Reference Points

B_{lim} = A biomass level, below which stock productivity is likely to be seriously impaired, that should have a very low probability² of being violated.

B_{buf} = A stock biomass level above B_{lim} that is required in the absence of analyses of the probability that current or projected biomass is below B_{lim} . In the absence of such analyses, B_{buf} should be specified by managers and should satisfy the requirement that there is a very low probability² that any biomass estimated to be above B_{buf} will actually be below B_{lim} . The more uncertain the stock assessment, the greater the buffer zone should be. In all cases, a buffer is required to signify the need for more restrictive measures.

Management strategies and courses of action are as follows:

MANAGEMENT STRATEGIES AND COURSES OF ACTION (TIME HORIZONS AND ACCEPTABLE RISK LEVELS SPECIFIED BY MANAGERS)	
Zone 1	Safe Zone: Select and set fishing mortality from a range of F values that have a low ¹ probability of exceeding F_{lim} in a situation where stock biomass (B) has a very low ² probability of being below B_{lim} . In this area, target reference points are selected and set by managers based on criteria of their choosing (e.g. stable TACs; socio-economic considerations).
Zone 2	Overfishing Zone: Reduce F to below F_{buf} .
Zone 3	Cautionary F Zone: The closer stock biomass (B) is to B_{lim} , the lower F should be below F_{buf} to ensure that there is a very low ² probability that biomass will decline below B_{lim} within the foreseeable future ³ .
Zone 4	Danger Zone: Reduce F to below F_{buf} . The closer stock biomass (B) is to B_{lim} , the lower F should be below F_{buf} to ensure that there is a very low ² probability that biomass will decline below B_{lim} within the foreseeable future ³ .
Zone 5	Collapsee Zone: F should be set as close to zero as possible.

Key features of the framework include:

- There must be a very low probability² that management actions result in projected biomass dropping below B_{lim} within the foreseeable future³. Below B_{lim} , fishing mortality should be kept as close to zero as possible.
- The fishing mortality limit should be no higher than F_{msy} . There should be a low probability¹ that realized fishing mortality will exceed F_{lim} .
- Fishing mortality targets are flexible, as long as they remain in Zone 1 of Fig. 1.
- If a stock assessment generates a current or projected biomass with some probability distribution, operationally the biomass distribution would be evaluated against B_{lim} . In other words, a risk analysis will provide the probability that current or projected biomass is below B_{lim} . If no probability distribution of biomass is available, but a value for B_{lim} exists, Fisheries Commission should establish a buffer zone (B_{buf}), against which the biomass would be evaluated. The same procedure should be used to establish a fishing mortality buffer (F_{buf}). If biomass is in the zone between B_{lim} and B_{buf} , action to reduce F below F_{buf} is required to ensure that there will be a very low probability² that biomass declines below B_{lim} in the foreseeable future³.

The revised framework attempts to address the managers' concerns as follows:

1) Prescribed harvest control rules (no fishing) below B_{lim} or B_{buf}

The new framework allows fishing below B_{buf} , subject to constraints such as ensuring a very low probability² that biomass will fall below B_{lim} in the foreseeable future³. However, below B_{lim} , fishing mortality should be as close to zero as possible.

2) A fishing mortality limit at F_{msy} :

Reasons for continuing to advise that $F_{lim} = F_{msy}$ are:

- Perhaps most importantly, F_{msy} as a limit is in conformance with the Precautionary Approach as described in several United Nations agreements (in particular, Annex II of the United Nations Straddling Stocks Agreement).
- Fishing somewhat below F_{msy} results in a relatively small loss in average catch, but a large increase in average biomass (which, in turn, results in a decreased risk to the fish stock, an increase in CPUE, and a decrease in the costs of fishing).
- Traditional bio-economic models indicate that the fishing mortality associated with maximum economic yield (F_{mey}) is usually considerably less than F_{msy} .
- Ensuring no major stock is fished harder than the single-species F_{msy} has often been recommended as a good first step towards ecosystem-based management. Ecosystem-based management will likely require even more conservative fishing mortality targets than "traditional" single-species-based management.

3) The perception of a linear decrease in fishing mortality from the biomass target to the biomass buffer:

- There is a range of options open to managers in this part of the framework (for example, no reduction in F is prescribed if stock biomass is above B_{buf} and F is below F_{buf}). Managers also decide on the levels of B_{buf} and F_{buf} in those cases where the risk of biomass being below B_{lim} or the risk of fishing mortality being above F_{lim} cannot be provided.

4) No consideration of the desirability for stable TACs:

- This is a difficult concept to capture in a simple schematic such as Fig. 2; however, considerable flexibility exists for managers in setting target F levels. Stable TACs are easier to achieve if the fishery remains in Zone 1. Furthermore, maintenance of biomass well above B_{lim} will minimize the instability caused by fishery closures.

5) No consideration of multi-species situations:

- Although the proposed PA Framework is focused on single species, ensuring that no individual species is fished harder than the single-species F_{msy} has frequently been suggested as a first step towards satisfying several important and common ecosystem objectives. In addition, two other aspects of multi-species management were considered in the proposed revision of the PA Framework. First, the de-emphasis of B_{msy} avoids the problem of the impossibility of maintaining all stocks in a multi-species assemblage simultaneously at their respective single-species B_{msy} levels. Second, by replacing the requirement that fishing mortality be zero when biomass is below B_{lim} with a requirement that fishing mortality to be as close to zero as possible in this situation, there is now recognition of the need for a certain amount of flexibility to account for technical interactions that result in unavoidable by-catch of depleted species.

b) **Limit Reference Point Study Group (LRP)**

At the Scientific Council Workshop on the Precautionary Approach held March-April 2003 it was noted that it is the responsibility of Scientific Council to calculate LRPs. Given that a number of approaches for LRPs have been discussed in the literature, it was recognized that there is a need to review the strengths and weaknesses of these alternative approaches and to make recommendations to Scientific Council on which are the most appropriate for defining LRPs. These recommendations are needed for stocks ranging from data-rich to data-poor and with a range of life-history parameters.

As a result Scientific Council **recommended** that *a Study Group on the estimation of limit reference points be established. Peter Shelton (Canada) was named as a co-Chair with other co-Chairs to be selected, and the Co-Chairs explore with colleagues possible themes for a Study Group working session in 2004.*

The following are the Terms of Reference for the Study Group:

- Review the properties of alternative LRPs, including the ability to quantify risk, and determine strengths and weaknesses of various alternatives.
- Provide guidance regarding the most appropriate approaches for stocks ranging from data rich to data poor and for a range of life-history strategies
- Provide example applications to Subarea 2 + Div. 3KLMNO Greenland halibut, Div. 3LNO yellowtail flounder and Div. 3LNO Thorny skate based on existing and recent biological, fisheries and survey data; recent stock assessments; and management measures. Other example stocks may also be explored.

c) **Possible Joint FC/SC Meeting**

The Council noted there could be a possible Intersessional Joint FC/SC Meeting on the Precautionary Approach. The Scientific Council discussed the possible remit for such a meeting and agreed the Chair of the Scientific Council will consult with the Chair of the Fisheries Commission, and work with the Chair(s) of the Joint Working Group to develop a work plan for that meeting.

XI. ELECTION OF STACFIS CHAIR

The Nominating Committee consisting of Joanne Morgan (Canada), Fred Serchuk (USA) and Antonio Vazquez (Spain) as appointed by the Chair, was requested to submit any nomination(s) for the office of the Chair of the Standing Committee on Fishery Science (STACFIS). Hilario Murua (EU-Spain) was nominated by the Committee. The Council elected him by unanimous consent.

XII. OTHER MATTERS

1. Consideration of Memorandum of Understanding with ICES

Scientific Council reviewed the submission with respect to "Memorandum of Understanding Between the Northwest Atlantic Fisheries Organization (NAFO) and The International Council for the Exploration of the Sea (ICES)" and the following text was agreed to:

Recognizing that the Northwest Atlantic Fisheries Organization (NAFO) hereinafter called "the Organization", exists to promote the conservation and optimum utilization of the fishery resources of the Northwest Atlantic area within a framework appropriate to the regime of extended Coastal State jurisdiction over fisheries, and accordingly to encourage international cooperation and consultation with respect to these resources; whose object is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the NAFO Convention Area.

Recognizing that the International Council for the Exploration of the Sea, hereinafter called "the Council", exists to (a) promote and encourage research and investigations for the study of the sea particularly related to the living resources thereof; (b) draw up programmes required for this purpose and to organize, in agreement with its Contracting Parties, such research and investigations as may appear necessary; (c) publish or otherwise disseminate the results of this work; and (d) provide scientific information and advice to Member Country governments, and the regulatory commissions with which cooperative relationships have been established. In order to carry out these tasks appropriately and efficiently the Council seeks, *inter alia*, to establish and maintain mutually agreed working arrangements with other international organizations which have related objectives.

Recognizing that the Scientific Council of the Organization is that body within the Organization that is most closely aligned with the Council as regards work activities and objectives, and that past collaborations have been of mutual benefit to the Organization and the Council.

Recognizing that there are mutual benefits to be gained, the Organization and the Council have, therefore, agreed to the following Memorandum of Understanding to be implemented through the Scientific Council of the Organization:

1. The Organization and the Council will encourage
 - a) reciprocal consultations and regular contact between the Organization and the Council on matters of common interest in the field of marine scientific research and related aspects, particularly those involving studies in the North Atlantic Ocean and its adjacent seas, and which fall within their respective competence;
 - b) regular exchanges between the Organization and the Council of information, documents, and publications relating to programme and project plans and to the results of activities of mutual interest, joint or otherwise;
 - c) joint activities, including the establishment of joint subsidiary bodies or other suitable arrangements as required, the study and reporting on matters of common interest, and the support of those programmes which are of joint concern and benefit.
2. The Organization and the Council will invite each other to be represented at their meetings that are of common interest, to the extent that this is possible within their respective working procedures.
3. The terms of this Memorandum of Understanding may be revised upon mutual agreement by the Organization and the Council. Either may withdraw from the Understanding at any time subject to giving one year's written notice.
4. Recognizing and fully respecting their various mandates, policies and priorities, the signatories agree that this Memorandum of Understanding shall enter into force upon signature and shall remain in force except for conditions as pursuant to Clause 3 above.

Signed:

President
International Council for the
Exploration of the Sea

President
Northwest Atlantic Fisheries Organization

Date: September, 2003

Date: September, 2003

2. Other Business

The Scientific Council again nominated Fernando Gonzalez-Costas (EU-Spain) to represent the Scientific Council at the ICES North Western Working Group Meetings of 2004.

XIII. ADOPTION OF REPORTS

1. Consideration of Report of the Geostatistics Workshop of 10-12 September 2003

The co-conveners, David Kulka and Lisa Hendrickson, of the Geostatistics Workshop held during 10-12 September 2003, presented a complete report of the meeting. The Council noted a summary is at Annex 1 of this Scientific Council Report, and the complete report will be published as SCS Doc. 03/22.

The Council noted the success of the Workshop and extended its appreciation to the co-conveners.

2. Committee Reports STACFIS, STACREC, STACPUB

The Council at its meetings on 18 September 2003 considered and **adopted** the reports of its Standing Committees, STACFIS, STACREC and STACPUB. These reports are given in Appendix I, II and III, respectively.

3. Report of Scientific Council

The Council at its concluding session on 19 September 2003 considered and **adopted** its own report.

XIV. ADJOURNMENT

The Chair thanked the members of the Scientific Council for their contributions during this meeting, noting especially the work of the Committee Chairs. Appreciation was extended to the NAFO Secretariat for their support during the meeting. Noting that this meeting concludes 6 consecutive years in different offices within the Scientific Council, the Chair extended sincere appreciation to all of the members of the Scientific Council over the past years for the hard work and spirit of cooperation that characterizes the Scientific Council. The Chair also noted that many Scientific Council officers will change at the end of this meeting, and thanked the outgoing officers for their hard and dedicated work and extended the incoming officers the best wishes. There being no other business, the meeting was adjourned at 1150 hours on 19 September 2003.

ANNEX 1. REPORT OF SCIENTIFIC COUNCIL SPECIAL SESSION

WORKSHOP ON MAPPING AND GEOSTATISTICAL METHODS FOR FISHERIES STOCK ASSESSMENT

10-12, September, 2003

The Scientific Council of the Northwest Atlantic Fisheries Organization held a Special Session, "*Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment*", at the Holiday Inn in Dartmouth, Nova Scotia during 10-12 September 2003. The Workshop was convened by David Kulka (Canada) and Lisa Hendrickson (USA) and the instructors were: Dr. Nicolas Bez (Centre de Géostatistique, Fontainebleau, France), Dr. Reiner Schlitzer (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany), and Jerry Black, Dr. Mark Simpson, and David Kulka (Department of Fisheries and Oceans, Canada). There were 28 participants from Canada, Denmark (Faroe Islands and Greenland), Estonia, the European Union (France, Germany, Portugal, and Spain), the Russian Federation, and the United States of America. The agenda (see below), relevant literature citations and links to the software utilized in the workshop were posted on the NAFO website prior to the workshop.

Lectures pertaining to geostatistical concepts and methods were presented and followed by hands-on exercises that incorporated survey and fisheries data from the Grand Banks. The objective of the workshop was to provide participants with a basic understanding of geostatistical concepts and methods, as well as the tools to apply this knowledge to fisheries stock assessment using freeware mapping and geostatistical software.

Data visualization and analysis techniques were presented using the GIS (Geographical Information System) software packages of SPANS, ACON and Ocean Data View. Participants viewed demonstrations of the software and completed hands-on exercises. Geostatistical concepts and methods, particularly related to kriging, were also presented and participants learned the basics of using the "R" software package (freeware) and conducted geostatistical analyses using routines prepared by programmers at the Centre de Géostatistique as well as those developed during the workshop.

The impetus for the workshop was an unfamiliarity of many Scientific Council members with a Voronoi analysis of yellowtail flounder distribution on the Grand Banks. As a result of the workshop, Scientific Council members now have a better understanding of basic geostatistical concepts and methods; particularly kriging. In addition, the workshop provided members with freeware software tools and hands-on exercises that can be applied to geo-referenced data from the NAFO region in the future.

Participants discussed how they might apply the knowledge gained at the workshop. A recommendation was made to investigate institutionalization of the mapping and geostatistical analyses presented by accessing them via an internet site, such as the GMBIS website, which already provides a mechanism for mapping any geo-referenced data set. However, it was also noted that the time commitment and programming knowledge required represent potential obstacles to implementation. Multiple participants expressed positive feedback about the workshop, particularly with respect to covering such a complex topic, in a short time span, in an understandable way and with the use of data from the Grand Banks in the vicinity of the NRA. Workshop participants felt that the knowledge gained at the workshop would now allow them to apply geostatistical analyses in their stock assessments.

A full Report on the Workshop containing descriptions of methodology and example analyses will be published as NAFO SCS Doc. 03/22 and made available on the NAFO Website.

WORKSHOP AGENDA

DAY 1

0800-0900 **Establish LAN connections and download software**

0900-0930 **Introduction**

Workshop Objectives, Agenda and Introduction of Instructors (D. Kulka/L. Hendrickson)

0930-1000 **Overview**

Workshop overview and brief history of geostatistics use in fisheries stock assessment (N. Bez)

- Data visualization (mapping techniques)
- Interpolation techniques - Point to Surface Transformation (i.e. Contouring, Voronoi, Potential Mapping, Kriging)
- Overlay modeling
- Geostatistics

Data Visualization

1000-1015 **Overview of mapping** (D. Kulka)

The value of visualization of biological and environmental data in the marine context will be reviewed. Spatial data structure will be described and illustrated.

1015-1035 *Break*

1035-1200 **Use of ACON software** (J. Black)

Participants will use ACON software (freeware) to map and analyze NAFO survey data. Transformation and visualization of point patterns to surface distributions will be examined. Tessellation methods such as plotting Voronoi polygons and the use of Delauney triangulation will be described.

1200-1330 *Lunch*

1330-1430 **SPANS software demonstration** (D. Kulka)

Key functions in SPANS (Spatial Analysis System), a GIS, will be demonstrated. Potential mapping, a point to surface transformation will be demonstrated. Potential mapping provides an optimal interpolated estimate for locations that were not sampled. The resulting classified surface (raster) facilitates analyses not possible with the original point data.

1430-1500 **Generalized Additive Models** (M. Simpson)

1500-1520 *Break*

1520-1830 **Use of Ocean Data View software** (R. Schlitzer)

Participants will use Ocean Data View software to map and analyze NAFO survey data. This exercise will involve exploration and visualization of oceanographic and other geo-referenced profile or sequence data.

DAY 2**Geostatistics**0830-1030 **Surface Overlay and Data Modelling** (D. Kulka)

Demonstration of overlaying surfaces and modeling to examine spatial relationships or to calculate spatial statistics. Examples will include species co-occurrence, habitat preferences and biomass calculations using NAFO data.

1030-1050 *Break*1050-1200 **Why should we use geostatistics?** (N. Bez)

- Sampling Theory (Cochran, 1977) is based on the assumption that the sample values can be modeled as independent and identically distributed random variables. Each of these concepts will be discussed. When this framework is not consistent with the characteristics of either the sampling or the data, one alternative method is to use geostatistics.
- Modeling and use the use of autocorrelation present in the sample values of a given variable. Kriging will be presented as a method to allow weighting of the data according to a) spatial structure, b) relative location in space, and c) position relative to the point or the polygon to be estimated.
- Analysis of spatially-correlated (multivariate geostatistics)

1200-1330 *Lunch*1330-1530 **The variogram** (N. Bez)

- Background on variance
- Decomposition of the variance into distance bins
- Random Functions
- Variogram definition
- Estimation of the variogram in practice
- Models
- Properties
- Interpretation of the spatial structure

1530- 1550 *Break*1550- 1730 **Estimation and interpretation of experimental variograms** (N. Bez)

- Exercises using R (freeware version of Splus) and geostatistical routines.

DAY 30830- 1030 **The variogram, continued** (N. Bez)

- The variogram as a tool to compute variances
- Nugget effect and the reduction of variance
- Cases where statistics is relevant (pure nugget effects)
- Weighted variograms

Kriging

- Principles
- Equations
- Kriging properties
- Illustrations
- Difference between the variable and its kriging
- Kriging weights
- Local estimation as opposed to global estimations

1030- 1050 *Break*

1050-1200 **Kriging exercises** (N. Bez)

Objectives include modeling the variograms and using them for kriging. Changes in the output maps by varying the variogram parameters will be examined.

1200- 1330 *Lunch*

1330-1530 **Elements of the transitive geostatistical approach** (N. Bez)

- Center of Gravity and Inertia to summarize survey maps and to describe a series of survey data.
- Elements of global estimation (estimation variances, survey design, etc.)
- Presentation of alternative software (EVA, Isatis)

1530-1550 *Break*

1550-1615 **Comparison of Techniques to solve a Practical Fisheries Problem**

1615-1700 **Wrap-up discussion**

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Participants of Workshop on "Mapping and Geostatistical Methods for Fisheries Stock Assessment, 10-12 September 2003.

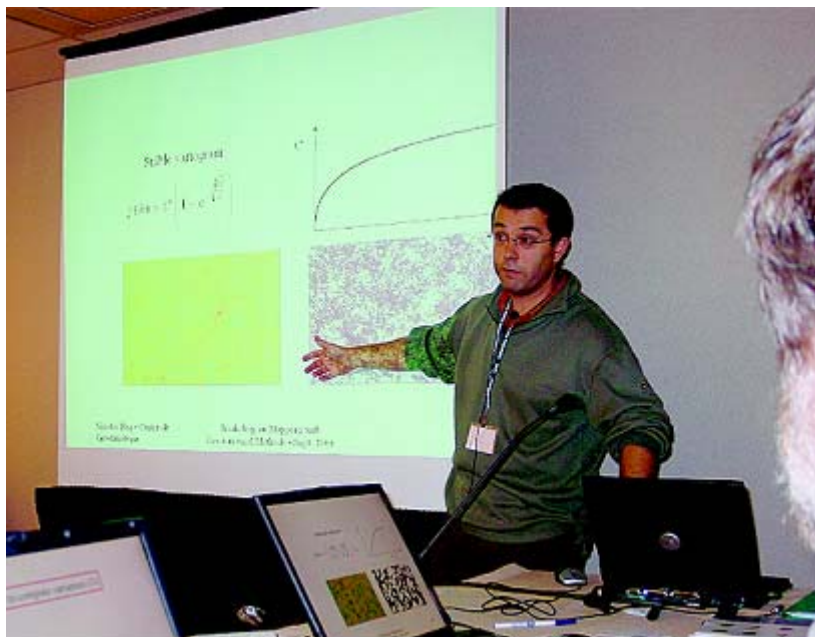
Left to Right: Dave Kulka, Bill Brodie, Kai Wieland, Cindy Kerr, Steve Walsh, Don Stansbury, Mark Simpson, Karen Dwyer, Dawn Maddock Parsons, Ralph Mayo, Jerry Black, Dave Orr, Lisa Hendrickson, Ricardo Alpoim, Fred Serchuk, Antonio Avila de Melo, Dorothy Auby, Reiner Schlitzer, Joanne Morgan, Nicolas Bez, Bob Branton, Toomas Saat, Arni Nicolajsen, Ray Bowering, Antonio Vazquez, Manfred Stein, Igor Sigae, Vladimir Shibanov, Konstantin Gorchinsky, Vladimir Babayan.

Front Centre: Fernando Gonzalez-Costas

Missing: Tissa Amaratunga, Leonid Kokovkin



Left to Right: Mark Simpson – Instructor (Department of Fisheries and Oceans, Canada), David Kulka – Co-convenor/Instructor (Department of Fisheries and Oceans, Canada), Jerry Black – Instructor (Department of Fisheries and Oceans, Canada) Dr. Nicolas Bez – Instructor (Centre de Géostatistique, Fontainebleau, France), Dr. Reiner Schlitzer – Instructor (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany) and Lisa Hendrickson – Co-convenor (USA).



Nicolas Bez giving overview and brief history of Geostatistics used in fisheries stock assessment.

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

Chair: Don E. Stansbury

Rapporteur: Don Stansbury

I. OPENING

The Committee met at the Holiday Inn Harbourview, Dartmouth, Canada during 15-19 September 2003, to consider and report on matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), Estonia, European Union (France, Germany, Portugal and Spain), Iceland, Japan, Russian Federation, Ukraine and United States of America.

The Chair, D. E. Stansbury (Canada), opened the meeting by welcoming participants. The Provisional Agenda was reviewed and **adopted** with no modifications.

II. NOMINATION OF DESIGNATED EXPERTS

STACFIS reviewed the list of Designated Experts for the stocks, which have to be assessed and for which management advice is requested. The final nomination of the Designated Experts will be conducted through the normal confirmation process between the various national institutes and the Secretariat. The nominations to date by STACFIS for the 2004 assessments are:

- From the Instituto de Investigaciones Marinas, Eduardo Cabello, 6, 36208 Vigo, Spain
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- for Cod in Div. 3M Antonio Vazquez
- From the Fish, Resour. – AZTI Foundation, Herrera Kaia,Portualde z/g, 20110 Pasaia, Basque Country, Spain [Phone: +34 9 43 00 48 00 – Fax: +34 9 43 00 48 01 – E-mail: hmurua@pas.azti.es]
- for Roughhead grenadier in SA 2+3 Hilario Murua
- From the Instituto Nacional de Investigacao Agrária e das Pescas (INIAP/IPIMAR), Av. de Brasilia, 1449-006 Lisbon, Portugal
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Redfish in Div. 3M Antonio Avila de Melo amelo@ipimar.pt
- From the Greenland Institute of Natural Resources, P. O. Box 570, DK-3900 Nuuk, Greenland
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- for Northern shrimp in SA 0+1 Carsten. Hvingel hvingel@natur.gl
Redfish in SA1 Helle Siegstad helle@natur.gl
Other Finfish in SA1 Helle Siegstad helle@natur.gl
Northern shrimp in Denmark Strait Carsten Hvingel hvingel@natur.gl
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- for Roundnose grenadier in SA 0+1 Ole Jørgensen
Greenland halibut in SA 0+1 Ole Jørgensen

- From the Marine Research Institute, Skulagata 4, P. O. Box 1390, 121 - Reykjavik, Iceland
[Phone: +354 552 0240 – Fax: +354 562 3790 – E-mail: unnur@hafro.is]

for Shrimp in Div. 3M

Unnur Skúladóttir

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for Capelin in Div. 3NO

Konstantin V. Gorchinsky

For the following stocks the nomination of Designated Experts has been deferred to October 2003, and the Secretariat was requested to contact the necessary national institutes well in advance of this:

for Greenland halibut in Div. 1A
Squid in SA 3+4
Cod in Div. 3NO
American Plaice in Div. 3LNO
Witch flounder in Div. 3NO
Witch flounder in Div. 2J3KL
Yellowtail flounder in Div. 3LNO
Greenland halibut in SA 2+3KLMNO
Roundnose grenadier in SA 2+3
Shrimp in Div. 3LNO
Elasmobranchs

III. OTHER MATTERS

1. Review of SCR and SCS Documents

There were no SCR or SCS documents to review.

2. Other Business

An errata sheet was circulated to Scientific Council and Fisheries Commission to correct figures in the November 2002 STACFIS report on Northern Shrimp in Div. 3M. STACFIS noted these corrections will appear on NAFO website only.

There being no other business, the Chair extended particular gratitude to the Secretariat for their assistance and support not only for work at the meetings but throughout the year. Acknowledgements were also given to the chair of Scientific Council for his overall leadership for the past two years and all participating members for their cooperation in conducting their assessments. The meeting was adjourned.

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

Chair: M. Joanne Morgan

Rapporteur: Lisa C. Hendrickson

The Committee met at the Holiday Inn Harbourview, Dartmouth, Nova Scotia, during 15-18 September 2003 to discuss matters pertaining to statistics and research referred to it by the Scientific Council. Representative attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), Estonia, European Union (France, Germany, Portugal and Spain), Iceland, Japan, the Russian Federation, Ukraine and the United States of America. The Deputy Executive Secretary was in attendance.

1. Opening

The Chair opened the meeting by welcoming the participants. Lisa C. Hendrickson (USA) was appointed rapporteur. The Provisional Agenda as presented was **adopted**.

2. Fisheries Statistics

a) Progress Report on Secretariat Activities in 2002/2003

i) Acquisition of STATLANT 21A and 21B reports for recent years

The Deputy Executive Secretary informed the Committee that there have been some STATLANT data submissions since June 2003. It was noted that the 2000 STATLANT 21B data submissions are almost complete.

Noting recent recommendations regarding submission of wolffish data by species, STACREC was informed that no new STATLANT 21B have been submitted, and that wolffish catches in the Provisional Monthly catch reports are still not being reported by species. It was decided to continue to monitor wolffish reporting and to decide at the June 2004 Committee Meeting whether additional steps are required to implement species-specific reporting.

ii) Publication of statistical information

The update on acquisition of STATLANT 21B data showed that the 2000 data are mostly complete, and the Statistical Bulletin could be published shortly.

b) CWP Intersessional Meeting in 2004

In June 2003, Scientific Council **recommended** that *the Deputy Executive Secretary attend the CWP Intersessional Meeting to be held in 2004*. Due to budgetary constraints noted by STACFAD during this meeting STACREC was informed the Deputy Executive Secretary would be unable to attend. STACREC recognizes the continued importance of the CWP to the business of NAFO, and STACREC anticipates that the Deputy Executive Secretary will attend future meetings.

3. Research Activities in 2003/2004

STACREC noted and reviewed the listings of Biological Sampling Data and survey activities in 2003 to early-2004 prepared by the NAFO Secretariat. These listings, usually published as Tables 3, 4 and 5 in the June report of STACREC, were found to be well reviewed and updated, and STACREC agreed the reports of research activities would be now published in SCS Doc. 03/20.

STACREC discussed the new process of reviewing these Tables prior to the September Meeting. It was agreed that this process increased the accuracy of the tables and should be continued in future years.

4. **FAO Fisheries Global Information System (FIGIS)**

- a) The Deputy Executive Secretary presented an overview of a meeting that he attended; the Ad Hoc Meeting on the Establishment of the Fisheries Resources Monitoring System (FIRMS) that was held 30 June-1 July 2003 at FAO headquarters in Rome, Italy. The meeting was also attended by representatives of fisheries organizations and programs, many of whom have previously participated in the development of the FIRMS Partnership Arrangement.

Two key objectives of the meeting were to:

- Develop a final version of the Partnership Arrangement, followed by procedures for the establishment of the FIRMS Partnership (an attachment to the Arrangement).
- Address the issue of the Rules of Procedure for a FIRMS Steering Committee (FSC), in terms of both content and future development.

The full text of the draft document was addressed in conceptual, technical, legal and administrative detail. The Articles and structural arrangement of the Partnership Arrangement were reviewed and revised. There was agreement by the end of the meeting that the meeting had been highly successful in developing a final draft.

Meeting participants revised the draft Rules of Procedure for the FSC and recognized that the text might be entirely replaced at the first meeting of the FSC or heavily adapted to meet the overall Partnership's needs.

STACREC reviewed the draft FAO Partnership Arrangement but noted the difficulty in doing so without legal expertise and given the short time period. STACREC **recommended** that *a draft version of Annex 2 (the section most pertinent to NAFO) of the FIRMS Partnership Arrangement should be prepared in advance of the June Scientific Council Meeting for review at that meeting.*

- b) Intersessional review (since June 2003) of the information proposed for immediate dissemination through the FIGIS website resulted in the discovery of many errors. The consensus of those involved in the review was that this information should not be put on the FIGIS website at this time. This decision was relayed to the FIGIS program manager at FAO, Marc Taconet.

5. **NAFO Observer Program**

- a) **Update on Meeting of STACTIC 16-20 June, Copenhagen**

There was extensive discussion of the Observer Program at the June STACTIC Meeting (FC Doc. 03/5). To date, a discussion of the Scientific Council recommendation made at its June 2003 Meeting has not occurred in STACTIC.

6. **Archival of Data Utilized in Stock Assessments**

STACREC discussed a proposal to archive data utilized in stock assessments, on a regular basis, in a standardized format and common location. The importance of the ability to reproduce stock assessments was emphasized. STACREC **recommended** that *the Designated Experts would be asked to place electronic versions of their stock assessment data (including time series of catch, survey indices, numbers at age, catch at age, weights at age, and maturity at age) on the server, in formats currently available, at the Scientific Council meetings. The data files provided should be annotated and include all survey indices available and catches in aggregate form. The Secretariat will archive these data following Scientific Council Meetings and make them available to members of the Scientific Council thereafter.*

7. Other Matters

a) Review of SCR and SCS Documents

There were no documents to review.

b) Other Business

The Deputy Executive Secretary informed STACREC that there is incomplete reporting of tuna catches in the STATLANT 21 data reports being submitted to NAFO. It was also noted that other international commissions dealing with tuna, such as ICCAT, receive the complete tuna reports and those data are more valuable to tuna data users. STACREC noted the tuna data were not required for the work of the Scientific Council, and STACREC **recommended** that *the Secretariat need not report tuna catches in the data tabulations prepared at NAFO and that CWP (and FAO) will be informed that tuna catches will no longer be recorded in the STATLANT 21 data.*

c) Acknowledgements

The Chair thanked the participants for their valuable contributions to the Committee. Special thanks were extended to the rapporteur and to the Deputy Executive Secretary and staff of the NAFO Secretariat for their invaluable assistance in preparation and distribution of documents. There being no other business, the Chair closed the September 2003 STACREC Meeting.

APPENDIX III. REPORT OF STANDING COMMITTEE ON PUBLICATIONS (STACPUB)

Chair: Manfred Stein

Rapporteur: Bill Brodie

The Committee met at the Holiday Inn, Dartmouth, Nova Scotia, Canada, on 15, 16, and 18 September 2003, to consider and report on publication-related topics and various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), Estonia, European Union (France, Germany, Portugal, Spain), Iceland, Japan, the Russian Federation, Ukraine and the United States of America. The Executive Secretary and Deputy Executive Secretary were in attendance.

1. Opening

The Chair opened the meeting by welcoming the participants. The agenda as presented in the Provisional Agenda was **adopted**. Bill Brodie (Canada) was appointed rapporteur.

2. Review of Recommendations from June 2003

There were no recommendations by the Committee in June 2003.

3. Review of Scientific Publications

a) Papers from June 2003 Meeting

The Committee did not propose any papers from the June 2003 Meeting for further publication considerations.

b) Status of the 2001 "Deep-sea Fisheries" Symposium

Volume 31 of the NAFO Journal contains papers from the Symposium on "*Deep-sea Fisheries*". To-date 23 papers, including an abstract, are final and ready to print and 11 are being prepared into galleys.

STACPUB noted that it is important for these papers to be published as far as possible in advance of another symposium on deep-sea fisheries scheduled for late-2003 in New Zealand. Recognizing the delays to date were as a result of a special situation, STACPUB **recommended** that *the 23 papers currently ready be placed on the NAFO Website by the beginning of October 2003, as part of Volume 31, ensuring a 2003 publication date*. Other papers should be added as they become available, and the Deputy Executive Secretary noted that the 11 papers currently being prepared into galleys should also be ready for the 2003 time-frame.

c) Information from the 2002 Elasmobranch Symposium

A special Volume containing papers from the Symposium on "*Elasmobranch Fisheries: Managing for Sustainable Use and Biodiversity Conversation*". A total of 50 papers have been received at the Secretariat and sent during January and February 2003 to proceedings co-editors for review. One paper has been withdrawn by author and 2 have been rejected. To date 5 papers have been received for preparation of galleys. This issue was initially suggested for publication by late-2003, but likely to be much later.

d) Status of Invitational Papers

There were no requests or suggestions for invitational papers thus far in 2003.

e) Other Reviews

Journal Volume 32 is being published on the NAFO website. There have been 7 miscellaneous papers received at the Secretariat for this publication. The 4 edited papers received at Secretariat to date from the Associate Editors are being published in the Journal.

On the **NAFO STATLANT Statistical Data**, STACPUB was informed that catches by country, species and Division are available on the NAFO website as text files for 1960-2002. Information is the most up-to-date available at the Secretariat and is updated as new information become available.

Studies Number 37: the publication on *Availability of Data for Estimating Productive Potential for Selected Stocks in the Northwest Atlantic*, was completed in August, 2003. Information was collected on a total of 53 stocks or stock complexes from both the northeast and northwest Atlantic. A series of tables was compiled that provide an overview of the availability of basic information, evaluate the quality of information and provide references to this information. This publication was distributed on CD to all Committee members. STACPUB **recommended** that *hard copy and web versions of Scientific Council Studies No. 37 be issued shortly.*

Concerning **NAFO Scientific Council Reports**, STACPUB was informed that the *NAFO Scientific Council Reports 2002* (Redbook) volume (323 pages) containing reports of the 2002 meetings of the Scientific Council in June, September and November was published and distributed in January 2003 and also placed on the NAFO website.

A new initiative at the Secretariat proposes to replace the calendar year publication schedule by the period 1 September of one year to 31 August of the next year. An example of this is demonstrated at this September 2003 Meeting with the publication of the *NAFO Scientific Council Reports 2002-2003* and issued as a new "Redbook" hard copy for the 2003 Annual Meeting participants.

Although cost savings were expected with this new schedule, STACPUB expressed concerns with the proposed change. One of the main concerns was that the new schedule would break the continuity of discussions within Scientific Council during a calendar year, e.g. issues carried over from June to September in a given year would appear in different "Redbooks". It was also noted that Scientific Council Meetings do not operate on the same schedule as Fisheries Commission or General Council, and that Scientific Council Reports therefore require a different printing schedule. Other concerns with the new schedule relate to calendar listings of SCR and SCS documents, lack of time to check and make revisions to the June Scientific Council Report prior to printing of the "Redbook" before the September meeting. The new initiative also proposed to eliminate using color printing in some of the reports where necessary. STACPUB **recommended** that *for the Scientific Council Reports, the Secretariat return to printing its reports on a calendar year basis, and that color printing be used where warranted in Scientific Council Reports. The Scientific Council Reports for calendar year 2003 should therefore be printed as the next "Redbook".*

4. Considerations of NAFO Website

a) Status of implementation of Journal and Council Studies on Website

STACPUB was informed that all Journal and Studies issues have been scanned and are available on CD. STACPUB **recommended** that *all scanned versions of the Journal and Studies be placed on the NAFO website as soon as possible, as this is a vital reference tool for users.*

b) "Restricted site" for Scientific Council

STACPUB concluded that there was no need for a "restricted site" for its use on the NAFO Website.

5. Editorial Matters Regarding Scientific Publications

a) Review of Editorial Board

At the June 2003 meeting, the STACPUB Chair requested Committee members to propose a replacement to the position of Associate Editor for Invertebrates. Dr. James R. Weinberg of the National Marine Fisheries Service, Woods Hole, USA was nominated to assume these duties. STACPUB approved the nomination and extended its appreciation to Dr. Weinberg, along with thanks to Fred Serchuk for his timely

follow-up on this matter. STACPUB also extended sincere thanks to Dr. Volker Siegel for his dedicated work in this position to date.

b) **Progress Report of Publications of Reproductive Potential WG (Journal and Studies)**

A special Volume 33 containing 9 peer-reviewed articles by members of the "Working Group on Reproductive Potential" is being prepared. Galleys have been prepared for 2 papers and the other galleys will be completed shortly. It is anticipated that this publication will be available late-2003.

c) **Progress Report of Publication on 2002 STACFEN Mini-Symposium on Decadal Trends**

The special volume containing papers from the 2002 STACFEN Mini-Symposium on Decadal Trends identified eight papers for consideration. Six (6) papers have been received and sent to co-editors for review, 2 papers have not been submitted by authors yet. The co-editors anticipated that all papers will be available in late-2003.

6. **Other Matters**

- a) STACPUB was presented with an overview of NAFO publication status and strategy, given by the Executive Secretary. A number of changes were proposed to allow improved service. The Secretariat is ready to implement electronic publishing in 2003 with resulting savings in costs and labor. At present, about 30% of publishing tasks within the Secretariat are devoted to editorial work, about 60% are related to document formatting, and about 10% related to production of the final products. The first strategy is to reduce costs and labor, and the second strategy is to improve quality of electronic publications. STACPUB agreed with the proposal to maintain the *status quo* for publishing the Journal. However, STACPUB did not agree with a proposal to make the Scientific Council Studies available only as an electronic version. Scientific Council Studies contains publications such as workbooks and workshop reports, and STACPUB concluded that this material must be made available in print. Therefore, STACPUB **recommended** that *Scientific Council Studies continue to be produced in printed versions recognizing the number of hard copies has been reduced*. Final versions of Scientific Council Documents, statistical bulletins, and sampling yearbooks would be fully electronic publications, but paper copies of SCR and SCS documents would be made available at Scientific Council Meetings as required.
- b) Website usage was reported for August 2003 (new website) compared to the period January to March 2003 (old website). There was an increase in visits in August over previous levels. The redesigned website has likely contributed to the increased web visits. STACPUB noted that it would be helpful to put a list of NAFO publications on the website. In addition, SCR and SCS documents should be placed on the web, for as many years as electronic versions exist.
- c) The issue of charging registration fees for Scientific Council Symposia, to offset publication costs of Journal and Studies related to the symposia, was raised. STACPUB agreed to place this on its agenda for June 2004.
- a) STACPUB noted that announcements of the 2004 Scientific Council Symposium "*The Ecosystem of the on Flemish Cap*" should contain a statement concerning publication of papers presented at the Symposium.

There being no other matters, the Chair closed the meeting by thanking the participants for their contributions and co-operation, the rapporteur for taking the minutes, and the NAFO Secretariat for their assistance.

PART G

Scientific Council Meeting, 5-11 November 2003

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Participants, Scientific Council Meeting, 5-11 November 2003 at NAFO Headquarters, Dartmouth, Nova Scotia, Canada

Back (left to right): Per Kannevorff, Sergey Bakanev, Kai Weiland, Bill Brodie, DorothyAuby, Tissa Amaratunga

Front (left to right): Helle Siegstad, Joanne Morgan, Unnur Skúladóttir, Michaela Aschan, Hilario Murua, Carsten Hvingel, Dave Orr, Árni Nicolajsen

Missing: Peter A. Koeller



Chairs and Designated Experts

Left to Right: Dave Orr (Shrimp Div. 3LNO), Joanne Morgan (SC Chair), Carsten Hvingel (Shrimp SA 0+1 and Denmark Strait), Unnur Skuladottir (Shrimp 3M) and Hilario Murua (STACFIS Chair)

REPORT OF SCIENTIFIC COUNCIL MEETING

5-11 November 2003

Chair: M. Joanne Morgan

Rapporteur: Tissa Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 5-11 November 2003. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Spain), Iceland, Norway and Russian Federation. The Deputy Executive Secretary was in attendance.

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

The opening session was called to order at 1015 hours on 5 November 2003

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

The Provisional Agenda was considered and **adopted** with editorial changes (see Appendix II). The Deputy Executive Secretary was appointed rapporteur.

The session was adjourned at 1045 hours.

The Council welcomed STACFIS to conduct its business through 5-8 November 2003, noting most of the Council's work would be addressed through 10-11 November 2003.

The concluding session was convened at 0900 hours on 11 November 2003. The Council addressed the requests of the Fisheries Commission and the Coastal States and considering the results of the assessments, provided advice and recommendations.

The Council then considered and **adopted** the STACFIS Report, and considered its own report and **adopted** the report of this meeting of 5-11 November 2003.

The meeting was adjourned at 1300 hours on 11 November 2003.

The Report of Standing Committee on Fisheries Science (STACFIS) as **adopted** by the Council is given at Appendix I.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, and List of Representatives and Advisers/Experts of this meeting are in Part H this volume.

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

II. FISHERIES SCIENCE

The Council **adopted** the Report of Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Hilario Murua. The full report is given at Appendix I.

The Council's summary sheets and conclusions on Northern shrimp in Div. 3M, Northern shrimp in Div. 3LNO, Northern shrimp in Subareas 0+1 and Northern shrimp in Denmark Strait and off East Greenland are presented in Section III of this report. The recommendations with respect to stock advice appear therein.

The research **recommendations** endorsed by the Council are as follows:

1. For Northern Shrimp in Division 3M

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*
- *a more detailed conversion document including information on the geometry and behaviour of the trawls and detailed calculations of the conversion for shrimp be presented at the September 2004 meeting.*
- *indices of stock size be presented with error bars where possible.*

2. For Northern Shrimp in Divisions 3LNO

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

3. For Northern Shrimp in Subareas 0 and 1

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in Subarea 1.*

4. For Northern Shrimp in Denmark Strait and off East Greenland

- *a survey series be established, to provide fishery independent data of the stock throughout its range.*
- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in the Greenland EEZ and improve in the Icelandic EEZ.*

III. MANAGEMENT ADVICE AND RESPONSES TO SPECIAL REQUESTS

1. Responses to Fisheries Commission

a) Advice on TAC and Other Management Measures

The Scientific Council reviewed the STACFIS assessments of Northern shrimp in Div. 3M and Div. 3LNO, and the agreed summaries are as follows:

Northern Shrimp (Pandalus borealis) in Division 3M

Background: The shrimp fishery in Div. 3M began in late-April 1993. Initial catch rates were favourable and, shortly thereafter, vessels from several nations joined. Since 1993 the number of vessels ranged from 40-110, and in 2003 there were approximately 41 vessels fishing shrimp in Div. 3M.

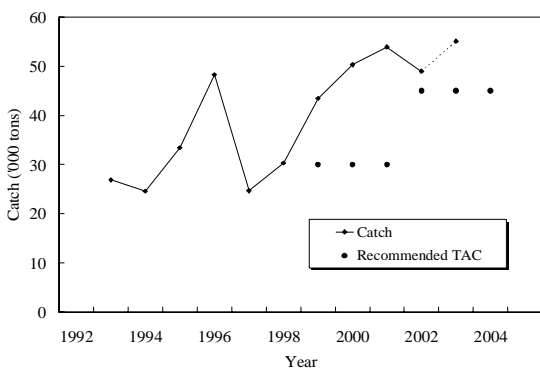
Fishery and catches: This stock is under effort regulation. Recent catches were as follows.

Year	Catch ('00 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	50	49 ¹	30	er
2001	54	51 ¹	30	er
2002	49	48 ¹	45	er
2003	55 ²		45	er
2004			45	er

¹ Provisional.

² Projected to end of 2003.

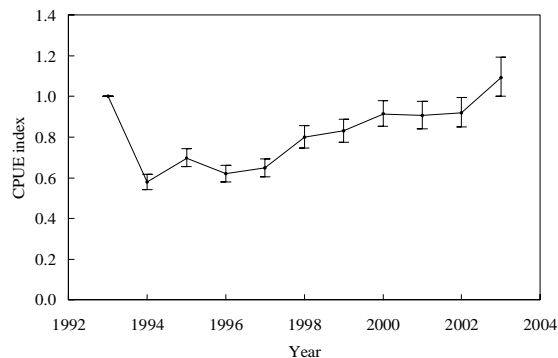
er Effort regulations.



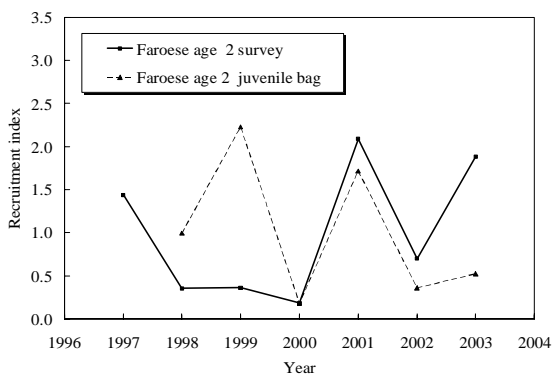
Data: Catch, effort and biological data were available from several Contracting Parties. A standardized CPUE index was developed to account for changes in gear (single, double and triple trawl), fishing power and seasonality. Time series of size and sex composition data were available from three countries and survey indices were available from Faroese and EU research surveys. A new research vessel was introduced in the EU survey in 2003. However the Scientific Council was unclear as to the conversion of the time series.

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

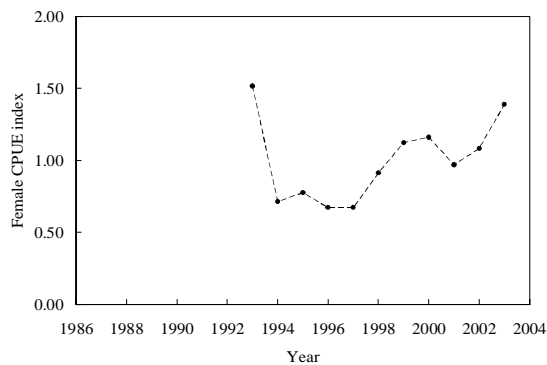
CPUE: Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2003.

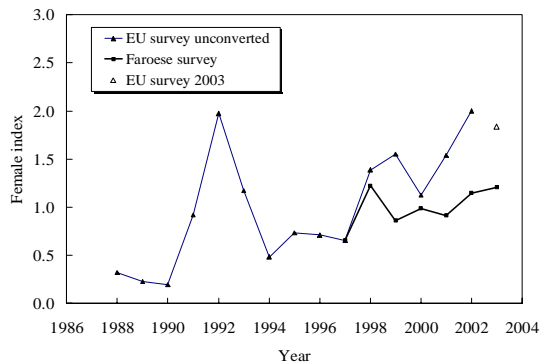


Recruitment: The 1999 year-class is strong while the 2000 year-class appears weak and the 2001 year-class appears average.



SSB: All indices of female biomass showed an increasing trend from 1997 to 2003.





State of the Stock: Stock size indicators have shown a general increase since 1997. The 1999 year-class is strong and will continue to contribute to the fishery in 2004, and possibly to some degree in 2005 as well. The 2001 year-class appears to be about average and shall be contributing to the fishery in 2004 and 2005. However, the 2000 year-class appears to be weaker.

Recommendations: The stock appears to have sustained an average annual catch of about 45 000 tons since 1998 with no appreciable effect on stock biomass. Of the year-classes that will be the main contributors to the fishery over the next few years, the 1999 year-class estimated to be strong, the 2000 weak and the 2001 average. The Scientific Council advises a catch of 45 000 tons for 2005.

Special comments: This advice will be reviewed based on updated information in September 2004.

Sources of Information: SCR Doc. 03/66, 72, 79, 80, 83, 84, 87, 88, 90, 91.

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

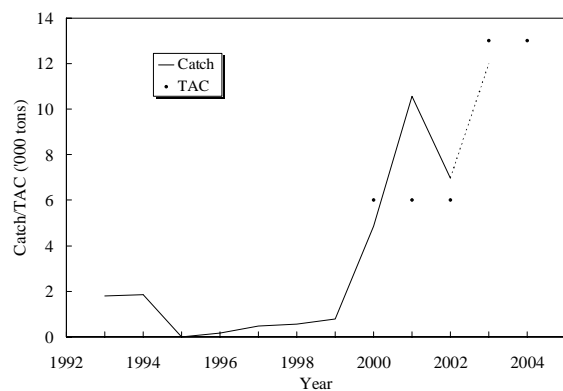
Background: Most of this stock is located in Div. 3L, and exploratory fishing began there in 1993. The stock came under TAC regulation in 2000, and fishing was restricted to Div. 3L.

Fishery and catches: Nine nations participated in the fishery in 2003. The use of a sorting grid to reduce by-catches of fish is mandatory for all fleets in the fishery. Recent catches from the stock are as follows:

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS	21A	Recommended	Agreed
2000	5	5 ¹	6	6
2001	11	5 ¹	6	6
2002	7	6 ¹	6	6
2003	12 ²		13	13
2004			13	13

¹ Provisional.

² Projected to the end of 2003.

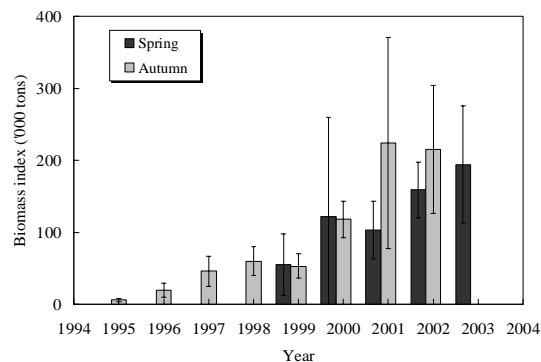


Data: Catch, effort and biological data were available from the commercial fishery. Biomass and recruitment indices, and size and sex composition data were available from research surveys conducted in Div. 3LNO during spring (1999 to 2003) and autumn (1995 to 2002).

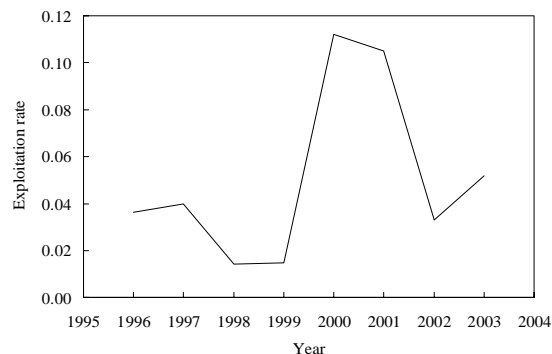
Assessment: No analytical assessment is available. Evaluation of the status of the stock is based on interpretation of research survey and biological indices.

Recruitment: The 1998 and 1999 year-classes are the two largest year-classes in the short time series, but are followed by the 2000 year-class which was slightly above average.

Biomass: There was a significant increase in SSB and total biomass between 1995 and 1997, followed by a period of stability from 1997 until 1999. Both SSB and total biomass have been at a higher level since 2000.



Exploitation: No estimates of fishing mortality were available. The exploitation index was 1-4% during 1996-99, increased to 10-11% in 2000-2001, and was estimated to be only 6% during 2003.



State of the Stock. SSB estimates have increased significantly since 1999 and are currently the highest observed. Recruitment of the 1998 and 1999 year-classes were the highest observed, however, the 2000 year-class has dropped to just above average. The stock appears to be well represented by a broad range of size groups, and exploitation is low.

Recommendation: Applying a 15% exploitation rate to the lower 95% confidence limit of the biomass estimates, averaged over the autumn 2000 to spring 2002 surveys, results in a catch of about 13 000 tons. Scientific Council reiterated that "the development of any fishery in the Div. 3L area take place in a gradual manner with conservative catch limits imposed and maintained for a number of years in order to monitor stock response". Scientific Council recommends that the TAC for shrimp in Div. 3LNO in 2005 should remain at 13 000 tons.

Scientific Council reiterated its recommendations that the fishery be restricted to Div. 3L and that the use of a sorting grate with a maximum bar spacing of 22 mm be mandatory for all vessels in the fishery.

Special Comments: Advice for the 2005 fishery will be reviewed at the September 2004 Scientific Council meeting, when results from the 2003 autumn and spring 2004 surveys will be available.

Sources of Information: SCR Doc. 03/72, 81, 82.

b) Responses to Special Requests from the Fisheries Commission

There were no special requests.

2. Responses to the Coastal States

The Scientific Council reviewed the STACFIS assessments for Northern shrimp in Subareas 0 and 1 and in Denmark Strait and off East Greenland, and the agreed summaries are as follows:

Northern Shrimp (Pandalus borealis) in Subareas 0 and 1

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

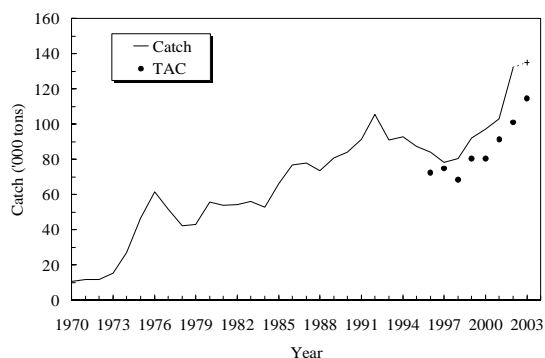
Fishery and catches: The fishery is conducted by Greenland and Canada. For this year's assessment catch figures of SA 1 were corrected for overpacking and product to live weight differences by applying a factor of 1.23 (average). Recent catches from the stock are as follows:

Year	Catch ('000 tons)		TAC ('000 tons)	
	STACFIS ¹	21A	Recommended	Actual
2000	97.2	80.1 ²	65.0	80.3
2001	102.8	85.0 ²	85.0	91.3
2002	132.1	109.2 ²	85.0	103.2
2003	135.0 ³		100.0	114.7

¹ Corrected for overpack.

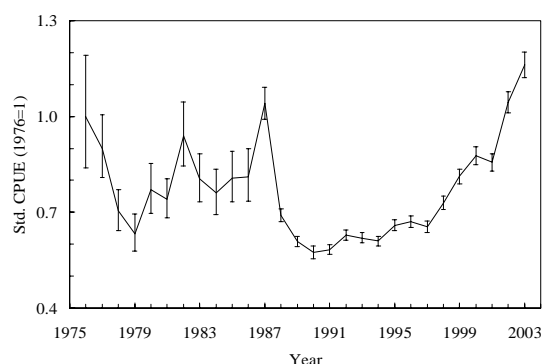
² Provisional.

³ Projected to the end of 2003.

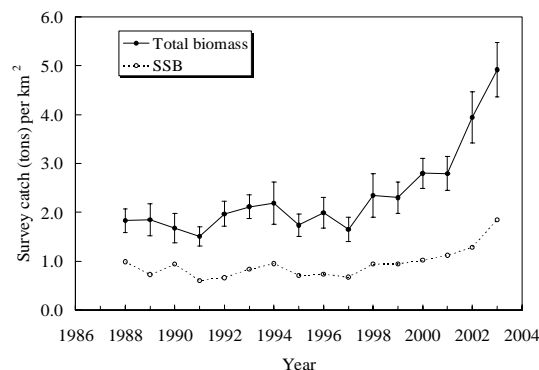


Data: Catch and effort data were available from all vessels. Time series of biomass and recruitment indices, size and sex composition data were available from research surveys. Series of cod biomass and cod consumption were available.

Indicators of biomass: The standardized CPUE series showed an increasing trend since 1990. The 2003-value is the highest of the time series.



The survey total biomass and SSB indices (female biomass) showed an increasing trend since 1997. For both indices the 2003-value is the highest of the series.

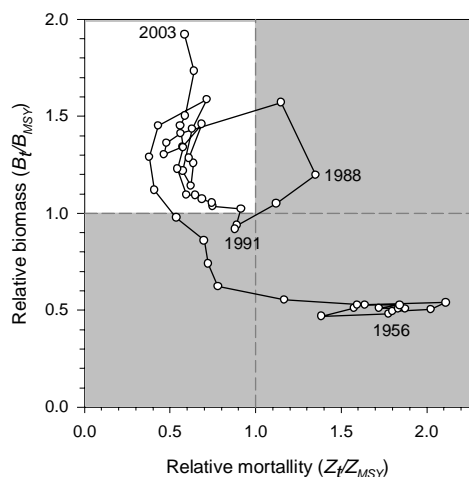


Exploitation rate: Indices of exploitation rate have shown a decline since the early-1990s.

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

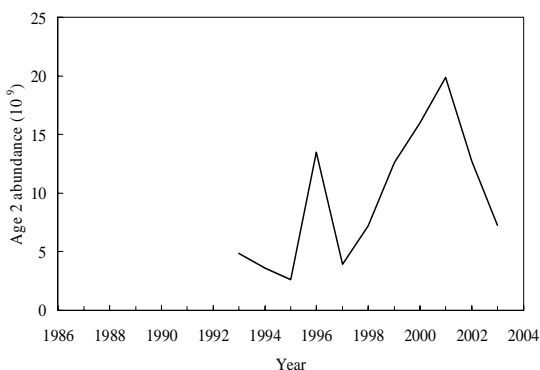
Mortality: The mortality caused by fishing and cod predation (Z) has been below the upper limit reference

(Z_{MSY}) for most of the time since 1970. Since 1997 mortality has been stable well below Z_{MSY} . The estimated risk of current mortality being above Z_{MSY} was less than 5%.



Biomass. Since the early-1970s the probability that biomass was below the optimum level (B_{MSY}) was low for most years. Since the early-1990s the stock has increased and reached its highest level in 2003. The estimated risk of current stock biomass being below B_{MSY} was less than 1%.

Recruitment. A recruitment index (shrimp at age 2) showed an increasing trend from 1997 to 2001 and a decrease thereafter. The 2003 value is below the average of the time series.



State of the Stock. The stock biomass has increased since the early-1990s and reached its highest level recorded in 2003. Biomass is well above B_{MSY} and mortality by fishery and cod predation is well below Z_{MSY} . In addition the stock appears to be well represented by a broad range of size groups.

Recommendations: If catches, measured as total live weight removals, including overpack, exceed 130 000 tons in 2004 there is a greater than 9% risk of exceeding

a mortality that is considered to be a limit reference point. Scientific Council therefore recommends that total catch (live weight, including overpack) in Div. 0A and SA 1 in 2004 should not exceed 130 000 tons.

Given the high probabilities of the stock being considerably above B_{MSY} , risk of stock biomass falling below this optimum level within a one-year perspective is low.

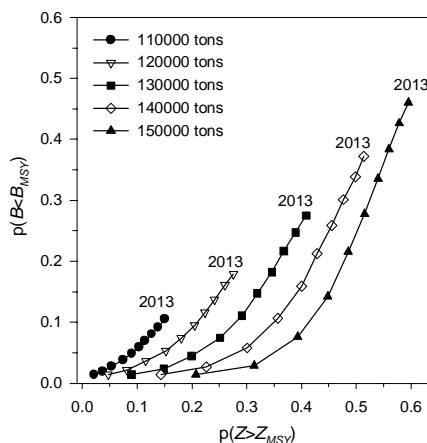
Risk associated with five optional catch levels for 2004 are as follows:

Catch option ('000 tons)	110	120	130	140	150
Risk of falling below B_{MSY}	2%	2%	2%	3%	3%
Risk of exceeding Z_{MSY}	2%	3%	9%	14%	21%

Medium-term Considerations: Ten-year projections of stock development were made using the assumption that the cod stock will remain at its low 2003 abundance. Five levels of annual catch: 110, 120, 130, 140 and 150 thousand tons were investigated.

With a catch of 130 000 tons/yr there is less than 10% risk of stock biomass falling below B_{MSY} in the first four years. However, this level of exploitation might not be sustainable in the longer term, as risk of falling below optimum biomass continues to increase through time.

Catches greater or equal to 130 000 tons/yr are not likely to be sustainable in the longer term.



Reference Points: The limit reference point for mortality in the current assessment framework is Z_{MSY} , i.e. Z-ratio=1. At this meeting Scientific Council was not in a position to define a reference for biomass (B_{lim}).

Special Comments: The TAC options for 2004 are considerably higher than the ones given for 2003. This

is, however, mainly due to a revision in catch estimates to account for overpack, and not due to a comparable increase in stock production. For example if overpack was accounted for, the 2003 recommended TAC of a 100 000 tons would be equivalent to 123 000 tons. The advice for 2004 may therefore not be interpreted as if actual removals by the fishery should be increased comparatively. The Scientific Council advice is based on catches in 2004 being reported correctly, accounting for overpack.

Predation by cod can have a major impact on shrimp stock size. If the cod stock were to increase rapidly above the current level, as seen in the late-1980s, consumption could reach the same level as the current catches within a 3-4 year period. Such an event should, however, be detected early by routine survey programs and management options can then be evaluated.

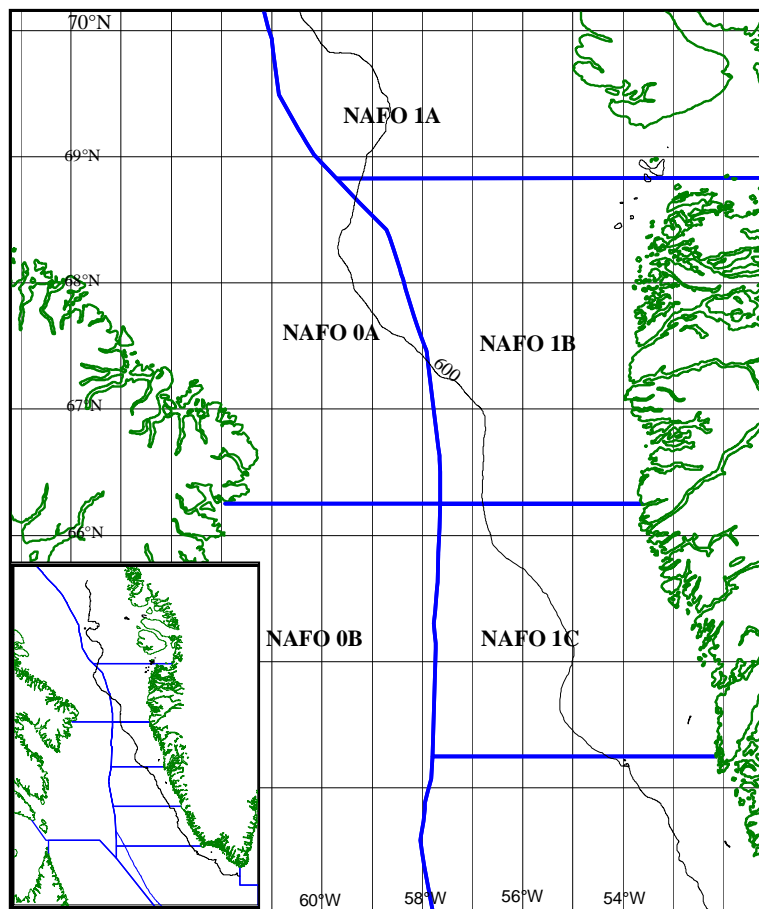
Sources of Information: SCR Doc. 03/70, 71, 73, 74, 75, 76, 86, 02/158.

a) **Response to Special Request from the Coastal State**

Denmark (in respect to Faroe Islands and Greenland) had asked the Scientific Council: *to update on the distribution of Northern shrimp and provide advice on allocation of TACs to Subarea 0 and Subarea 1.*

The Scientific Council with respect to allocation of TACs to Subareas 0 and 1, responded:

The distribution area of the Northern shrimp stock off West Greenland includes Subarea 1, from Cape Farewell to 72°30' N and an adjacent small part of Div. 0A between 67° and 69°N, east of 60°W and shallower than 600 m (see map).



Surveys conducted by Greenland covered the distribution of Northern shrimp in Subarea 1 and Div. 0A, east of 60°W. The survey from 1994-2002 has consistent coverage, allowing comparison between the two areas. The annual estimates of biomass have high uncertainty and variance, and therefore the average and range over this period are given. The average percentage of the biomass in Div. 0A was 1.7%, ranging from 0.1% to 4.1%. If TAC for shrimp in Subarea 1 and Div. 0A is split according to the biomass distribution, the split would be 98.3% in Subarea 1 and 1.7% in Div. 0A. There is no information on the abundance of shrimp in Div. 0A outside of the survey area. Advice on allocation of TAC can be revised, if information on the distribution of shrimp changes.

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

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

Fishery and Catches: Five nations participated in the fishery in 2003. For this year's assessment catch figures were corrected for overpacking and product to live weight differences by applying a factor of 1.24 (average). Recent catches and recommended TACs are as follows:

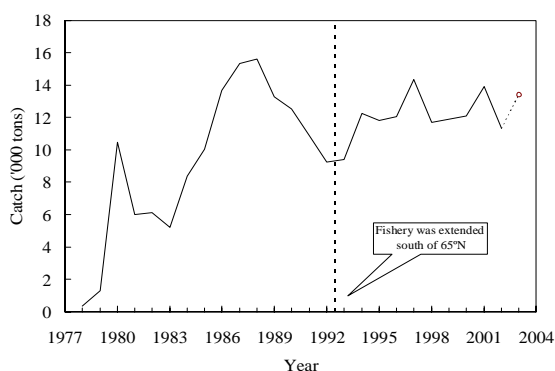
Year	Catch ('000 tons)		TAC ('000 tons)		
	STACFIS ¹	21A	Recom.	GR EEZ	ICE EEZ ²
2000	12.1	9.6 ³	9.6	12.6	-
2001	13.9	11.1 ³	9.6	10.6	-
2002	11.4	9.3 ³	9.6	10.6	-
2003	13.5 ⁴		9.6	10.6	-

¹ Corrected for overpack.

² Fishery unregulated in Icelandic EEZ.

³ Provisional catches.

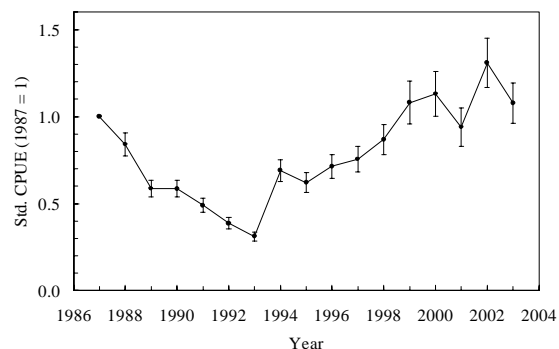
⁴ Projected to the end of 2003.



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.

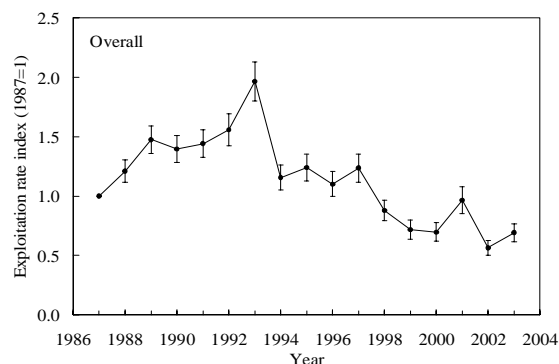
CPUE: Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter to approximately the same level in 2000-2003 as at the start of the time series in 1987.



Recruitment: No recruitment estimates were available.

Biomass: No direct biomass estimates were available.

Exploitation rate: From 1998 through 2003 an exploitation rate index (catch/CPUE) has been at its lowest levels in the 17-year series.



State of the Stock: Standardized CPUE data for all the areas combined indicate a general increasing trend in fishable biomass since 1993. The 2000 to 2003 values equal the relatively high values at which the series started in 1987.

Recommendation: Since 1994, annual catches measured as total live weight, including overpack, have remained near an average of 12 400 tons, while stock biomass indices have increased. This increase may not, however, have continued after 1999. Scientific Council therefore advises that catches of shrimp in Denmark Strait and off East Greenland should not exceed 12 400 tons in 2004.

Special Comments: The apparent increase in the advised TAC for 2004 is based on a revision of catch estimates to account for overpack and not on a comparable increase in stock production. The advice for 2004 may therefore not be interpreted as if actual removals by the fishery should be increased comparatively. The Scientific Council advice is based on catches in 2004 being reported correctly, accounting for overpack.

Sources of Information: SCR Doc. 03/74, 77, 85.

IV. OTHER MATTERS

1. Scientific Council Meeting, October/November 2004

The Scientific Council agreed to the dates 27 October to 4 November 2004 for this meeting to be held jointly with the ICES Pandalus Assessment Working Group at ICES Headquarters in Copenhagen, Denmark

2. Scientific Council Meeting, October/November 2005

The Scientific Council tentatively agreed to the dates 25 October to 2 November 2005 for this meeting to be held at the NAFO Headquarters, Dartmouth, Nova Scotia, Canada. Dates and location will be reviewed in June 2004.

3. Coordination with ICES Working Groups on Shrimp Stock Assessments

Scientific Council considered a joint meeting with the ICES Pandalus Assessment Working Group (WGPAND) in Copenhagen, Denmark during 27 October to 4 November 2004. The Council noted that the proposal received from ICES at this meeting deviated substantially from that agreed at the 2004 September Meeting of Scientific Council. The proposal entails a joint meeting of STACFIS and WGPAND with specific arrangements to be determined by the Chairs of Scientific Council, STACFIS and WGPAND. The Scientific Council and WGPAND meetings may be opened separately with STACFIS and WGPAND meeting together to assess the various shrimp stocks. The work of STACFIS and WGPAND will be covered in reports of the respective groups. The report of STACFIS will not contain a report of the shrimp stocks in the ICES area. The respective Secretariats will produce the reports of the two groups. Although this is a much different meeting plan than agreed previously by Scientific Council, the importance of increasing the participation of shrimp scientists in the assessments was deemed great enough to agree to this meeting plan. As usual the Scientific Council agenda will be issued 60 days prior to the meeting. The Chairs of Scientific Council and STACFIS will begin arranging the meeting agenda with the Chair of WGPAND in early-2004. Scientific Council hopes that in future STACFIS and WGPAND will be able to work together as a single body on the assessment of shrimp stocks.

V. ADOPTION OF REPORTS

The Council at its session on 11 November 2003 considered and **adopted** the Report of STACFIS (see Appendix I). The recommendations made by STACFIS and endorsed by the Scientific Council are given therein in Sections II and III above. The Council then considered and **adopted** its own Report of this 5-11 November 2003 Meeting.

VI. ADJOURNMENT

The Chair noted that the concluding session was taking place on Remembrance Day and noted that this was set aside in Canada as a time to remember the sacrifice of all those who have fought for freedom. The Chair thanked the participants, noting especially the efforts of the Designated Experts and Chair of STACFIS, and the support of the NAFO Secretariat. The Chair also noted that this was the last Scientific Council Meeting for Per Kannevorf and thanked him for 30 years of work in Council. There being no other business, the meeting was adjourned at 1300 hr on 11 November 2003.

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

Chair: Hilario Murua

Rapporteur: Various

I. OPENING

The Committee met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 5-11 November 2003, to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on certain Northern shrimp stocks. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Spain), Iceland, Norway and Russian Federation. The Deputy Executive Secretary was in attendance.

The Chair, Hilario Murua (EU/Spain), opened the meeting on 5 November 2003 welcoming the participants. The Agenda was reviewed and a plan of work developed for the meeting. The provisional agenda was adopted (see Appendix II).

II. GENERAL REVIEW

1. Review of Recommendations in 2002 and 2003

STACFIS reviewed the recommendations from 2002 during considerations of each relevant stock.

2. Review of Catches of Shrimp

STACFIS reviewed and agreed on the catch figures available for all stocks being assessed at this meeting. Catch figures for shrimp in Subarea 1 and in Denmark Strait and off East Greenland were corrected for overpacking and product to live weight differences for the first time in 2003.

3. Environmental Review (SCR Doc. 03/71, 78)

Division 3M (SCR Doc. 03/78). Oceanographic data from the summer of 2003 on the Flemish Cap were examined and compared to the long-term (1971-2000) average. The cold near-surface temperatures (0.5° to 2°C below normal) experienced over the Cap from 1993-96 had warmed to 0.5° to 1.5°C above normal by July of 1997, and increased further to 2°C above normal by the summer of 1999. Upper layer temperatures over the Flemish Cap during the spring of 2001 and the summer of 2002 generally showed a downward trend with temperatures decreasing to below normal values. During the summer of 2003, temperatures directly over the Cap were highly variable while adjacent areas showed significant positive anomalies. Near bottom temperatures over the Cap were generally around 3.5°C, which was below normal in some areas particularly on the western side of the Cap. Salinities over most of the upper water column during the summer of 2002 and 2003 were generally saltier-than-normal. In the deeper water (>100 m depth) salinities were about normal. During the summers of 2002 and 2003 most areas of the water column experienced highly variably salinity conditions with near-surface values below normal in 2002 and above normal in 2003. Dissolved oxygen levels were about normal for the region. Both the measured currents and the geostrophic estimates, while showing considerable differences and variability between years, confirm the existence of a general anticyclonic circulation around the Flemish Cap during the summer.

Divisions 3LNO (SCR Doc. 03/78). Bottom temperatures on the Grand Bank during the spring of 2003 were mostly below normal. The areal extent of bottom water less than 0°C reached a minimum in 1998-99, but has been increasing since then. Temperatures during the spring of 2003 throughout the water column along a section across the Grand Bank decreased from 2002 to 2003, to below normal values. In general, water temperatures on the Grand Bank have been declining up to the spring of 2003 from the record highs of 1998-99.

Subarea 1 (SCR Doc. 03/71). Bottom temperatures in Subarea 1 and Div. 0A east of 60°W recorded at depths between 150 and 600 m during the West Greenland Bottom Trawl Survey in summer 2003 were examined and compared to previous results in the survey series. In 2003, bottom temperatures ranged from 1.1°C in the north

to 5.9°C in the south and the spatially weighted mean amounted to 3.1°C. Mean bottom temperature increased from 1.7°C in 1995 to 3.3°C in 1998 and remained between 3.0 and 3.4°C thereafter. The temperature change comprised all depth ranges, and the 2003 values are between 0.5 and 1°C above the average of the time series (1991-2003).

III. STOCK ASSESSMENTS

1. Northern Shrimp (*Pandalus borealis*) in Division 3M (SCR Doc. 03/66, 72, 79, 80, 83, 84, 87, 88, 89, 90, 91)

a) Introduction

The shrimp fishery in Div. 3M began in late-April 1993. Initial catch rates were favourable and, shortly thereafter, vessels from several nations joined. Since 1993 the number of vessels ranged from 40-110, and in 2003 there were approximately 41 vessels fishing shrimp in Div. 3M.

Total catches were approximately 27 000 tons in 1993, increased to 48 000 tons in 1996, declined in 1997, increased steadily to 54 000 in 2001 and declined to about 49 000 tons in 2002 (Fig. 1.1). Catch statistics to 1 October 2003 indicate removals of about 46 000 tons. This will likely result in a total catch of about 55 000 tons by the end of the year.

Recent catches and TACs (tons) are as follows:

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recommended TAC					30 000	30 000	30 000	45 000	45 000	45 000
STATLANT 21 A	19 341	39 042	23 916	30 035	42 041	49 184 ¹	51 426 ¹	47 907 ¹		
STACFIS	33 471	48 300	24 675	30 308	43 438	50 311	53 922	48 979	55 000 ²	

¹ Provisional.

² Projected to the end of the year.

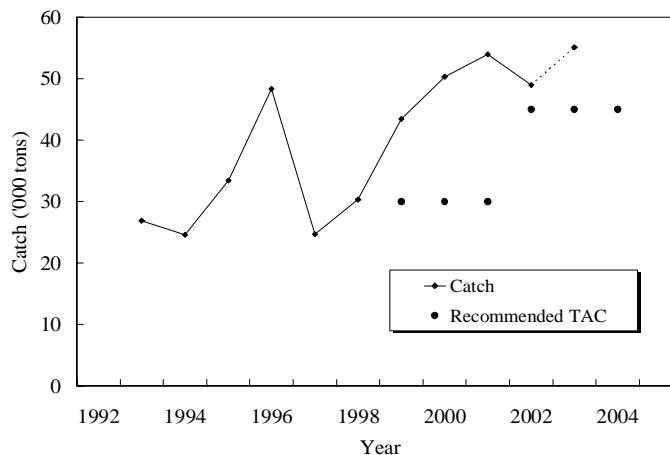


Fig. 1.1. Shrimp in Div. 3M: catches (2003 projected to end of the year).

b) Input Data

i) Commercial fishery data (SCR Doc. 03/72, 79, 83, 88, 89, 91)

Effort and CPUE. Data from logbooks of Canadian, Greenlandic, Icelandic, Faroese, Norwegian and Russian vessels were available. An unstandardized CPUE series is not considered to be reflective of stock status. A standardized CPUE series addressed differences due to seasonality, fishing power and

gear (single, double and triple trawl). The model was standardized to 1993, June, single trawl and Icelandic catch-per-unit-effort data. CPUE decreased from 1993 to 1994, varied without a trend to 1997 and increased until 2003 (Fig. 1.2).

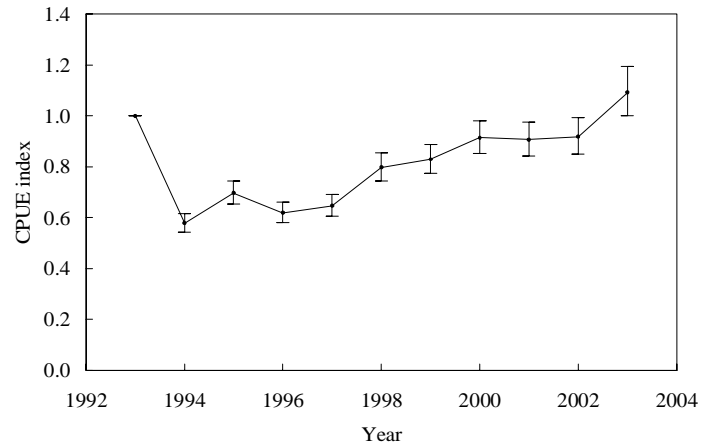


Fig. 1.2. Shrimp Div. 3M: the standardized CPUE of shrimp on Flemish Cap between 1993-2003.

Standardized CPUE female SSB. A spawning stock index was calculated from the standardized CPUE as kg/hr of primiparous plus multiparous females. The spawning stock declined from 1993 to 1997, and has shown an increasing trend since then.

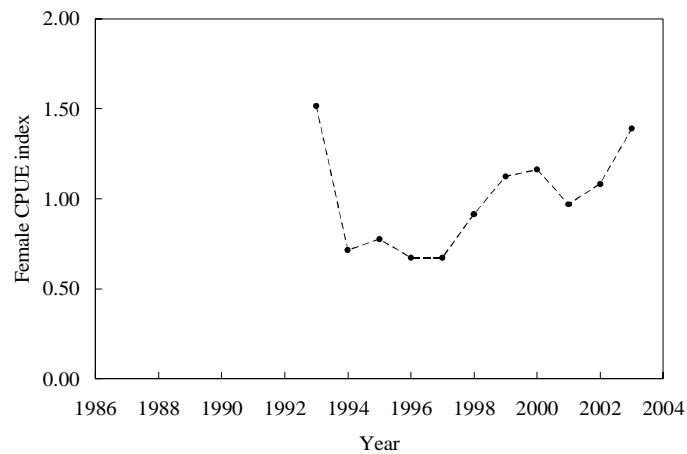


Fig. 1.3. Shrimp Div. 3M: standardized female CPUE index, 1993-2003. The series was standardized to the mean of the series.

Biological data. Age composition was assessed from commercial samples obtained from Canada, Greenland, Russia, Iceland and Estonia. Number/hour was calculated for each year-class by applying a weight/age relationship and the total number as calculated from the nominal catch and the standardized CPUE data.

The results in the Table below indicate that age 4 generally dominates the commercial catch in numbers. In both 2001 and 2002 the 1997 year-class appears to be above average according to its contribution to the commercial catch rates. The 1998 year-class on the other hand, appears to be below average. In 2002 and 2003 the 1999 year-class is even more numerous than the 1997 year-class was as

three and four year olds. The 2000 year-class is very low in numbers in 2003 and is considered a weak year-class.

Numbers per hours at age in the commercial fishery.

Age	1996	1997	1998	1999	2000	2001	2002	2003
1				5			21	21
2	2 425	2 058	3 072	2 462	851	6 422	4 224	4 580
3	25 396	16 338	17 974	14 658	21 246	8 601	35 637	8 185
4	7 736	16 953	21 028	16 954	23 980	27 529	12 128	37 082
5	2 238	3 330	6 707	13 640	14 311	13 943	14 697	15 669
6	1 169	675	2 494	4 911	3 583	4 112	3 002	4 594
7		58	280	57	177	556	119	2
	38 964	39 412	51 555	52 687	64 148	61 163	69 828	70 133

ii) Research survey data

EU surveys (SCR Doc. 03/80). EU groundfish surveys have been conducted on Flemish Cap in July from 1988 to 2003. The 1994 and 1998 total biomass indices are likely biased due to changes in sizes of codend mesh. The female biomass is however, not considered to be affected by the change of codend mesh size. The female shrimp biomass declined to relatively low values in 1994 to 1997, increased to a higher level in 1998-2002 (Fig. 1.4). A new research vessel was introduced in 2003 however STACFIS was unclear about the details of the conversion in SCR Doc. 03/80.

Age has been assessed from the length distributions of the EU surveys back to 1988. Results for age 4 indicate that the 1997 year-class was far above average in 2001 and also at age 5 in 2002. In the 2002 survey the 1998 year-class at age 4 does not appear to be strong whereas the 1999 year-class at age 3 appears strong.

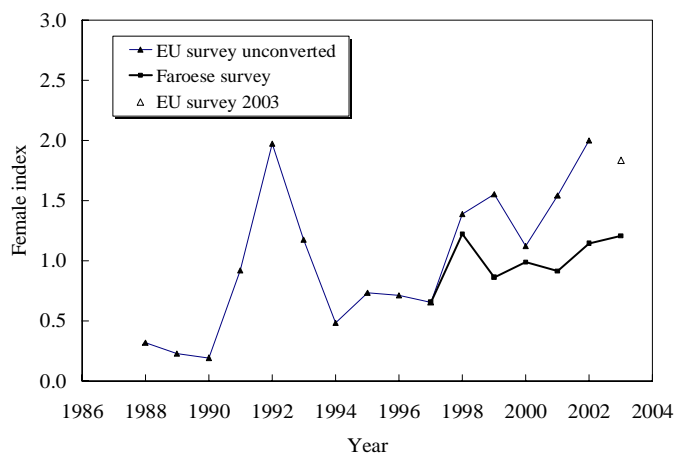


Fig. 1.4. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2003 and Faroese survey, 1997-2003. Each series was standardized to the mean of that series.

Faroese survey (SCR Doc. 03/66, 87). Stratified-random surveys were conducted in June-July 1997-2003 by a Faroese shrimp trawler. Surveys utilized a juvenile bag attached to the codend since 1998. The total biomass index fluctuated between 16 000 and 22 000 tons in the years 1997 to 2001 increasing to about 27 000 in 2002 and 2003 (Fig. 1.4). Results indicate that the 1997 and 1999 year-

classes are above average, the 1998 and 2000 year-classes appear weak and the 2001 is average (Fig. 1.5).

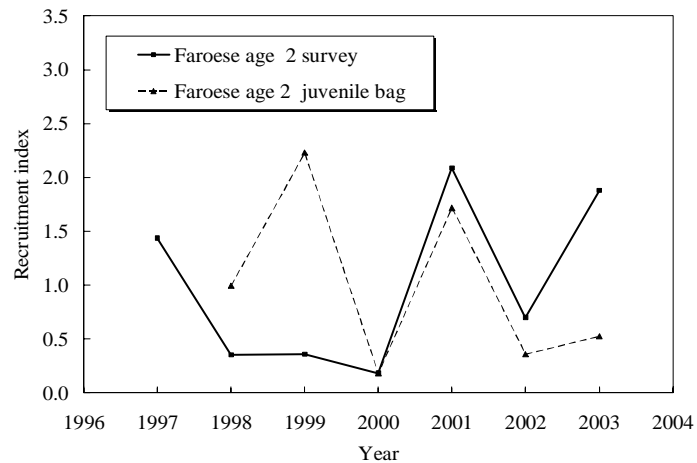


Fig. 1.5. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey. Each series was standardized to its mean.

c) Assessment Results

Commercial CPUE. Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2003.

Recruitment. The 1999 year-class is strong while the 2000 year-class appears weak and the 2001 year-class appears average.

Spawning Stock Biomass. All indices of female biomass showed an increasing trend from 1997 to 2003.

State of the Stock. STACFIS is unable to estimate absolute stock size. Stock size indicators have shown a general increase since 1997. The 1999 year-class is strong and will continue to contribute to the fishery in 2004, and possibly to some degree in 2005 as well. The 2001 year-class appears to be about average and shall be contributing to the fishery in 2004 and 2005. However, the 2000 year-class appears to be weaker.

STACFIS considers it important to recognize that its ability to assess the resource will improve with the continuation of a series of research surveys directed for shrimp, particularly if a juvenile bag is used.

d) Research Recommendations

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

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*
- *a more detailed conversion document including information on the geometry and behaviour of the trawls and detailed calculations of the conversion for shrimp be presented at the September 2004 meeting.*
- *indices of stock size be presented with error bars where possible.*

2. Northern Shrimp (*Pandalus borealis*) in Divisions 3L, 3N and 3O (SCR Doc. 03/72, 81, 82)

a) Introduction

This shrimp stock is distributed around the edge of the Grand Banks mainly in Div. 3L. The fishery began in 1993 with catches around 1 800 tons. Exploratory fishing from 1996-99 resulted in catches ranging from 179 to 795 tons. In 2000, Fisheries Commission implemented a TAC of 6 000 tons, and fishing was restricted to Div. 3L. For 2003, Fisheries Commission increased the TAC to 13 000 tons because biomass had increased significantly since 1999.

Catches from 1993 to 2000 are as reported in the STATLANT 21A database. Reliable catch reports were not available for all countries in 2001, and 2002. Estimates from other sources were used in these cases. For 2003, estimates of catch were available for all countries, so STACFIS was able to project total catches to the end of 2003. The total catch to date in 2003 is estimated to be about 10 600 tons, and is projected to 12 000 tons for the full year (Fig. 2.1).

In 2000, small vessels (less than 500 tons) caught about three-quarters of the Canadian catch. In 2001 and 2002, the Canadian quota was divided equally between the large and small vessel fleets. As a result, the proportion of catch taken by large vessels increased and most of their catch came from single trawls. In 2003, about 60% of the Canadian TAC was assigned to the small vessel fleet; consequently this fleet took 6 537 tons of shrimp. Canada's large vessel fleet caught 3 352 tons of shrimp in Div. 3L as of 1 November 2003. In all years, most of the Canadian catch occurred along the northeast slope in Div. 3L. The use of a sorting grid to reduce by-catches of fish is mandatory for all fleets in the fishery.

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

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
TAC	-	-	-	-	-	6 000	6 000	6 000	13 000	13 000
STATLANT 21A	0	179	485	567	795	4 903 ¹	5 323 ¹	5 697 ¹		
STACFIS	0	179	485	567	795	4 903	10 566	6 977	12 000 ²	

¹ Provisional catches.

² Projected catches for 2003.

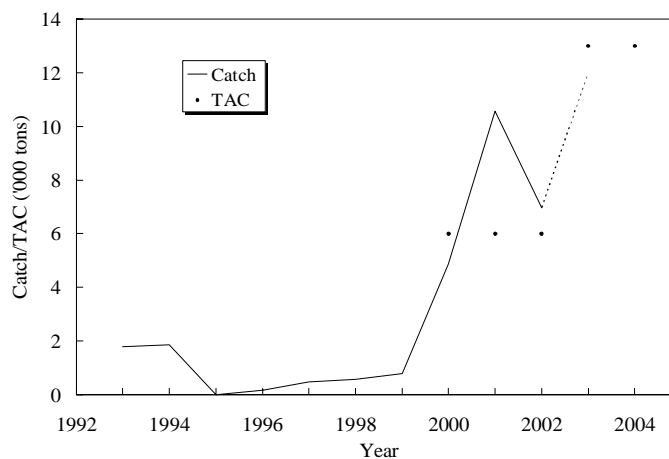


Fig. 2.1. Shrimp in Div. 3LNO: catches and TAC.

b) **Input Data**

i) **Commercial fishery data** (SCR Doc. 03/82)

Fishing effort and CPUE. Catch and effort data have been available from Canadian fishing vessel logbooks and observer records since 2000. Unstandardized catch rates (both single and double trawl) for large vessels increased to more than 1 700 kg/hr. Whereas, Canadian small vessel CPUE remained at approximately 370 kg/hr. Some CPUE data were available from a few vessels fishing in the Div. 3L NRA, and were generally quite variable.

Catch composition. Observers sampled and measured Canadian catches (approximately 2-5% of the small vessel catches and over 90% of the large vessel catches were observed) in Div. 3L. Length frequency distributions were presented from catches taken by large vessels during 2000-2002. At least four year-classes were evident in all three length frequency distributions. The relatively strong 1997-99 year-classes could easily be tracked over the short time series. The 1997-99 year-classes appear very strong compared to the weak 1995 and 1996 year-classes. The female distributions are broad throughout the short time series indicating that they are composed of more than one year-class.

Adequate length frequencies were not available from either the 2000-2003 small vessel or 2003 large vessel fisheries, therefore, these distributions were not presented.

ii) **Research survey data** (SCR Doc. 02/82)

Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen shrimp trawl, during spring and autumn since late-1995. Data for shrimp were available from the autumn surveys in 1995-2002, and from spring surveys in 1999-2003. In all surveys, over 90% of the biomass was found in Div. 3L, distributed mainly along the northeast slope in depths from 185-550 m. Based upon confidence intervals, there was a significant increase in autumn shrimp biomass/ abundance indices between 1995-97 followed by stability from 1997 until 1999. Both biomass and abundance indices remained at a higher level since 2000 (Fig. 2.2). Similarly, spring 2002 and 2003 indices are significantly higher than spring 1999 indices (Fig. 2.3).

Canadian multi-species survey autumn and spring biomass indices are indicated below:

Year	Autumn			Spring		
	Lower 95% C. L.	Estimate	Upper 95% C.L.	Lower 95% C.L.	Estimate	Upper 95% C.L.
1995	3.6	5.9	8.2			
1996	10.2	20.1	29.9			
1997	25.5	46.2	66.9			
1998	40.0	59.9	79.8			
1999	36.2	53.1	70.1	12.6	55.3	98.1
2000	93.1	118.2	143.2	-15.9	122.8	259.5
2001	77.6	224.0	370.4	62.4	102.6	142.8
2002	126.2	215.0	303.8	121.1	159.5	197.9
2003				112.3	193.8	275.2

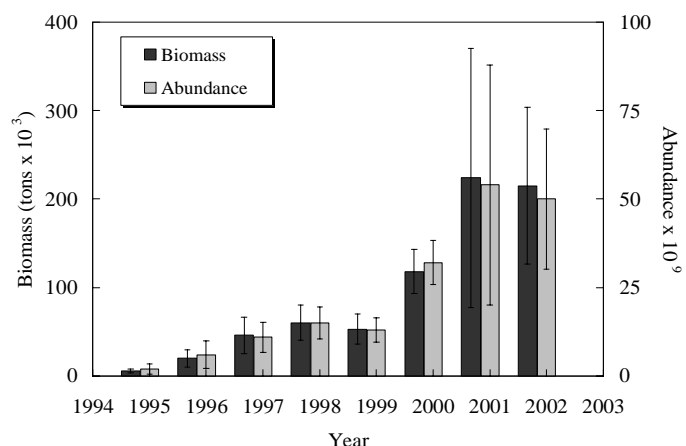


Fig. 2.2. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian autumn multi-species surveys with 95% confidence intervals.

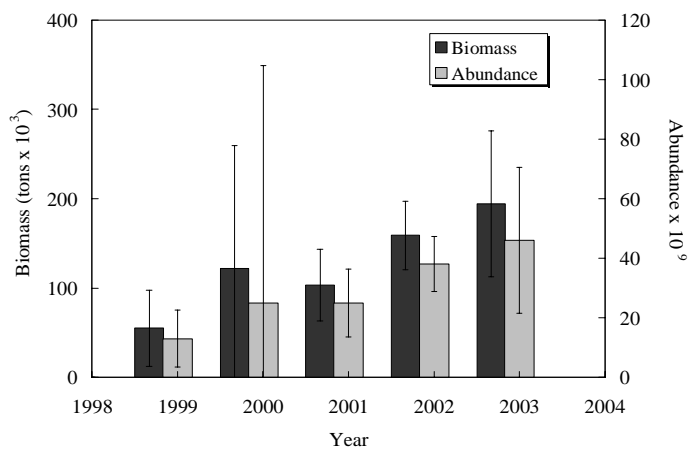


Fig. 2.3. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian spring multi-species surveys with 95% confidence intervals.

Sex and length composition. Estimated total number (10^9) of shrimp in Div. 3LNO from autumn 1995 to spring 2003 are as follows:

Survey	Males	Females	Total	Males %	Female %
Autumn 1995	1.3	0.8	2.1	61.9	38.1
Autumn 1996	5.5	0.4	5.9	93.2	6.8
Autumn 1997	7.7	2.9	10.5	73.3	26.7
Autumn 1998	13.3	2.0	15.3	86.9	13.1
Spring 1999	9.7	3.0	12.7	76.4	23.6
Autumn 1999	10.4	2.6	13.1	79.4	20.6
Spring 2000	17.0	8.0	25.0	68.0	32.0
Autumn 2000	27.8	4.3	32.2	86.3	13.7
Spring 2001	19.2	5.8	25.0	76.8	23.2
Autumn 2001	45.8	8.3	54.1	84.7	15.3
Spring 2002	26.8	10.7	37.5	71.5	28.5
Autumn 2002	39.8	10.5	50.3	79.1	20.9
Spring 2003	39.2	13.4	46.3	84.7	15.3

Autumn abundances of shrimp have increased to the highest levels in the time series during 2001 while spring abundance was highest during 2003. The proportion of females in the surveys has varied around the mean of 21%. Abundance estimates from the autumn 2002 survey were dominated by males with a modal length of 17.0 mm CL (1999 year-class). This year-class was preceded by 1997 and 1998 year-classes which were also strong relative to all previous year-classes. The relatively broad female size distribution suggests that it consisted of more than one year-class.

Trends in the SSB index from the autumn surveys were similar to those for total biomass (Fig. 2.4).

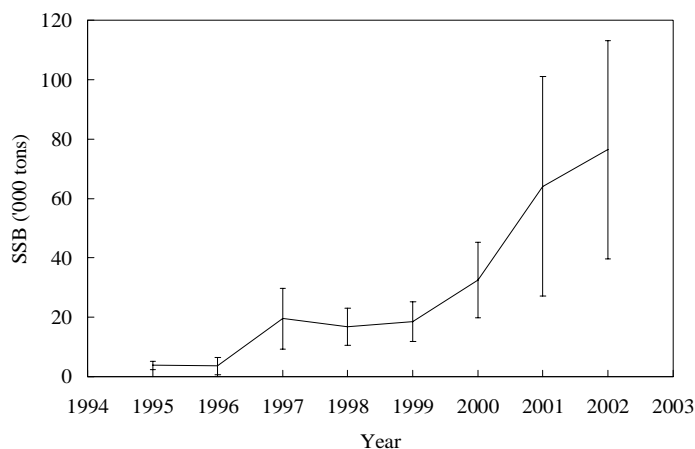


Fig. 2.4. Shrimp in Div. 3LNO: Spawning stock biomass (SSB) estimates from Canadian autumn multi-species surveys with 95% confidence intervals.

A recruitment index (shrimp considered to be age 2) from the autumn surveys of 1995-2002 shows that the 1998 and 1999 year-classes are the two largest in the short time-series. These year-classes are followed by the 2000 year-class which was slightly above average for the time series (Fig. 2.5). A comparable estimate of the 2001 year-class at age 2 was not available, as the autumn survey of 2003 was not completed at the time of the assessment.

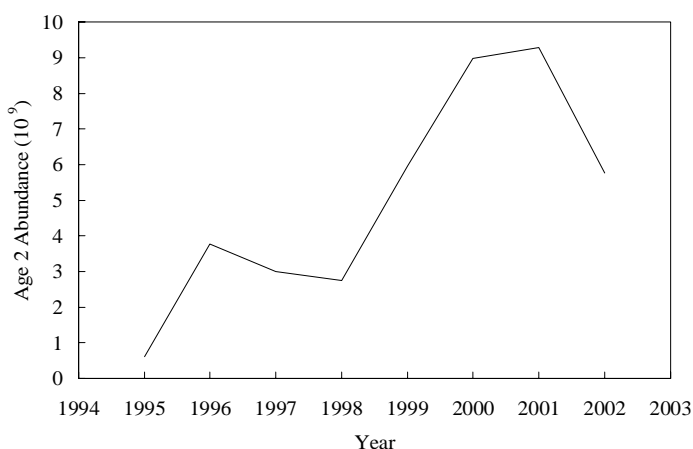


Fig 2.5. Shrimp in Div. 3LNO: age 2 recruitment index as determined from Canadian autumn multi-species surveys.

An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index (shrimp biomass for all animals with carapace lengths greater than or equal to 17 mm) from the

previous autumn survey (Fig. 2.6). The index was 1-4% during 1996-99, but increased to 10-11% in 2000-2001; the first two years of TAC regulation. Even though catches are projected to increase to 12 000 tons in 2003, exploitation is estimated to be only 6% due to an increase in biomass. Catch has always been less than 15% of the lower 95% confidence limit of the previous autumn survey biomass estimate.

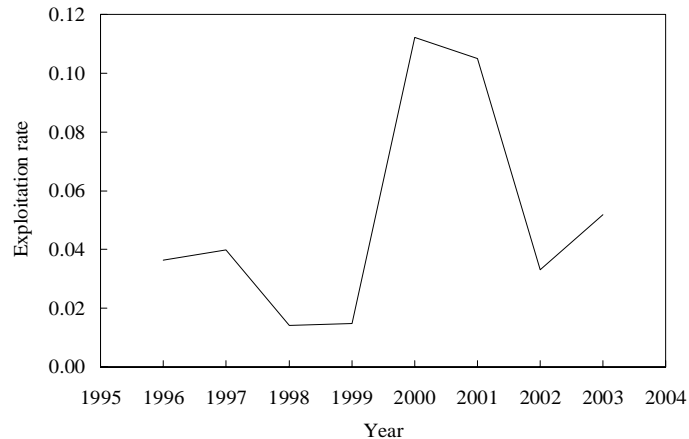


Fig 2.6. Shrimp in Div. 3LNO: exploitation rates as derived by catch/previous year's fishable biomass index.

ii) **Biological studies** (SCR Doc. 03/81)

Spatial distributions and abundances of northern shrimp were presented in relation to their thermal habitat for Div. 3LNO as determined from Canadian spring (1999-2003) and autumn (1995-2002) multi-species bottom trawl surveys. During spring surveys, the highest numbers of shrimp were caught in the 2°-4°C temperature range, however, the highest autumn catches were in the 1°-3°C temperature range. In general, most large spring catches were found in the warmer water along the slopes of Div. 3LN. During autumn there was an apparent shift in distribution toward colder temperatures upon the Grand Bank and toward inshore regions resulting in a greater proportion of the catches being taken in the 0°-1°C temperature range.

c) **Assessment Results**

Recruitment. The 1998 and 1999 year-classes are the two largest year-classes in the short time series, but are followed by the 2000 year-class which was slightly above average.

Biomass. There was a significant increase in SSB and total biomass between 1995 and 1997 followed by a period of stability from 1997 until 1999. Both SSB and total biomass have been at a higher level since 2000.

Exploitation: No estimates of fishing mortality were available. The exploitation index (catch/fishable biomass) was 1-4% during 1996-99, increased to 10-11% in 2000-2001, and was estimated to be only 6% during 2003.

State of the Stock. STACFIS is not able to provide estimates of absolute stock size. SSB estimates have increased significantly since 1999 and are currently the highest observed. Recruitment increased over much of this time period. The 1998 and 1999 year-classes were the highest observed, however, recruitment of the 2000 year-class has dropped to just above the time series average. The stock appears to be well represented by a broad range of size groups, and exploitation is low.

d) **Research Recommendations**

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

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

3. **Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1** (SCR Doc. 03/70, 71, 73, 74, 75, 76, 86, 02/158)

a) **Introduction**

The shrimp stock off West Greenland is distributed in Subarea 1 and Div. 0A east of 60°W. Shrimp within this area is assessed as a single population. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A to 1F) in offshore and inshore areas (primarily Disko Bay). Since 1981 the Canadian fishery has been limited to Div. 0A.

Three fleet components, one from Canada and two from Greenland (vessels above and below 80 GRT) participated in the fishery since the late-1970s. The Canadian fleet and the Greenland large-vessel fleet have been restricted by areas and quotas since 1977. The fishery by the Greenland small-vessel fleet was unrestricted until January 1997, when quota regulation was imposed. In 2003, the advised TAC for the entire stock was 100 000 tons. In 2003 the Greenland authorities set a TAC for Subarea 1 of 100 000 tons, and a TAC for Div. 0A east of 60°30'W of 14 667 tons was set by the Canadian authorities for the same year. The use of a sorting grid with 22 mm bar distance to reduce by-catches of fish is mandatory for both the Greenland large-vessel fleet and the Canadian fleet. Discarding of shrimp is prohibited.

Until 2003 catches of shrimp taken in SA 1 have been reported without accounting for "overpacking" – the amount of surplus weight in packaging – or the difference between the product weight and live weight. Advised and actual TACs have been set in the same units as used within the reporting practice. On 1 January 2004 new legislation should be enforced to ensure that total removals by fishing are reported in units of live weight. To allow management advice derived from the stock assessment to be stated in the units of the future catch reporting, a correction of the input catch data series was performed (SCR Doc.03/74):

Year	Reported catch SA 1 (tons)	Correction factor SA 1	Corrected catch SA 1 (tons)	Catch Div. 0A (tons)	Total STACFIS estimate
1970	8559	1.2285	10515	0	10515
1971	9437	1.2285	11593	0	11593
1972	9656	1.2285	11862	0	11862
1973	12642	1.2285	15530	0	15530
1974	22009	1.2285	27038	0	27038
1975	37890	1.2285	46547	0	46547
1976	49674	1.2285	61023	392	61415
1977	41643	1.2285	51158	457	51615
1978	34347	1.2285	42195	122	42317
1979	33458	1.2285	41102	1732	42834
1980	43278	1.2285	53166	2726	55892
1981	39516	1.2285	48545	5284	53829
1982	42515	1.2285	52229	2064	54293
1983	41354	1.2285	50803	5413	56216
1984	41241	1.2285	50664	2142	52806
1985	51396	1.2285	63139	3069	66208
1986	60134	1.2285	73873	2995	76868
1987	57641	1.2463	71836	6095	77931
1988	54392	1.2453	67735	5881	73616
1989	58422	1.2570	73436	7235	80671
1990	63184	1.2312	77793	6177	83970
1991	69092	1.2259	84701	6788	91489
1992	79258	1.2364	97994	7493	105487
1993	70123	1.2196	85522	5491	91013
1994	71811	1.2260	88039	4766	92805
1995	68329	1.2444	85027	2361	87388
1996	66610	1.2230	81463	2632	84095
1997	64000	1.2127	77611	517	78128
1998	65170	1.2208	79562	933	80495
1999	73985	1.2184	90145	2046	92191
2000	78337	1.2181	95424	1782	97206
2001	81398	1.2182	99156	3625	102781
2002	103000	1.2223	125894	6247	132141
2003*	105000	1.2186	127955	7000	134955

*projected from October to the end of the year

Overall annual catch has increased from about 10 000 tons in the early-1970s to more than 105 000 tons in 1992 (Fig. 3.1). Restrictions by the Greenlandic authorities to reduce effort, and fishing opportunities elsewhere for the Canadian fleet resulted in catches decreasing to about 80 000 tons in 1998. Since then overall catches have increased. The projected catch of 2003 is expected to be around 135 000 tons (Fig. 3.1) based on data through October 2003.

Recent nominal catches, projected figures for 2003 and recommended TACs (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1994	1995	1996	1997	1998	1999	2000 ²	2001 ²	2002 ²	2003 ³
Recommended TAC ¹	50 000	60 000	60 000	60 000	55 000	65 000	65 000	85 000	85 000	100 000
Actual TAC			72 422	74 800	68 379	80 350	80 350	91 350	101 000	114 667
SA 1	71 811	68 329	66 610	64 000	65 170	73 985	78 337	81 398	103 000	105 000
Div. 0A	4 766	2 361	2 632	517	933	2 046	1 782	3 625	6 247	7 000
Total STATLANT 21A	76 577	70 690	69 242	64 517	66 103	76 031	80 119	85 023	109 247	
Total STACFIS ⁴	92 805	87 388	84 095	78 128	80 495	92 191	97 206	102 781	132 141	135 000

¹ Until 1994 the recommended TAC was only for offshore south of 71°N. After 1994, it included offshore north of 71°N and inshore. Until 2003 recommended TAC were given in the units of the STATLANT reporting.

² Provisional catches.

³ Catches projected to end of 2003.

⁴ Estimates corrected for overpack.

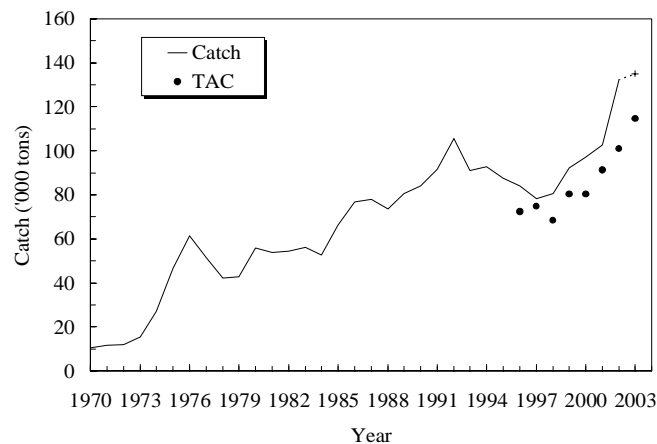


Fig. 3.1. Shrimp in Subareas 0 and 1: total catches (2003 projected to the end of the year) and actual TACs.

Until 1988, the fishing grounds in Div. 1B have been the most important. Since then, a southward expansion in the offshore fishery has taken place, and from 1990 catches in Div. 1C and 1D have exceeded those from Div. 1B. At the end of the 1980s, exploitation began in Div. 1E and 1F, and catches from these areas now account for about 20% of the total catch. The Canadian fishery in Div 0A east of 60°W has taken from 0.7 to 4.7% of total annual catches in the recent five years. The distribution of the fishery has not changed since 1996.

b) Input Data

i) Commercial fishery data

Fishing effort and CPUE. Catch and effort data from the shrimp fishery were available from fishing records from Canadian vessels in Div. 0A east of 60°W and from Greenland logbooks for Subarea 1 (SCR Doc. 03/75).

Multiplicative models were used to calculate fleet specific annual catch rate indices. From these individual indices one unified time series covering 1976-2003 was derived. All fleets included in the analysis mainly exploit shrimp greater than 16 mm carapace length (CL). The CPUE indices are therefore indicative of the combined biomass of older males and the females.

The standardized CPUE series showed an increasing trend since 1990 (Fig. 3.2). The 2003 mean value is the highest in the time series.

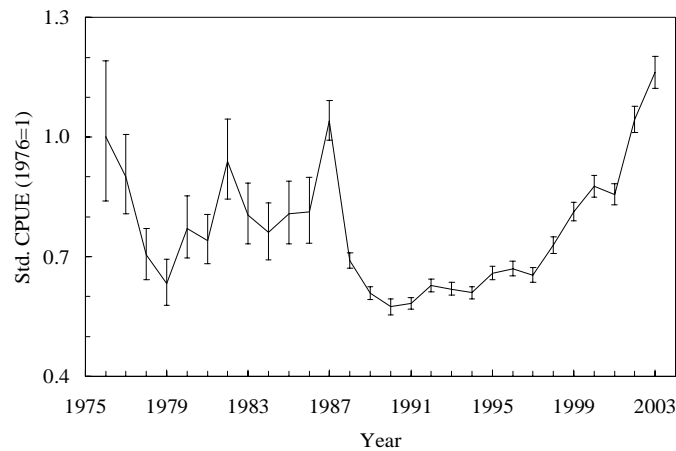


Fig. 3.2 Shrimp in Subareas 0 and 1: standardized CPUE index. Error bars are upper and lower quartiles.

Catch composition. Catch composition was assessed from samples obtained by observers in the commercial fishery in Div. 0A from 1981 to 2001, and in Subarea 1 from 1991 to 2001 (SCR Doc. 03/75). The mean size of shrimp caught has declined since 1991. In spite of these changes, the proportions of female to male shrimp in the catches seemed relatively stable until the late-1990s. In 2002 STACFIS recommended that "sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established". However, the sampling program remained inadequate and sparse sampling prohibited an analysis of catch composition for the years 2002 and 2003.

ii) Research survey data

Greenland trawl survey. Stratified-random trawl surveys have been conducted since 1988 in offshore areas (Subarea 1 and Div. 0A east of 60°W) and since 1991 also in inshore Subarea 1 (SCR Doc. 03/71). From 1993, the survey extended further south into Div. 1E and 1F.

Biomass. The survey biomass indices indicated a fairly stable stock size from 1988 to 1997. Since then a significant increasing trend was observed. The 2003-value is the highest of the time series (Fig. 3.3).

Within the survey area, large year-to-year variations in the distribution of biomass were observed geographically as well as over depth zones. Some areas account for a large proportion of the variances of the estimated biomasses. During the recent period of increasing biomass indices, an increased proportion of the biomass was seen in depths between 200 and 300 m and in the northern most areas.

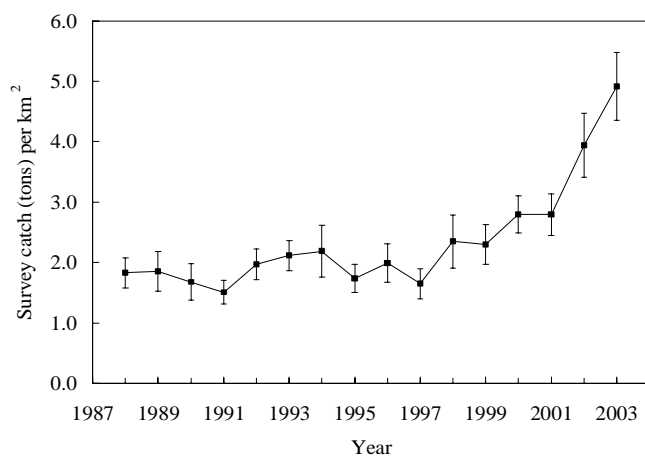


Fig. 3.3. Shrimp in Subareas 0 and 1: Survey indices of biomass, ± 1 standard error.

Sex and length composition. Indices of total abundance ($\times 10^9$) of shrimp in Subarea 1 and Division 0A east of 60°W from 1988 to 2003 are as follows (SCR Doc. 03/71):

Year	Males	Females	Total	Males, %	Females, %
1988 ¹	24.3	9.9	34.2	71.0	29.0
1989 ¹	35.0	7.6	42.5	82.2	17.8
1990 ¹	28.5	10.0	38.5	74.1	25.9
1991	17.4	6.2	23.6	73.8	26.2
1992	29.7	7.3	36.9	80.3	19.7
1993	35.5	9.7	45.2	78.5	21.7
1994	33.9	10.9	44.8	75.7	24.3
1995	29.2	7.9	37.1	78.7	21.3
1996	41.4	8.1	49.5	83.7	16.3
1997	29.5	7.6	37.0	79.6	20.4
1998	42.9	11.5	54.5	78.8	21.2
1999	44.8	11.3	56.2	79.9	20.1
2000	66.7	12.7	79.4	84.0	16.0
2001	61.1	13.7	74.8	81.7	18.3
2002	90.6	16.7	107.2	84.5	15.5
2003	103.2	27.9	131.1	78.7	21.3

¹ No inshore survey in 1988-90. The numbers in 1988 to 1990 represent an average of the estimated numbers of shrimp inshore from 1991-97 added to the actual estimates from the offshore area.

The index of total abundance of shrimp in 2003 was the highest in the series. The proportion of males in 2003 was at the average of the values recorded in the time series.

The overall length-frequency distributions in 2003 showed male modes (at 16 and 20 mm CL), a mode of primiparous females at 24 mm CL and one of multiparous females at 25.5 mm CL (Fig. 3.4). The strong presence of males between 14 and 22 mm CL indicates that recruitment of small males to the fishable stock and large males to the female group is secured for the coming year.

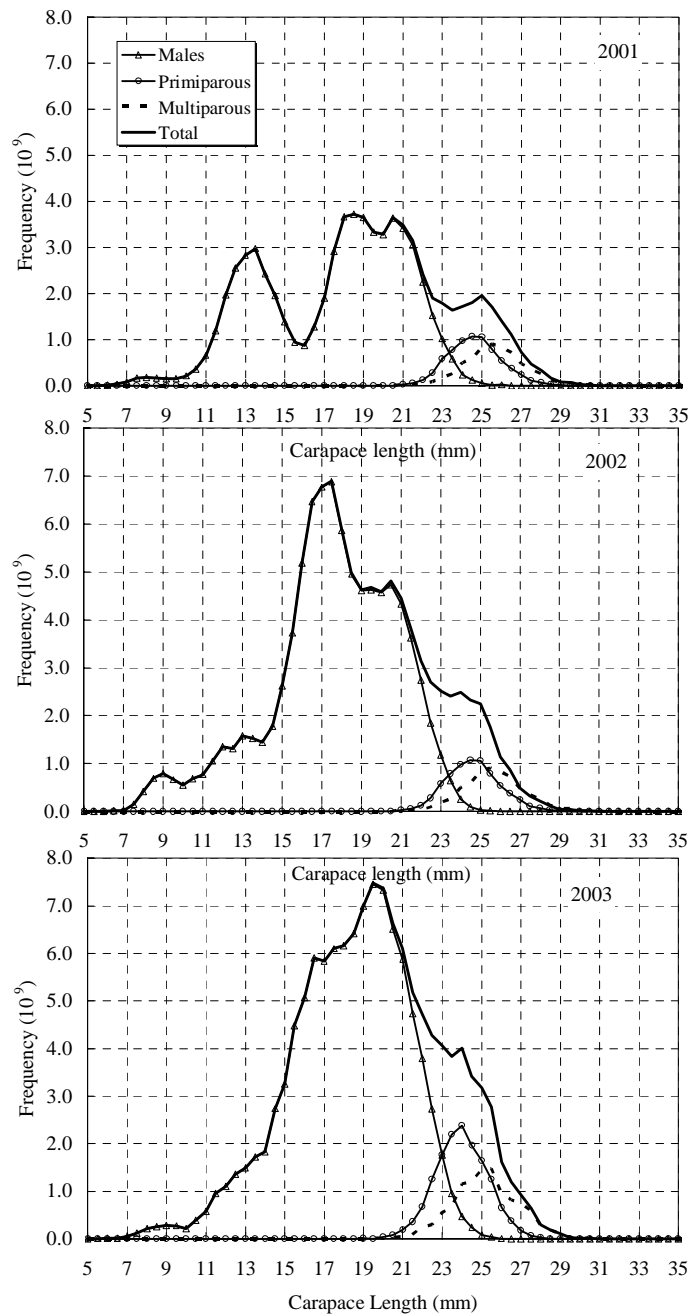


Fig. 3.4. Shrimp in Subareas 0 and 1: Numbers of shrimp by 0.5 mm CL length group in the total area during 2001-2003 (mesh size in the cod-end 20 mm stretched).

Index of recruitment. Abundance at age 2 (SCR Doc. 03/76) showed an increasing trend from 1997 to 2001 and a decrease thereafter (Fig. 3.5). The 2003 value is below the average of the time series.

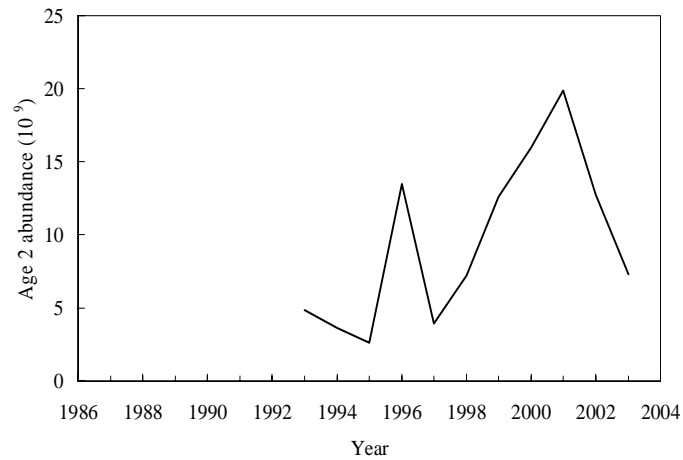


Fig. 3.5. Shrimp in Subareas 0 and 1: recruitment index (age 2 abundance)

Index of spawning stock biomass. The index of female biomass (SCR Doc. 03/71) showed an increasing trend since 1997 and the value in 2003 is the highest observed in the series (Fig. 3.6).

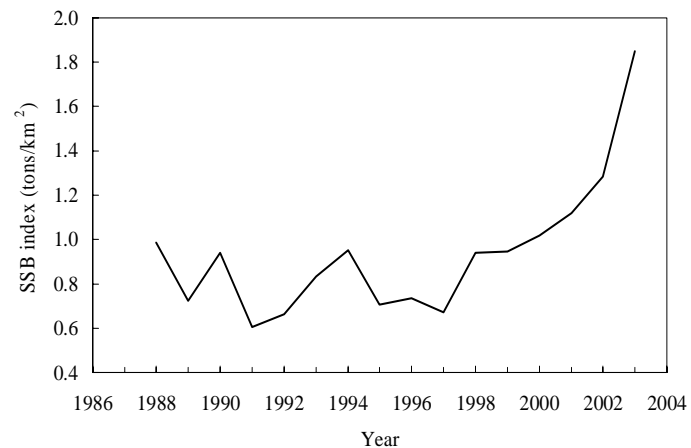


Fig. 3.6. Shrimp in Subareas 0 and 1: female spawning stock biomass index.

Exploitation rate. An index of exploitation rate (SCR Doc. 03/71) calculated as the proportion of total catch to corresponding survey estimates of fishable biomass (shrimp ≥ 17 mm CL) (Fig. 3.7) declined since 1991.

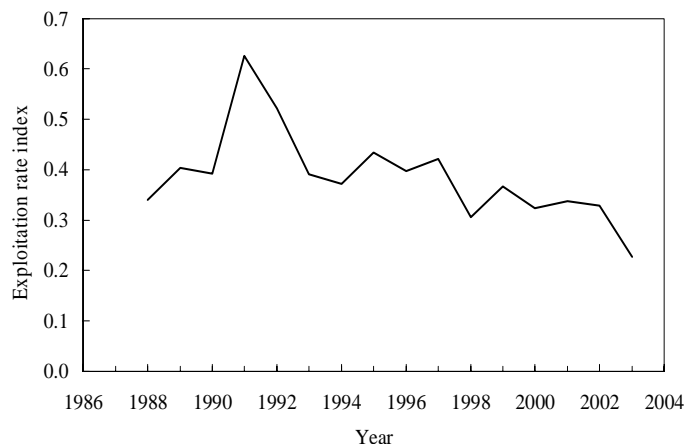


Fig. 3.7. Shrimp in Subareas 0 and 1: Index of exploitation rate (proportion of total catch to corresponding survey estimate of fishable biomass).

iii) Other studies

Length frequency distributions of northern shrimp (*Pandalus borealis*) from the West Greenland bottom trawl surveys in the years 1993 to 2003 were examined in order to extract mean lengths and abundance indices for age 1, 2 and 3 by modal analysis (SCR Doc. 03/76). The original survey data were pooled into five major regions defined by latitudinal differences in bottom temperature. Mean size at age differed considerably between regions and years. The changes in mean size were positively correlated to bottom temperature for all of the three age groups and a trend towards smaller size at age and slower growth was observed for the most recent years in which population density has increased substantially in large parts of the area. The estimates of the 1-group abundance appeared to be seriously effected by low catchability. Abundance at age 2 correlated significantly with the fishable biomass lagged by two years, and the survey estimates of abundance for this age can thus be regarded as suitable to assess short-term changes in recruitment to the fishery.

A method for the calculation of a TAC for northern shrimp off West Greenland one and two years ahead was presented (SCR Doc. 03/86). The method considers explicitly recruitment in the short term and combines survey estimates of fishable biomass and fishery information on the level of exploitation. Maintaining the current level of exploitation the method suggest TACs of 130 000 tons for 2004 and approximately 100 000 tons for 2005.

Catches of *Pandalus montagui* in the West Greenland bottom trawl surveys were reported (SCR Doc. 03/70). Derived indices of biomass had high variance large inter annual variability, and showed no trend over time. The proportion of biomass of *P. montagui* to *P. borealis* were estimated to be less than 0.01. However, as the survey design has been made with reference to the distribution of *P. borealis*, it is likely that too few stations in the distribution area of *P. montagui* have been applied to give reliable estimates of the biomass.

c) Estimation of Parameters

Parameters relevant for the assessment and management of the stock were estimated, based on a stochastic version of a surplus-production model that included an explicit term for predation by cod (*Gadus morhua*). The model was formulated in a state-space framework and Bayesian methods were used to construct "posterior" likelihood distributions of the parameters (SCR Doc. 02/158).

The model synthesized information from input priors and the following data: a 16-year series of a survey biomass indices of shrimp ≥ 17 mm CL; a 28-year series of combined CPUE indices; a 49-year series of

catches by the fishery; a 49-year series of a cod biomass estimates; and a short series (4 years) of estimates of the shrimp biomass consumed by cod (SCR Doc. 03/73).

Absolute biomass estimates had relatively high variances. For management purposes therefore it is desirable to work with biomass on a relative scale in order to cancel out the uncertainty of the "catchability" parameters (the parameters that scale absolute stock size). Biomass, B , is thus measured relative to the biomass that yields Maximum Sustainable Yield, B_{MSY} . The estimated mortality, Z , refers to the removal of biomass by fishing and cod predation and is scaled to Z_{MSY} - the mortality at MSY.

d) Assessment Results

The model estimated the median annual consumption by cod 1956-2003 in the range of 200 tons to about 116 000 tons. The estimated consumption declined since 1960 as a result of a decline in cod abundance at West Greenland (Fig. 3.8). A short-lived resurgence of the cod stock in the late-1980s caused consumption to increase. The cod disappeared in the beginning of the 1990s and estimates of consumption went to zero.

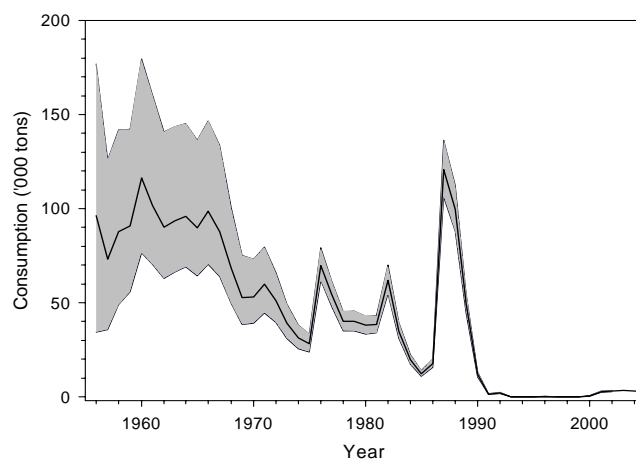


Fig. 3.8. Shrimp in Subareas 0 and 1: Estimated consumption of shrimp by cod (solid line is the median and shaded area indicates the range between the 25th and 75th percentiles).

The trajectory of the median estimate of 'biomass-ratio' (B_t/B_{MSY}) plotted against 'mortality-ratio' (Z_t/Z_{MSY}) (Fig. 3.9) starts in 1956 at half the optimum biomass ratio and at a mortality-ratio well above 1. The stock maintained itself in this region during the years when cod were abundant. When the cod stock declined in the late-1960s, and predation pressure was lifted (Fig. 3.8), shrimp stock biomass increased and eventually began cycling in the left upper corner of the graph (Fig. 3.9) during the current regime of low cod abundance (SCR. Doc. 03/73).

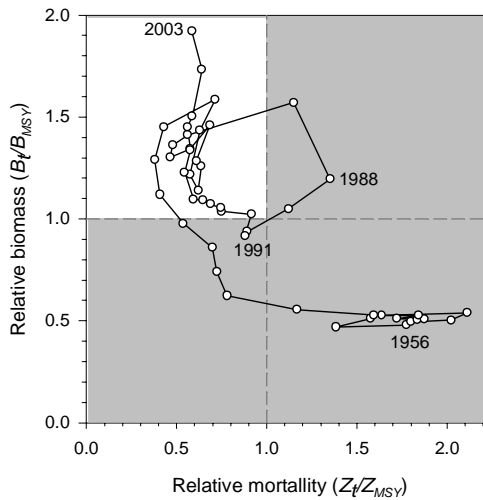


Fig. 3.9. Shrimp in Subareas 0 and 1: estimated annual median biomass-ratio (B_t/B_{MSY}) and mortality-ratio (Z_t/Z_{MSY}) 1956-2003.

Since the early-1970s the estimated median biomass-ratio ranged from about 0.96 to 1.92 (Fig. 3.9) and the probability that it had been below the optimum level was small for most years (Fig. 3.10), i.e. it seemed likely that the stock had been at or above its MSY-level throughout the modern fishery. The median estimate of biomass-ratio dipped just below the optimum in 1990-91 following a short-lived resurgence of the cod stock (Fig. 3.9). The stock has increased since then and reached its highest level ever in 2003 with a median estimate of biomass-ratio of 1.92, corresponding to about 87% of estimated median carrying capacity. The estimated risk of stock biomass being below B_{MSY} was 0.01 (Fig. 3.10).

The mortality ratio (Z-ratio, which includes mortality by fishing and predation by cod) has been below 1 for most of the time since 1970, except for the period of high cod predation in the late- 1980s (Fig. 3.9). Since 1997, annual median Z-ratio has been stable at approximately 0.6, i.e. well below the value that maximizes yield. The median of estimate for 2003 is 0.59 with a risk of only 0.04 of being above 1 (Fig. 3.10).

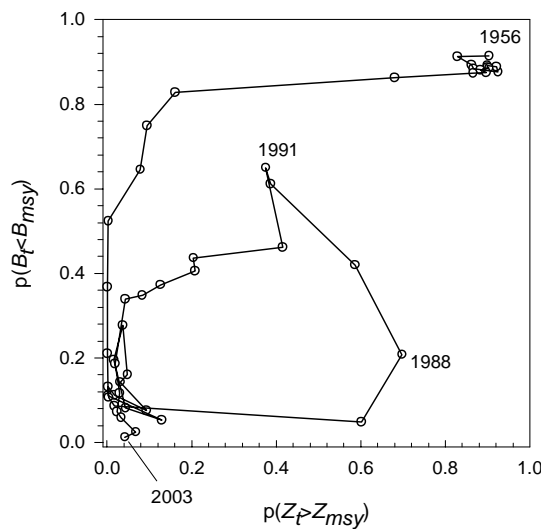


Fig 3.10. Shrimp in Subareas 0 and 1: risk of annual biomass being below B_{MSY} and of mortality caused by fishing and cod predation being above Z_{MSY} 1956-2003.

The median estimate of the maximum annual production surplus, available to the fishery and the cod (MSY) was estimated to 132 000 tons (Fig. 3.11). The risk function relating the probability of exceeding MSY to the combined removal by fishery and cod predation is given as the integral of this distribution (Fig. 3.11).

The catch series has been corrected for "overpacking" and input annual catch data values were therefore increased by on average 23% as compared to the assessment in 2002. As catches are important in scaling shrimp stock production, the model estimate of MSY would thus increase proportionally. The increase in median MSY from 101 000 tons the 2002 assessment to 132 000 tons in the current, is therefore mainly caused by the revision of the catch series.

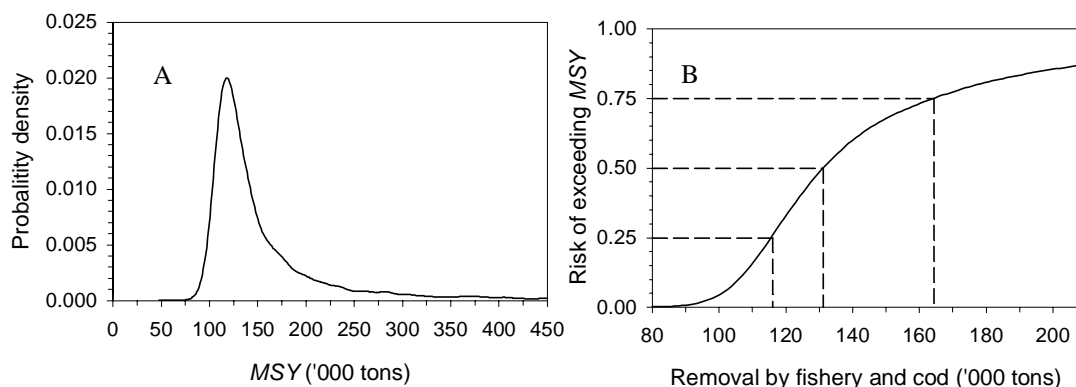


Fig. 3.11. Shrimp in Subareas 0 and 1: Posterior probability distribution of the maximum annual production surplus, (A) available to the fishery and cod (MSY) and (B) the cumulative probability of exceeding MSY (right panel).

Given the high probabilities of the stock being considerably above B_{MSY} , risk of stock biomass falling below this optimum level within a one-year perspective is low. Risk associated with five optional catch levels for 2004 are as follows:

Catch option ('000 tons)	110	120	130	140	150
Risk of falling below B_{MSY}	2%	2%	2%	3%	3%
Risk of exceeding Z_{MSY}	2%	3%	9%	14%	21%

Predation by cod can be significant (Fig. 3.8) and have a major impact on shrimp stock size. Currently the cod stock at West Greenland is at a very low level. A large cod stock that would significantly increase shrimp mortality could be established in two ways: either by a slow rebuilding process or by immigration of one or two large year-classes from areas around Iceland as seen in the late-1980s. An increase in cod abundance through growth of the existing stock would, however, be noted in an early phase during routine monitoring programs and fisheries management would have several years to respond before the shrimp stock is driven below optimal levels – given the current good condition of the stock. Although the biological and environmental conditions for immigration of cod from Icelandic areas have seemed favorable in recent years, no indications of such events were registered in the annual surveys. If and when the development of the cod stock warrants, management options given this scenario can be evaluated by STACFIS.

Ten-year projections of stock development were therefore made under the assumption that the cod stock will remain at its current low abundance. Five levels of annual catch: 110 000, 120 000, 130 000, 140 000 and 150 000 tons were investigated (Fig. 3.12).

At the investigated catch options of 110000 and 120000 tons/yr the stock is likely to remain above B_{MSY} during the ten years of projection (Fig. 3.12). The combined relative fishing and cod predation mortality, Z_t/Z_{MSY} , has a high probability of being below 1 within this period (Fig. 3.13).

A catch option of 130 000 tons/yr is near the estimated median MSY but is not likely to drive the stock below B_{MSY} in the short to medium term (Fig. 3.12), i.e. the risk is less than 10% within the first four years and just above 25% after year 10 (Fig. 3.13). However, this level of exploitation might not be sustainable in the longer term, as risk of exceeding B_{MSY} continues to increase through time.

Fishing 140 000 or 150 000 tons/yr bears a 60% and 70% risk respectively of being above MSY (Fig. 3.11), thus these catch levels are not likely to be sustainable in the longer term. Owing to the current high stock level the risk of exceeding B_{MSY} is no more than 20% after five years at 150 000 tons/yr, although after 10 years it is close to 50% (Fig. 3.13).

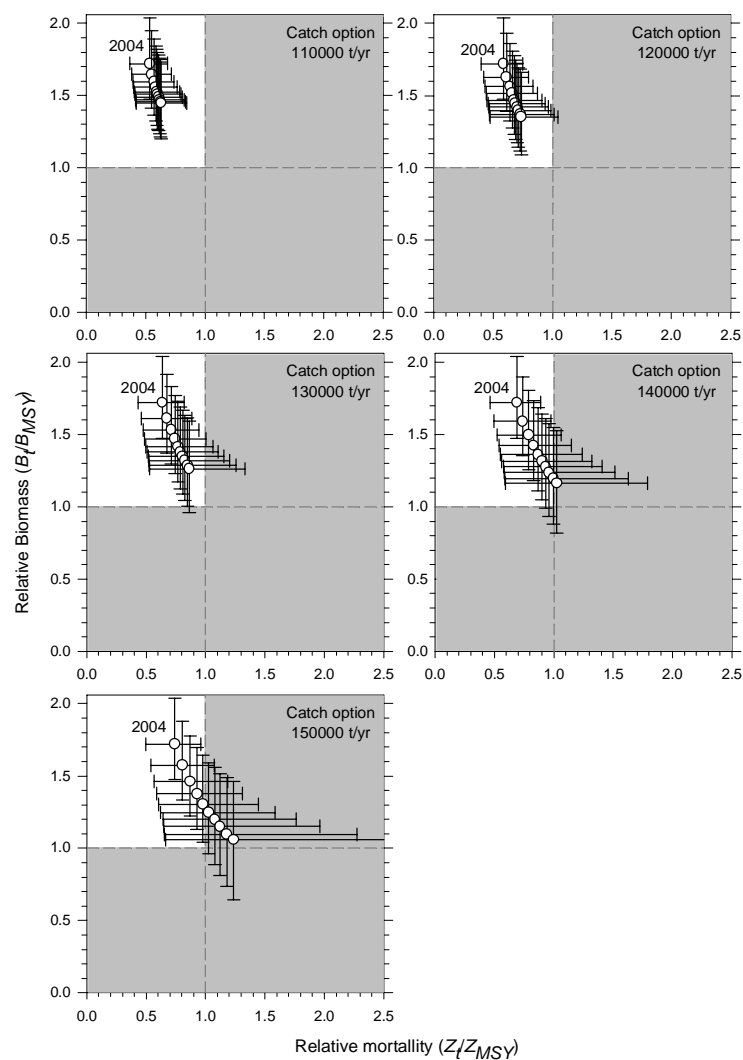


Fig. 3.12. Shrimp in Subareas 0 and 1: projections of stock development for the period 2004-2013 quantified in a biomass (B/B_{MSY})-mortality (Z/Z_{MSY}) continuum. Dynamics at 110, 120, 130, 140 and 150 thousand tons of fixed annual catch levels are shown as medians with error-bars at the 25th and 75th percentiles. Dashed lines indicate level of biomass and mortality at MSY.

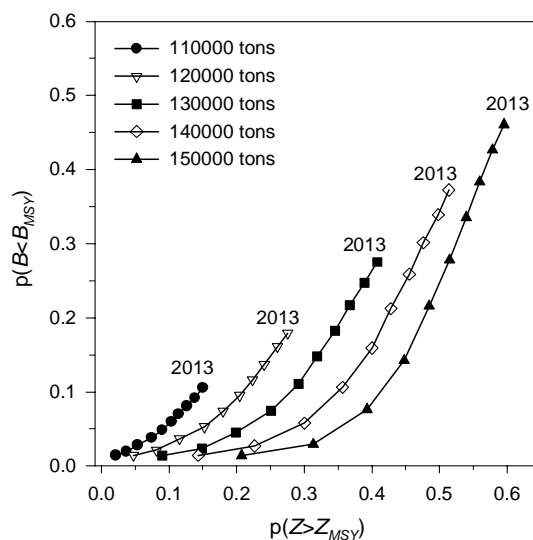


Fig.3.13. Shrimp in Subareas 0 and 1: risk of exceeding Z_{MSY} and of driving the stock below B_{MSY} by maintaining optional annual catch levels of 110-150 000 tons/yr during the period 2004-2013.

If on the other hand there is an abrupt increase in cod biomass resulting from immigration from other areas changes of shrimp stock condition may be much more rapid. Investigations of the event of an immigration of two large year-classes of cod were made by simulating a repetition of the short-lived resurgence of the cod stock seen in the late-1980s. The simulation showed that predation could within a 3-4 year period go from negligible to between 80 000 and 140 000 tons (SCR Doc. 03/73).

CPUE. The standardized CPUE series showed an increasing trend since 1990. The 2003 mean value is the highest in the time series.

Recruitment. A recruitment index (shrimp at age 2) showed an increasing trend from 1997 to 2001 and a decrease thereafter. The 2003 value is below the average of the time series.

SSB. SSB (female biomass) showed an increasing trend since 1997 and the value in 2003 is the highest observed in the series since 1988.

Exploitation rate. All indices of exploitation and relative mortality have shown a decline since the early 1990s.

State of the Stock. The stock biomass has increased since the early-1990s and reached its highest level recorded in 2003. Biomass is well above B_{MSY} and mortality by fishery and cod predation is well below Z_{MSY} . In addition the stock appears to be well represented by a broad range of size groups.

e) **Precautionary Approach**

The "Precautionary Approach" framework developed by Scientific Council defines a limit reference point for fishing mortality, F_{lim} , as equal to F_{MSY} . The limit reference point for stock size measured in units of biomass, B_{lim} , is the spawning stock biomass below which unknown or "low" recruitment is expected. Buffer reference points, B_{buf} and F_{buf} , are also requested to provide a safety margin that will ensure a small risk of exceeding the limits.

The limit reference point for mortality in the current assessment framework is Z_{MSY} , i.e. Z-ratio=1 and the risk of exceeding this point is given in this assessment. B_{lim} could not be defined. For one thing stock-recruitment figures were only available for relative high stock sizes and extrapolation to define an area of "low recruitment" was not readily justified. Buffer reference points are not given here as the risk of exceeding the limit reference can be directly calculated and uncertainty associated with the entire process is taken into account.

f) **Research Recommendations**

For the shrimp stock in Subarea 1 and Div. 0A east of 60°W, STACFIS **recommended** that:

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in Subarea 1.*

4. **Northern shrimp (*Pandalus borealis*) in Denmark Strait and off East Greenland** (SCR Doc. 03/74, 77, 85)

a) **Introduction**

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

In 1993 a new fishery began in areas south of 65°N down to Cape Farewell. Access to all these fishing grounds depends heavily on ice conditions.

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

In the Greenland EEZ, the minimum permitted mesh size in the 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 by-catch of fish are mandatory. Discarding of shrimp is prohibited in both areas.

Catches of shrimp taken have been reported without accounting for "overpacking" – the amount of surplus weight in packaging – or the difference between the product weight and live weight. In this assessment, catches in the Greenland and Icelandic EEZ have been adjusted for overpacking (SCR Doc. 03/74):

Year	Reported catch GR EEZ (tons)	Correction factor GR EEZ	Corrected catch GR EEZ (tons)	Reported catch ICE EEZ (tons)	Correction factor ICE EEZ	Corrected catch ICE EEZ (tons)	Total STACFIS estimate
1978				363	1.2000	436	436
1979	800	1.2511	1001	485	1.2000	582	1583
1980	7646	1.2511	9566	759	1.2000	911	10477
1981	4667	1.2511	5839	125	1.2000	150	5989
1982	4902	1.2511	6133	0	1.2000	0	6133
1983	4132	1.2511	5169	43	1.2000	52	5221
1984	5989	1.2511	7493	742	1.2000	890	8383
1985	6316	1.2511	7902	1794	1.2000	2153	10055
1986	9814	1.2511	12278	1150	1.2000	1380	13658
1987	10848	1.2669	13743	1330	1.2000	1596	15339
1988	11125	1.2479	13882	1431	1.2000	1717	15600
1989	9416	1.2397	11673	1326	1.2000	1591	13264
1990	9994	1.2207	12199	281	1.2000	337	12536
1991	8192	1.2564	10292	465	1.2000	558	10850
1992	5764	1.2406	7151	1750	1.2000	2100	9251
1993	5095	1.2430	6333	2553	1.2000	3064	9396
1994	8298	1.2555	10418	1514	1.2000	1817	12235
1995	8355	1.2491	10437	1151	1.2000	1381	11818
1996	9147	1.2439	11378	566	1.2000	679	12057
1997	8733	1.2479	10898	2856	1.2000	3427	14325
1998	7900	1.2659	10001	1421	1.2000	1705	11706
1999	8698	1.2589	10950	769	1.2000	923	11873
2000	9462	1.2598	11921	132	1.2000	158	12079
2001	11043	1.2588	13901	10	1.2000	12	13913
2002	8025	1.2583	9956	1231	1.2000	1477	11433
2003*	8550	1.2550	10672	703	1.2000	844	11515

*until November

Total catches increased rapidly to about 15 500 tons in 1987 and 1988, but declined thereafter to about 9 000 tons in 1992 and 1993. Following the extension of the fishery south of 65°N, catches increased again to about 14 300 tons in 1997. Catches in recent years have been between 11-14 000 tons (Fig. 4.1).

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

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003 ¹
Recommended TAC	5 000	5 000	5 000	5 000	5 000	9 600	9 600	9 600	9 600	9 600
North of 65°N, Greenland EEZ	3 359	4 823	2 351	1 300	3 115	3 223	3 404	1 769	859	2 500
North of 65°N, Iceland EEZ	1 514	1 151	566	2 856	1 421	769	132	10	1 231	1 000
North of 65°N, total	4 873	5 974	2 917	4 156	4 536	3 992	3 536	1 779	2 003	3 500
South of 65°N, Greenland EEZ	4 939	3 532	6 796	7 433	4 785	5 475	6 058	9 274	7 166	7 500
Total STATLANT 21A	9 812	9 506	9 713	11 589	9 321	9 467	9 594 ²	11 053 ²	9 256 ²	
Total STACFIS ³	12 235	11 818	12 057	14 325	11 706	11 873	12 079	13 913	11 433	13 500

¹ Catches projected to end of 2003.

² Provisional.

³ Estimate corrected for overpack.

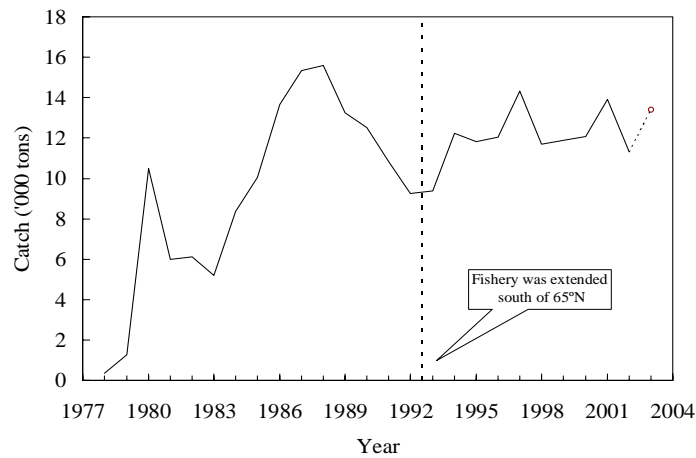


Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: total catches (2003 projected to the end of the year based on January to 1 November data).

b) Input Data

i) Commercial fishery data

Fishing effort and CPUE. Catch and effort (hours fished) from logbooks were available from Greenland, Norway, Iceland, Faroe Islands and EU-Denmark since 1980 and from EU-France for 1980 to 1991.

Standardized catch rates based on logbook data from Danish, Faroese, Greenlandic and Icelandic vessels in the northern area declined continuously from 1987 to 1993 - showed a significant increase between 1993 and 1994 and fluctuated with a slightly increasing trend thereafter (Fig. 4.2). A standardized catch-rate series for the same fleets (Iceland excluded) in the southern area increased until 1999, and fluctuated without trend thereafter (Fig. 4.3).

A combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, showed a significant increase between 1993 and 1994, and continued thereafter at an increasing trend. The 1999 to 2003 values equals that at the start of the time series in 1987 (Fig. 4.4).

The addition of new data for 2002 and 2003, have only caused minor changes in the CPUE index series as compared to the corresponding series resulting from last years analyses. However, the perception of the 2002 value was changed in a positive direction for the southern and overall area indices.

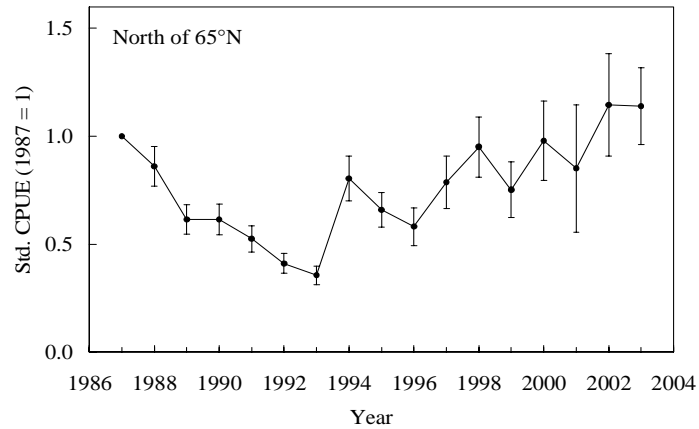


Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ± 1 SE calculated from logbook data from Danish, Faroese, Greenlandic and Icelandic vessels fishing north of 65°N.

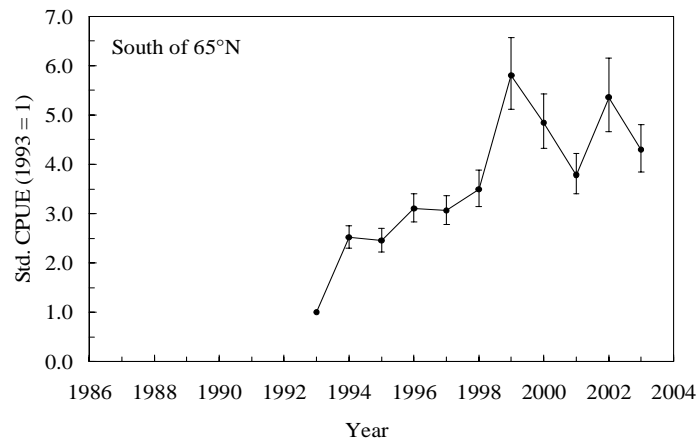


Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ± 1 SE calculated from logbook data from Danish, Faroese and Greenlandic vessels fishing south of 65°N.

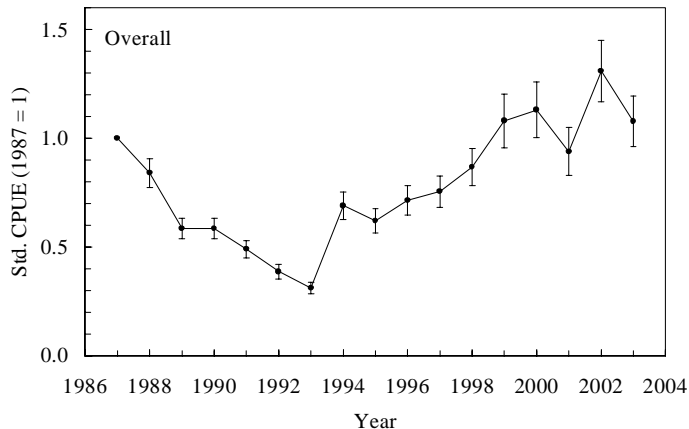


Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 SE combined for the total area.

An index of exploitation rate (catch divided by standardized CPUE) for the total area showed a decreased trend since 1993. Recent levels are the lowest of the time series (Fig. 4.5).

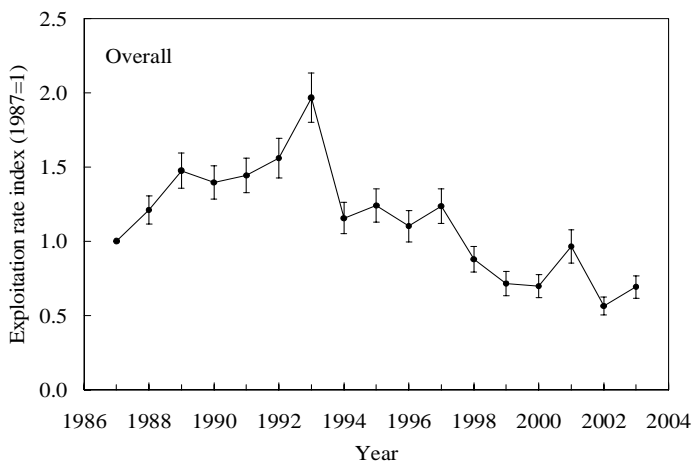


Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized exploitation-rate indices (± 1 SE; 1987 = 1), combined for the total area.

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

ii) **Research survey data**

No surveys have been conducted since 1996.

c) **Assessment Results**

Commercial CPUE. Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter to approximately the same level in 2000–2003 as at the start of the time series in 1987.

Recruitment. No recruitment estimates were available.

Biomass. No direct biomass estimates were available.

Exploitation rate. From 1998 through 2003 the exploitation rate index (catch/CPUE) has been at its lowest levels in the 17-year series.

State of the stock. STACFIS was not able to provide estimates of absolute stock size. Standardized CPUE data for all the areas combined indicate a general increasing trend in fishable biomass since 1993. The 2000 to 2003 values equal the relative high values at which the series started in 1987.

d) **Research Recommendations**

For shrimp in Denmark Strait and off East Greenland, STACFIS **recommended** that:

- *a survey series be established, to provide fishery independent data of the stock throughout its range.*
- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in the Greenland EEZ and improve in the Icelandic EEZ..*

IV. OTHER BUSINESS

1. **Assessment Methodology**

STACFIS noted the need for the development and review of the methodologies for stock assessment. STACFIS proposes that the Chair of Scientific Council should initiate discussion on this matter.

2. **Adjournment**

There being no other business, the Chair expressed his gratitude to the members of the Committee for their valuable contributions, especially from the Designated Experts, and to the Secretariat for the excellent support in all respects, and adjourned the meeting.

PART H

Miscellaneous

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AGENDA I**SCIENTIFIC COUNCIL MEETING, 15-19 SEPTEMBER 2003**

- I. Opening (Chair: Ralph K. Mayo)
 1. Appointment of rapporteur
 2. Adoption of agenda
 3. Attendance of observers
 4. Plan of work
- II. Review of Scientific Council Recommendations from June 2003
- III. Fisheries Science (STACFIS Chair: Don E. Stansbury)
 1. Opening
 2. Nomination of Designated Experts
 3. Other Matters
 - a) Review of SCR and SCS documents (if necessary)
 - b) Other business
- IV. Research Coordination (STACREC Chair: M. Joanne Morgan)
 1. Opening
 2. Fisheries Statistics
 - a) Progress reports on Secretariat activities
 - i) Acquisition of STATLANT 21 data
 - ii) Publication of statistical information
 3. Research Activities
 - a) Biological sampling
 - i) Report on data availability for stock assessments (by Designated Experts)
 - b) Biological surveys
 - i) Review of survey activities in 2002 (by National Representatives and Designated Experts)
 - ii) Surveys planned for 2003 and early-2004
 - c) Review of new process for documenting research activities
 4. FAO Fisheries Global Information System (FIGIS)
 5. NAFO Observer Program
 - a) Update on meeting of STACTIC 16-20 June, Copenhagen
 6. Archiving of Data for Assessments
 7. Other Matters
 - a) Review of SCR and SCS documents (if necessary)
 - b) Other business
- V. Publications (STACPUB Chairman: M. Stein)
 1. Opening

2. Review of recommendations from June 2003
 3. Review of Scientific Publications
 - a) Papers from June 2003 Meeting
 - b) Status of the 2001 "Deep-sea Fisheries" Symposium proceedings
 - c) Information from the 2002 Elasmobranch Symposium
 - d) Status of invitational papers
 - e) Other Reviews
 4. Consideration of NAFO Website
 - a) Status of implementation of Journal and Council Studies on website
 - b) "restricted site" for Scientific Council
 5. Editorial Matters Regarding Scientific Publications
 6. Other Matters
- VI. Special Requests from Fisheries Commission and Coastal States
1. Update on advice for northern shrimp in Div. 3M
 2. Update on advice for northern shrimp in Div. 3LNO
- VII. Review of Future Meeting Arrangements
1. Scientific Council Meeting on shrimp, November 2003
 2. Scientific Council Meeting, June 2004
 3. Special Session and Annual Meeting, September 2004
 4. Scientific Council Meeting on shrimp, October/November 2004
 5. Scientific Council Meeting, June 2005
- VIII. Future Special Sessions
1. Proposal for Special Session 2004
 2. Topics for Special Session in 2005
- IX. NAFO Working Groups or Workshops
1. Update on activities of NAFO WG on Reproductive Potential
 2. ICES/NAFO WG on Harp and Hooded Seals
- X. Scientific Council Working Procedures and Protocol
1. Timetable and frequency of assessments
 2. Revised Precautionary Approach Framework
- XI. Election of STACFIS Chair
- XII. Other Matters
1. Consideration of Memorandum of Understanding with ICES
 2. Other business
- XIII. Adoption of Reports
1. Consideration of Report of the Geostatistics Workshop of 10-12 September 2003
 2. Committee Reports STACFIS, STACREC, STACPUB
 3. Report of Scientific Council
- XIV. Adjournment

AGENDA II**SCIENTIFIC COUNCIL ANNUAL MEETING, 5-11 NOVEMBER 2003**

- I. Opening (Chair: M. Joanne Morgan)
 1. Appointment of rapporteur
 2. Adoption of agenda
 3. Plan of work

- II. Fisheries Science (STACFIS Chair: Hilario Murua)
 1. Review of recommendations in 2002 and 2003
 2. Review of catches of shrimp
 3. Environmental review
 4. Stock assessments (Annexes 1A and B, 2 and 3)
 - Northern shrimp (Div. 3M)
 - Northern Shrimp (Div. 3LNO)
 - Northern shrimp (Subareas 0 and 1)
 - Northern shrimp (in Denmark Strait and off East Greenland)
 5. Other business

- III. Formulation of Advice (see Annexes 1A and B, 2 and 3)
 1. Advice for Northern Shrimp
 - Northern shrimp (Div. 3M)
 - Northern shrimp (Div. 3LNO)
 - Northern shrimp (Subareas 0 and 1)
 - Northern shrimp (in Denmark Strait and off East Greenland)

- IV. Other Matters
 1. Meeting of October/November 2004
 2. Meeting of October/November 2005
 3. Coordination with ICES Working Groups on Shrimp Stock Assessments

- V. Adoption of Reports

- VI. Adjournment

**ANNEX 1A FISHERIES COMMISSION'S REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT
IN 2004 OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4**

1. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of the following fish and invertebrate stocks or groups of stocks in 2004:

Shrimp (Div. 3M, 3LNO)
Greenland halibut (Subarea 2 and Div. 3KLMNO)
Capelin (Div. 3NO)

2. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of the following fish stocks on an alternating year basis:

Cod (Div. 3NO; Div. 3M)
Redfish (Div. 3M; Div. 3LN)
Yellowtail flounder (Div. 3LNO)
American plaice (Div. 3LNO; Div. 3M)
Witch flounder (Div. 2J3KL; Div. 3NO)
Squid (Subareas 3 and 4)

- In 2002, advice was provided for 2003 and 2004 for cod in 3M, American plaice in 3M, yellowtail flounder in 3LNO, witch flounder in 3NO and squid in SA 3&4. These stocks will next be assessed in 2004.
- In 2003, advice will be provided for 2004 and 2005 for cod in 3NO, American plaice in 3LNO, witch flounder in 2J3KL, redfish in 3M and redfish in 3LN. These stocks will next be assessed in 2005.

The Fisheries Commission requests the Scientific Council to continue to monitor the status of all these stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in by-catches in other fisheries, provide updated advice as appropriate.

3. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of redfish in Div. 3O including recommendations regarding the most appropriate TAC for 2004 and 2005. This stock will be assessed in alternate years thereafter.
4. The Commission and the Coastal State request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above:
 - a) The preferred tool for the presentation of a synthetic view of the past dynamics of an exploited stock and its future development is a stock assessment model, whether age-based or age-aggregated.
 - b) For those stocks subject to analytical-type assessments, the status of the stocks should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. As general reference points, the implications of fishing at $F_{0.1}$ and F_{2002} in 2004 and subsequent years should be evaluated. The present stock size and spawning stock size should be described in relation to those observed historically and those expected in the longer term under this range of options.
 - c) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. In this case, the general reference points should be the level of fishing effort or fishing mortality (F) which is calculated to be required to take the MSY catch in the long term and two-thirds of that effort level.
 - d) For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.
 - e) Spawning stock biomass levels considered necessary for maintenance of sustained recruitment should be recommended for each stock. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing reproductive potential of the stock, management options should be offered that specifically respond to such concerns.

- f) Information should be provided on stock size, spawning stock sizes, recruitment prospects, fishing mortality, catch rates and TACs implied by these management strategies for the short and the long term in the following format:
- I. For stocks for which analytical-type assessments are possible, graphs should be provided of all of the following for the longest time-period possible:
 - historical yield and fishing mortality;
 - spawning stock biomass and recruitment levels;
 - catch options for the year 2004 and subsequent years over a range of fishing mortality rates (F) at least from $F_{0.1}$ to F_{max} ;
 - spawning stock biomass corresponding to each catch option;
 - yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.
 - II. For stocks for which advice is based on general production models, the relevant graph of production as a function of fishing mortality rate or fishing effort should be provided. Age-aggregated assessments should also provide graphs of all of the following for the longest time-period possible:
 - exploitable biomass (both absolute and relative to B_{MSY})
 - yield/biomass ratio as a proxy for fishing mortality (both absolute and relative to F_{MSY})
 - estimates of recruitment from surveys, if available.
 - III. Where analytical methods are not attempted, the following graphs should be presented, for one or several surveys, for the longest time-period possible:
 - time trends of survey abundance estimates, over:
 - an age or size range chosen to represent the spawning population
 - an age or size-range chosen to represent the exploited population
 - recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
 - fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.

For age-structured assessments, yield-per-recruit graphs and associated estimates of yield-per-recruit based reference points should be provided. In particular, the three reference points, actual F, $F_{0.1}$ and F_{max} should be shown.

5. Noting the progress made by the Scientific Council on the development of a framework for implementation of the Precautionary Approach, the Fisheries Commission requests that the Scientific Council provide the following information for the 2003 Annual Meeting of the Fisheries Commission for stocks under its responsibility requiring advice for 2004, or 2004 and 2005:
 - a) the limit and target precautionary reference points as described in Annex II of the UN Fisheries Agreement indicating areas of uncertainty (when precautionary reference points cannot be determined directly, proxies should be provided);
 - b) information including medium term considerations and associated risk or probabilities which will assist the Commission in developing the management strategies described in paragraphs 4 and 5 of Annex II in the Agreement;
 - c) information on the research and monitoring required to evaluate and refine the reference points described in paragraphs 1 and 3 of Annex II of the Agreement; these research requirements should be set out in the order of priority considered appropriate by the Scientific Council;
 - d) any other aspect of Article 6 and Annex II of the Agreement which the Scientific Council considers useful for implementation of the Agreement's provisions regarding the precautionary approach to capture fisheries;
 - e) propose criteria and harvest strategies for re-opening of fisheries and for new and developing fisheries; and
 - f) to work toward the harmonization of the terminology and application of the precautionary approach within relevant advisory bodies.
6. In addition, the following elements should be taken into account by the Scientific Council when considering the precautionary approach:
 - a) Many of the stocks in the NAFO Regulatory Area are well below any reasonable level of B_{lim} or B_{buf} . For these stocks, the most important task for the Scientific Council is to inform on how to rebuild the stocks. In this context and building on previous work of the Scientific Council in this area, the Scientific Council is requested to evaluate various scenarios corresponding to recovery plans with timeframes of 5 to 10 years, or longer as appropriate. This evaluation should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, including information on the consequences and risks of no action at all.

References to "risk" and to "risk analyses" should refer to estimated probabilities of stock population parameters falling outside biological reference points.

- b) Where reference points are proposed by the Scientific Council as indicators of biological risk, they should be accompanied by a description of the nature of the risk incurred if the reference point is crossed (e.g. short-term risk of recruitment overfishing, loss of long-term yield, etc.)
 - c) When a buffer reference point is proposed in order to maintain a low probability that a stock, measured to be at the buffer reference point, may actually be at or beyond the limit reference point, the Scientific Council should explain the assumptions made about the uncertainty with which the stock is measured, and also the level of 'low probability' that is used in the calculation.
 - d) Wherever possible, short and medium term consequences should be identified for various exploitation rates (including no fishing) in terms of yield, stability in yield from year to year, and the risk or probability of moving the stock beyond B_{lim} or B_{buf} . Whenever possible, this information should be cast in terms of risk assessments relating fishing mortality rates to the risks of falling below B_{lim} and B_{buf} , as well as of being above F_{lim} and F_{buf} , the risks of stock collapse and recruitment overfishing, as well as the risks of growth overfishing and the consequences in terms of both short and long term yields.
 - e) When providing risk estimates, it is very important that the time horizon be clearly spelled out. By way of consequence, risks should be expressed in timeframes of 5, 10 and 15 years (or more), or in terms of other appropriate year ranges depending on stock specific dynamics. Furthermore, in order to provide the Fisheries Commission with the information necessary to consider the balance between risks and yield levels, each harvesting strategy or risk scenario should include, for the selected year ranges, the risks and yields associated with various harvesting options in relation to B_{lim} (B_{buf}) and B_{target} , and F_{lim} (F_{buf}) and F_{target} .
7. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting, to consider options available for the provision of annual advice as regards shrimp in Div. 3LNO and 3M in advance of the Annual Meetings.
8. Regarding pelagic *S. mentella* redfish in NAFO Subareas 1-3, the Scientific Council is requested to review the most recent information on the distribution of this resource, as well as on the affinity of this stock to the pelagic redfish resource found in the ICES Sub-area XII, parts of SA Va and XIV and to the shelf stocks of redfish found in ICES Sub-areas V, VI and XIV, and NAFO Subareas 1-3.
9. With respect to thorny skate in Divisions 3LNO, the Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2003 Annual Meeting to provide the following:
- a) Information on exploitation rates in recent years, as well as information on by-catches of other groundfish in the 3LNO skate fishery;
 - b) Information on abundance indices and the distribution of the stock in relation to groundfish resources, particularly for the stocks which are under moratorium;
 - c) Information on the distribution of thorny skate in Divisions 3LNO, as well as a description of the relative distribution inside and outside the NAFO Regulatory Area;
 - d) Advice on reference points and conservation measures that would allow for exploitation of this resource in a precautionary manner;
 - e) Information on annual yield potential for this stock in the context of (d) above;
 - f) Identification and delineation of fishery areas and exclusion zones where fishing would not be permitted, with the aim of reducing the impact on the groundfish stocks which are under moratorium, particularly juveniles;
 - g) Determination of the appropriate level of research that would be required to monitor the status of this resource on an ongoing basis with the aim of providing catch options that could be used in the context of management by Total Allowable Catch (TAC); and
 - h) Information on the size composition in the current catches and comment on these sizes in relation to the size at sexual maturity.
-

**ANNEX 1B. FISHERIES COMMISSION'S REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT
IN 2005 OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4**

1. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2004 Annual Meeting, provide advice on the scientific basis for the management of the following fish and invertebrate stocks or groups of stocks in 2005:

Shrimp (Div. 3M, 3LNO)
Greenland halibut (Subarea 2 and Div. 3KLMNO)

2. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 2004 Annual Meeting, provide advice on the scientific basis for the management of the following fish stocks on an alternating year basis:

Cod (Div. 3NO; Div. 3M)
Redfish (Div. 3M; Div. 3LN; Div. 3O)
Yellowtail flounder (Div. 3LNO)
American plaice (Div. 3LNO; Div. 3M)
Witch flounder (Div. 2J3KL; Div. 3NO)
Capelin (Div. 3NO)
Northern Shortfin Squid (Subareas 3 and 4)

- In 2003, advice was provided for 2004 and 2005 for cod in 3NO, American plaice in 3LNO, witch flounder in 2J3KL, redfish in 3M, redfish in 3LN, redfish in 3O and capelin in 3NO. These stocks will next be assessed in 2005.
- In 2004, advice will be provided for 2005 and 2006 for cod in 3M, American plaice in 3M, yellowtail flounder in 3LNO, witch flounder in 3NO and northern shortfin squid in SA 3&4. These stocks will next be assessed in 2005.

The Fisheries Commission requests the Scientific Council to continue to monitor the status of all these stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in by-catches in other fisheries, provide updated advice as appropriate.

3. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2004 Annual Meeting, to provide advice on the scientific basis for the management of skates in Div. 3LNO including recommendations regarding the most appropriate TAC for 2005 and 2006. This stock will be assessed in alternate years thereafter.
4. The Fisheries Commission with the concurrence of the Coastal State requests Scientific Council, at a meeting in advance of the 2004 Annual Meeting, to provide information on the status of the Greenland halibut in SA 2+ Div. 3KLMNO in relation to the Rebuilding Strategy including commentary on progress in relation to targets described in the Strategy.
5. The Commission and the Coastal State request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above:
 - a) The preferred tool for the presentation of a synthetic view of the past dynamics of an exploited stock and its future development is a stock assessment model, whether age-based or age-aggregated.
 - b) For those stocks subject to analytical-type assessments, the status of the stocks should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. As general reference points, the implications of fishing at $F_{0.1}$ and F_{2003} in 2005 and subsequent years should be evaluated. The present stock size and spawning stock size should be described in relation to those observed historically and those expected in the longer term under this range of options.
 - c) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. In this case, the following reference points should be calculated: 1) the level of fishing effort or fishing mortality (F) required to take the MSY catch in the long term; 2) two-thirds of that level; 3) 75% of that level; and 4) 85% of that level.

- d) For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.
- e) Spawning stock biomass levels considered necessary for maintenance of sustained recruitment should be recommended for each stock. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing reproductive potential of the stock, management options should be offered that specifically respond to such concerns.
- f) Information should be provided on stock size, spawning stock sizes, recruitment prospects, fishing mortality, catch rates and TACs implied by these management strategies for the short and the long term in the following format:
- I. For stocks for which analytical-type assessments are possible, graphs should be provided of all of the following for the longest time-period possible:
 - historical yield and fishing mortality;
 - spawning stock biomass and recruitment levels;
 - catch options for the year 2005 and subsequent years over a range of fishing mortality rates (F) at least from $F_{0.1}$ to F_{max} ;
 - spawning stock biomass corresponding to each catch option;
 - yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.
 - II. For stocks for which advice is based on general production models, the relevant graph of production as a function of fishing mortality rate or fishing effort should be provided. Age-aggregated assessments should also provide graphs of all of the following for the longest time-period possible:
 - exploitable biomass (both absolute and relative to B_{MSY})
 - yield/biomass ratio as a proxy for fishing mortality (both absolute and relative to F_{MSY})
 - estimates of recruitment from surveys, if available.
 - III. Where analytical methods are not attempted, the following graphs should be presented, for one or several surveys, for the longest time-period possible:
 - time trends of survey abundance estimates, over:
 - an age or size range chosen to represent the spawning population
 - an age or size-range chosen to represent the exploited population
 - recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
 - fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.

For age-structured assessments, yield-per-recruit graphs and associated estimates of yield-per-recruit based reference points should be provided. In particular, the three reference points, actual F, $F_{0.1}$ and F_{max} should be shown.

6. Noting the progress made by the Scientific Council on the development of a framework for implementation of the Precautionary Approach, the Fisheries Commission requests that the Scientific Council provide the following information for the 2004 Annual Meeting of the Fisheries Commission for stocks under its responsibility requiring advice for 2005, or 2005 and 2006:
- a) the limit and precautionary reference points as described in Annex II of the UN Fisheries Agreement indicating areas of uncertainty (when precautionary reference points cannot be determined directly, proxies should be provided);
 - b) information including medium term considerations and associated risk or probabilities which will assist the Commission in developing the management strategies described in paragraphs 4 and 5 of Annex II in the Agreement;
 - c) information on the research and monitoring required to evaluate and refine the reference points described in paragraphs 1 and 3 of Annex II of the Agreement; these research requirements should be set out in the order of priority considered appropriate by the Scientific Council;
 - d) any other aspect of Article 6 and Annex II of the Agreement which the Scientific Council considers useful for implementation of the Agreement's provisions regarding the precautionary approach to capture fisheries;
 - e) propose criteria and harvest strategies for re-opening of fisheries and for new and developing fisheries; and
 - f) to continue to work toward the harmonization of the terminology and application of the precautionary approach within relevant advisory bodies.

7. In addition, the following elements should be taken into account by the Scientific Council when considering the precautionary approach:

- a) Many of the stocks in the NAFO Regulatory Area are well below any reasonable level of B_{lim} or B_{buf} . For these stocks, the most important task for the Scientific Council is to inform on how to rebuild the stocks. In this context and building on previous work of the Scientific Council in this area, the Scientific Council is requested to evaluate various scenarios corresponding to recovery plans with timeframes of 5 to 10 years, or longer as appropriate. This evaluation should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, including information on the consequences and risks of no action at all.

References to “risk” and to “risk analyses” should refer to estimated probabilities of stock population parameters falling outside biological reference points.

- b) Where reference points are proposed by the Scientific Council as indicators of biological risk, they should be accompanied by a description of the nature of the risk incurred if the reference point is crossed (e.g. short-term risk of recruitment overfishing, loss of long-term yield, etc.)
 - c) When a buffer reference point is proposed in order to maintain a low probability that a stock, measured to be at the buffer reference point, may actually be at or beyond the limit reference point, the Scientific Council should explain the assumptions made about the uncertainty with which the stock is measured, and also the level of ‘low probability’ that is used in the calculation.
 - d) Wherever possible, short and medium term consequences should be identified for various exploitation rates (including no fishing) in terms of yield, stability in yield from year to year, and the risk or probability of moving the stock beyond B_{lim} . Whenever possible, this information should be cast in terms of risk assessments relating fishing mortality rates to the risks of falling below B_{lim} , as well as of being above F_{lim} and, the risks of stock collapse and recruitment overfishing, as well as the risks of growth overfishing and the consequences in terms of both short and long term yields.
 - e) When providing risk estimates, it is very important that the time horizon be clearly spelled out. By way of consequence, risks should be expressed in timeframes of 5, 10 and 15 years (or more), or in terms of other appropriate year ranges depending on stock specific dynamics. Furthermore, in order to provide the Fisheries Commission with the information necessary to consider the balance between risks and yield levels, each harvesting strategy or risk scenario should include, for the selected year ranges, the risks and yields associated with various harvesting options in relation to B_{lim} , and F_{lim} and target F reference points selected by managers.
8. Regarding pelagic *S. mentella* redfish in NAFO Subareas 1-3, the Scientific Council is requested to review the most recent information on the distribution of this resource, as well as on the affinity of this stock to the pelagic redfish resource found in the ICES Sub-area XII, parts of SA Va and XIV and to the shelf stocks of redfish found in ICES Sub-areas V, VI and XIV, and NAFO Subareas 1-3.
9. Regarding white hake in Divisions 3NO, the Scientific Council is requested to provide the following:
- a) Information on the fishing mortality on white hake in Divisions 3NO in recent years, as well as information on by-catches of other groundfish in the 3NO white hake fishery;
 - b) Information on abundance indices and the distribution of the stock in relation to groundfish resources, particularly for the stocks which are under moratorium;
 - c) Information on the distribution of white hake in Divisions 3NO, as well as a description of the relative distribution inside and outside the NAFO Regulatory Area;
 - d) Advice on reference points and conservation measures that would allow for exploitation of this resource in a precautionary manner;
 - e) Information on annual yield potential for this stock in the context of (d) above;
 - f) Identification and delineation of fishery areas and exclusion zones where fishing would not be permitted, with the aim of reducing the impact on the groundfish stocks which are under moratorium, particularly juveniles;
 - g) Determination of the appropriate level of research that would be required to monitor the status of this resource on an ongoing basis with the aim of providing catch options that could be used in the context of management by Total Allowable Catch (TAC); and

- h) Information on the size composition in the current catches and comments on these sizes in relation to the size at sexual maturity.
10. Regarding redfish in Divisions 3L, 3N and 3O, Scientific Council is requested to review all available information and provide advice regarding whether the current management units (3LN and 3O) or any alternative may be the most appropriate.

**ANNEX 2. CANADIAN REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2004
OF CERTAIN STOCKS IN SUBAREAS 0 TO 4**

1. Canada requests that the Scientific Council, at its meeting in advance of the 2003 Annual Meeting of NAFO, subject to the concurrence of Denmark (on behalf of Greenland), provide advice on the scientific basis for management in 2004 of the following stocks:

Shrimp (Subareas 0 and 1)
Greenland halibut (Subareas 0 and 1)

The Scientific Council has noted previously that there is no biological basis for conducting separate assessments for Greenland halibut throughout Subareas 0-3, but has advised that separate TACs be maintained for different areas of the distribution of Greenland halibut. The Council is asked therefore, subject to the concurrence of Denmark (on behalf of Greenland) as regards Subarea 1, to provide an overall assessment of status and trends in the total stock throughout its range and comment on its management in Subareas 0+1 for 2004.

Greenland halibut in the offshore area of Division 0A+1A is currently being managed separately from the remainder of SA 0+1. However, given the bathymetry of Baffin Bay and its proximity to the NAFO boundaries of Divisions 0A, 1A and 1B, the Scientific Council is requested to:

- a) advise on whether it is more appropriate for management purposes to include Division 1B with the current management area of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-F;
- b) advise on appropriate TAC levels for 2004, separately, for Greenland halibut in the offshore area of Divisions 0A+1A (plus Division 1B depending on the result of (a) above) and Divisions 0B+ 1C-F (plus Division 1B depending on the result of (a) above). The Scientific Council is also asked to advise on any other management measures it deems appropriate to ensure the sustainability of these resources;
- c) comment on the Greenland halibut size composition throughout SA0+1 (offshore), the potential relationship between fish in Baffin Bay and Davis Strait and the impact of harvesting on these stock components; and
- d) advise on the most appropriate protocols for the conduct of exploratory fisheries in Division 0A north of 71°30'N including precautionary catch limits.

The Council also is asked to advise on appropriate TAC levels separately – for Greenland halibut in SA 2 + Division 3K and for Divisions 3LMNO.

Scientific Council has, in the past, advised that fishing effort for Greenland halibut in SA2 + 3KLMNO should be distributed in relation to biomass. Scientific Council is requested to comment on:

- a) the current distribution of the resource between SA2 + 3K and 3LMNO and comment on how this compares with the current distribution of quota allocation; and
- b) the appropriate distribution of quota allocation if it was based on the distribution of biomass.

With respect to shrimp, it is recognized that the Council may, at its discretion, delay providing advice until later in the year, taking into account data availability, predictive capability, and the logistics of additional meetings.

2. Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for Shrimp and Greenland halibut in Subareas 0 and 1:
- a) For those stocks subject to analytical-type assessments, the status of the stock should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. The implications of no fishing as well as fishing at $F_{0.1}$, and F_{2002} in 2004 and subsequent years should be evaluated in relation to precautionary reference points of both fishing mortality and spawning stock biomass. The present stock size and

spawning stock size should be described in relation to those observed historically and those to be expected in the longer term under this range of fishing mortalities, and any other options Scientific Council feels worthy of consideration under a precautionary framework.

Opinions of the Scientific Council should be expressed in regard to stock size, spawning stock sizes, recruitment prospects, catch rates and catches implied by these management strategies for the short and long term. Values of F corresponding to the reference points should be given. Uncertainties in the assessment should be evaluated and presented in the form of risk analyses related to B_{lim} (B_{buf}) and B_{target} , and F_{lim} (F_{buf}) and F_{target} .

- b) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. Management options should be within the precautionary framework.
- c) For those resources for which only general biological advice and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and management options evaluated in the way described above to the extent possible. Management options should be within the precautionary framework.
- d) Presentation of the results should include the following:
 - I. For stocks for which analytical-type assessments are possible:
 - A graph of historical yield and fishing mortality for the longest time period possible;
 - A graph of spawning stock biomass and recruitment levels for the longest time period possible;
 - Graphs and tables of catch options for the year 2004 and subsequent years over a range of fishing mortality rates (F) at least from $F=0$ to $F_{0.1}$ including risk analyses;
 - Graphs and tables showing spawning stock biomass corresponding to each catch option including risk analyses;
 - Graphs showing the yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.
 - II. For stocks for which advice is based on general production models, the relevant graph of production on fishing mortality rate or fishing effort.

In all cases, the reference points, $F=0$, actual F , and $F_{0.1}$ should be shown.

3. For the cod stock in Divisions 2J + 3KL, the Scientific Council is requested to report on recent trends in the total and spawning biomass based on the most recent Stock Status Report.

P. S. Chamut
 Assistant Deputy Minister
 Fisheries Management, Department of Fisheries and Oceans
 Ottawa, Canada

ANNEX 3. DENMARK (GREENLAND) REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2004 OF CERTAIN STOCKS IN SUBAREAS 0 AND 1

1. In the Scientific Council report of 2002, scientific advice on management of Roundnose grenadier in Subarea 0+1 was given as a 3-year advice (for 2003, 2004 and 2005). Denmark, on behalf of Greenland, requests the Scientific Council to continue to monitor the status of Roundnose grenadier in Subarea 0+1 annually and, should significant change in stock status be observed (e.g. from surveys), the Scientific Council is requested to provide updated advice as appropriate.
2. Advice for redfish (*Sebastes* spp.) and other finfish in Subarea 1 was in 2001 given for 2002 and 2003. Denmark, on behalf of Greenland, requests that the Scientific Council in advance of the 2003 Annual Meeting, provide advice on the scientific basis for the management of these stocks in Subarea 1 for 2004 and 2005.
3. Subject to the concurrence of Canada as regards Subarea 0, the Scientific Council is requested to provide advice on the scientific basis for management of Greenland halibut overlapping Subarea 0 and 1 in 2004, and as many years forward as data allow.

Given the bathymetry of the Baffin Bay and Davis Strait, the Scientific Council is asked to advise on whether it is more appropriate for management purposes to include Division 1B with the current management of offshore Divisions 1A+0A or have it remain in the current management area of Divisions 0B+1B-F.

The Scientific Council is asked to advise on the most appropriate protocols for the conduct of exploratory fisheries in Divisions 1A north of 74°N including precautionary catch limits.

Further, for Subarea 1A inshore, the Council is asked to provide advice on allocation of TACs distributed in the areas of Ilulissat, Uummannaq and Upernavik, respectively.

The Council is asked in its advice to assess the impact from the offshore fisheries in Baffin Bay and Davis Strait on the status and trends of the Subarea 1A inshore stock components, and *vice versa*.

4. Subject to the concurrence of Canada as regards Subarea 0, Denmark, on behalf of Greenland, further requests the Scientific Council of NAFO before December 2003 to provide advice on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Subarea 0 and 1 in 2004, and as many years forward as data allow.

The Scientific Council is asked to update the information on the distribution of Northern shrimp (*Pandalus borealis*) and provide advice on allocation of TAC's to Subarea 0 and Subarea 1.

Further, the Council is requested to advise, in co-operation with ICES, on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Denmark Strait and adjacent areas east of southern Greenland in 2004, and as many years forward as data allow.

On behalf of
The Department of Fisheries, Hunting and Agriculture
Sincerely
Amalie Jessen
Deputy Minister (acting)

LIST OF RESEARCH AND SUMMARY DOCUMENTSSeptember^a and November^b 2003**RESEARCH DOCUMENTS (SCR)**

SCR No.	Serial No.	Author(s) and Title
03/65 ^a	N4892	ORR, D. C., P. J. VEITCH and D. J. SULLIVAN. Divisions 3LNO northern pink shrimp (<i>Pandalus borealis</i>) – interim monitoring update. (8 pages)
03/66 ^a	N4893	NICOLAJSEN, Á. and S. BRYNJOLFSSON. Young northern shrimp (<i>Pandalus borealis</i>) index for Flemish Cap (NAFO Division 3M) 2003. (4 pages)
03/67 ^a	N4894	NICOLAJSEN, Á. Biomass estimate of the northern shrimp (<i>Pandalus borealis</i>) stock on Flemish Cap (NAFO Division 3M) for 2003. (6 pages)
03/68 ^a	N4895	SKÚLADÓTTIR, U. The assessment of the international fishery for the shrimp (<i>Pandalus borealis</i>) in Division 3M (Flemish Cap), 1993-2003. (9 pages)
03/69 ^a	N4896	SKÚLADÓTTIR, U. The Icelandic shrimp fishery (<i>Pandalus borealis</i> Kr.) at Flemish Cap in 1993-2003. (7 pages)
03/70 ^b	N4909	KANNEWORFF, P. Occurrence of <i>Pandalus montagui</i> in trawl survey samples from NAFO Subareas 0+1. (4 pages)
03/71 ^b	N4910	KANNEWORFF, P. and K. WIELAND. Stratified-random trawl survey for northern shrimp (<i>Pandalus borealis</i>) in NAFO Subareas 0+1 in 2003. (26 pages)
03/72 ^b	N4911	SIEGSTAD, H. The Greenland fishery for northern shrimp (<i>Pandalus borealis</i>) in NAFO Divisions 3M and 3L in 2000-2003. (5 pages)
03/73 ^b	N4912	HVINGEL, C. Assessment, prediction and risk analysis: stock development and production of northern shrimp off West Greenland. (14 pages)
03/74 ^b	N4913	HVINGEL, C. Correction of reported past catches of northern shrimp within the Greenland EEZ to conform to a revision of reporting practices. (3 pages)
03/75 ^b	N4914	HVINGEL, C. The fishery for northern shrimp (<i>Pandalus borealis</i>) off West Greenland, 1970-2003. (26 pages)
03/76 ^b	N4915	WIELAND, K. Abundance of young (age 1, 2 and 3) northern shrimp (<i>Pandalus borealis</i>) off West Greenland (NAFO Subareas 0+1) in 1993-2003, and changes in mean size-at-age related to temperature and stock size. (22 pages)
03/77 ^b	N4918	HVINGEL, C. Data for the assessment of the shrimp (<i>Pandalus borealis</i>) stock in Denmark Strait/off East Greenland, 2003. (23 pages)
03/78 ^b	N4919	COLBOURNE, E. Oceanographic conditions on the Flemish Cap in NAFO Division 3M during the summer of 2003. (14 pages)

^a Scientific Council Meeting, 15-19 September 2003.

^b Scientific Council Meeting, 5-11 November 2003

SCR No.	Serial No.	Author(s) and Title
03/79 ^b	N4920	CASAS, J. M., and J. L. DEL RIO. The Spanish shrimp fishery on Flemish Cap (NAFO Division 3M) in 2002. (4 pages)
03/80 ^b	N4921	DEL RIO, J. M., J. M. CASAS, and D. GONZÁLEZ TRONCOSO. Northern shrimp (<i>Pandalus borealis</i>) on Flemish Cap in June 2003. (18 pages)
03/81 ^b	N4922	COLBOURNE, E. B., AND D. C. ORR. The distribution and abundance of northern shrimp (<i>Pandalus borealis</i>) in relation to bottom temperatures in NAFO Divisions 3LNO based on multi-species surveys from 1995-2003. (18 pages)
03/82 ^b	N4924	ORR, D. C., P. VEITCH, and D. SULLIVAN. An update of information pertaining to northern shrimp (<i>Pandalus borealis</i> , Krøyer) and groundfish in NAFO Divisions 3LNO. (51 pages)
03/83 ^b	N4925	SKÚLADÓTTIR, U. An update of the Icelandic shrimp fishery (<i>Pandalus borealis</i> Kr.) at Flemish Cap in 1993-2003. (20 pages)
03/84 ^b	N4926	SKÚLADÓTTIR, U. The by-catch in the shrimp fishery of Iceland at Flemish Cap in 1996-2003. (6 pages)
03/85 ^b	N4927	SKÚLADÓTTIR, U. The Icelandic shrimp fishery (<i>Pandalus borealis</i>) in the Denmark Strait in 2003. (4 pages)
03/86 ^b	N4928	KANNEWORFF, P., and K. WIELAND. Calculating a TAC for northern shrimp (<i>Pandalus borealis</i>) in West Greenland waters (NAFO Subareas 0+1). (5 pages)
03/87 ^b	N4929	NICOLAJSEN, Á. Biomass estimate, growth, length and age distribution of the northern shrimp (<i>Pandalus borealis</i>) stock on Flemish Cap (NAFO Division 3M) in June 2003. (11 pages)
03/88 ^b	N4930	BAKANEV, S. V. The Russian shrimp fishery (<i>Pandalus borealis</i>) on the Flemish Cap, NAFO Division 3M, in 1993-2003. (9 pages)
03/89 ^b	N4931	GUDMUNSDOTTIR, A. A Short note on modelling in S-plus the standardized CPUE for northern shrimp (<i>Pandalus borealis</i>) in Division 3M. (5 pages)
03/90 ^b	N4932	GUDMUNSDOTTIR, A., and Á. NICOLAJSEN. Standardized CPUE indices for Shrimp (<i>Pandalus borealis</i>) in Division 3M (Flemish Cap) 1993-2003. (6 pages)
03/91 ^b	N4933	SKÚLADÓTTIR, U. An update of the assessment of the international fishery for shrimp (<i>Pandalus borealis</i>) in Division 3M (Flemish Cap), 1993-2003 in November 2003. (14 pages)

^a Scientific Council Meeting, 15-19 September 2003.

^b Scientific Council Meeting, 5-11 November 2003.

SUMMARY DOCUMENTS (SCS)

SCS Doc.	Serial No.	Author(s) & Title
03/20 ^a	N4897	NAFO. Available data from the Commercial Fisheries related to stock assessment (2002), Inventory of biological surveys conducted in 2002 and planned for 2003 and early-2004. (11 pages)
03/21 ^a	N4898	NAFO. Report of Scientific Council, 15-19 September 2003 Meeting. (43 pages)
03/22 ^a	N4899	NAFO. Report of the Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment. (35 pages, revised)
03/23 ^a	N4900	SCIENTIFIC COUNCIL. Proposed NAFO Precautionary Approach Framework (September 2003). (5 pages)
03/24 ^a	N4923	FISHERIES COMMISSION. Fisheries Commission's Request for Scientific Advice on Management in 2005 of Certain Stocks in Subareas 2, 3 and 4. (4 pages)
03/25 ^b	N4934	NAFO. Scientific Council Meeting Report, 5-11 November 2003. (58 pages)
02/26 ^b	N4935	NAFO SECRETARIAT. A Compilation of Research Vessel Surveys on a Stock-by-stock Basis. (14 pages)

^a Scientific Council Meeting, 15-19 September 2003.

^b Scientific Council Meeting, 5-11 November 2003.

APPENDIX VII. LIST OF REPRESENTATIVES AND ADVISERS/EXPERTS, 2003

September-November 2003

Meetings***CANADA****Representatives:**

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Meetings*

- A Scientific Council Annual Meeting, 15-19 September 2003 (Note: "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment" participants are listed with its report).
- B Scientific Council Meeting, 5-11 November 2003.

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Meetings*

- A Scientific Council Annual Meeting, 15-19 September 2003 (Note: "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment" participants are listed with its report).
- B Scientific Council Meeting, 5-11 November 2003.

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Meetings*

- A Scientific Council Annual Meeting, 15-19 September 2003 (Note: "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment" participants are listed with its report).
- B Scientific Council Meeting, 5-11 November 2003.

Meetings*

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Meetings*

- A Scientific Council Annual Meeting, 15-19 September 2003 (Note: "Workshop on Mapping and Geostatistical Methods for Fisheries Stock Assessment" participants are listed with its report).
- B Scientific Council Meeting, 5-11 November 2003.

LIST OF RECOMMENDATIONS IN SEPTEMBER AND NOVEMBER 2003

The following are the specific **recommendations made by the Scientific Council** at its meetings through September and November 2003 besides those made with respect to scientific advice on stocks considered. The recommendations with respect to stock advice appear in the stock-by-stock Summary Sheets presented in this publication. Recommendations listed under the Standing Committees were **endorsed** by the Scientific Council.

All recommendations listed here were **adopted** by the Scientific Council and are presented as they appear in this publication under the relevant sections and pages mentioned.

Scientific Council Meeting, 15-19 September 2003

SCIENTIFIC COUNCIL

X. SCIENTIFIC COUNCIL WORKING PROCEDURES/PROTOCOL

2. Revised Precautionary Approach Framework

b) **Limit Reference Point Study Group (LRP)** (page 376)

Scientific Council **recommended** that *a Study Group on the estimation of limit reference points be established. Peter Shelton (Canada) was named as a co-Chair with other co-Chairs to be selected, and the Co-Chairs explore with colleagues possible themes for a Study Group working session in 2004.*

RESEARCH COORDINATION (STACREC)

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

4. **FAO Fisheries Global Information System (FIGIS)** (page 390)

STACREC **recommended** that *a draft version of Annex 2 (the section most pertinent to NAFO) of the FIRMS Partnership Arrangement should be prepared in advance of the June 2004 Scientific Council Meeting for review at that meeting.*

6. **Archival of Data Utilized in Stock Assessments** (page 390)

STACREC **recommended** that *the Designated Experts would be asked to place electronic versions of their stock assessment data (including time series of catch, survey indices, numbers at age, catch at age, weights at age, and maturity at age) on the server, in formats currently available, at the Scientific Council meetings. The data files provided should be annotated and include all survey indices available and catches in aggregate form. The Secretariat will archive these data following Scientific Council Meetings and make them available to members of the Scientific Council thereafter.*

7. **Others Matters**

b) **Other Business** (page 391)

STACREC noted the tuna data were not required for the work of the Scientific Council, and STACREC **recommended** that *the Secretariat need not report tuna catches in the data tabulations prepared at NAFO and that CWP (and FAO) will be informed that tuna catches will no longer be recorded in the STATLANT 21 data.*

PUBLICATIONS (STACPUB)

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

3. **Review of Scientific Publications**

b) **Status of the 2001 "Deep-sea Fisheries" Symposium"** (page 393)

STACPUB **recommended** that *the 23 papers currently ready be placed on the NAFO Website by the beginning of October 2003, as part of Volume 31, ensuring a 2003 publication date.*

e) **Other Reviews** (page 394)

STACPUB **recommended** that *hard copy and web versions of Scientific Council Studies No. 37 be issued shortly.*

STACPUB **recommended** that *for the Scientific Council Reports, the Secretariat return to printing its reports on a calendar year basis, and that color printing be used where warranted in Scientific Council Reports. The Scientific Council Reports for calendar year 2003 should therefore be printed as the next "Redbook".*

4. **Considerations of NAFO Website**

a) **Status of Implementation of Journal and Council Studies on Website** (page 394)

STACPUB was informed that all Journal and Studies issues have been scanned and are available on CD. STACPUB **recommended** that *all scanned versions of the Journal and Studies be placed on the NAFO website as soon as possible, as this is a vital reference tool for users.*

6. **Other Matters** (page 395)

Scientific Council Studies contains publications such as workbooks and workshop reports, and STACPUB concluded that this material must be made available in print. Therefore, STACPUB **recommended** that *Scientific Council Studies continue to be produced in printed versions recognizing the number of hard copies has been reduced.*

Scientific Council Meeting, 5-11 November 2003

FISHERIES SCIENCE (STACFIS)

III. STOCK ASSESSMENTS

1. **For Northern shrimp in Division 3M** (page 417)

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*
- *a more detailed conversion document including information on the geometry and behaviour of the trawls and detailed calculations of the conversion for shrimp be presented at the September 2004 meeting.*
- *indices of stock size be presented with error bars where possible.*

2. **For Northern shrimp in Divisions 3LNO** (page 423)

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

3. **For Northern shrimp in Subareas 0 and 1** (page 436)

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in Subarea 1.*

4. **For Northern shrimp in Denmark Strait and off East Greenland** (page 441)

- *a survey series be established, to provide fishery independent data of the stock throughout its range.*
- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in the Greenland EEZ and improve in the Icelandic EEZ.*