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Final Report of the 2001 Annual Meeting of the Fisheries Oceanography Committee

Held on March 27-30, 2001
At the Gulf Fisheries Centre
Moncton, New Brunswick

D.P. Swain, Chairperson[1] (FOC)
P. Ouellet, Chairperson[2] (Theme Session)

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Executive Summary of the 2001 FOC Annual Meeting

The Fisheries Oceanography Committee (FOC) of the Department of Fisheries and Oceans (DFO) met in Moncton, New Brunswick at the Gulf Fisheries Center on 27-30 March 2001. The Committee reviewed environmental conditions in the Northwest Atlantic during 2000, convened a theme session on oceanographic factors affecting the distribution, abundance and productivity of invertebrate populations, reviewed additional papers on physical and biological oceanography, and conducted its annual business meeting.

1. **Physical Environment in 2000**: Six papers were reviewed on the meteorological and physical oceanographic conditions in 2000. Air temperatures were warmer than normal in 2000 throughout most of the northwest Atlantic, although they declined relative to the record-setting temperatures of 1999. Sea ice coverage and duration were below average in most areas. Though lower than the high 1999 values, water temperatures from southern Labrador to the Grand Bank and off southern Newfoundland generally remained above normal values. A substantial warming and thinning of the CIL occurred in the Gulf of St. Lawrence in 1999. This warming continued in 2000, when the CIL core temperature index rose above the longterm average for the first time since 1983. The area of cold bottom water on the Magdalen Shallows remained well below the high 1989-1998 values in 2000. Warm conditions dominated the Scotian Shelf and Gulf of Maine during 2000. Subsurface temperatures on the northeastern Scotian Shelf continued to warm in 2000, remaining above-average. Warm conditions, re-established in 1999 after the cold-water event of 1998, persisted in 2000 in the deep basins on the Shelf and in the Gulf of Maine. Though generally weaker in 2000 than in 1999, stratification remained higher than normal over the Scotian Shelf.

2. **Biological Environment in 2000:** Seven presentations on the biological and chemical oceanographic conditions in 2000 were reviewed. In Newfoundland waters, nutrients were higher and phytoplankton blooms less extensive in 2000 than in 1999; zooplankton abundance, notably the abundance of large calanoid nauplii, tended to be greater in 2000 than in 1999. In the St. Lawrence Estuary and northwestern Gulf, spring phytoplankton biomass was much lower in 2000 than in 1999. No major bloom was observed in the Estuary in 2000. Densities of both krill and mesozooplankton in this area in 2000 were comparable to the 1995-1999 levels, but about half of the high 1994 values. Nutrient concentrations in 2000 were similar to the 1999 levels on the Scotian Shelf and in the Gulf of Maine in spring and summer but higher than in 1999 in the southern Gulf of St. Lawrence in fall. Satellite data indicate that the spring phytoplankton blooms in the Maritimes region were later in 2000 than in 1999 but were similar to the historical timing for the bloom. Overall, zooplankton biomass levels in this region were similar between 2000 and 1999.

3. **Recruitment** overviews were presented for selected marine fish and invertebrate stocks. It was decided that this would be expanded for future meetings, with recruitment indices presented annually along with the environmental overviews. A recruitment "scorecard" will be developed for presentation at the annual meeting. A working group was formed to assemble recruitment data and set up a recruitment database.

4. A large number of presentations were reviewed in the **general environmental session**. These focussed on research and development related to the **Atlantic Zonal Monitoring Program**. A presentation on modelling pelagic ecosystems emphasized the need for improved monitoring of key pelagic components of marine ecosystems. A working group on monitoring of pelagic ecosystems was formed to examine this issue.

5. A **theme session** on oceanographic factors affecting the distribution, abundance and productivity of invertebrate populations was convened during the meeting. The response to the session was good with 14 presentations. The presentations reflected the current relative importance of different invertebrate species to the fisheries: there were 5 presentations on lobster, 4 on snow crab, 3 on shrimp, 1 on scallop, and 1 on the occurrence of long-finned squid *Loligo pealei* on Newfoundland in 2000. A general discussion followed.

6. Reports of the **FOC working groups** were presented. The **Environmental Indices Working Group** has completed its objectives and will disband after publishing its work as a technical report. The **Cod Distribution Working Group** was unable to conduct further work in 2000/2001 and it was decided that this group would be disbanded. The working group on **Incorporating Environmental Information into Stock Assessments** was unable to meet in 2000/2001 but will attempt to review and summarize environment-stock relationships for the 2002 theme session. New working groups on **Monitoring of pelagic ecosystems** and **Recruitment Indices** were formed following recommendations made at the meeting.

7. The **2002 Annual Meeting** will be held at the Bedford Institute of Oceanography in Dartmouth during the last week in March. The theme session will be on incorporating environmental information into stock assessments.

Résumé de la réunion annuelle de 2001 du Comité sur océanographie des pêches (COP)

Le Comité sur l'océanographie des pêches (COP) du ministère des Pêches et des Océans (MPO) s'est réuni au Centre des pêches du Golfe, à Moncton (Nouveau-Brunswick), du 27 au 30 mars 2001. On y a examiné les conditions environnementales qui ont marqué l'Atlantique Nord-Ouest en 2000, on a tenu une séance thématique sur les facteurs océanographiques qui influencent la répartition, l'abondance et la productivité des populations d'invertébrés, on a examiné d'autres articles sur l'océanographie physique et biologique, et on a traité des affaires de régie interne.

8. **Milieu physique en 2000** : Le COP a examiné six articles sur les conditions météorologiques et océanographiques physiques en 2000. Les températures de l'air ont été plus chaudes que la normale en 2000 dans presque tout l'Atlantique Nord-Ouest, mais elles ont baissé par rapport aux températures record de 1999. L'étendue de la couverture de glace et la durée de la présence de la glace ont été inférieures à la moyenne. Les températures de l'eau du sud du Labrador jusqu'aux Grands Bancs et au large de la côte sud de Terre-Neuve sont restées en général supérieures à la normale, mais inférieures aux valeurs élevées de 1999. Un réchauffement et un amincissement importants de la couche intermédiaire froide (CIF) avaient été notés dans le golfe du Saint-Laurent en 1999. Or, ce réchauffement s'est poursuivi en 2000, et l'indice de température centrale de la CIF a grimpé plus haut que la moyenne à long terme pour la première fois depuis 1983. La température des eaux du fond du plateau madelinien est demeurée bien en deçà des valeurs élevées qui avaient été notées de 1989 à 1998. Le temps chaud a cependant dominé le plateau Scotian et le golfe du Maine en 2000. Les températures des eaux de sous-surface dans la partie nord-est du plateau Scotian ont continué de grimper, demeurant plus hautes que la moyenne. Les mesures effectuées en eaux profondes, sur le plateau comme dans le golfe du Maine, indiquent que les conditions de chaudes températures, rétablies en 1999 après l'épisode d'eaux froides de 1998, se poursuivent. Par ailleurs, la stratification est demeurée plus élevée que la normale dans l'ensemble du plateau Scotian en 2000, bien qu'elle n'ait pas été aussi prononcée qu'en 1999.

9. **Milieu biologique en 2000 :** Sept articles sur les conditions océanographiques biologiques et chimiques de 2000 ont été présentés. Dans les eaux de Terre-Neuve-et-Labrador, les éléments nutritifs étaient plus abondants et les floraisons de phytoplancton étaient moins importantes qu'en 1999. En outre, le zooplancton, plus particulièrement les nauplii de grands copépodes calanoides, a semblé plus abondant en 2000 qu'en 1999. Dans l'estuaire du Saint-Laurent et dans le nord-ouest du golfe du Saint-Laurent, la biomasse du phytoplancton du printemps était nettement inférieure à ce qu'elle était en 1999. Aucune floraison importante n'a été observée dans l'estuaire en 2000. Les biomasses de mésozooplancton et de krill dans cette zone étaient comparables en 2000 à celles de 1995 à 1999, mais elles étaient deux fois inférieures aux valeurs élevées notées en 1994. Les concentrations d'éléments nutritifs observées sur le plateau Scotian et dans le golfe du Maine, au printemps et à l'été de 2000, étaient semblables aux niveaux de 1999, mais les concentrations notées dans le sud du golfe du Saint-Laurent à l'automne de 2000 étaient supérieures à celles de 1999. Des données obtenues par satellite indiquent que la floraison printanière de phytoplancton dans la région des Maritimes a été plus lente à venir en 2000 qu'en 1999 mais qu'elle était conforme aux

données historiques. Dans l'ensemble, les niveaux de la biomasse de zooplancton dans cette région étaient semblables à ceux de 1999.

10. On a présenté des aperçus du **recrutement** de certains stocks d'invertébrés et de poissons. Il a été décidé qu'aux futures réunions, on irait encore plus loin, en présentant des indices de recrutement annuels ainsi que des examens environnementaux. Un « bilan » du recrutement sera mis au point et sera présenté à la réunion annuelle. Un groupe de travail a été créé pour rassembler toutes les données sur le recrutement et établir une base de données à cet égard.

11. Bon nombre d'articles ont été présentés au cours de la **séance sur l'environnement en général**. Ces exposés portaient sur les activités de recherche et de développement menées dans le cadre du **Programme de monitorage de la zone atlantique**. Un exposé sur la modélisation des écosystèmes pélagiques a fait ressortir le besoin d'améliorer les méthodes de surveillance des composantes pélagiques clés des écosystèmes marins. Le COP a créé un groupe de travail qui examinera la pertinence d'un monitorage des écosystèmes pélagiques.

12. Au cours de la réunion, on a tenu une **séance thématique** sur les facteurs océanographiques qui influencent la répartition, l'abondance et la productivité des populations d'invertébrés. Les gens ont bien répondu à l'appel et 14 exposés ont été présentés. Les articles reflétaient l'importance relative actuelle des diverses espèces d'invertébrés visées par la pêche. Cinq présentations portaient sur le homard, quatre visaient le crabe des neiges, trois portaient sur la crevette et un exposé parlait de pétoncle. Le dernier exposé traitait de l'apparition du calmar à longues nageoires (*Loligo pealei*) dans les eaux de Terre-Neuve-et-Labrador en 2000. Une discussion générale a suivi la présentation des exposés.

13. Certains **groupes de travail du COP** ont présenté leurs rapports. Le **Groupe de travail sur les indicateurs environnementaux** a atteint ses objectifs; il sera donc dissous après la publication de ses travaux dans un rapport technique. Le **Groupe de travail sur la répartition de la morue** n'a pas pu poursuivre ses travaux durant l'exercice 2000-2001; on a décidé de le démanteler. Le groupe de travail sur **l'intégration d'information environnementale dans des évaluations de stocks** n'a pas pu se réunir en 2000-2001, mais il tentera d'examiner et de résumer les relations entre l'environnement et les stocks d'ici à la séance thématique de 2002. On a créé deux nouveaux groupes de travail qui s'occuperont respectivement d'examiner la question d'un monitorage **des écosystèmes pélagiques** et **des indices de recrutement**, selon les recommandations formulées au cours de la réunion annuelle.

14. La réunion **annuelle de 2002** aura lieu à l'Institut océanographique de Bedford, à Dartmouth, pendant la dernière semaine de mars. La séance thématique portera sur l'intégration d'information environnementale dans les évaluations de stocks.

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1. Introduction

The Fisheries Oceanography Committee (FOC) of the Department of Fisheries and Oceans (DFO) met in Moncton, New Brunswick, at the Gulf Fisheries Center on 27-30 March, 2001, to (1) review the environmental conditions in the Northwest Atlantic during 2000, (2) review other papers on the environment or fisheries-environment linkages, and (3) conduct the annual FOC business meeting and review progress of the working groups of the FOC. A theme session on oceanographic factors affecting distribution, abundance and productivity of invertebrate populations was convened during the meeting. This report provides a summary of the working papers presented at the meeting, the discussions during the meeting and the recommendations following from these discussions. The agenda, and lists of working papers and meeting participants, appear in the Appendices.

2. FOC Core-Membership

While participation in the activities of the FOC are open to all, the Committee formally consists of a number of core-members whose responsibilities are to disseminate information in their respective laboratories and to provide a leadership role within the committee. At the time of 2001 annual meeting, the FOC core-members were:

Name	Region	Location
John Anderson	Newfoundland Region	NAFC
Denis D'Amours	DFO Headquarters	Ottawa
Martin Castonguay	Laurentian Region	IML
Eugene Colbourne	Newfoundland Region	NAFC
Ken Drinkwater	Maritimes Region	BIO
Ken Frank	Maritimes Region	BIO
Denis Gilbert	Laurentian Region	IML
Glen Harrison	Maritimes Region	BIO
Savi Narayanan	MEDS, DFO Headquarters	Ottawa
Patrick Ouellet	Laurentian Region	IML
Fred Page	Maritimes Region	SABS
Dave Reddin	Newfoundland Region	NAFC
Doug Swain, Chairman	Maritimes Region	Moncton
John Tremblay	Maritimes Region	BIO

3. 2000 Environmental Overviews

As part of the FOC mandate, the Committee provides an annual review of environmental conditions in the Northwest Atlantic. A total of 13 papers were reviewed, six on the physical environment and seven on the biological environment. Each environmental overview paper was assigned a reviewer to improve the quality of the manuscripts by providing detailed comments, ensuring editorial correctness and including possible suggestions for next year's overview papers. Reviewers delivered their comments to the senior authors before the end of the meeting or made arrangements to provide them shortly thereafter. A physical environmental "scorecard" was developed and is included below (Table 1).

*3.1 **Meteorological and Sea Ice Conditions** (K. Drinkwater et al.)*

Annual mean air temperatures throughout most of the northwest Atlantic were warmer than normal in 2000, although from southern Labrador to the eastern Gulf of Maine, they declined relative to the record setting temperatures of 1999 (Fig. 1). Consequently, sea-surface temperatures throughout eastern Canadian waters were also warmer-than-normal.

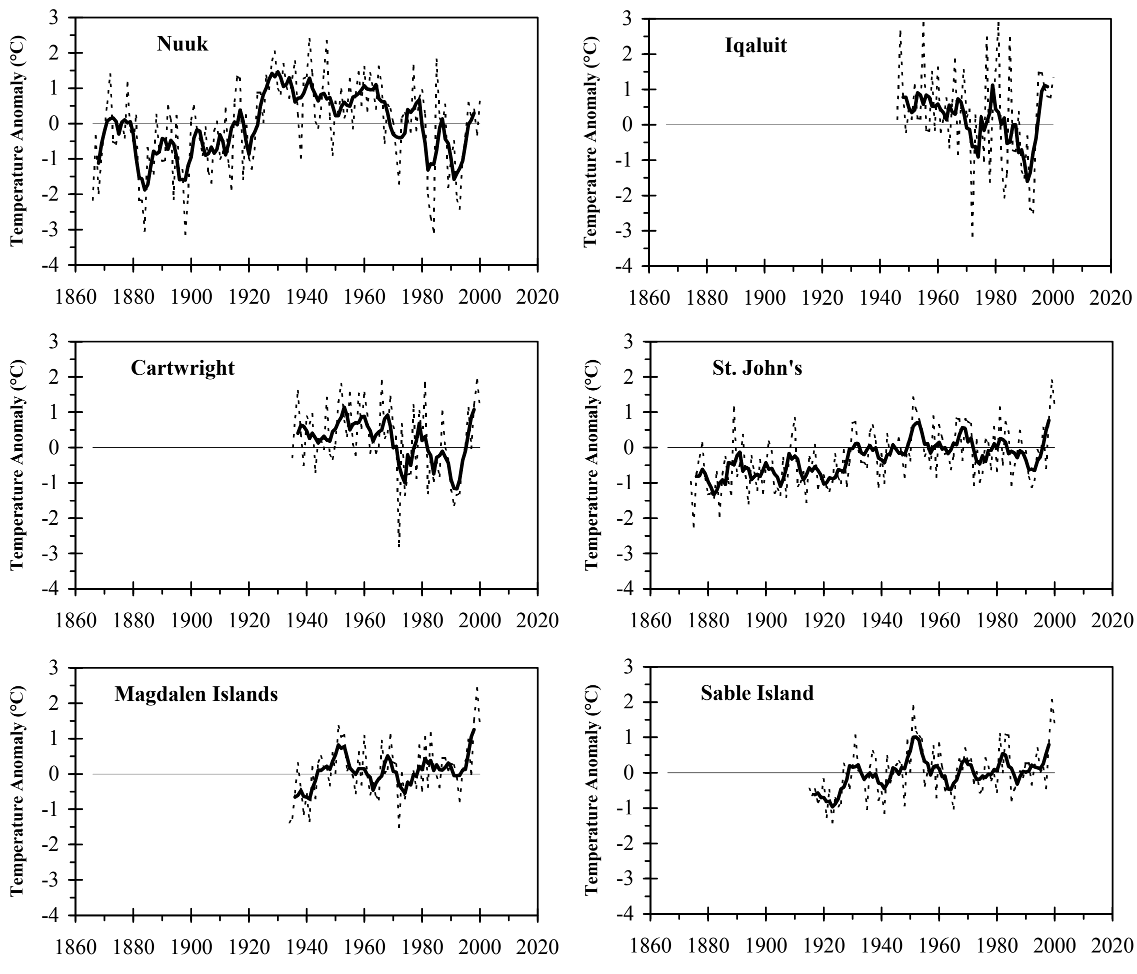

Fig. 1. Annual (dashed) and 5-yr running means (solid) of air temperature anomalies relative to 1961-1990 means at selected sites in the western North Atlantic.

The North Atlantic Oscillation (NAO) index was above normal and similar to 1999 (Fig. 2). It was well above the values of 1996-1998 but similar to levels seen in the cold period of the early 1990s. The high index means that the large-scale atmospheric circulation, including the Icelandic Low and Azores High, was more intense than normal in 2000. In the past, a high NAO index was usually associated with cold air and sea temperatures. That this did not occur in 2000 is attributed to the more eastward displacement of the centers of the Icelandic Low and Azores High. In addition, the Azores High pushed further north on the western side of the Atlantic carrying warmer-than-average air from the south into the region during the winter. Sea ice on the southern Labrador and Newfoundland shelves generally appeared late or on schedule but left early, resulting in a shorter duration of ice than usual. The ice coverage in these areas was lower than average (Fig. 3). The number of icebergs reaching the Grand Banks in 2000 was 843, well up from the 22 icebergs observed in 1999, but lower than the numbers recorded through most of the 1990s. In the Gulf of St. Lawrence, sea ice also appeared late or on schedule but disappeared much earlier-than-normal. Little to no ice reached the Scotian Shelf and the areal coverage of ice in the Sydney Bight area off eastern Cape Breton was much less-than-normal.

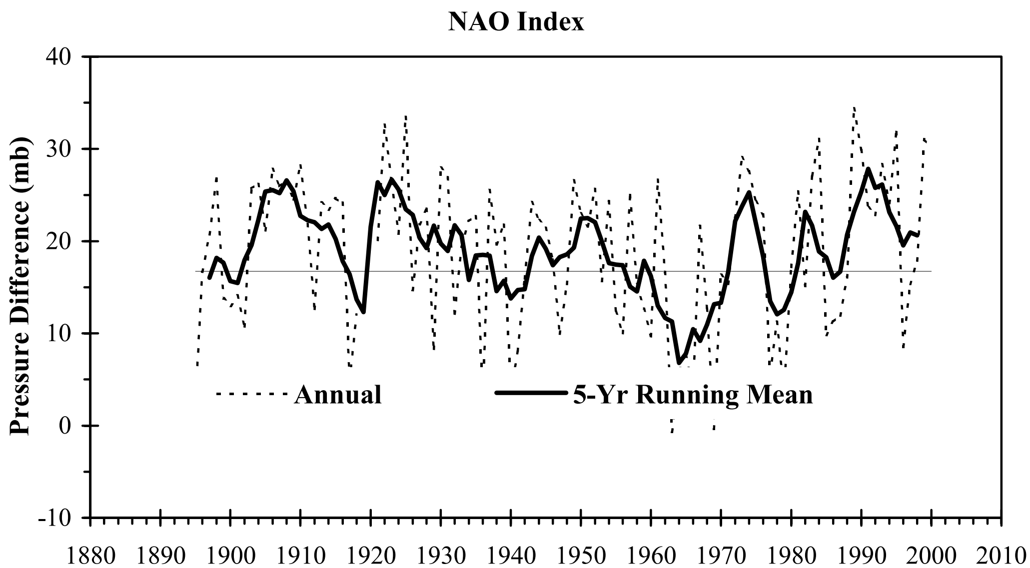

Fig. 2. The North Atlantic Oscillation Index.

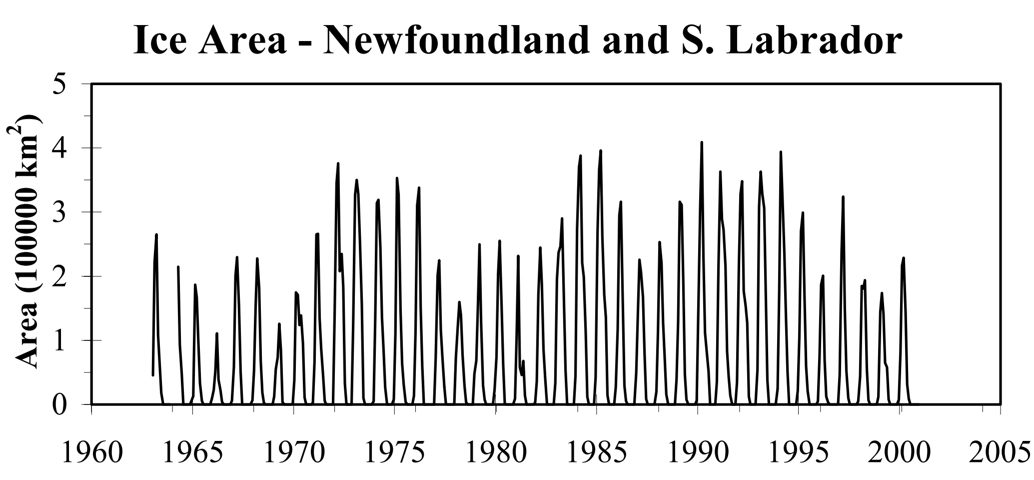

Fig. 3. The time series of the monthly mean area of sea ice off southern Labrador and northern Newfoundland between 45ºN and 55ºN.

3.2 ***Physical Oceanographic Conditions***

3.2.1 <u>*Newfoundland/Southern Labrador*</u> *(E. Colbourne)*

The annual water-column-integrated temperature at Station 27 for 2000 cooled slightly compared to 1999 but remained above the long-term mean. Surface temperatures were above normal for 9 out of 12 months with anomalies reaching a maximum of near 1.5°C during August (Fig. 4). The June, July and December values were about normal. Bottom temperatures at Station 27 were above normal (by >0.5°C) during the first 6 months of the year and about normal during the remainder. Salinities at Station 27 were below normal during the winter months and near normal during the rest of the year. The vertically integrated salinity for the summer months was about normal. Similar trends in temperatures and salinity were observed on the Flemish Cap and on Hamilton Bank during 2000. Temperatures at 10-m depth in the inshore regions along the east coast of Newfoundland during 2000 were above normal by up to 3°C during the summer months.

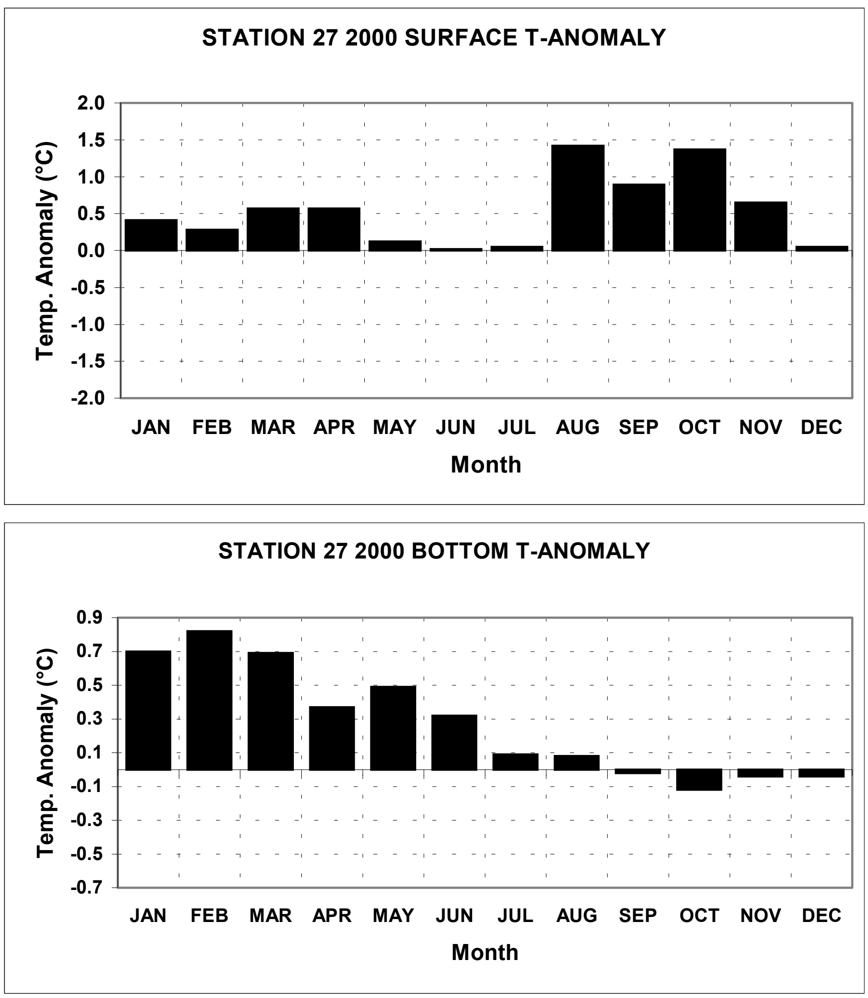

Fig. 4. Monthly temperature anomalies at the surface (top panel) and bottom (bottom panel) at Station 27 in 2000.

The cross-sectional area of the cold intermediate layer (CIL), defined as water at temperatures below 0 °C, increased on the Newfoundland and Labrador Shelves during the summer of 2000 over 1999 values. The CIL areas ranged from below normal on the Grand Band (Flemish Cap transect), near normal on the east coast (Bonavista transect) and slightly above normal off southern Labrador (Seal Island Transect). The total volume of the CIL on the shelf during the fall increased compared to 1999 but amounts were still below that observed during cold years (Fig. 5). Minimum CIL core temperatures during the summer of 2000 were also slightly cooler than 1999 values but about normal.

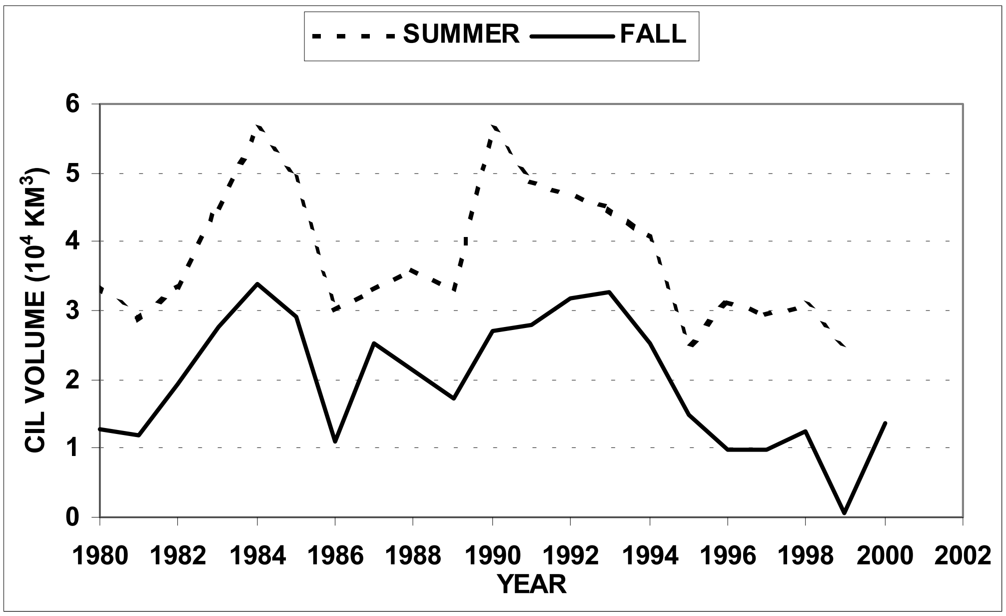

Fig. 5. Summer and fall cold-intermediate-layer (CIL, temperature < 0 °C) volumes over the 2J3KL areas. Data were insufficient to calculate a summer 2000 value.

Bottom temperatures on the Grand Banks during the spring of 2000 ranged from 0.5°C above normal in 3L and up to 2°C above normal in 3O (Fig. 6). During the fall they decreased to mostly below normal values except in regions of northern 3L. Fall bottom temperatures in Divs. 2J and 3K were above normal in most areas, however, the mean bottom temperature in all regions decreased from 1999 values. Correspondingly, the area of the bottom in all areas covered by water in the lower end of the temperature range (<1°C) increased slightly over 1999 values while the area of warmer water decreased. The largest increase in the area of sub-zero °C water occurred over the Grand Banks during both summer and fall with still no sub-zero °C water in 2J during the fall of 2000.

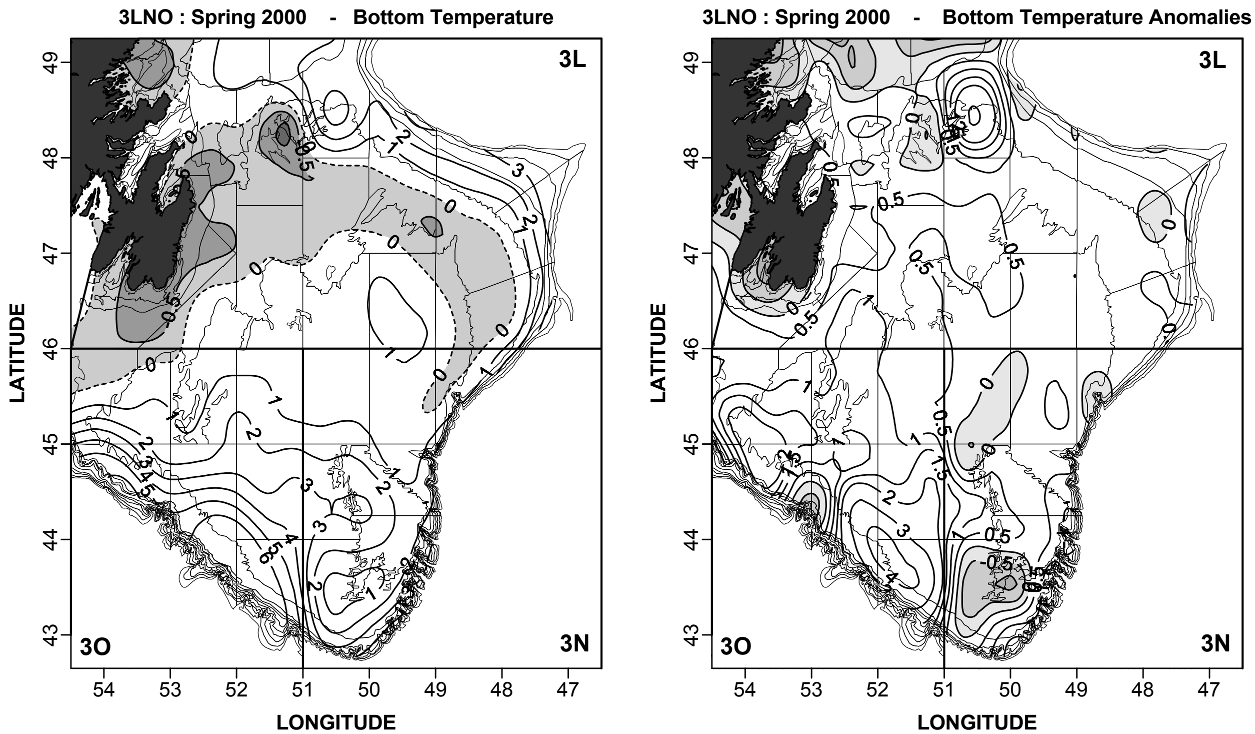

Fig. 6. Bottom temperature (°C) and its anomalies for the spring of 2000 from the multi-species survey of NAFO Divs. 3LNO.

In general, the below normal trends in temperature and salinity, established in the late 1980s on the Newfoundland and Labrador Shelves, reached a peak in 1991. This cold trend continued into 1993 but started to moderate during 1994 and 1995. During 1996 temperature conditions were above normal over most regions; however, summer salinity values continue to be slightly below the long-term normal. During 1997 to 1999 ocean temperatures continued above normal over most areas, with 1999 one of the warmest years in the past couple of decades. During 2000, ocean temperatures were generally cooler than 1999 values but remained above normal over most areas, continuing the trend established in 1996. Salinities during 2000 were similar to 1999 values, generally fresher than normal throughout most regions, which is a continuation of the trend observed during most of the 1990s.

Bottom temperatures on the banks off southern Newfoundland (NAFO Subdivisions 3Pn and 3Ps) were relatively cold in the mid to late 1980s and early 1990s (Fig. 7), resulting in large areas of subzero bottom waters (Fig. 8). Conditions moderated in the mid 1990s, with near average bottom temperatures and little subzero bottom water over the banks in 1996. Bottom waters cooled again in 1997 but returned to near average temperatures with little subzero bottom water in 1998. Temperatures continued to warm during 1999 and 2000 and were above normal over most of the water column, including near bottom. No subzero bottom water occurred on these banks in 1999 and 2000.

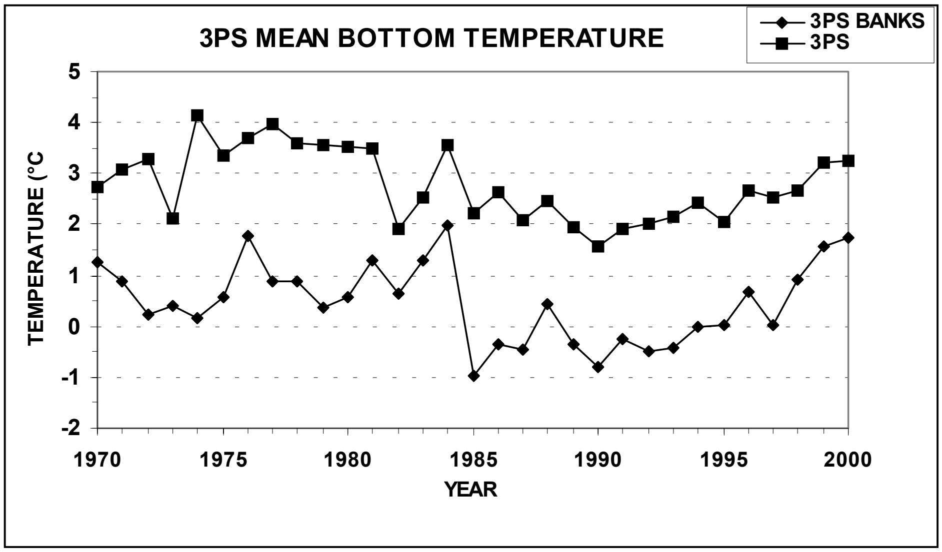

Fig. 7. Mean bottom temperature (°C) in NAFO Subdivion 3Ps for all strata and for strata shallower than 100 m (mainly Burgeo, St. Pierre and Green Banks).

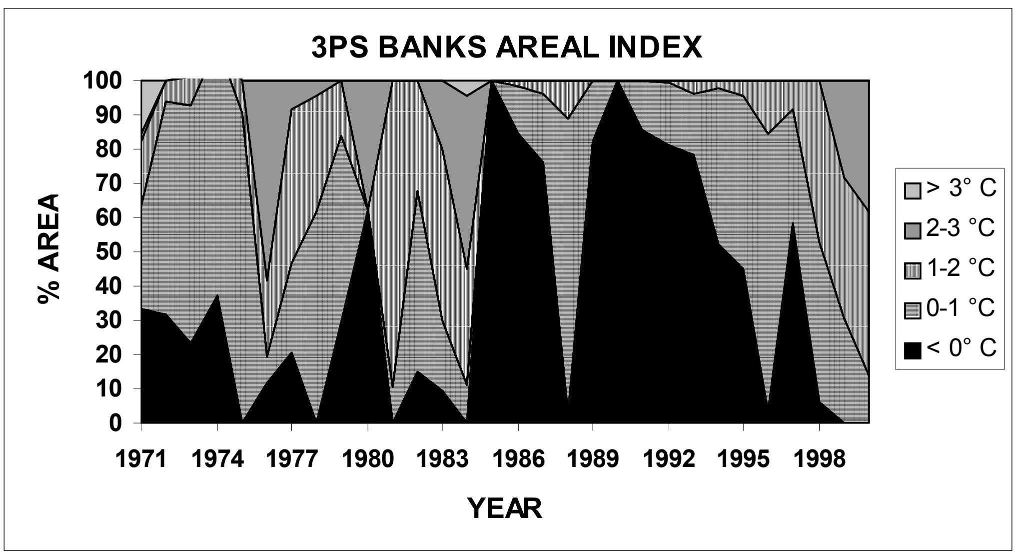

Fig. 8. Area of the bottom in NAFO Subdivion 3Ps covered by water with temperatures ≤0 °C, 0-1 °C, 1-2 °C, 2-3 °C, and ≥3 °C during spring, for strata shallower than 100 m (mainly Burgeo, St. Pierre and Green Banks).

3.2.2 Gulf of St. Lawrence (J. Plourde et al.)

A substantial warming and thinning of the CIL occurred in the Gulf of St. Lawrence in 1999. This warming continued in 2000, when the CIL core temperature increased to 0.15 °C, rising above the 1961-1990 average for the first time since 1983 (Fig. 9). On the Magdalen Shallows, the areas with bottom waters <0°C and <1°C decreased substantially in 1999, ending the period of cold bottom conditions that persisted from 1989 to 1998 (Fig. 10). In 2000, the area of the southern Gulf covered by cold bottom waters remained well below the high values of the 1989-1998 period. In deeper waters of the Gulf (100-200 m and 200-300 m), temperatures changed little in 2000 relative to 1999, and were slightly above normal (the 1961-1990 average) in 2000.

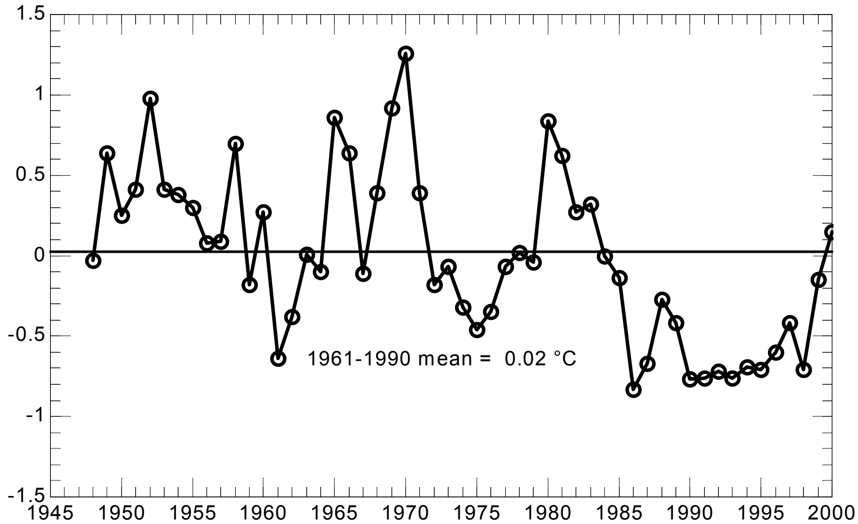

Fig. 9. Composite index of CIL core temperature anomaly (°C) in the Gulf of St. Lawrence (1961-1990 mean = 0.03°C).

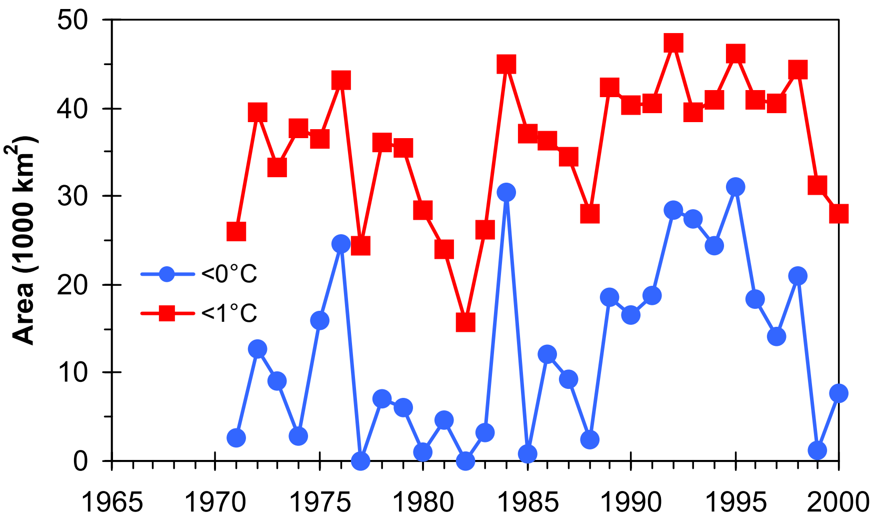

Fig. 10. Bottom area with T < 0°C (circles) and T < 1°C (squares) in September in the southern Gulf of St. Lawrence.

RIVSUM, an index of freshwater discharge from the St. Lawrence, was slightly below average in 1999 and 2000. Mean monthly flow of the St. Lawrence River at Quebec City were near-average throughout the year, in contrast to recent years when large anomalies were observed in spring (positive anomalies in 1997 and 1998, and negative anomalies in 1999).

3.2.3 <u>Scotian Shelf/Gulf of Maine</u> (K. Drinkwater et al.)

Warm conditions dominated the Scotian Shelf and Gulf of Maine during 2000. Coastal sea surface temperatures, fisheries surveys, transect data, fixed monitoring sites and other CTD stations all indicate that surface temperatures were well above normal throughout the year. Subsurface temperatures in the northeastern portions of the Scotian Shelf continued their warming trend, were above normal and rose slightly relative to 1999 (Fig. 11). This followed nearly 15 years of below normal temperatures with the minimal temperatures recorded in the early to mid-1990s. Waters in the deep basins both on the Shelf and in the Gulf of Maine indicate continuance of the warm conditions re-established in 1999 after the cold water event of 1998 (Fig. 12). Near bottom temperatures throughout the Scotian Shelf were also above normal in 2000 (Fig. 13) and the area of bottom covered by cold temperatures decreased significantly. The cold intermediate layer waters emanating from the Gulf of St. Lawrence were also warmer-than-usual. Warm Slope Water was located offshore and there was no evidence of Cold Slope Water along the Scotian Shelf or off the Gulf of Maine during 2000. While the vertical stratification in the upper water column (between surface and 50 m) over the Scotian Shelf generally weakened in 2000 relative to 1999, it remained higher than normal. The Shelf/Slope front and the Gulf Stream were well shoreward of their normal positions. For the Gulf Stream it was the 2nd most shoreward position in the 29-year record.

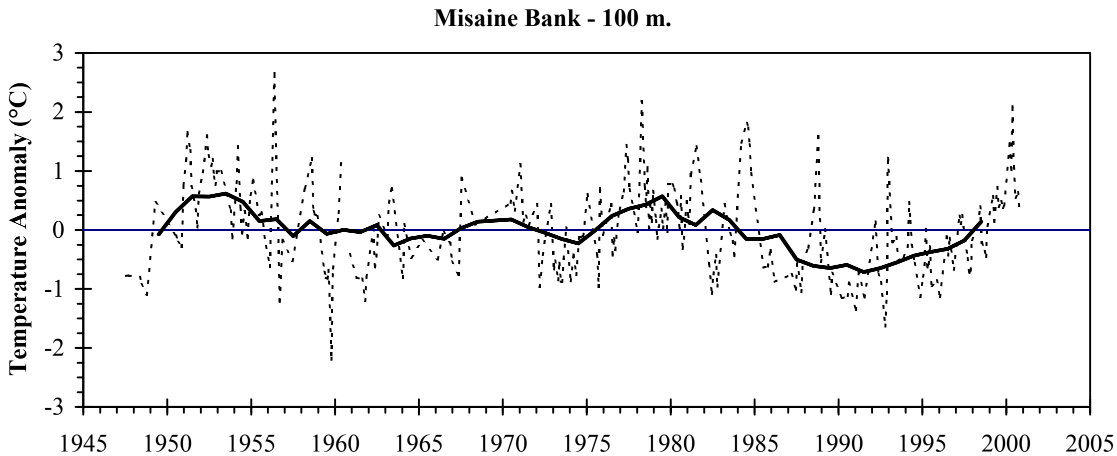

Fig. 11. Monthly (dashed) and 5-yr running means (solid) of the temperature anomalies at 100 m on Misaine Bank in the northeastern Scotian Shelf.

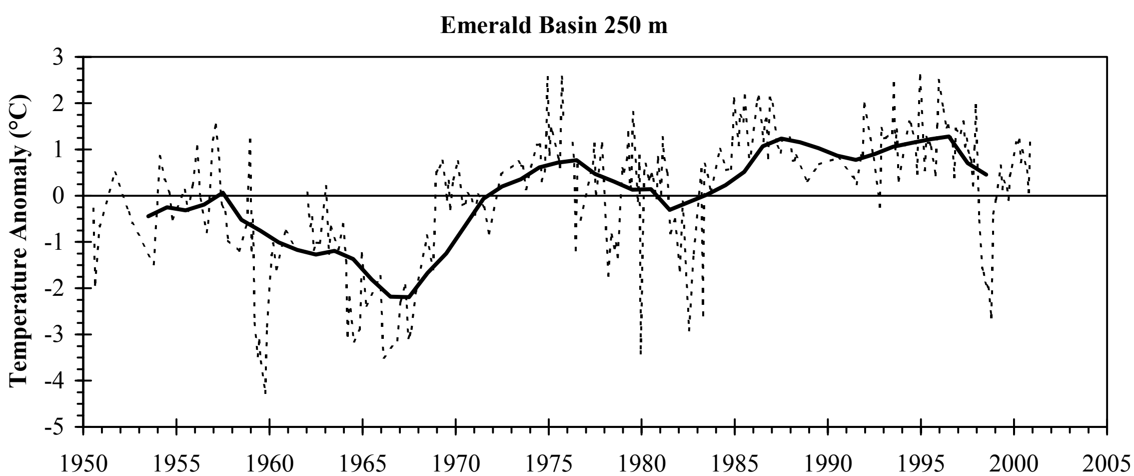

Fig. 12. Monthly (dashed) and 5-yr running means (solid) of the temperature anomalies at 250 m in Emerald Basin on the central Scotian Shelf.

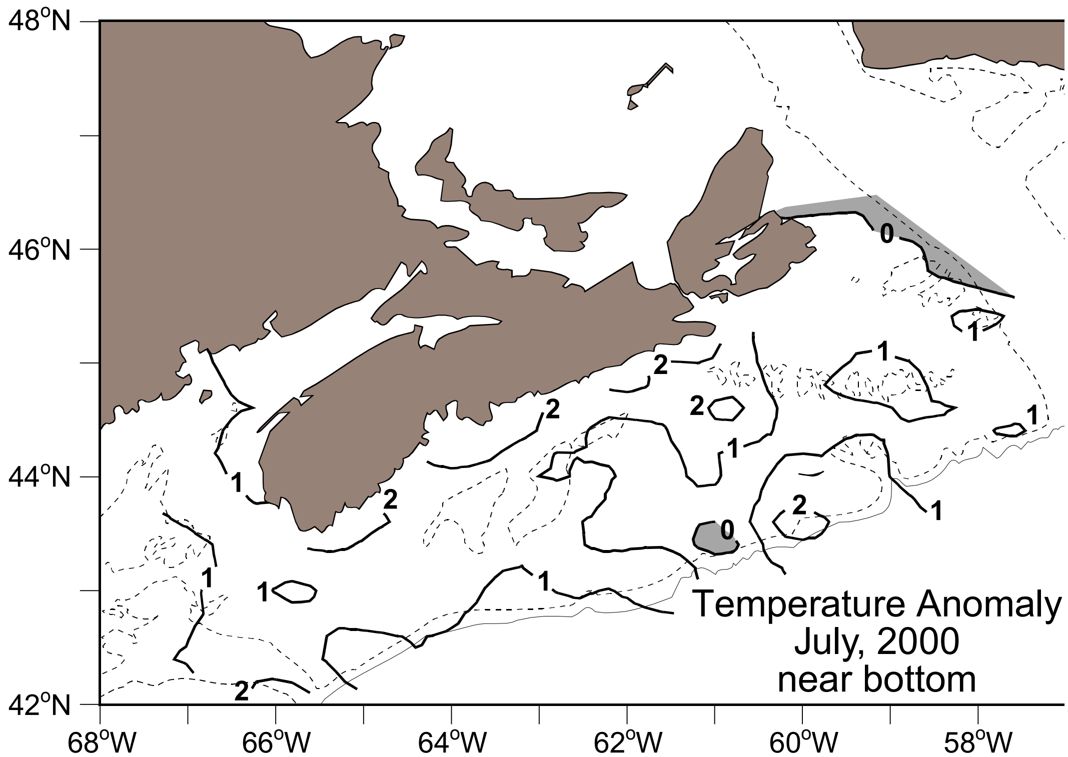

Fig. 13. Near-bottom temperature anomaly (relative to 1961-1990 mean) in 2000 during the July groundfish survey. Negative anomalies are shaded.

A stratum-specific analysis of temperature and salinity data from the 2000 July trawl survey of NAFO Divisions 4VWX was presented by Losier et al. Sampling effort in 2000 occurred within the same time period as in 1999. Near-bottom temperatures were above average throughout the area. The geographic distribution of stratum mean salinities was similar in 2000 to the 1980-1990 stratum means.

3.2.4 Physical Environment Scorecard

Following the practice instituted at the 1998 FOC meeting, a physical oceanographic "scorecard" was constructed to summarize changes in the many standard environmental indices (Table 1). Following suggestions made at the 1998 meeting, quantitative information was incorporated by indicating, where possible, the strength of the 2000 anomaly in terms of its standard deviation from the longterm average. Conditions were generally warmer than the longterm averages throughout the Atlantic zone.

3.2.5 Questions and Discussion

The NAO index and its link to meteorological conditions in the NW Atlantic were discussed. The relationship between the NAO index and air temperatures in the NW Atlantic has deviated from the usual pattern in the past few years. Spatial and temporal shifts in the pressure centers have resulted in changes in the index's relationship to meteorological conditions such as wind.

Current positions of the high and low pressure centers result in stronger gradients in the eastern North Atlantic. Pressure gradients in the west are weaker and thus less strong winds result for a given NAO index value. Efforts are being made internationally to refine the index, although it is recognized that the North Atlantic system is complex and a simple two-point indicator will not easily capture the dynamics of all regions.

Questions following the presentations on oceanographic conditions off Newfoundland centered on the general flow fields in the Newfoundland region and connections with local hydrodynamics and with other regions. It was noted that the magnitude of the geostrophic currents is determined principally by the horizontal density gradient between shelf and slope water (salinity-driven).

The presentation on oceanographic conditions in the Gulf of St. Lawrence included material on the frequency and distribution of "warm" and "cold" temperature profiles. Analyses were restricted to profiles for which the lower boundary of the CIL could be detected (i.e., to deeper areas of the Gulf). A profile was characterized as cold if its minimum temperature was below 0°C. Questions and discussion centered on the derivation and interpretation of these statistics. It was suggested that the spatial structure seen in the distribution of warm and cold profiles (i.e., "warm" profiles from Cabot Strait and "cold" ones from Belle Isle Strait) may indicate an advective component to CIL formation. It was agreed that advection is important but regional differences in heat exchange are also thought to be important, e.g. role of local heating/cooling evident in the Eastern Gulf. It was suggested that the frequency of "cold" profiles might be used to predict a longterm sustained event, but it was agreed that further evaluation of these statistics was needed.

The stratification index calculated for the Scotian Shelf was discussed. The index is calculated from the average density differences between 0 and 50 m for all profiles per month. Data are scanty for some months. It was questioned whether the specific stratification trends seen on the Scotian Shelf could be due to a seasonal bias (as the data come mostly from the July trawl survey), but this was not thought to be the case. The cause of increased stratification in recent years seemed to be fresher surface waters.

Possible improvements to the scorecard were discussed. It was noted that geographic comparisons were difficult given the current indices. For example, in 2000, the near-bottom temperature anomaly was greatest for St. Pierre Bank, but this does not mean that temperatures are warmest there – anomalies are calculated within series and cannot be combined between series to construct a composite picture. All that can be inferred from the scorecard is that bottom temperatures warmed in all regions. It was suggested that indices should be standardized between geographic regions but no conclusion was reached on how the scorecard could be improved to facilitate the construction of geographic composites.

The question of why warming of bottom waters in the Gulf was delayed relative to warming in other areas was raised. The explanation is not known. It may be that the Labrador current warmed first, but the relative importance of local forcing compared to advection is not well known.

Table 1. Environmental scorecard for 2000. Conditions for 2000 are shown as anomalies in standard deviations from the longterm average and are compared to 1999 and the previous 5 yr. Shading indicates conditions that were unusually cold/fresh or warm/salty. GSL = Gulf of St. Lawrence. N/A – not available for 2000.

Index	Area	2000	Cold Fresh	Warm Salty	Relative To 1999	Relative to 1995-1999
NAO		1.38			Up	Up
Annual	Labrador	1.09			Down	Up
Air	Newfoundland	1.82			Down	Up
Temperature	Gulf of St. Lawrence	2.25			Down	Up
	Scotian Shelf	2.50			Down	Up
	Gulf of Maine	-0.21			Down	Up
Sea Ice	Nfld/Lab (Area)	-0.62			Up	Down
	Scotian Shelf (Area)	-1.20			Up	Down
Near-bottom	Nfld – Grand Bank	1.66			Down	Up
Temperature	Station 27	0.68			Down	Up
	St. Pierre Bank	2.30			Up	Up
	Magdalen Sh. area T<0	0.15			Up	Down
	Magdalen Sh. area T<1	0.72			Down	Down
	Misaine Bank - 100 m	1.69			Up	Up
	Emerald Basin - 250 m	0.71			Up	Down
	Georges Basin – 200 m	1.13			Down	No Trend
	Bay of Fundy P5 – 90 m	1.70			Up	Up
CIL	Nfld Bonavista Bay (Area)	0.02			Down	Down
	GSL (Min. Temp. 1948-99)	0.24			Up	Up
Integrated	Station 27	0.70			Down	Up
Temperature	Cabot Strait (200-300 m)	0.54			Down	Up
	GSL 0-30 m	N/A			N/A	N/A
	GSL 30-100 m	N/A			N/A	N/A
	GSL 100-200 m	N/A			N/A	N/A
	GSL 200-300 m	N/A			N/A	N/A
Surface	Station 27	0.60			Down	Up
Temperature	Halifax	0.43			Up	Up
	Bay of Fundy – St. Andrews	1.94			Down	Up
	Gulf of Maine – Boothbay	3.13			Up	Up
Salinity	Station 27	0.40			Up	Up
	Prince 5 (90 m)	0.66			Down	Up

*3.3 **Chemical and Biological Oceanographic Conditions***

3.3.1 Newfoundland/Southern Labrador (P. Pepin & G. Maillet, E. Dalley et al.)

Nutrient concentrations in the surface layer (top 50m) in 2000 were similar to those of 1999. The seasonal depth of the nutricline at Station 27 appeared to be shallower in spring in 2000 than in 1999 (Fig. 14). In 2000, the depth over which nutrient depletion occurred increased during the course of the summer and fall, and mixing of the water column had yet to occur by mid-December (Fig. 14). This contrasted with 1999 when the depth of the nutricline was relatively constant throughout the summer and there was a substantial increase in surface nutrient concentrations by early December.

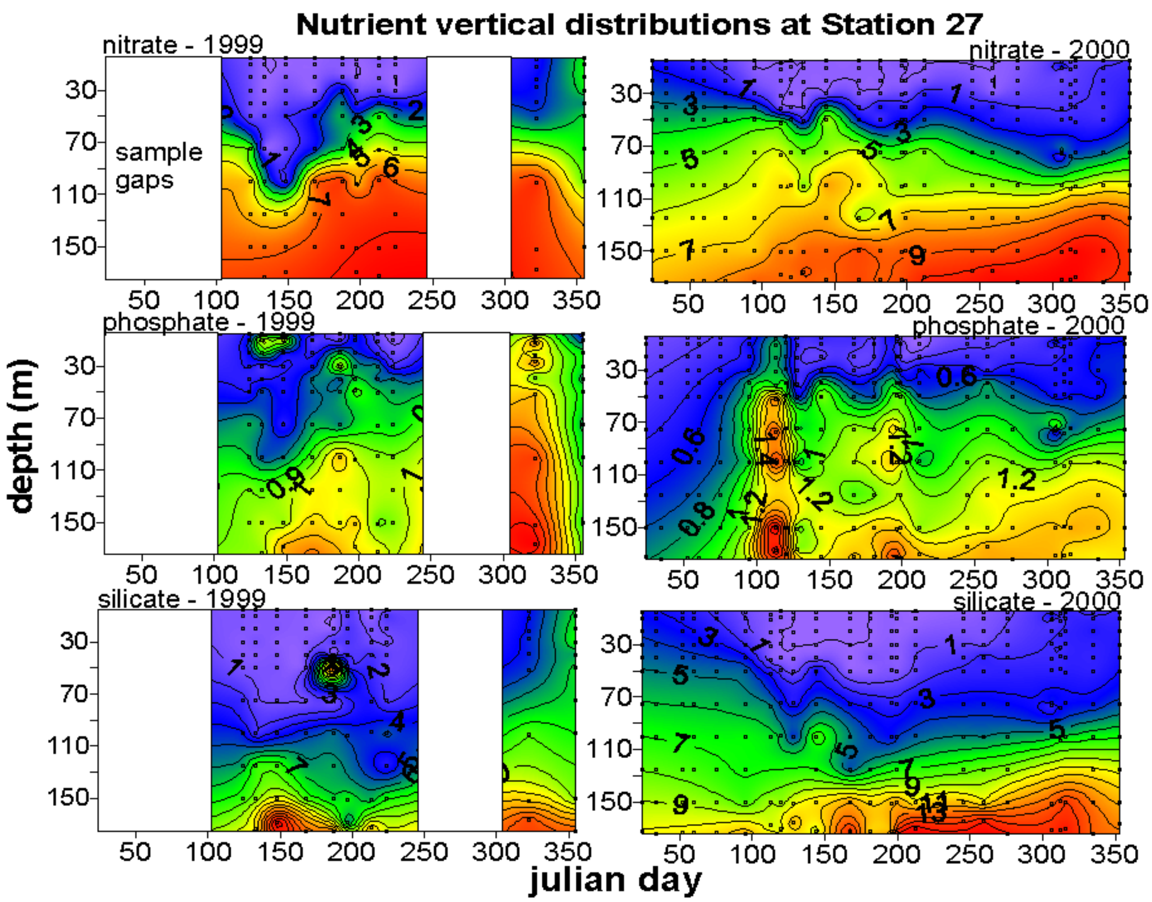

Fig. 14. Vertical distribution of nutrients at Station 27 in 1999 and 2000.

There was a distinct north-to-south gradient in the depth of the nutricline during the spring and summer when the nutricline was closer to the surface in the north. There was no such pattern in the fall, when the nutricline was at 50m on the Newfoundland Shelf and on the Grand Banks. In contrast to 1999, near-bottom nutrient concentrations on the Newfoundland Shelf off Bonavista, in the Avalon Channel and on the continental slope were higher during the fall of 2000 than in the spring.

The seasonal cycle in phytoplankton biomass in 2000 was less dynamic than in 1999 (Fig. 15). The spring phytoplankton bloom was restricted to the upper 60m of the water column whereas it extended from surface to bottom in 1999. There was little evidence of subsurface blooms during the summer of 2000 whereas high concentrations were frequently observed in 1999.

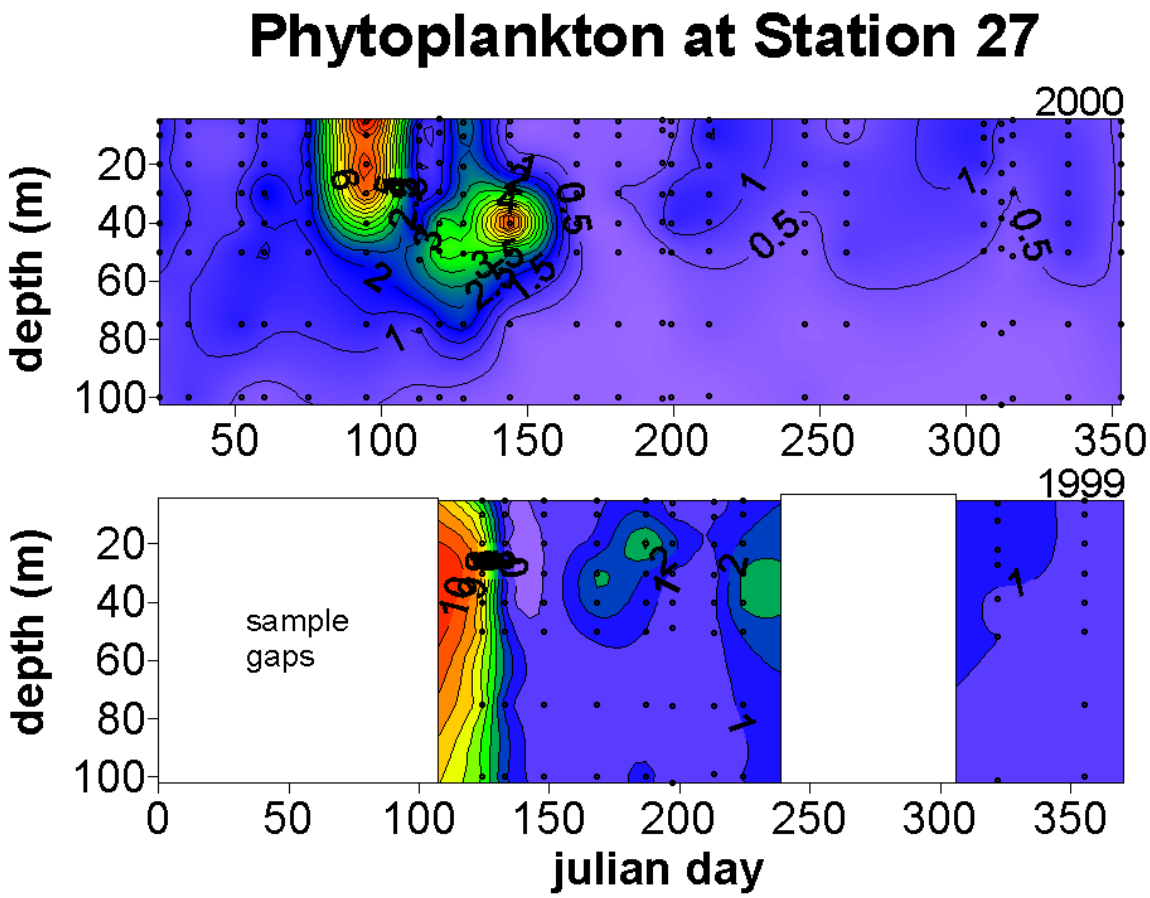

Fig. 15. Seasonal vertical distribution of phytoplankton at Station 27 during 1999 and 2000.

Phytoplankton biomass (chlorophyll concentration) was spatially and temporally variable but concentrations were always higher in spring than in summer and fall. In spring and fall, concentrations were higher on the northern Grand Banks or the Newfoundland Shelf than they were on the Southeast Shoal. During the summer, concentrations were greater along the Labrador coast than on the Newfoundland Shelf. These patterns reflect latitudinal differences in the timing of stratification. Within any season, higher concentrations tended to be associated with strong horizontal currents, such as the Labrador Current found in the Avalon Channel and on the continental slope. There was no evidence of a fall bloom on the shelf or Grand Banks, in contrast to 1999 when there was a notable increase in phytoplankton biomass on the Southeast Shoal.

Analysis of the phytoplankton community composition at Station 27 showed that diatoms showed a strong seasonality whereas this was not the case for dinoflagellates and flagellates. Concentrations of the latter two groups were approximately constant throughout the year, with flagellates being the numerically dominant taxa. This pattern was also observed during the spring, summer and fall oceanographic surveys of the Newfoundland Shelf and Grand Banks.

Zooplankton abundance was relatively uniform across the entire shelf in both the spring and the summer. *Oithona similis* and *Pseudocalanus* sp. were numerically dominant but the bulk of the biomass was found in copepodites stages of *Calanus* sp.. The abundance of the former two species was higher in 2000 than in 1999 whereas number of *Calanus* sp. copepodites were near 1999 levels. There was a significant increase in the numbers of large calanoid nauplii (probably a combination of *C. finmarchicus* and *C. glacialis*) and larvaceans following the spring phytoplankton bloom. In contrast, the overall abundance of copepod nauplii peaked in late summer and remained high throughout the fall. Overall species community structure and diversity was similar in 1999 and 2000.

The overall abundance of large calanoid nauplii in 2000 was approximately twice that observed in 1999 and the average abundance ratio of nauplii to adult CVI copepodites of *Calanus* sp., where the two stages co-occurred, was approximately 3 times that observed in 1999. Adult stages of *Calanus* sp. were not found on the Grand Banks although earlier developmental stages were widely distributed across the area. Adult *Calanus* sp. were primarily found on the Newfoundland Shelf, the Avalon Channel and in the offshore branch of the Labrador Current.

Invertebrate zooplankton of the Northeast Newfoundland shelf and Grand Banks were examined from pelagic surveys carried out during late summer, 1991-1999. The community was dominated by copepods that comprised 82-84% of all zooplankton. Trends in abundance of other zooplankton were similar to that of copepods. All zooplankton were low in abundance during the early part of the decade and peaked in abundance from 1997 to 1999. The estimates for some smaller species (e.g. *O. similis*) are negatively biased in 1991 and 1992, by use of a larger mesh (.505 mm). However, even larger zooplankton, whose catch was not biased by mesh size, (e.g. larger stages of *Calanus finmarchicus*, *C. hyperboreus*, chaetognaths, amphipods, and euphausids) were all low in abundance in the early 1990's. The most numerically abundant copepod species were *Oithona similis*, *Pseudocalanus sp*., *C. finmarchicus*, *Temora longicornis*, and *Centropages hamatus,* all of which peaked in abundance from 1997-1999. *C. finmarchicus* dominated in terms of biomass, with maximum biomass in the last year of the time series. Although *C. hyperboreus* was relatively low in numbers compared to other copepods, its biomass was also significant, particularly in the north, due to its large individual size. Cladocerans were the dominant other zooplankton, peaking in 1997, followed by *Limacina* which peaked in 1996, and bivalve larvae which peaked in 1999. The geographic extent of the survey is sufficient to delineate northern limits of more temperate species (e.g. *T. longicornis* and *C. hamatus)* and the southern limit of more boreal species (e.g. *C. hyperboreas)* on the Newfoundland shelf.

3.3.2 Gulf of St. Lawrence (M. Starr et L. St-Amand, M. Harvey)

In contrast to previous years in the 1995-1999 period, no major bloom of phytoplankton was observed in 2000 at the Rimouski station in the lower St. Lawrence Estuary (Fig. 16). The average phytoplankton biomass level at the station in spring-summer 2000 was about a sixth of the very high 1999 level and a third of the average level for the 1995-1998 period. Phytoplankton biomass levels in the Gaspé Current were also much lower in spring 2000 than in 1999. New spring production in the Anticosti Gyre also appeared to be lower in 2000 than in 1999.

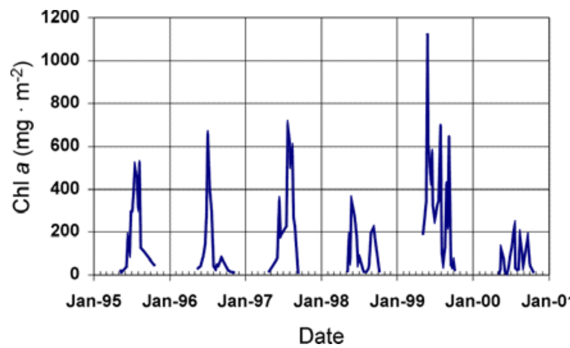

Fig. 16. Chlorophyll *a* concentrations in the upper 50 m of the water column at the Rimouski station during spring-summer 1995-2000.

A zooplankton survey has been conducted in the lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence in September each year since 1994. The estimated average wet biomass of both mesozooplankton and krill were greatest in 1994 and lowest in 1996 (Fig. 17). For both components of the zooplankton, mean biomass in 2000 was comparable to the 1995-1999 levels, but about half of the high 1994 level.

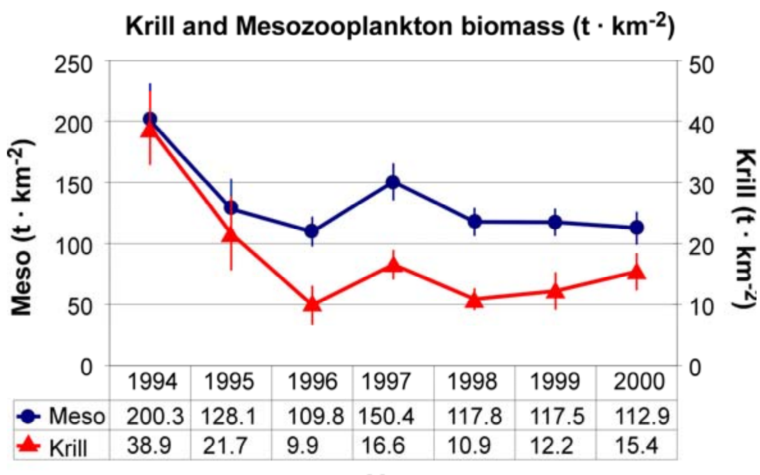

Fig. 17. Mean wet biomass of mesozooplankton and krill for the lower St. Lawrence Estuary from 1994 to 2000.

Data from the two AZMP fixed stations (Anticosti Gyre and Gaspé Current) indicateded that the mean integrated zooplankton biomass in the Anticosti Gyre and the Gaspé Current were slightly lower in 2000 than in 1999. As in 1999, total zooplankton biomass was much higher in the Anticosti Gyre than in the Gaspé Current for all seasons in 2000, largely due to the higher abundance of *Calanus hyperboreus*. Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 50% of the zooplankton community at all sampling dates at both stations. Small copepods (*Oithona similis*, Oncea *borealis*, *Microcalanus pusillis*, *Pseudocalanus* spp.) were dominant at all sampling dates in the Gaspé Current except in July, when larger species such as *Calanus finmarchicus* and *C. hyperboreus* were more abundant. On the other hand, *C. finmarchicus* and *C. hyperboreus* were dominant at all sampling dates in the Anticosti Gyre except in November, when smaller species were more abundant. Peak abundance of copepodite stages CI-CIII from the three most important copepods species occurred at the same time at the two stations, except for *C. finmarchicus* in the Gaspé Current, where two peaks of abundance of CI-CIII were observed: one in June and a second in November. The three species also reproduced at different times of the year at both stations: *Calanus hyperboreus* reproduced in early spring in both stations; *Calanus finmarchicus* reproduced in summer and fall in the Gaspé Current and only in summer in the Anticosti Gyre; and *Metridia longa* reproduced in September, October, and November at both stations.

The total zooplankton biomass varied between 6 and 305 g ww · m^{-2} along the six transects sampled in June and November 2000 in the Lower Estuary and the Gulf of St. Lawrence. The highest biomasses were found along the transects located over the Laurentian Channel (St. Lawrence Estuary, Mont-Louis, Anticosti, and Cabot Strait) and the lowest in the northern (Bonne Bay) and the southern (Magdalen Island) regions. The zooplankton biomass was higher in November than in June along all transects except at two stations of the Mont-Louis transect, where the inverse was true. Juvenile and adult copepods were clearly dominant along all sampled transects, accounting for more than 50% and 80% of the assemblage in June and November respectively. In June and November 2000, small copepod species (*Pseudocalanus* spp., *Microcalanus pusilis*, *Oncea borealis*, *Temora* spp., *Oithona* spp.) were more abundant than large species (*Calanus* spp.. *Metridia longa*) in all regions of the Lower Estuary and Gulf of St. Lawrence, except over the Laurentian Channel in June.

3.3.3 Scotian Shelf and the Magdalen Shallows (G. Harrison et al., D. Sameoto)

Spatial and temporal variability in selected chemical (NO_3, SiO_3, PO_4, O_2) and biological (chlorophyll, zooplankton biomass, phytoplankton and zooplankton species abundance and community structure) properties of Maritime region waters in 2000 were reviewed and compared with conditions in 1999 and long-term conditions where available. Results were presented from three fixed stations (HFX-2, P-5, Shediac Valley), seasonal sections (Spring & Fall; Browns Bank, Halifax Louisbourg and Cabot Strait lines) and the two major groundfish surveys (Summer - Scotian Shelf, Fall – Southern Gulf of St Lawrence). The major findings were:

- Near surface and bottom water nutrient concentrations on the Scotian Shelf in summer were similar to levels observed in 1999 but bottom water concentrations were somewhat higher in the east and lower in the west than historical levels. Near surface and bottom water nutrient concentrations in the Southern Gulf of St Lawrence in fall were higher in 2000 than in 1999.
- Spring nutrient concentrations in the upper water column (0-50m) of the Scotian Shelf were higher than concentrations in fall. Concentrations in 2000 were similar to levels observed in 1999 in spring but lower than 1999 levels in the fall.
- Nutrient cycles at the three AZMP fixed stations in 2000 showed similar seasonal patterns; near surface concentrations decreased in spring following winter maximum concentrations, remained low in summer and increased again in fall. Annual average nutrient concentrations, however, differed among the stations; concentrations were highest at P-5 and lowest at HFX-

2, differing by about a factor of two. Conditions at the fixed stations in 2000 were similar to 1999.

- Phytoplankton biomass (chlorophyll concentration) was spatially and temporally variable but concentrations were always higher in spring than in summer and fall. Both field sampling and satellite ocean colour imagery indicated that spring concentrations in 2000 were higher on the eastern Scotain Shelf than on the western Shelf. The seasonal phytoplankton cycles at the HFX-2 and Shediac Valley fixed stations were characterized by a single "bloom" in spring (April) and small biomass increase in fall. The phytoplankton bloom at P-5 occurred later (June), was more intense than at the other stations and was followed by a significant late summer bloom.
- Satellite ocean colour data indicated that the spring phytoplankton blooms in the Maritimes region occurred later in 2000 than in 1999 but were similar to the historical timing for the bloom.
- Analysis of community composition at the fixed stations showed that the blooms were dominated by diatoms whose relative contribution to the community decreased (as flagellates increased) through the summer/fall period.
- Zooplankton biomass was highly variable and no geographic or seasonal patterns in distribution were apparent except that levels were somewhat lower at the HFX-2 fixed station in 2000 than in the previous year. Peak biomass levels were observed in summer at the three fixed stations. Levels were highest at the Shediac Valley station, due in part to the presence of large cold-water *Calanus* species (*C. hyperboreus*, *C. glacialis*). Biomass levels were lowest on average at P-5. Overall, zooplankton biomass levels in 2000 were similar to 1999 levels.
- *Calanus finmarchicus* abundance peaked in spring on the Scotian Shelf and dominated the zooplankton biomass at that time. Reproduction started in the February/March period in 2000, almost a month later than in 1999. *C. finmarchicus* was a relatively less important component of the zooplankton at the other fixed stations, particularly P-5 where *Acartia spp*. (spring), *Centropages*, *Oithona* and *Pseudo/Paracalanus spp*. were dominant.

An update was presented on the processing and analysis of phytoplankton biomass (chlorophyll) and sea-surface temperature (SST) data collected at BIO from the satellite-mounted Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and the Advanced Very High Resolution Radiometer (AVHRR), respectively. Highlights of activities in 2000 included a major reprocessing of the SeaWiFS ocean colour data by NASA in the spring and the development of protocols for calculating primary productivity from the ocean colour data. Data products that are routinely produced now include:

- Bi-weekly composite images of SST, near surface chlorophyll concentrations and column-integrated daily primary productivity rates of the NW Atlantic
- Basic statistics (pixel count, mean, median, standard deviation, frequency distribution, etc) of SST, chlorophyll and productivity for 24 sub-regions (Hudson Strait to Georges Bank)
- Basic statistics of SST, chlorophyll and productivity for the six zonal Fixed-Stations (defined by 3x3 pixels area)
- Basic statistics of SST, chlorophyll and productivity for the 17 zonal sections (defined by 3 pixel swath)

A number of applications of the satellite data and current analyses, including a study of the temporal/spatial scales of variability (kms to NW Atlantic zone) were described. Ocean colour data documented an intense spring phytoplankton bloom on the eastern Scotian Shelf in 2000 and confirmed conclusions drawn from AZMP survey results that the timing of the spring bloom was generally later and of smaller in magnitude in most regions of the NW Atlantic in 2000 than in 1999.

Temporal and geographic variation in phytoplankton and *Calanus finmarchicus* abundance were described based on Continuous Plankton Recorder (CPR) data for the 1961-1999 period. Phytoplankton abundance on the Scotian Shelf was higher in the 1990s than in the 1960s and early 1970s. In contrast, *Calanus finmarchicus* abundance has been lower than the historical mean since the mid-1990s. There were close similarities in abundance trends for *C. finmarchicus* between the western North Atlantic, Scotian Shelf and Gulf of Maine. Therefore, it may be possible to use Gulf of Maine data to fill in missing years (1977 to 1990) of data on the Scotian shelf. These analyses plus net sample data from the Scotian Shelf suggested that this period, between 1977 and 1990, was one of high abundance of *C. finmarchicus* on the Scotian Shelf and the decline in numbers on the shelf in the late 1990s was greater than the incomplete CPR data series suggested. The seasonality of *C. finmarchicus* stages 1 - 4 on the western north Atlantic, Scotian Shelf and the Gulf of Maine were distinctly different. The Atlantic population showed a seasonal peak in July, the Scotian Shelf and Gulf of Maine populations had a peak between May and June. These data suggest that *C. finmarchicus* populations in the three regions had different reproductive patterns with the Gulf population showing a much higher level of abundance than the other regions. This in turn may account for the significantly higher abundance of *C. finmarchicus* in the Gulf of Maine compared to the Scotian Shelf.

3.3.4 Questions and Discussion

Newfoundland/Southern Labrador: The occurrence of high nutrient concentrations in summer in deep layers in 2000 but not in 1999 and the cause of increased nauplii abundance in 2000 were discussed. T,S properties of the deep layer were not examined but will be in the future to attempt to disinguish between local production versus advection. The increased nauplii abundance in 2000 may be related to higher survival or greater reproductive effort. This issue may be resolved through modeling, although it was noted that late stage abundance (nauplii and copepodid) was also higher in 2000. The change in mesh size in the pelagic surveys was also discussed. This change complicates interpretation of the results of the survey, since smaller animals were "under-sampled" in the earlier years when coarser mesh nets were used. Comparative gear trials could allow for adjustment fo the earlier data. However, it was also pointed out that between 1991-1994 all components of the zooplankton were low, both large and small. It was noted that Calfin 1-4 and 5-6 increased recently on the Z-line of the CPR route. Finally, log transformation of the data was recommended for statistical analyses.

Gulf of St. Lawrence: The absence of a spring bloom off Rimouski in 2000 was discussed. It was suggested that both ice conditions and the hydrographic properties of the water column be closely examined for a possible explanation. The occurrence of a new species at the Rimouski station was noted – a toxic dinoflagellate apparently originating from the inner GSL.

The spawning pattern of *Calanus finmarchicus* was discussed: why was it bimodal in the Gaspé Current but unimodal in the Anticosti Gyre? The cause of this difference was not known.

Why was zooplankton abundance relatively low in the Southern Gulf compared to other areas? This result may be due to shallower depths in this area and the expression of the data in abundance per meter squared.

Scotian Shelf and Magdalen Shallows: A question was asked regarding physical stratification and whether or not this broke down in the autumn, based on observations of the monitoring program? The answer was not immediately available, based on analyses to date.

For the calculation of anomalies, it was asked how much data were available? The amount of data available varies among the regions surveyed. For the Scotian Shelf there is in excess 40,000 observations spanning the period 1974-2000. However, these data are primarily for the shelf area off Halifax. There is much less data available on the Eastern Scotian Shelf and in the Southern Gulf.

It was asked whether vertical stratification differed between the fixed monitoring stations. Differences were noted but there were uncertainties about the importance of advection in these differences.

The suitability of the fixed station locations was discussed. It was noted that inter-annual de-correlation scales were relatively high compared to within year spatial de-correlation scales. This means that it is important to first identify the time period over which comparisons are going to be made before proceeding to examine the degree of spatial representativeness.

General Discussion on the Biological Overviews

Pierre Pepin began by providing the following summary of the overviews. Nutrients were higher in 2000 compared to 1999 in Newfoundland waters and at the fixed station off Rimouski in the Gulf of St. Lawrence. Nutrients were lower during 2000 in the Maritimes region and in the surface layers of the Gulf. There was an apparent injection of nutrients in the deep waters at Halifax Station 2 through upwelling and at Station 27 in Newfoundland. Nutrient levels in 2000 were comparable to the long-term means although there was a slight increase in Newfoundland waters towards the end of the year. Chlorophyll-a blooms in all regions in spring were less extensive during 2000 compared to 1999 and there was no fall bloom in contrast to 1999. Zooplankton tended to increase during 2000 from 1999 levels. The increase was mainly in the smaller species as the larger species such as *Calanus finmarchicus* were more consistent with 1999 levels.

Glen Harrison noted that in the Maritimes, biomass levels of zooplankton from surveys and fixed stations were similar in the 2 years. The biggest difference in *Calanus finmarchicus* was that the reproductive cycle began later in 2000. Community composition, abundance and distribution of zooplankton were roughly similar between the years, however. Michel Harvey stated that there was slightly lower zooplankton biomass in 2000 in the Gulf compared to 1999. Pierre Pepin noted that the number of nauplii was up compared to the adults.

The causes of variations in upper layer nutrient levels in the Gulf of St. Lawrence were discussed. It was suggested that they were due to the changes in the amount of ice cover. This was because it is believed that ice formation leads to increased vertical mixing due to brine rejection. In the winter of 2000 it was suggested that there was not as much ice, hence less mixing and lower nutrient levels. However, as others pointed out, less ice means more open water and hence greater wind mixing in these areas. The relative importance of the two processes was not clear. Glen Harrison noted that the amount of nutrients in the water at the end of winter would affect the intensity of the bloom but not its timing. Jean-Claude Therriault stated that based upon his research the timing of the chlorophyll-a bloom was related to the timing of the freshwater runoff and the amount of seed cells available. These seed cells may have been overwintering in the sediments or within the water column.

Stratification is known to affect both nutrient levels and chlorophyll-a abundance. Glen Harrison remarked that in the Maritimes they have not examined stratification systematically at the fixed stations but will for next year. Glen asked if we can refine the stratification index and come up with an agreed upon definition that could be applied throughout the zone. The FOC agreed this should be done. Those involved in the analysis of the physical oceanographic data were given this responsibility. Pierre Pepin also felt we needed operational criteria for the depth of the mixed layer, the depth of the nutricline, the euphotic depth, and some measure of the nutrient gradient. Glen Harrison indicated that researchers in remote sensing are promising estimates of the euphotic depth and integrated chlorophyll-a in the near future but these will need to be validated once they become available. Glen agreed to put together relevant publications and web sites on how the satellite calculations on primary production and other variables are made and will distribute them to those who are interested.

Glen Harrison also brought up the need for sea surface irradiance data. These can be obtained from satellite and bi-weekly irradiance data should be available within a year or so from Trevor Platt's group at BIO. These will not work in the St. Lawrence Estuary, however. Glen noted that irradiance measurements are routinely made on board ship in the Maritimes Region but the data are needed on a continuous basis. Data are collected on Sable Island by Environment Canada (EC). This should be representative of the Scotian Shelf. Gary Maillet indicated that there are no data for Newfoundland. The sensor at the St. John's airport is not working and has not been replaced to his knowledge. Jean-Claude Therriault thought that there should be enough irradiance data within the Zone. He felt stratification was much more important than irradiance in controlling nutrient levels and the biology. Glen still felt that it is important to know whether there are large year-to-year differences in irradiance or not. Alain Vezina said that from their modelling work, which dealt with monthly averages, that there was not much difference in irradiance at the sea surface at interannual time scales. Also, the models suggest there is enough light around for blooms to begin at the first of the year. These same models indicate that stratification and advection are more important in controlling the timing of the spring bloom. However, Alain noted that these 1-D models have not been able to reproduce the observations on the Scotian Shelf. Because the models used to date have been one-dimensional, this lack of agreement may be due to neglect of advection. Ken Drinkwater noted that this was consistent with heat flux models, which required advection in order to recreate the seasonal changes in the heat content of the water.

Pierre Pepin noted the need for modelling along with data collection. Models are required to interpret the mechanisms responsible for the observed variability in nutrients, chlorophyll and zooplankton. Alain Vezina agreed and stated the importance of nonlinearities in the system making it difficult to predict *a priori* what the response will be to changes in almost any variable. Modellers presently are working on the Scotian Shelf and Station 27. They need the data AZMP is collecting in order to test their models. Future modelling work may require financial support, however. Pierre stressed the need for the observationalists and modellers to work together, not just for the observationalists to provide data to the modellers.

Glen Harrison reiterated the need for water optics. While measurements are taken at sea, it was noted that at Station Halifax 2, 21 out of the 24 occupations were at night and so no secchi depths or light measurements were available. It was further noted that there is no continuous record of incident irradiance taken at BIO although measurements are taken by EC at the Halifax Citadel that could be applied for Station H2. No one records light at Newfoundland and in general it was felt that the Maritimes was not well covered. Savi Narayanan reported that John Davis of DFO and David Grimes, his equivalent at EC, had recently met to discuss increasing cooperation. Thus it may be a good time for the FOC or AZMP to request help in obtaining irradiance data. John Davis should be alerted to such a request. It was also reported that EC will be making all meteorological data for operational and research purposes available free of charge.

Given that the seasonal and interannual variation in incident radiation is an important variable that potentially influences the timing and magnitude of the phytoplankton production cycle and that there are currently few continuous measurements of this variable across the Atlantic zone, the FOC *recommends that EC be requested to collect continuous irradiance measurements in proximity to the AZMP fixed stations and, if possible, to establish additional sites over the Atlantic Zone in order to characterize the general seasonal and interannual changes in irradiance.*

The discussion turned to why chlorophyll-a biomass in 2000 was so low throughout the Zone. Grazing by zooplankton was suggested as possibly a controlling factor. Pierre Pepin reiterated the need for models to explore possible hypotheses related to this question. Jean-Claude expressed concern because measurements of primary production are generally not being made by AZMP. He felt that these should be undertaken at the fixed stations. Glen Harrison felt that because production parameters do not change greatly over time, estimates of primary production could be made using these parameters and fluorescence data. This would eliminate the need to make production measurements on a routine basis, which if required would add to the workload and the costs of the program. Such production estimates could also fill in the gaps for those sites where measurements have been made or will be taken. At present, attempts are being made to build a bank of optical properties for the Gulf of St. Lawrence and these could be used in estimating primary production there.

It was noted that total production is not as useful for fisheries as the amount of new production. This is because a large percentage of the total production is simply recycled and hence would not be available for higher levels of the food web. Glen Harrison noted that at H2 they are attempting to determine the amount of new production. Total primary production simply sets an upper limit for the amount of available food.

Erica Head suggested that examining the number of nauplii per adult copepod would not be a useful index. Survival is more important than egg production and egg production rates do not change much. Estimating egg production is costly both in terms of time and money. Regarding survival, one of the important aspects is predation. Thus looking at numbers of nauplii at each stage may not be very useful. Pierre Pepin agreed and indicated the need to look at fluxes and the production cycle of zooplankton. He felt that again a model was needed for this.

3.4 ***Recruitment Trends***

In order to promote work on the link between variation in oceanographic conditions and fish production, it was decided at the AZMP meeting in December 2000 that overviews of recruitment trends for marine fish and invertebrates should be presented at the annual FOC meeting. This was initiated for the March 2001meeting.

3.4.1 Newfoundland/Southern Labrador (J. Anderson et al.)

An inventory of recruitment data was prepared for stocks in the Newfoundland Region. Currently, there are 24 species, or species groups, assessed within the Newfoundland Region and approximately 39 stocks for which status evaluations are done (Table 1). Here we have lumped some assessments together as a single evaluation. For example, White Hake is a single category where status is assessed for Divisions 3L, 3N, 3O and 3Ps which may represent different stocks. The information we required from assessment staff was a brief written summary addressing three questions:

1. What indices are available, both currently and historically?
2. Are all indices readily available in electronic format?
3. Are there any conditions that must be specifically addressed in using or interpreting any individual index?

3.4.2 Southern Gulf of St. Lawrence (D. Swain et al.)

Three measures of recruitment were discussed: recruitment *R* (the number of individuals at a particular early age), recruitment rate (*R*/SSB, the number of recruits divided by the spawning stock biomass that produced them), and residuals from a stock-recruit relationship. It was argued that recruitment rate or residuals from a stock-recruit relationship were the more apporpriate measures for investigations of environmental effects on recruitment. Variation in recruitment can reflect variation in the level of SSB, whereas variation in the latter measures reflects variation in survival rates of early life history stages (or variation in the quality of the spawning biomass). Environmental effects on recruitment are most likely to occur as a result of effects on early survival rates.

Recruitment rate can be estimated directly from research survey catch rates or can be based on results of sequential population analyses (SPA). The latter can depend strongly on model assumptions. Recent estimates based on SPA can also change dramatically as additional years of data are included in analyses. An example for southern Gulf cod was given.

Recruitment time series were presented for southern Gulf cod, American plaice, white hake, herring and snow crab. Cod recruitment was below average in the 1990s but recruitment rate was above average. Recruitment was low and recruitment rate low to average for American plaice in the 1990s. Both recruitment and recruitment rate increased to high levels in the late 1990s for white hake. Recruitment has been above average since the mid 1990s for fall-spawning herring but below average for spring-spawning herring. Abundance of R3 snow crab (crab that will contribute to recruitment in 3 yr) appeared to be low in the mid-1990s but high in 1999 and 2000.

Recruitment rate appeared to be unusually high for a number of fishes in the southern Gulf in the late 1970s and early 1980s (Fig. 18). This period of high recruitment rate coincided with the collapse of the dominant pelagic fish populations in the southern Gulf (herring and mackerel). One hypothesis for the unusually high recruitment rates during this period is that they reflect reduced predation by pelagic fishes on eggs and larvae.

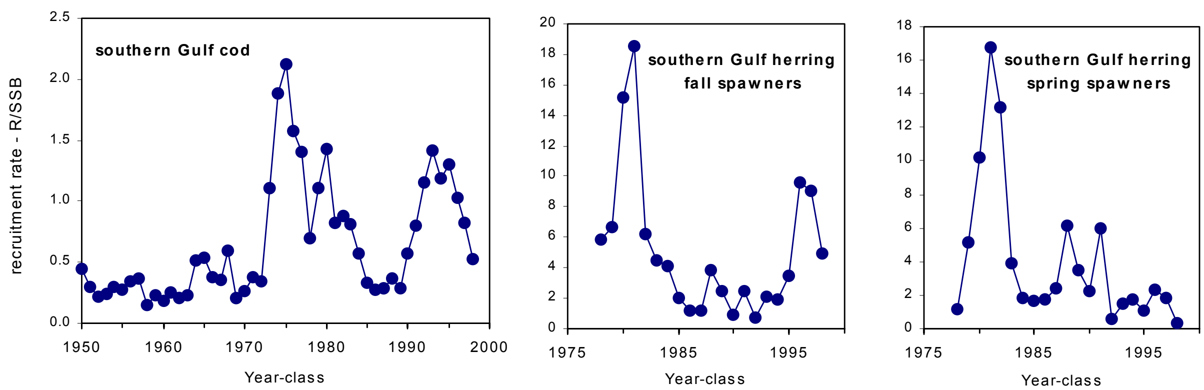

Fig. 18 Recruitment rates of southern Gulf of St. Lawrence cod and herring, based on SPA.

Recruitment rate often decreases at high SSB due to compensatory (density-dependent) mechanisms. All three groundfish species examined and both herring spawning components showed this tendency. In these cases, the best approach for testing possible environmental effects on recruitment would be to examine relationships with residuals from the stock-recruit relationship, or to include the potential explanatory variabels as covaiates in this relationship.

3.4.3 Scotian Shelf and Gulf of Maine (K. Frank)

The list of stocks assessed in the Maritime Provinces by RAP is extensive including about 30 groundfish stocks, 10 pelagic stocks, 22 diadromous stocks, and 70 invertebrate stocks. Stock Status Reports (SSRs) and Research Documents are now more readily available than at any time in the past through the Canadian Stock Assessment Secretariat (CSAS) web site (www.dfo-mpo.gc.ca/csas/). The quantity of information for each stock is quite variable -- some stocks are well surveyed and researched while others are not and the information is piecemeal. Recruitment indices do not exist for the majority of these stocks. However, on a geographical basis – nearly all of the groundfish, pelagic and invertebrate stocks on Georges Bank have surveys, age information, and research projects associated with their assessments. From a species perspective – traditional groundfish stocks (cod, haddock, pollock, silver hake and some flatfish stocks), herring, and a few invertebrate stocks have been the best studied. There are many reasons for the lack of recruitment data such as limited or no data (e.g. no RV surveys), and lack of age information (this includes most flatfish, several minor groundfish stocks and most invertebrate stocks). Sometimes recruitment data is available but it is not reliable due to lack of knowledge about stock structure or life history patterns of the species.

For those stocks that have recruitment indices, the data may not accurately reflect the production patterns or the estimates may be highly uncertain. For example, among the best studied stocks Unit 3 redfish is slow growing and difficult to age making it difficult to isolate year-classes; 4VWX5Zc Pollock is a semi-pelagic species that is difficult to monitor using standard trawl survey techniques. Also, 0-group pollock inhabit nearshore waters outside the survey area. 4Vn Cod is problematic because mixing with adjacent stocks is known to occur and it has not been quantified. Finally, several recruitment time series exist for 4VsW cod because of different VPA formulations and it can be difficult to decide which estimates to use.

In the late 1990s good year-classes of haddock appeared throughout its range of distribution in the NW Atlantic. Because this time period is coincident with AZMP and GLOBEC reasonably good descriptions of environmental conditions exist. A good 1998 year-class was evident from Georges Bank, Scotian Shelf and possibly extending to the southern Grand Banks. The 1999 year-class on the eastern Scotian Shelf was extraordinarily large. Early indications are that the 2000 year-class is good in this region, in direct contrast to the very low recruitment for cod

In conclusion, there is a much easier access to recruitment data compared to the past. Although RAP assesses > 100 commercial stocks, the number of stocks with recruitment estimates is far fewer. When recruitment estimates do exist they may need to be used with caution (best to consult author). Systematic examination of survey data for non-commercial species could result in a broader base of species with recruitment estimates. Initiating ageing of more commercial species and possibly some non-commercial species (i.e. to develop a growth model) could yield more recruitment time series. Surveys that yield collections of 0-group could be aged to estimate birth dates (useful as proxy for spawning time).

3.4.4 Questions and Discussion

Reliability of the recruitment estimates was discussed. What are the confidence levels on the estimates? How large a difference is required to detect true change? It was indicated that this varied between stocks, with quite reliable annual estimates for some stocks and very imprecise estimates for others.

The loss of recruitment indices for some stocks (e.g. capelin) due to the cancellation of survey was discussed. Commercial data were suggested as a potential source of indices but it was argued that these were unreliable for stocks like capelin in the Newfoundland Region.

The strong haddock recruitment in the late 1990s was discussed. It was noted that this coincided with increases in ocean temperature and strong year-classes of some other species such as scallop.

The utility of the Scotia-Fundy MFD virtual data centre (VDC) for assembling recruitment indices was emphasized. It was noted that efforts are under way to establish an Atlantic-wide database similar to the VDC. The possibility of establishing and maintaining a database on recruitment was discussed.

The request by AZMP for annual recruitment over views was discussed. This was seen as a first step in efforts to establish links between oceanographic conditions and recruitment variability.

These discussions led to two recommendations:

1) It was recommended that the Recruitment indices should be presented annually at FOC.

2) It was recommended that a scorecard on recruitment indices should be developed.

4. General environmental Session

Each year the FOC receives several papers that are not directly related to the annual environmental overviews or the major theme session. This year the committee reviewed a record number of presentations in this category. Most of the these papers were reports on research and development work related to the Atlantic Zonal Monitoring Program (AZMP).

F. Page presented papers on the analysis of plankton community structure. As part of a regional toxic phytoplankton monitoring program, phytoplankton has been monitored since 1988 at a fixed station near the Wolves Islands in the western Bay of Fundy. Samples have been collected at four depths (0, 10, 25 and 50m) at weekly to monthly intervals using water-sampling bottles. These data have been explored from several perspectives, including that of the annual timing of phytoplankton blooms. These analyses have used aggregate groups of dinoflagellates and diatoms. Cell counts were aggregated from all depths and taxonomic units within each group for each sample date. Cumulative cell counts were calculated within each year beginning in January of each year. Each sum was divided by the annual total and plotted against the day of year. These cumulative curves indicated that the annual increase in diatom abundance began around day 110, reached 50% of its annual total between days 150 and 250 and had returned to background levels by about day 275. The spread in the median day was due largely to an early increase of diatoms in 1991 relative to the other years. The median day for the remaining 11 years ranged between about days 200 and 250. The cumulative curves for dinoflagellates indicated the annual increase began around day 150 or about 40 days later than for diatoms. The range in the median day for dinoflagellates was much narrower than for diatoms and ranged between about days 210 and 230 for most years. In 1998 the dinoflagelatte cycle appeared to be early with 50% of the cells counted occurring by about day 180. A comparison of the cumulative curves for diatoms and dinoflagellates within each year suggests that in some years (1988, 1994, 1995, 1998 and 1999) the dinoflagellate cycle precedes that of the diatoms whereas in other years (1989, 1991, 1992, 1993) the diatom bloom procedes the dinoflagellate bloom. This type of analysis was also conducted for an inshore station located within Lime Kiln Bay in the western Bay of Fundy. This station is in the heart of the local salmon aquaculture industry. In the future there are plans to further refine and quality control our database and explore the temporal and spatial variability in the patterns more fully. For example, statistical methods will be applied to comparisons of the cumulative curves between years and locations, to detecting significant time patterns in inter-annual variability, for detecting patterns in community structure and for exploring potential associations between the species abundance and environmental patterns.

F. Page presented papers on vertical coherence in the abundance of plankton at station 16 in the Bay of Fundy. At a recent AZMP meeting it was suggested that taking plankton samples at a single depth, specifically 10m below the surface, would be a practical approach for monitoring plankton at fixed stations. It was also recognised that it would be useful to analyse some existing data sets that contain information from several depths to determine if information from 10m is representative of a broader depth range. Fortunately, plankton has been monitored on a weekly to monthly basis for a 12 year period (1988-1999) at an offshore phytoplankton monitoring station within the Bay of Fundy. During each visit to the station water bottle samples have been taken from four depths (0, 10, 25 and 50m). Species specific plankton cell counts (cells/L) were determined from sub-samples of each bottle. To help address the issue of how representative a 10m sample is of other depths within the water column, preliminary analysis focused on comparing the time series of abundance of three major plankton groupings (dinoflagellates, diatoms, and zooplankton) at four different depths. The 1988 to 1999 monthly mean cell counts of total diatoms, dinoflagellates and small zooplankton were determined for each depth. The cell counts for all three organism categories show a seasonal cycle. The dinoflagellates begin to increase in abundance in April. Their abundance peaks in July or August and decreases until December. The amplitude of the peak decreases with depth. The diatoms begin to increase in abundance in April and begin to decrease in September. The cell counts peak in May-June and August-September. The amplitude of this annual pattern is similar at the 0, 10 and 25m sampling depths but lower at the 50m sampling depth. The zooplankton begin to increase in abundance in May, peak in July and decrease throughout August to December. The amplitude of the annual zooplankton pattern decreases with sampling depth. The time series of monthly deviations from the long-term monthly means are serially uncorrelated. The zero lag correlations between the four depths range from -0.04 and 0.37 for dinoflagellates, 0.50 and 0.80 for diatoms and 0.02 to 0.22 for zooplankton.

A second analysis focused on comparing the time series of the presence and absence of each plankton taxa at the four different depths. The presence (P) and absence (A) data were used to estimate the degree of agreement and disagreement between the 10m, 0m and 0+25+50m time series for each organism type. Agreement was measured as the combination of pairwise mutual matches (PP+AA) and disagreement as mutual mismatches (PA+AP). In these comparisons the pairs consisted of samples taken at the same time from the two depth categories being compared. The level of agreement ranged from 41 to 100%. The level of minimum agreement decreased with increases in the depth separation, and increased as organisms became less prevalent in the sample series because of an increase in the number of mutual absences. Several organisms that were found at one depth were not found at all at the comparison depth. In an effort to remove the influence of mutual absences on the comparisons between depths, the number of mutual presences (PP) as a proportion of the total number of presences at 10m was also calculated for each organism type. These proportions ranged from 0 to 100% and were independent of the prevalence of the organism and of the depth combinations used in the comparisons. The analyses suggest that samples obtained in this way from one depth are not indicative of the presence or absence of organisms at other depths. Further analyses of the data are planned to explore the robustness of this finding.

F. Page presented a paper on preliminary efforts to estimate bio-volumes for selected species of phytoplankton from the Bay of Fundy. As part of the Toxic Phytoplankton Monitoring Program (TPM) and the AZMP, phytoplankton species composition and abundance, in the form of cell counts, are monitored at a series of fixed stations distributed throughout Atlantic Canada. This type of information is useful for determining integrated indices of bio-diversity as well as time trends in species-specific abundance. However, it has limited value for considerations of rate processes, such as total phytoplankton nutrient uptake or the relative demand for nutrients by one species, since these considerations are based more closely on the biomass of the organisms. Hence, it has often been suggested that cell counts be multiplied by the average cell volume for each species to obtain an estimate of phytoplankton biomass. Cell volume is commonly calculated by assigning a geometric shape to a species, then measuring a representative sample of the organisms along the appropriate dimensions. Since there have been no previous efforts to estimate the bio-volume of phytoplankton cells from Bay of Fundy region, a pilot study was initiated to provide some familiarity with the issues and practicalities associated with estimating the bio-volume of the local phytoplankters and to assess whether acquiring size information would be practical and of some value. Seven phytoplankton species, commonly found in the Bay of Fundy, were therefore selected and measured for bio-volume estimation. The species examined to date include the diatoms *Eucampia zodiacus, Guinardia delicatula*, *G. flaccida, Leptocylindrus danicus*, *Pseudo-nitzschia delicatissima* group and *Skeletonema costatum*, the dinoflagellate *Ceratium lineatum,* the silicoflagellate *Dictyocha speculum*, the tintinnid *Helicostomella* spp., and the ciliate *Mesodinium rubrum.* The *P. delicatissima* group refers to a number of different species that are difficult to differentiate without the use of an electron microscope because of their small size in width (1.5-2.0 µm). Volumes could only be estimated for 7 of the 10 species. All of the necessary dimensions could not be measured in the dinoflagellate *C. lineatum*, and the diatoms *E. zodiacus* and the *P. delicatissima* group. It is hoped that additional species will be measured in the future. Fifty cells for each species were measured. The mean, median, standard deviation and standard error of each measurement type and the associated volume estimate was calculated. The mean volumes varied by a factor of over 200x and ranged from 367 μm^3 to 84,660 μm^3. The ratio of the standard error to the mean ranged from 1.97 to 10.85. In four out of the seven species successfully measured, estimates of the mean and median volumes stabilised after 30 - 50 cells had been measured. The standard error did not stabilised after 50 cells in any of the species. The experience gained from this pilot study suggests that with the use of light and scanning electron microscopy it may be feasible to estimate the bio-volume of many of the important phytoplankton species found in the Bay of Fundy.

E. Head presented data from a time-series station, showing that the dominant and ecologically significant Scotian Shelf copepod, *Calanus finmarchicus*, has an annual life cycle in the waters off Halifax (at Station 2). In 2000, young copepodite stages started to appear in April, when the spring phytoplankton bloom was occurring and late stages left the surface layers to overwinter at depth by the end of August. Shelf-wide abundances of *C. finmarchicus* in April 1998, 1999 and 2000 were generally high in the areas affected by intrusions of warm offshore water (mid- and outer central and western shelf regions) and low in areas affected by the cold outflow from the Gulf of St. Lawrence. Stage compositions, combined with temperature dependent development rates, were used to estimate the timing of the onset of reproduction in different regions. In each year reproduction started earlier on the central and western shelf than on the eastern shelf and it started 2-4 weeks earlier in 1999 than in 1998 or 2000. *C. finmarchicus* eggs, naupliar and copepodite stages are important food sources for larval and juvenile groundfish and their timely presence in the spawning grounds is a pre-requisite for survival in a given year. In each of the three years there was good survival of larval haddock through to settled juveniles on Western and Browns Banks, and in each of the three years *C. finmarchicus* offspring would have been present at the same time as larval haddock. In 1999, haddock survival was especially high and reproduction of *C. finmarchicus* occurred unusually early, but whether these events are linked remains unclear.

M. Harvey presented a paper on interannual variability of the krill standing stock biomass in the Lower St. Lawrence Estuary and its impact on fin whales dispersion. An annual zooplankton survey was initiated in 1994 to study the spatio-temporal variability of zooplankton biomass in the lower St. Lawrence Estuary (LSLE). This survey is conducted in September at up to 48 stations along 8 transects. Systematic whale observations were made from commercial whale-watching vessels at the head the Laurentian Channel from June to September 1994 to 2000. The average number of fin whales per sighting - within 2000 m radius - was used as an annual index of whale dispersion. The krill standing stock biomass was not evenly distributed within the LSLE and showed high interannual variability. The estimated average wet biomass of krill varied between 7.2 and 38.1 $t \cdot km^{-2}$ from 1994 to 1999 with the highest and the lowest values found in 1994 and 1996 respectively. The decrease in standing stock biomass observed in 1996, corresponded to a change in the community structure of macrozooplankton characterized by a large decrease in the total abundance of the euphausiids (300 to 50 ind. $\cdot m^{-2}$) and an increase in the abundance of the mysids (20 to 70 ind. $\cdot m^{-2}$). The interannual variability of the krill standing stock biomass explains 96% of the interannual fin whale dispersion index. This highly significant relationship suggests that krill biomass in the LSLE influences fin whale aggregation behavior at the head of the Laurentian Channel. The authors hypothesize that fin whales move to the head of the Laurentian Channel to feed on capelin schools (*Mallotus villosus*) when krill biomass is low while they disperse throughout the Estuary in years when krill biomass is high. This hypothesis will be tested in collaboration with Dr. Véronique Lesage (Fish and Marine Mammals Division, IML), who will use stable isotope analysis on fin whale skin and fat samples to identify the trophic level (fish or invertebrates) on which the whales mostly fed during each summer since 1994.

J. Plourde made a presentation on hindcasting of ice-ocean conditions in the Gulf of St. Lawrence using the MLI regional ocean model. Discussion after the presentation focussed on whether AZMP should consider monitoring in key areas that are useful to circulation modelers. For example, there appears to be a desire for increased monitoring of the flows and hydrographic conditions in Cabot Strait and the Strait of Belle Isle. It was mentioned that it is not a simple effort to instrument Cabot Strait in a useful manner. It was also suggested that sea level data for the Strait of Belle Isle might be useful and more feasible that current moorings. It was also suggested that perhaps the Cabot Strait Ferry could be instrumented. It was recognized that this was a good idea, although the effort would result in surface data only.

J. Craig presented preliminary studies of density stratification and fluorescence on the Newfoundland Shelf. Annual cycles of stratification index that were calculated from monthly means and harmonic regression of data in the standard reference period were very similar in phase and amplitude. The optimal number harmonics for the regression of the 1961-1990 data was 4. An increasing trend was observed in the amplitude of the annual signal of the stratification index and stratification anomaly for the past decade. Alternate methods of calculating stratification from density profiles were investigated. Numerical differentiation gave consistent results but required treatment of the data before and after differentiation to yield a clearly defined maximum in gradient. Fitting a function to the data eliminated the need for an arbitrarily selected smoothing routine and gave a uniquely defined maximum gradient and corresponding depth. The maximum gradient method appeared to be sensitive to small-scale processes in the water column and yielded values with greater variability than the stratification index during the winter. The annual signal in stratification arises from changes in the salinity and temperature of the surface water. Summer stratification indices are increased by a phase lag in the seasonal density cycle at 50 metres. Reduced salinity of the surface water appears to be driving the increase in the stratification index over the past decade. A spring bloom precedes the onset of stratification at station 27. Higher levels of fluorescence were seen with lower levels of stratification, which decreased with distance from the coast.

G. Maillet presented a paper on investigations of the seasonal relationship of *in-situ* chlorophyll a fluorescence to chlorophyll a concentration in the Northwest Atlantic. The ability to estimate chlorophyll a concentration based on *in-situ* chlorophyll a fluorescence profile data will allow reconstruction of reliable time series and greatly expand spatial and temporal information on phytoplankton biomass in this region. Preliminary seasonal algorithms have been developed for Station 27 and the standard oceanographic transect surveys. Overall, the algorithms developed in this region reiterate the need to consider other parameters such as irradiance, temperature, macro-nutrients, and phytoplankton assembledge on fluorescence yields. The newly-developed algorithms will be refined and used in future studies to determine the reliability of chlorophyll a estimates derived from *in-situ* chlorophyll a fluorescence.

D. Caissie made a presentation on long-term hydrologic conditions in the Miramichi River and the potential implication of climate change to aquatic resources. Mean annual air temperature is projected to increase from 2°C to 6°C in the Maritime Provinces in the next 100 years. Such an increase in air temperature will ultimately result in increased river water temperatures, alteration to the steamflow regime and potential changes in fish habitat conditions. This study looked at current long-term trends in hydrometeorological data in the Miramichi River including long-term trends in fish condition, i.e. at-age fork length (FL) of juvenile Atlantic salmon. Data on river discharge, air and water temperatures were obtained from two river systems within the Miramichi basin, the Northwest (NW) and the Southwest (SW) Miramichi rivers. Biological data were also obtained from a number of sites (> 13 sites in SW; > 22 sites in NW) within these two river systems from 1970-1999. In order to extend the river water temperatures time series between 1970-1999 in the two river systems, to correspond to the biological data, a stochastic water temperature model was used. This stochastic model considered the water temperature time series in two components, the annual component (long-term) and the short-term residuals (departure from long-term). The short-term residuals in water temperatures were then linked to short-term residuals in air temperature using regression analysis, and the water temperature time series were simulated. Using existing water temperature data (1992-99), the model's performance was calculated at 0.76 °C, using the root-mean-square error. Long-term trends were studied with the simulated water temperatures. A significant increase in mean annual air temperatures occurred in both river systems. The Northwest Miramichi River showed an increase of 0.42°C per decade while the Southwest Miramichi showed an increase of 0.24°C. No significant increases in river water temperatures were observed in the Miramichi rivers. When studying the timing of the spring peak flows in the Miramichi, both the Northwest and the Southwest Miramichi rivers showed significant and earlier spring peaks of 5-6 days per decades. Low flows in the Miramichi River also showed a decreasing trend for both the Northwest and Southwest Miramichi rivers. When looking at the fork length (FL) of juvenile Atlantic salmon over the past 30 years, significant decreasing trends were observed for 1^+ and 2^+ parr, where salmon fry (0^+) showed no significant trends. These decreasing trends in FL were also linked to environmental condition. Increases in mean annual air temperatures as well as mean spring water temperatures were related to decreasing trends of at-age size of juvenile Atlantic salmon. Although the mechanisms relating environmental conditions to decreasing size-at-age of fish is not fully understood, it is believed that a warmer climate is resulting in more stressful days for fish (high temperatures) during the summer months.

A. Vézina and G. Evans made a presentation on modelling pelagic ecosystems. They presented results from ecosystem modelling analyses of open ocean and shelf ecosystems that bear lessons for future model-based interpretations of AZMP data. An attempt to estimate parameters of a standard biological model using data from a short time series at a fixed station (NABE) showed that critical parameters were well constrained by the data. This allows some optimism that local time series can be useful to extrapolate model parameters to larger scales, bearing in mind that some parameterization issues remain unresolved for now. Parameter estimation is also useful to derive fluxes among biological components, as illustrated by an example of fitting a data series collected in Bonne Bay on the western coast of Newfoundland. Another study at an ocean station in the eastern Atlantic (EUMELI) indicated that the timing of the observations is critical. The cruises during that program were not conducted at the most informative times, making it difficult to properly resolve model dynamics.

They also presented results from a preliminary modelling study of weather-driven biological productivity on the Scotian shelf. A physical-ecosystem model was driven over 20 years (1976-1995) by the meteorological forcing reconstructed from (National Center for Environmental Prediction) NCEP re-analyses. Despite strong interannual variations in the timing of the spring bloom, both new and total production were remarkably insensitive to year-to-year variations in weather patterns (e.g. cold vs warm winters). The sensitivity of simulated production and timing of the spring bloom to model parameters was examined. The simulated spring bloom timing was much less sensitive to model parameters than to forcing variability, indicating good potential to resolve these timings events using this modelling approach. On the other hand, integral fluxes such as production tended to be more sensitive to model parameters than to forcing variability. Therefore, more work is required to make the model more robust to parameter ucertainty.

One conclusion from this presentation is that as AZMP identified the specific questions it wants to address, physical-biological modelling can help to design sampling strategies and to evaluate their success in meeting stated objectives. The models should also be viewed as 'intelligent' interpolators of sparse data that can provide more information than is contained in the data alone. Modellers are also likely to benefit by using the data to improve their models.

J. Anderson presented a paper on modelling pelagic ecosystems in the Northwest Atlantic. He suggested that the primary scientific question to ask in the context of managing marine ecosystems is whether or not the ocean's carrying capacity is changing over time. When it does, then multiple states will exist within fish populations that require different realizations of their ability to produce young and to withstand fishing mortality. To detect change it will be necessary to establish long term observational programs (LTOP) monitoring key components of marine ecosystems. The most significant components will be in the species compositions of the higher trophic levels and the relevant scales of study will be regional, rather than global or local. A fundamental question is whether changing productive capacity is driven by top down control by predators or bottom up production by plankton. Pelagic fish sit at the centre of the marine ecosystem in Newfoundland, as a primary consumer of secondary production and as the primary prey for piscivores, mammals and seabirds. Pelagic juvenile 0-group fish are an important, and ephemeral, component of the pelagic ecosystem. Year-class strength typically is established by the pelagic juvenile stage. Monitoring the abundance of pelagic fish and other components of the nekton will provide direct links to physical and biological factors determing the production of fish. Results from Pelagic Juvenile Fish Surveys carried out from 1994 to 1999 demonstrated large scale changes in distributions, abundances and biomass for all components of the nekton. These changes include:

- expansion of spawning range, for temperate species
- order of magnitude increases in abundance, for temperate species
- approximate doubling of plankton and nekton biomass
- increased fish growth and condition
- earlier spawning and longer spawning times

These changes have occurred within a warming ecosystem, following the extensive ice cover and record low temperatures of 1991. The magnitude and direction of the observed biological changes suggest there has been an increase in the carrying capacity of the ocean in the waters off Newfoundland and Labrador since the mid-1990's.

F. Savoie described the coastal temperature monitoring program in the southern Gulf of St. Lawrence. Bottom and surface water temperatures were monitored electronically every two hours from early spring to late fall. Temperature monitoring stations were located in coastal waters of the southern Gulf of St. Lawrence. From 1998 to 2000, only bottom water temperature was recorded. Since 1999, the temperature recorders have been attached to navigational buoys. Mean daily temperatures and monthly-accumulated degree-days were presented for each monitoring station from 1996 to 2000.

General discussion of environmental overviews and zonal monitoring

Discussion focussed on the need to improve monitoring of pelagic ecosystems. Failure to monitor key components of these ecosystems may generate a missing link in the chain between oceanographic variability and fisheries production. It was recognized that these components of the ecosystem are very difficult to monitor. It was also noted that surveys monitorng these ecosystems or components of them have recently been cancelled. It was concluded that the FOC should establish a working group to examine the need for enhanced monitoring of pelagic components of Atlantic Zone ecosystems, the feasibility of doing this and approaches that could be taken to accomplish this.

5. 2001 Theme session: Oceanographic Factors Affecting Distribution, Abundance, and Productivity of Invertebrate Populations

Introduction

For the first time since the meeting of 1997, the FOC Theme session was entirely dedicated to presentations on topics related to the abundance and productivity of invertebrate populations. The current situation in most groundfish stocks is about the same that it was four years ago and today invertebrate fisheries are by far the most important in term of value in eastern Canada. The success of the invertebrate fisheries is due to high landing levels for three major decapods species: shrimp; *Pandalus borealis*, snow crab; *Chionocetes opilio*, and lobster; *Homarus americanus*. Stocks or populations of each of these species increased in abundance in the mid-1990 and they are still at record high levels in most regions in the Atlantic. More information on the biology and ecology of these populations should help fishery managers in the conservation of these resources. The question of what role was or is played by oceanographic factors in abundance and recruitment of invertebrate populations was then the focus of this year Theme session, more specifically:

- Were there causal relationships (e.g., trophic interactions) between recent increases in abundance of some invertebrate stocks and the decline of groundfish stocks, or did invertebrate species benefit from the recent environmental conditions?

- What are the oceanographic and ecological factors affecting recruitment and productivity in invertebrate stocks/populations?

- What are the relationships between oceanographic conditions and spatial and temporal invertebrate distribution patterns?

- What are the responses of invertebrate stocks to change in oceanographic regime?

The response to the session was good with 14 presentations, but only 3 working papers were make available for review at the meeting. The presentations reflect the current relative importance of different invertebrate species to the fisheries: there were 5 presentations on lobster, 4 on snow crab, 3 on shrimp, 1 on scallop, and 1 on the occurrence of long-finned squid *Loligo pealei* on Newfoundland in 2000. A general discussion followed.

Presentations

A paper by G. Lilly examined the relation between the increase in shrimp biomass and the collapse of cod on the Northeast Newfoundland Shelf during the late 1980s and the early 1990s. The question of the role of reduced cod predation in the increase of shrimp population remains unresolved as the timing of both the decline in cod biomass and the increase of shrimp abundance is unclear. Although the recent large increase in shrimp stocks abundance and the expansion of distribution coincided with the low level of cod density, shrimp abundance began to increase in the mid-1980 when cod were still abundant. There are also large uncertainties about the consumption of shrimp by cod. Nevertheless, the current high level in shrimp biomass appear related at least in part to the collapse of cod.

P. Koeller presented a summary of the ICES-PICES-NAFO Symposium on Pandalid shrimp (Halifax, Sep. 1999. J. Northw. Atlantic. Fish., 27). Large-scale climatic and oceanographic changes are supposed to be responsible for the recent changes in shrimp abundance and distribution in the Northwest Atlantic. However, factors like changes in predation pressure, habitat and food availability must also be considered. For example, the often observed negative relationship between shrimp abundance and temperature in the southern limits of their distribution may be linked to changes in POC sedimentation processes (habitat quality, food availability) associated with sea-ice. Pandalid shrimp are considered an indicator species for ecological regime shift in the northeastern Pacific. Similar changes may rapidly be evident in the Northwest Atlantic and the Scotian Shelf could be a good area to study the influence of oceanographic factors on *Pandalus borealis* populations. The Shelf is an area of transition which shows oceanographic conditions characteristics of both more southern and more northern areas.

S. Smith presented a paper on the relation between scallop abundance (year-class strength) and temperature in the Bay of Fundy. The relationships between water temperatures and scallop annual landings have been investigated before and a correlation between catch and bottom temperature lagged by 6 years was revealed. The lag suggest an effect of temperature on pelagic larval stages. This year analysis used a more refined auto-regressive model and do not confirm the results from the previous analyses, and the new model did not show very good predictive power. It appears that temperature is not the determining factor in scallop recruitment. Alternative explanations (phytoplankton production, circulation) were discussed but the occurrence of the strong 1998 year-class is not explained.

K. Drinkwater presented an analysis that compared the distributions of snow crab and bottom temperatures in the southern Gulf of St. Lawrence and on northeastern Scotian Shelf. Snow crab habitat is defined by bottom area covered by cold-water and the increase in snow crab biomass in the eastern Scotian Shelf followed the extension of the cold-water at the bottom. Although snow crab on eastern Scotian Shelf habits area of warmer temperature relative to the southern Gulf, it is not clear how temperature changes will affect future stocks abundance.

A 3D circulation model of the Gulf of St. Lawrence and extending on the Scotian Shelf, was presented by J. Chassé. The power of the model was illustrated by a simulation of snow crab larvae drift over the Gulf. Snow crab larvae at the surface (upper 5m) dispersed widely over the southern Gulf and are transported on eastern Scotian Shelf in response to the winds. However, the pattern of distribution of the megalopae stage and snow crab recruitment over specific areas are very dependent on basic assumptions made on the vertical distribution and mortality rates of the larval stages. More researches on snow crab larvae distribution, development and mortality in the region are necessary before the tool can be used to predict recruitment and population structure in snow crab.

E. Dawe presented the distribution of snow crab at Newfoundland and Labrador Shelf. One observation was the size segregation of crabs over the area with large crabs at the Shelf edge at the southern area and smaller, younger crabs more inshore at shallower depth and at colder temperature. Different habitat preference (substrate type, temperature) and/or reduction of predation pressure are suggested to explain the pattern.

D. Orr presentation showed the distribution and abundance of snow crab early benthic stages (0-group, 1 and 2 years old) at Newfoundland and Labrador. The distribution of those young stages is very patchy and catchability problems may contribute to the observed changes between years but the differences in abundance of the different instars varied by nearly an order of magnitude between 1999 (highest) and 2000. However, at this stage it is not possible to relate these differences to survival or production changes between the years.

Time series analyses of environmental variables and shrimp, snow crab, and lobster abundance, inferred from commercial fishery data, were presented by D. Parsons. Ice cover on the Newfoundland and Labrador Shelf seems to have a negative effect on shrimp catch-per-unit-effort at lag 0 year and a positive effect at 6 year lag. Water column temperature at Station 27 showed a 0-year-lag positive correlation with snow crab abundance and a negative correlation at 8 year lag. Average summer temperature at Station 27 was correlated positively with lobster landings at a lag of 9 years. Lags of 6, 8 and 9 years were consistent with the approximate mean age in the commercial catches for shrimp, crab and lobster, respectively, and inferences for the effect of environmental factors (i.e. shrimp and crab - cold, lobster - warm) were consistent with documented information for each species. However, there is a general lack of knowledge concerning functional relationships between environment and production of decapods on the Newfoundland Shelf and the environmental variables investigated might not be the most appropriate. The empirical time series models also have low predictive power at this stage.

On a different note, E. Dawe reported of the unexpected occurrence of long-finned squid at Newfoundland in 2000. No explanation is given to the phenomenon.

Results from the CLAWS (Canadian Lobsters Atlantic Wide Studies) programme were presented by P. Ouellet. One project of CLAWS had the objective to investigate the relationships between lobster larvae production and post-larvae abundance at the Magdalen Islands in the southern Gulf of St. Lawrence. The abundance and the distribution of planktonic lobster larval stages were monitored at the Magdalen Islands from 1996 to 1998. A high resolution 3D circulation model of the area was developed and validated by surface drifters, and current-meter moorings data. The regional winds are driving the surface circulation around the Magdalens. A comparison of simulated larval distribution patterns with the observed distribution of lobster larvae strongly suggest that winds (i.e., surface circulation) explain the spatial variability and abundance of lobster larvae over the area. For subsequent analyses, the objective will be to compare past time series of local winds with estimated recruitment to the population.

In a second paper on lobster at the Magdalen Islands, P. Ouellet presented an analysis of the seasonal variability in size and growth rates of the larval stages. The effect of seasonal changes in water temperature on the duration of the stage and the mean growth rates explained the seasonal decline in mean larval size and in post-larvae size, at least in 1998. The proposition was made that the high variability in size at age observed in lobster may originate during conditions for larval development.

M. Hanson presented data from trawl surveys of pre-commercial and commercial size lobsters in Northumberland Strait in 1999 and 2000. The 2000 survey used a otter trawl equipped with rockhopper foot gear allowing the sampling of the entire area (LFA 25 and part of LPA 26A). Lobsters are not distributed evenly with most of the biomass in less that 25m water and larger lobsters in the eastern sectors. Small lobsters were abundant along New Brunswick shoreline suggesting recruitment in that sector. It is suggested that this type of survey could produce an early index of fishable biomass.

J. Tremblay discussed long term trends in the occurrence of ovigerous and large females lobster in traps off eastern Cape Breton. Fishermen have long noted appearance of different lobsters in traps during the season. The changes in catchability may be related to differences in movement linked to seasonal advance each year. Measurements of lobster catch at sea were available for 25 years from 1947 to 2000, with temperature data available for some years, and the analysis revealed an increase in catch and size of ovigerous females as the season progress. However, at this point, seasonal warming cannot be shown to relate to the increase in catchability of large females late in the season. The analysis also revealed an apparent decline in size at maturity in the area during that period.

R. Claytor presented an analysis to separate temperature and fishery effects on declining catch rates in lobsters. The method used measures changes of catch rates overtime in a portion of the population not being depleted (i.e., sub-legal lobsters) and one that is being depleted (i.e., legal lobsters) by fishing. The objective was to partition the variation in slopes between the sub-legal and legal lobsters using analysis of covariance. This partitioning would identify the portion of the variation in legal lobsters CPUE decline that resulted from fishing vs temperature effects. It is hypothesized that the proportion of the decline in legal CPUE due to fishing would be a relative index of exploitation rate. Simulations were realized to evaluate this approach, the model being CPUE = q(N-K) where the linear effect of temperature on catchability "q" was modelled as $q = q_{ref} (T - T_{ref})$ where T_{ref} (the temperature at which lobsters become active) and T is observed temperature. A range in q_{ref} was tested that correspond to exploitation rates varying from 24 to 99%. In the tests, the proportion of the slope due to fishing effects in legal lobsters increased with exploitation rates. The analysis was applied to empirical data sets and revealed that declines in catch rates for legal lobsters varied from totally due to fishing to temperature effects only among different fishing areas. The analysis of covariance results are not sensitive to variation in q_{ref} between the depleted and non-depleted groups. The question of the reliability of T_{ref} between years, size group, molt stage etc. was discussed. This approach appears to permit changes in CPUE to be evaluated for high compared to low temperature years provided catch data (for each size-group) are collected simultaneously.

General discussion

A brief discussion followed the presentations. While the reduction of groundfish predation may have played a role, it is unlikely that this is the only explanation for the recent expansion of distribution and the increase in abundance of shrimp and snow crab populations. The main emphasis for establishing environmental relationships for stock assessments is on the effects of environment on changes in population abundance. Ultimately, we would like to be able to forecast future changes in abundance based on current environmental observations. At the moment, environmental variables are not quantitatively integrated into invertebrate stock assessments. The statistical models tested to date which link populations abundance to environmental variables have very low predictive power, however, it was said that we should risk prediction even with high variability in the models (precautionary approach?). Monitoring the right variables is also important and these are unknown for most species/populations. We also know too little of complex environment/predator-prey relationships to predict changes to ecosystems when environmental conditions change. Ecosystems seem to exhibit many equilibrium levels and it is very probable that we will not see a return to a previous state. The FOC believes that more attention should be given to the question of how to integrate environmental information into the stock assessment process. A working group chaired by Ken Drinkwater will investigate this issue and the 2002 Theme session will likely be dedicated to the topic.

Overall, the session was a useful discussion and it showed the clear interest from the people working with invertebrates in oceanographic and environmental questions related to these populations.

6. General Business

Stock Status Reports

Draft Stock Status Reports were reviewed and editorial changes were suggested. General consensus was reached that all technical jargon should be reduced as much as possible in SSR’s. An attempt will be made to standardize background and introduction sections for both biological and environmental overviews. It was also noted that the accepted standard for averaging periods (e.g. 1961-1990) should be maintained for all environmental overviews. Pierre Pepin will prepare memo for distribution to all members indicating the requirement from each region to prepare both SSR and research documents for all biological and environmental overviews, as agreed upon during the November 1999 AZMP meeeting. All revisions are to be emailed to Doug Swain, after which SSRs will be forwarded to the regions for final evaluation. The data analysis subcommittee chair will prepare a memo to address the requirement of standardizing different biological and environmental measures for use in preparation of SSR documents.

Environmental indices working group

Ken Drinkwater indicated that environmental indices working group was unable to meet during this past year. The working group is planning to submit a technical report and a final report. Ken will canvas for input of primary publications to include in final report and recommendations. Savi suggested that 1-2 page summaries of major recommendations should be prepared and distributed to Science Directors. The technical and final reports will be submitted before year end of 2001. It was concluded that working group will be dissolved.

Working group on incorporation of environmental data into stock assessments

This working group has been unable to meet in 2000. Ken Drinkwater indicated the importance of moving forward with this initiative, given the response and papers presented at this years' FOC meeting. The working group will attempt to review and provide summaries of environmental – stock relationships to be considered for evaluation. Current members of working group include Jake Rice, Patrick Ouellet, Ken Drinkwater, and Pierre Pepin. Its mandate will be to assemble environment-stock relationships for each region which show some predictive ability. The working group will prepare terms of reference documentation.

Working group on the relative effects of temperature and abundance on the distribution of cod in the northwest Atlantic

The working group was unable to meet in 2000. Martin Castonquay indicated that a primary publication is anticipated to be submitted derived from the Fall 1998 Moncton, NB workshop proceedings. It was recommended by Martin that the working group be disbanded. This recommendation was accepted.

Proposed working group on monitoring of pelagic ecosystems

The mandate of this group is to examine the feasibility of applying pelagic monitoring of nekton to various regions. The importance of including both fish and invertebrate stocks in pelagic monitoring was highlighted. Each region was to nominate one or more individuals to discuss the details and specific requests and plans for pelagic monitoring. It was suggested that the working group prepare a group perspective on the relative importance of pelagic monitoring for each Region with rationale. Prospective candidates from regions were indentified; John Anderson from Newfoundland, Paul Fanning from Maritimes, Doug Swain from the Gulf region, Erica Head from Maritimes. Several lead members for the working group were suggested; Jacque Gagne (Laurentian), Jim Carscadden and John Anderson (Newfoundland). It was suggested that a data management person be included in the working group (Laure Devine, Laurentian). Initial working group initiatives to include:
1). Development of rationale for improvement for regional pelagic ecosystem monitoring.
2). Identifying the missing links in monitoring program within each region.
3). Definition of specific program needs within each region.
Doug Swain will prepare outline of proposal and forward to all members for further discussion.

Recruitment indices database working group

The mandate of the group includes assembling recruitment data, setting up a database and developing a scorecard which will be updated annually and presented at the FOC meeting. The database will consist initially of an Excel spreadsheet file. Members of the working group include Ken Frank, Martin Castonquay, John Anderson, and Doug Swain. The group will meet later this year to prepare and setup database.

2002 Meeting

The 2002 meeting will be held at the Bedford Institute of Oceanography during the last week of March (tentative dates March 26-29, 2002). The theme session will be on “Incorporation of environmental data into stock assessments”. It was suggested that AZMP methodological papers be moved to AZMP fall meeting in 2002.

Other business

Doug Swain will be stepping down as FOC chairman after this year. Patrick Ouellet was nominated and accepted as new chair for FOC 2002-2004. Suggestions for a National Meeting were put forward by group members. Initial discussions are to be initiated by the FOC chair.

Appendix 1: Agenda

Annual Meeting, March 27-30, 2001
Miramichi Room
Gulf Fisheries Center, Moncton, NB

Tuesday, Mar. 27

8:30 Introduction and administrative details
- Chairman

1. Review of 2000 environmental conditions in the Northwest Atlantic.

Physical Environment

8:45 Meteorological, Sea Ice and Sea Surface Conditions off Eastern Canada in 2000. ***WP1***
- Ken Drinkwater, Brian Petrie, Roger Pettipas and Liam Petrie

9:15 Oceanographic conditions in NAFO Divisions 2j3klmno during 2000 with comparisons to the long-term (1961-1990) average. ***WP2***
- Eugene Colbourne

Oceanographic conditions in NAFO Subdivisions 3Pn and 3Ps during 2000 with comparisons to the long-term (1961-1990) average. ***WP3***
- Eugene Colbourne

9:50 Oceanographic Conditions in the Gulf of St. Lawrence during 2000. ***WP4***
- Plourde, J., K. Drinkwater, L. Petrie, D. Lefaivre, D. Bourgault, D. Gilbert, F. Saucier and J.-C. Therriault

10:20 Break

10:40 Physical oceanographic conditions on the Scotian Shelf and in the Gulf of Maine during 2000. **WP5**
- K. Drinkwater, B. Petrie, R. Pettipas, L. Petrie and V. Soukhovtsev

11:10 Overview of near-bottom temperature and salinity during the 2000 summer groundfish survey conducted on the Scotian Shelf and Bay of Fundy. ***WP6***
- R. Losier and F. Page

11:30 Physical Environmental Scorecard – Discussion of physical overviews – similarities and contrasts between areas

12:00 Lunch

Biological Environment

13:00 Further discussion of physical environmental overviews

13:30 Variations in biological and chemical oceanographic conditions on the Newfoundland Shelf. ***WP7***
- P. Pepin and G. Maillet

14:00 Decadal Time-Series of Invertebrate Zooplankton on the Newfoundland Shelf and Grand Banks, 1991-1999 **WP8**
- Edgar Dalley, John Anderson, and Denise Davis

14:20 Oceanographic conditions in the Estuary and Gulf of St. Lawrence during 2000: Phytoplankton. **WP9**
- Michel Starr and Liliane St-Amand

14:45 Break

15:15 Oceanographic conditions in the Estuary and Gulf of St. Lawrence during 2000: Zooplankton. ***WP10***
- Michel Harvey

15:40 Chemical and biological oceanographic conditions 2000 - Maritimes Region **WP11**
- Glen Harrison et al.

16:10 Update on SeaWiFS phytoplankton biomass and primary productivity fields of the NW Atlantic. ***WP12***
- Glen Harrison and Brian Petrie

16:35 Decadal changes in phytoplankton color index and selected calanoid copepods in CPR data from the Scotian Shelf ***WP13***
- Doug Sameoto

Wednesday, March 28

08:30 Zonal overview of biological/chemical environmental conditions in 2000 – Discussion of biological overviews – similarities and contrasts between areas

Recruitment Trends

09:30 Recruitment of exploited fishes and invertebrates on the Newfoundland Shelf, the Grand Bank and St. Pierre Bank **WP14**
- Dale Parmiter, John Anderson and Dave Reddin

10:00 Recruitment of exploited fishes and invertebrates in the northern Gulf of St. Lawrence **WP15**

- Martin Castonguay

10:20 Break

10:40 Recruitment of exploited fishes and invertebrates in the southern Gulf of St. Lawrence **WP16**
- Doug Swain

11:00 Recruitment of exploited fishes and invertebrates on the Scotian Shelf and in the Gulf of Maine **WP17**
- Ken Frank

11:30 Recruitment Scorecard – similarities and contrasts between areas and species

12:00 Lunch

2. Atlantic Zone Monitoring - Research and Development

13:00 An update on Phytoplankton and zooplankton community structure analyses for at Prince 5. ***WP18***
- F. Page and A. Hanke

Preliminary explorations of phytoplankton community structure at station 16 in the Bay of Fundy - a fixed monitoring station near Prince 5. **WP19**
- F. Page, J. Martin, and A. Hanke

13:30 How representative is the 10m sample series of phytoplankton at station 16 in the Bay of Fundy. ***WP20***
- F. Page, A. Hanke, and J. Martin

13:50 Preliminary efforts to define phytoplankton bio-volumes for the Bay of Fundy. ***WP21***
- F. Page, J. Martin, and J. Miller

14:10 Applying the Atlantic Zonal Monitoring Programme output to biological questions. I. Investigating the link between food supply for larval haddock and their subsequent recruitment success ***WP22***
- Erica Head

14:30 Break

15:00 Interannual variability of the krill standing stock biomass in the lower St. Lawrence estuary: impact on fin whale dispersion **WP23**
- Harvey, M., R. Michaud and J.A. Runge

15:20 Hindcast of ice-ocean conditions in Gulf of St. Lawrence during year 2000 using the MLI regional ocean model ***WP24***

- F. J. Saucier and J. Plourde

15:40 Preliminary studies of density stratification and fluorescence on the Newfoundland Shelf ***WP25***
- J. Craig, G. Maillet and E. Colbourne

16:00 Seasonal patterns of chl a concentrations in the northwest Atlantic estimated from in-situ chl a fluoresence: comparison of methods and test of Holm-Hansen et al. 2000 algorithms. **WP26**
- G.L. Maillet, S.M. Fraser, and P. Pepin

16:20 Long-term hydrologic conditions in the Miramichi River and potential implication of climate change to aquatic resources ***WP27***
- Daniel Caissie, Erin Swansburg, Gerald Chaput and Nassir El-Jabi

16:40 Modelling Pelagic Ecosystems and the Zonal Monitoring Program **WP28**
- Geoff Evans and Alain Vézina

Thursday, March 29

8:30 Monitoring Pelagic Ecosystems in the Northwest Atlantic **WP29**
- John Anderson

9:00 Coastal temperature monitoring program in the southern Gulf of St. Lawrence. **WP30**
- Fernand Savoie

9:10 General discussion of environmental overviews and zonal monitoring
- Discussion of developing biological monitoring programs: methodology, metrics, etc.
- Monitoring pelagic ecosystems (e.g., ichthyoplankton, pelagic juveniles)
- Discussion of results for 2000 – contrasts and similarities between regions; possible relationships (physical vs biological vs recruitment overviews)

10:00 Break

3. Theme session: Oceanographic Factors Affecting Distribution, Abundance, And Productivity Of Invertebrate Populations

10:30 Opening Remarks
- Patrick Ouellet, theme session organizer

10:40 Was the increase in shrimp biomass on the Northeast Newfoundland Shelf a consequence of a release in predation pressure from cod? ***WP31***
- Lilly, G.R., Parsons, D.G., and Kulka, D.W

11:00 Oceanographic factors affecting distribution, abundance, and productivity of Pandalid Shrimp ***WP32***

- Peter Koeller

11:20 Recruitment patterns for scallops in the Bay of Fundy. ***WP33***
- Smith, S.J. and Lundy, M.J.

11:40 Temperature- catch relationships of snow crab in the southern Gulf of St. Lawrence and on the northeastern Scotian Shelf ***WP34***
- Ken Drinkwater, Mikio Moriyasu, and Michel Comeau

12:00 Lunch

13:00 Modeling of the drift, growth and survival of the early life stages of snow crab in the Gulf of St. Lawrence and NorthEast Scotian Shelf ***WP35***
- Joël Chassé and Mikio Moriyasu

13:20 Distribution and demography of snow crab at Newfoundland and Labrador during 1995-2000. ***WP36***
- E. Dawe and E. Colbourne

13:40 Distribution of early benthic stage snow crab at Newfoundland and Labrador during 1999 and 2000. ***WP37***
- D. Orr et al.

14:00 Environmental (oceanographic) influences on production within crustacean populations at Newfoundland and Labrador. ***WP38***
- D. Parsons et al.

14:20 Squids as possible indicator species; an unusual abundance of long-finned squid (*Loligo pealei*) at Newfondland in 2000. ***WP39***
- E. Dawe et al.

14:40 Break

15:10 Production and distribution of lobster (*Homarus americanus*) larvae and postlarvae abundance at Îles-de-la-Madeleine, southern Gulf of St. Lawrence. ***WP40***
- Ouellet P. & Lefaivre D.

15:30 Seasonal and inter-annual variability in larval lobster size, growth, and condition at Îles-de-la-Madeleine, southern Gulf of St. Lawrence. ***WP41***
- Ouellet P.

15:50 Pre-fishery distribution of lobster in western Northumberland Strait, 1999-2000. ***WP42***
- Mark Hanson

16:10 Temperature and the availability of lobsters to commercial fishing - A case study of the catch of females off eastern Cape Breton, 1947-2000. ***WP43***
- John Tremblay et al.

16:30 Adjusting lobster CPUE trends for temperature effects ***WP44***
- Ross Claytor

16:50 Discussion

Friday, March 30

9:00-12:00 FOC Business Meeting

1. Stock Status Reports
   -Discussion and Approval of Environmental Overview SSRs
2. FOC Working Groups
   -Cod Growth Working Group
   -Environmental Indices Working Group
   -Working Group on the relative role of temperature and abundance on the distribution of cod in the norhtwest Atlantic
   -Working Group on incorporating environmental data into stock assessment
   -Other possible working groups? e.g., working group on the precautionary approach, climate change.
3. Next year's Meeting
   -Theme Session
   -Date and Location
4. Other business.

Appendix 2: Meeting Participants

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