The Ecosystem of the Flemish Cap

8-10 September 2004 – Dartmouth, NS, Canada

I. INTRODUCTION

The Symposium on The Ecosystem of the Flemish Cap was held in Holiday Inn Harbourview in Dartmouth, Nova Scotia during 8-10 September 2004. The purpose of this Symposium was to better understand the ecosystem of the Flemish Cap and its evolution, particularly addressing the topics: Oceanography of the Flemish Cap, including description of any trend, the interactions between species and their environment, and oceanographic linkages with other areas ; General biology of species on the Flemish Cap, including comparisons with other nearby populations; the isolation of the Flemish Cap or its connection to surrounding areas including studies on tagging, genetics, parasites, and similarity in timing of events; the development of fisheries for species on the Flemish Cap and their effects on the whole ecosystem; ecology of communities on the Flemish Cap, including studies on niche overlap, species assemblage, trophic linkage and their dependence from environmental conditions; comparative results from other partially isolated oceanic areas.

The Chair of Scientific Council opened the meeting by welcoming participants and explaining the role of Scientific Council. She noted that it was a unique situation to have the Chair and Vice-Chair of Scientific Council as co-conveners of the same Symposium. The Vice-Chair of Scientific Council also welcomed participants and introduced the work plan and objectives.

The Symposium was organized into five sessions: The physical environment, descriptive ecology, the ecosystem in space, trophic ecology and the ecosystem in time. As outlined in the meeting program there were 3 invited topical presentations. A group discussion concluded the symposium.

The first was by John Shaw, Bedford Institute of Oceanography, Halifax, Canada, on Palaeogeography of Atlantic Canadian continental shelves, from the last glacial maximum to the present.

The next was by Eugene B. Colbourne, Department of Fisheries and Oceans, St. John's, Canada, on Hydrographic Variability and Circulation of the Waters on and Adjacent to the Flemish Cap.

The third invited presentation opened the session the ecosystem in space. This presentation was by Enrique de Cárdenas, Secretaria General de Pesca, Spain, on Relative isolation of the Flemish Cap cod population.

The Symposium was attended by 30 participants from 8 countries (Canada, Germany, Iceland, Italy, Portugal, Russian Federation, Spain and United States of America). The Symposium consisted of 31 other papers that were presented and discussed under the selected session topics.

II. SESSION 1: THE PHYSICAL ENVIRONMENT

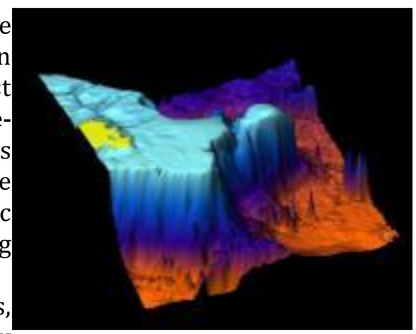
Session Chair: Manfred Stein

The first invited paper focused on the geological history of Flemish Cap, from the last glacial maximum to the present. Most of this work was based on core sampling carried out during the 1970s and early-1980s.

The presentation showed the history of glaciations of the past 20 000 years was characterized by several long-term cycles. The most prominent event was a river of ice in the Atlantic region in the Laurentian Channel. Depressed under the weight of the ice, the earth's crust rose with the retreat of the ice. The changes in sea level were however, not uniform in Atlantic Canada. For the Labrador region a falling sea level was observed, for Newfoundland and Nova Scotia falling and rising sea levels are encountered, and for the Quebec region a fall in sea level of more than 200 m was observed.

The most important finding of this paper in the context of the Symposium was that the Flemish Cap area was probably not glaciated and was not above sea level. The area was shallower 20 000 years Before Present (BP) than today and impacted by surge waves. The region of the Flemish Cap was shown to have been intensively impacted by icebergs in the past.

With the Laurentian Channel (LC) being the dominant ice feature in the area of Atlantic Canada, different scenarios on the ice retreat were shown: 14 000 years BP the ice front of LC retreated to the region of today's Quebec City , 13 000 years large islands formed on the Grand Banks , the Sable Island Bank and on Georges Bank . The processes of ice reduction were twofold: calving from ice rivers like the LC, and after the disappearance of the major ice rivers, inland ice melting. At about 11 000 years BP, Paleo Indians settled on Nova Scotia . The authors suggested that their subsequent disappearance may have been due to the advancing ice.

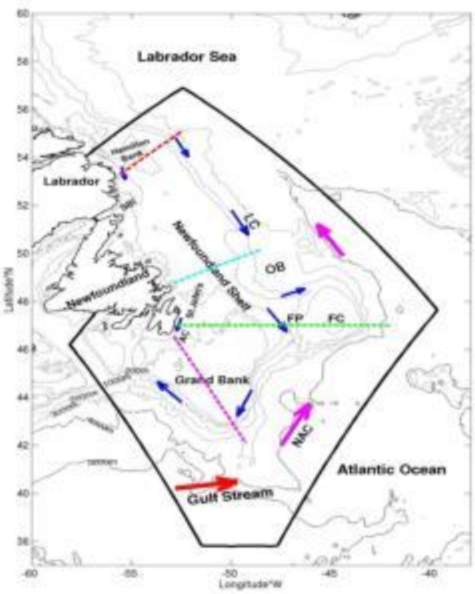


An invited paper on the hydrographic variability and circulation of the waters on and adjacent to the Flemish Cap was presented. Historic data in the Flemish Cap area were collected as early as 1910 but the first systematic observations were not initiated until 1931. From the late-1940s to early-1950s standardized work along repeated sections was initiated. During 1955, reports on oceanographic observations were presented to the International Commission for the Northwest Atlantic Fisheries (ICNAF). Presently 38 hydrographic stations are occupied along the Flemish Cap section during spring, summer and autumn surveys.

By means of satellite derived sea surface temperature (SST) records, acoustic Doppler current profiles (ADCP) from vessels and data on density stratification, the author presented evidence for a well formed gyre circulation over Flemish Cap. Previous studies suggest that Taylor Columns might play a role in the Gyre formation. The gyre strength was found to be minimum in winter/spring and maximum during summer/autumn.

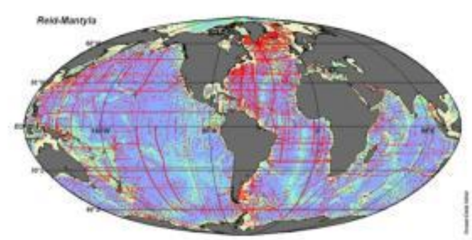
There is an annual cycle in subsurface temperatures, to approximately 100 m depth, below that temperatures range between 3.5°C and 4.0°C throughout the year. A comparison of annual temperature/salinity data from Station 27 (near St. John's , NL) and the Flemish Cap showed that the Cold Intermediate Layer (CIL) which is observed on the Newfoundland Shelf is replaced by modified Labrador Current slope water at Flemish Cap.

The long-term trends in temperature at Station 27 and the Flemish Cap correlate at 63%, whereas salinity correlates at 30%, due to the salinity at Station 27 being driven by shelf ice melt. With regard to large scale correlations, the North Atlantic Oscillation (NAO) signal comparing Newfoundlandand the Barents Sea (Kola Section) in the Northeast Atlantic reveals an inverse correlation. There are positive correlations between NAO and sea ice and CIL on the Newfoundland Shelf. Flemish Cap temperature/salinity data correlate at 50%/40% with NAO. Based on Flemish Cap averaged temperature and heat flux it is shown that advection is the principle forcing in the Flemish Cap region.



A paper on a model on seasonal and interannual circulation variability in the Flemish Cap region was presented. The modelling used climatic forcing based on data of the 1990s provided from the National Centers for Environmental Prediction (NCEP), USA and the National Center for Atmospheric Research (NCAR), USA . For tidal forcing the M_2 tides were applied. At the boundaries of the modelling area monthly mean sea level data were used. May and November current flow fields were analysed. It was shown that anticyclonic (clockwise on the Northern Hemisphere) eddies were observed in both seasons. The model results for November indicated a much stronger flow (+25%) than data derived from current meter moorings. In the model the anticyclonic gyres were stronger. The water transports were lower in summer and stronger in winter. It was found that residence times of the water on Flemish Cap were much longer than those found in previous studies. It was also noted that the modelling did not include wind forcing.

A paper on the Oceanography of the Flemish Cap and adjacent waters was presented. The intention was to indicate how publicly available data can be used with suitable software to map oceanographic properties like temperature, salinity, currents and nutrients on regional and ocean-wide scales. The presentation was based on oceanographic data from the World Ocean Database 2001 (and the Reid-Mantyla Dataset consisting of about 10 000 stations. Both data sets were handled with the Ocean Data View software environment, a software provided by the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven , Germany . A third data set, consisting of global near real-time altimeter geostrophic velocity data was provided by the Colorado Center for Astrodynamics Research (CCAR), Dept. of Aerospace Engineering Sciences University of Colorado, Boulder . The transatlantic scale of the 47°N transect based on the Reid-Mantyla data set and the regional subset for the upper 1 000 m in the Flemish Cap region, clearly indicate that the Flemish Cap region is unique in its oceanographic properties compared to the adjacent North Atlantic ocean. The region is influenced to a great extent by water masses of polar origin which provide a highly oxygenated environment. There is a rich supply of nutrients, e.g. phosphate and nitrate. This might be one major reason for good environmental conditions for marine vertebrates and invertebrates. Based on satellite derived data, an example of sea surface height anomaly in the vicinity of the Flemish Cap was given. The positive and negative anomalies reveal anticyclonic and cyclonic eddy activities, mostly associated with the northeastward flowing Gulf Stream . A survey of individual pictures throughout the year – shown as a movie clip during the presentation– indicated that the area of the Flemish Cap is rarely affected by these strong eddies.

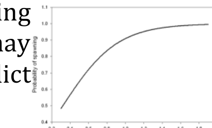


III. SESSION 2: DESCRIPTIVE ECOLOGY

Session Chair: Joanne Morgan

The Descriptive Ecology session included papers on the life history, reproduction and ecology of cod, redfish, and shrimp, as well as descriptions of the occurrence of harp and hooded seals and seabirds on the Flemish Cap.

The papers on cod examined the effect of condition on reproduction and the relationship between the age composition of the spawning stock biomass and recruitment. Including such factors in estimates of reproductive potential may improve our ability to understand and predict recruitment.



The paper on redfish examined some basic life history and biological aspects of the three species of redfish found on the Flemish Cap. It also presented a comparison of these aspects among these species.

Growth, size at sex change and spawning period, were among the information examined for shrimp on Flemish Cap. The estimated size at sex change decreased from 1996-2000 but this may be an artefact of some change in the time of year at which sex change is occurring.

The occurrence of harp and hooded seals was examined through the use of satellite telemetry. Hooded seals seemed to spend much more time on the Flemish Cap in 1994 than in the most recent tagging study. Harp seals were found to spend little or no time on the Cap.

Most of the sea birds that were identified on the Cap would be those that were not breeding or were outside of their breeding season. The edges of the Cap seemed to be the richest area for sea birds.

The paper on the occurrence of seals on the Flemish Cap engendered significant discussion, particularly with respect to the possibility of collaborative studies between those analyzing fish distribution and the studies on seal distribution. Symposium participants encouraged this type of collaboration. In addition it recommended that Scientific Council request WGHARP to provide Council with an update on the results of the tagging studies using satellite tracking and any collaborative studies, when WGHARP's next report to Council is presented.

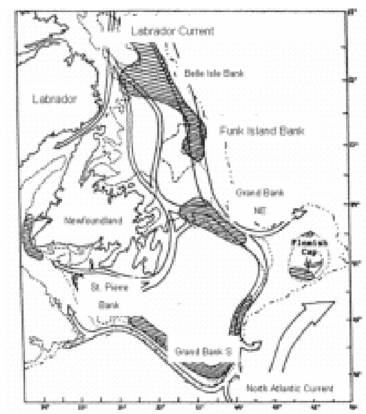
IV. SESSION 3: THE ECOSYSTEM IN SPACE

Session Chair: Antonio Vázquez

This session consisted of 11 papers, including an invited paper. The session was focused on the isolation of the fish populations on Flemish Cap or their linkage with the stocks on neighbouring areas, as well the spatial distribution patterns of species.

It is well known that Flemish Pass is not a barrier for distribution of deep-sea species, such as Greenland halibut and grenadiers, and their population on Flemish Cap were long time ago recognized as belonging to wider distributed stocks. The situation is quite different for the shallowest species, such as cod, American plaice, redfish, and shrimp among commercial species.

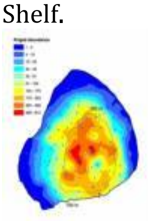
Three possible mechanisms to link populations inhabiting the shallowest areas were considered in the invited paper: migration of adult individuals to outside the Flemish Cap, exchange of individuals with neighbouring areas, and larval drift from surrounding areas. For cod, migration of adults to outside the Cap has been proved by tagging experiments, however immigration was never observed. However, a paper presented during this session on mitochondrial DNA analyses concluded that the cod stock on Flemish Cap appears to be a separate stock.



Larval drift from surrounding areas to Flemish Cap was predicted based on oceanographic variables. Before the eastern branch of the Labrador Current moves to Flemish Cap it crosses areas of the Labrador Shelf and Northern Grand Bank where species also inhabiting the Cap are known to spawn. Flemish Cap would be connected in this way more likely with those areas than with central and southern Grand Bank. However, even if larval drift occurs, larval survival is the main factor in determining the resulting recruitment to the Cap. Based on these considerations, larval transport to the Cap from Labrador or Northern Grand Bank is not likely.

A paper on possible mixing of American plaice populations in the area of the Flemish Pass showed that the exchange of American plaice between Flemish Cap and northern Grand Bank is unlikely to occur based on its no occurrence in the deepest strata of Flemish Pass , even though this species reaches deep areas in some seasons. Furthermore, individuals at both sides of the Flemish Pass were clearly different in mean length at age and in their maturation. Another paper on redfish showed that the three redfish species on Flemish Cap constitute independent stocks according to results of morphometric analyses.

Two papers on northern shrimp on the Flemish Cap detailed the increase in abundance and area of distribution of shrimp in the area. Differences in year-class strength, between the Flemish Cap and adjacent areas may indicate that shrimp on Flemish Cap are not connected to those on the Newfoundland Shelf.



Papers examining the spatial distribution patterns of several species were presented. The fish fauna in Flemish Cap appears distributed in a persistent structural zonation based on factor analyses of demersal survey trawls during 1995-2000 with redfish being the dominant fish species in the area. Changes in species spatial distributions in the most recent years are related to decreases in the main demersal fish species: cod and American plaice. Declines in the cod and American plaice abundance during 1989-2002 coincided with severe range contraction and a breakdown in the spatial structure of both stocks, which have high degree of spatial overlap.

Results of a longline survey indicated that Greenland halibut and roughhead grenadier (*Macrourus berglax*) were distributed at depths up to 2 050 m, based on a long-line survey between 700 and 3 000 m depth. Other deep-sea species replaced the above mentioned ones at greater depths. Greenland halibut abundance and biomass appear related to bottom temperature, being the warmer the water, the more abundance of halibut and vice versa.

Discussion of this session brought up information on the witch flounder stock on Flemish Cap. In this area the species is distributed in the shallowest strata, so depth preferences are quite different from stocks on Labrador and Grand Bank, which are distributed in deep areas. This particular behaviour may point to the isolation of the stock over the Cap.

Some of the changes in depth distribution described in papers in this session may be related to distribution of fish by size. Large fish tend to occupy deeper waters. As populations declined and the number of bigger, older fish decreased, an apparent move to shallow water could result.

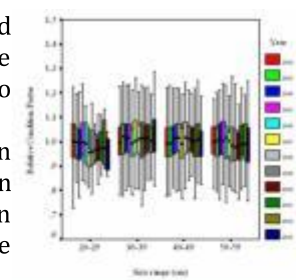
V. SESSION 4: TROPHIC ECOLOGY

Session Chair: Dave Orr

Three papers were presented. The first paper discussed the food and feeding of the fifteen (15) most abundant fish species, on the Flemish Cap. It dealt with indices of feeding intensity, dietary breadth and various indices of dietary importance (% frequency of occurrence, % volume and % number). The index of feeding intensity ranged from 96.3% among Atlantic cod (*Gadus morhua*) to 35% among Arctic eelpout (*Lycodes reticulatus*) indicating that respectively fewer than 4% of the Atlantic cod and 65% of the Arctic eelpouts had empty stomachs.

Crustaceans such as hyperiid amphipods, northern shrimp (*Pandalus borealis*), copepods, fish and ophiurans were the most important food items for fish living on the Flemish Cap.

Specialists, low diversity feeders and high diversity feeders were identified according to dietary breadth. Specialists are characterized as indices of breadth (1.55-2.53) indicating that they prey upon a relatively low number of species. Witch flounder (*Glyptocephalus cynoglossus*) and northern wolfish (*Anarhichas denticulatus*) were provided as examples. Low diversity feeders where characterized as having breadth indices between 3.75 and 5.69, eating an intermediate number of species and changing diets with size. Spotted wolfish (*Anarhichas minor*) and Arctic eelpout are presented as examples of low diversity feeders. High diversity feeders exhibited dietary breadth indices between 6.53 and 10.12, at a wide variety of prey species and changed diet as they grew. Greenland halibut (*Reinhardtius hippoglossoides*) is an example of a high diversity feeder.



The next two papers focused upon American plaice and Greenland halibut. Food and Relative condition factors (Kr) of animals from Div. 3LNO, 3M and ICES Area IIB were compared. Condition factors varied with species, location, season and sex. There was no relationship between Kr and biomass within each stock.

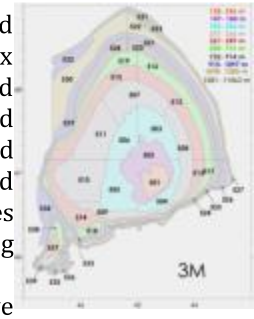
Feeding intensity for American plaice and Greenland halibut was highest in Div. 3M, then Div. 3LNO and lowest in ICES Div. IIB. American plaice diets were dependent upon location and specimen size. Echinoderms, fish and crustaceans predominated diets in Flemish Cap, Div. 3LNO and ICES Div. IIb, respectively. While diet varied with size, there was no clear trend of one prey item increasing with American plaice size.

In all areas, Greenland halibut ate mainly fish followed by crustaceans in Div. 3M and ICES Div. IIb, and molluscs in Div. 3LNO. The overall diet varied little between the 1993 and 2003; however, diet did appear to be dependent upon size of Greenland halibut. Greenlandhalibut <20 cm in TL fed mainly upon crustaceans, but became more piscivorous as they grew.

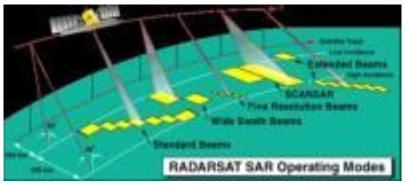
Participants noted the importance of food and feeding studies to the understanding of ecosystems and encouraged such work to continue.

VI. SESSION 5: THE ECOSYSTEM IN TIME

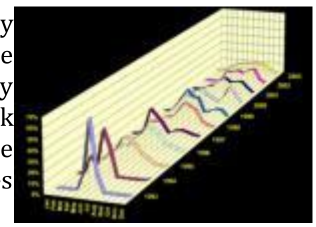
Session Chair: Bill Brodie



There were ten presentations, covering a wide range of topics. Three papers presented summaries of various time series of surveys on Flemish Cap, including plankton surveys. Six papers dealt with biology, distribution and fisheries on several species, primarily cod and redfish, but also including shrimp and roughhead grenadier. Some of these papers also considered environmental influences on species distribution and dynamics. One paper dealt with improving fisheries monitoring using satellite-based vessel reporting systems.



From the presentations, it was clear that there have been major changes in the Flemish Cap ecosystem since the 1980s. Traditional groundfish fisheries on cod and American plaice have disappeared, as these species abundance declined to very low levels and have remained at these low levels. Major fisheries for Greenland halibut and shrimp have developed on and around Flemish Cap since the early-1990s.



Discussion focused on possible environmental influences compared to fishery effects. Although hypotheses involving environmental effects are possible, there did not seem to be strong support for this in the studies presented. Many participants stated that overfishing appeared to be the primary cause of stock depletion on Flemish Cap. It was agreed that comparative studies involving the ecosystems of Flemish Cap and other areas (e.g. Greenland, Grand Banks, Georges Bank/ Gulf ofMaine) would be useful as follow-up work from this Symposium.

VII. SESSION 6: DISCUSSION/SUMMING UP

Session Chairs: Antonio Vázquez and Joanne Morgan

The discussion suggested that paleogeography of the Flemish Cap played an important role in shaping the ecosystem of today. In particular the fact that the Flemish Cap was neither glaciated nor exposed during the last major glaciation event appears to mean that it may have served as a refuge for marine species. The overall ecosystem of the Cap may have then served as specialized refugia in a historic sense.

The participants recognized the current oceanographic conditions are a major factor in the ecosystem of the Cap. The area has a fairly stable bottom temperature with very little seasonal or annual variability, and temperatures are in general warmer than the northern Grand Bank. The water retention times on the Cap may be longer than previously thought, but its implications for recruitment are unclear at this time. The gyre appears to play an important role in the area. Studies of currents indicate a closer relation between the waters of the Cap and those of the Labrador Shelf and Northern Grand Bank than with the Southern Grand Bank.

There is the possibility of interchange of individuals of various populations with other areas, either as eggs and larvae or as adults leaving the Flemish Cap. However, all of the studies presented during the Symposium that examined the relationships between most populations on the Cap and other areas found that there was little connection and that the populations on the Cap were distinguishable from those in other areas. The exceptions to this are Greenland halibut and roughhead grenadiers which are generally found in deep waters and have a wide distribution.

The meeting noted large changes occurred in the ecosystem of the Cap during the 1990s and they have continued until the present. There were major declines in the abundance of cod and American plaice, coincident with a decrease in their area of distribution and their move to shallower waters. At the same time of the cod and American plaice decline, Greenland halibut spread into shallower depths on the Cap and there was a large increase in the abundance of shrimp. Although these phenomena occurred over a similar time period, the discussion showed the cause is not necessarily the same.

Participants in the Symposium expressed particular interest in studies comparing the Flemish Cap ecosystem with other ecosystems. The discussions again brought to focus that ecosystem changes, both in time and biology, in all of the Atlantic , for example in areas off southeast and west Greenland , Labrador Shelf/Grand Banks, Scotian Shelf and Georges Bank , may show comparable patterns. They suggested that a Symposium on comparative studies of ecosystems in the Northwest Atlantic would be very worth while and of great interest, and accordingly recommended that the Scientific Council should consider this as a future area of study.

VIII. AGENDA

Presentations

Wednesday, 8 September (Symposium)
Registration
Welcome and Introduction (Scientific Council Chair/Convenors)

Symposium Session 1: The Physical Environment

Invited Paper: J. Shaw - *Palaeogeography of Atlantic Canadian continental shelves, from the last glacial maximum to the present*
Abstract:

Palaeogeography of Atlantic Canadian continental shelves, from the last glacial maximum to the present.
J. Shaw
Dept. of Fisheries and Oceans
Dartmouth, NS Canada

Dramatic environmental changes have occurred on the continental shelves off southeastern Canada over the last 20 000 or so years. At the last glacial maximum (LGM), glacier ice extended close to the edge of the continental shelves in many areas. Fast flowing ice streams occupied the deep troughs (e.g. Laurentian Channel, Trinity Trough), and discharged icebergs to the ocean; along the remainder of the shelf, relatively 'quiescent' grounded glacier ice was present along shelf edges. Flemish Cap was free of glaciers, and experienced low relative sea level; a small area may have been sub aerially exposed. After LGM, ice retreated in the region, the prime mechanism being ungrounding and calving along the trough ice streams. Relative sea level started to rise on Flemish Cap. At c. 14.5 ka BP (radiocarbon years) massive un-grounding of ice in the Gulf of St. Lawrence and other troughs isolated a Newfoundland Ice Cap, and lesser ice caps on the Grand Banks and other shallow shelf areas. By 13 ka Flemish Cap was undoubtedly submerged, but large islands remained on the adjacent continental shelf. The largest island was on Grand Banks. The Newfoundland Ice Cap progressively diminished in size and, together with the continental shelf ice caps, eventually disappeared. Rising relative sea level progressively drowned the shelf islands, the last of which disappeared below the waves at c. 8 ka.

Invited Paper: E. B. Colbourne - *Hydrographic Variability and Circulation of the Waters on and Adjacent to the Flemish Cap*
Abstract:

Hydrographic variability and circulation of the waters on and adjacent to the Flemish Cap
E. B. Colbourne
Dept. of Fisheries and Oceans
St. John's, NL Canada

Oceanographic data from the Flemish Cap and adjacent waters collected by Canadian ocean monitoring programs, which have been on-going since the early-1950s, together with all available historical data are used to elucidate the principal oceanographic features of this region. In general, the water mass characteristics of the Flemish Cap area are derived principally from Labrador Current Slope Water with influences from North Atlantic Current Water in the southern regions. The waters of the Flemish Cap are generally warmer and saltier than the sub-polar shelf waters of the adjacent Grand Banks with sub-surface temperatures ranging from 3° to 4°C and salinities in the range of 34 to 34.8. The Labrador Current which flows southeastward along the slopes of the Newfoundland and Labrador Shelf undergoes a bifurcation in the vicinity of the northeast Grand Bank. The major portion of this current then flows southward through the Flemish Pass following the bathymetry southward to the tail of the Grand Bank. A smaller portion of the current flows eastward north of the Cap and then southward on the eastern side of the Cap. To the south, the Gulf Stream flows to the northeast mixing with remnants of the Labrador Current to form the North Atlantic Current which influences the waters around the southern areas of the Cap. Ocean current measurements including direct observations, geostrophic calculations and drifting buoy data show considerable variability in the circulation patterns directly over the Cap, however, they all show a generally sluggish clockwise circulation, which frequently breaks down into meandering cross-bank flows, resulting in a finite residence time (<0.5 above normal at the surface. In general, water property variations on the Flemish Cap are highly correlated with those observed in the shelf waters of Newfoundland and Labrador. Studies have shown that

these conditions are linked to the large-scale atmospheric winter circulation, sea ice conditions, atmospheric forcing and advection. An examination of local air-sea heat flux on the Cap indicates that advection of Labrador Current Slope Water into the region is most likely the principle cause of oceanic variability over the central and northern areas of the Flemish Cap, while variations in the Gulf Stream and North Atlantic Current system contribute to the variability in southern regions.

Han, G. – Seasonal and interannual circulation variability and its implications in the Flemish Cap region: A modelling study

Stein, M. – Oceanography of the Flemish Cap and Adjacent Waters

Discussion

Symposium Session 2: Descriptive Ecology

Morgan, M.J. and G.R. Lilly – The impact of condition on reproduction in Flemish Cap cod

Saborido-Rey, F., M.J. Morgan, and R. Domínguez – Estimation of reproductive potential for Flemish Cap cod

Saborido-Rey, F., D. Garabana and R. Dominguez – A review of redfish life history, biology and ecology in Flemish Cap

Skuladottir, U., U.G. Petursson, and S. Brynjolfsson – The Biology of Northern Shrimp (*Pandalus borealis*Kr.1838) at Flemish Cap

Stenson, G.B., M.O. Hammill and B. Sjare – The Seasonal Distribution and Diving Behaviour of Harp and Hooded Seals on the Grand Banks and Flemish Cap

Martinez Leyenda, P and I. Munilla Rumbao. The summer seabird community of the Flemish Cap in 2002.

Discussion

Thursday, 9 September

Symposium Session 3: The Ecosystem in Space

Invited Paper: E. de Cárdenas – *Relative isolation of the Flemish Cap cod population*
Abstract:

Relative isolation of the Flemish Cap cod population

E. de Cárdenas
Secretaria General de Pesca Maritima
Madrid, Spain

The cod population distributions in the Northwest Atlantic and their migratory schemes, has been analyzed by several authors using different methods, such as genetics analysis, biological markers (parasitism, infections), meristics (vertebral number, fin rays, etc.) and tagging. The main conclusion of these studies was the existence of a separated cod stock in Flemish Cap (NAFO Division 3M), without connections with neighboring cod populations. However, information on egg and larval distribution and geostrophic circulation in particular periods, or the age and length distribution of the population, and the mature component of Flemish Cap cod population, in comparison with other cod stocks, could suggest, some relationship with neighboring cod stocks. Here, a review is presented of these papers dealing with the Flemish Cap cod population structure, discussing the results in light of the basis of each method.

González, D., X. Paz and X.A. Cardoso – Persistence and Variation in the Distribution of bottom-trawl Fish Assemblages over Flemish Cap

de Cárdenas, E., H. Murua, R. Alpoim and J.M. Casas – Bathymetric distribution of deep water species in Flemish Pass

Hendrickson, L. and A. Vázquez – A spatial analysis of predominant fish species inhabiting the Flemish Cap during July

Marshall , H.D., K.A. Johnstone, A.M. Pope, and S.M. Carr – Population Genomics and Stock Structure of Atlantic Cod on (& off) the Flemish Cap: insights from whole-mitochondrial-genome DNA sequences

Garabana, D. and F. Saborido-Rey – Relationships between Flemish Cap and adjacent redfish populations: Is Flemish Cap an isolated population? A morphometric approach

Igashov, T.M. and S.E. Lobodenko – The effect of oceanographic conditions on dynamics and distribution ofGreenland halibut stock in the Flemish Cap area in 1988-2001

Casas, J. M., and J. L. del Rio. Northern shrimp (*Pandalus borealis*) on Flemish Cap: 1988-2002.

Orr, D., G. Han, J. Craig, A. Nicolajsen, and P. Koeller – Is the 3M Northern Shrimp (*Pandalus borealis*) fishery sustained through immigration of shrimp from 3LNO?

Morgan, M.J. and W.R. Bowering – Is there mixing of American plaice populations in the Flemish Pass ?

Symposium Session 4: Trophic Ecology

Román, E., C. González and E. Cevallos – Food and feeding of most abundant fish species in Flemish Cap

González, C., E. Román and X. Paz – Condition and feeding of American plaice (*Hippoglossoides platessoides*) in the North Atlantic with emphasis in Flemish Cap

Román, E., C. González and X. Paz – Condition and feeding of Greenland halibut (*Reinhardtiushippoglossoides*) in Flemish Cap and other areas

Discussion

Friday, 10 September

Symposium Session 5: The Ecosystem in Time

Bakay,Yu.I., K.V. Gorchinsky, S.F. Lisovsky, S.E. Lobodenko, and A.A. Vaskov – Review of Soviet/Russian Research on the Flemish Cap during Recent 20 years

Brodie, W.B. – Canadian trawl surveys on Flemish Cap (NAFO Division 3M) from 1949-2004

Maillet, G.L., P. Pepin, S. Fraser, and D. Lane – Overview of biological and chemical conditions on the Flemish Cap with comparisons of nearby Grand Banks Shelf and Slope waters during 1996-2003

Cerviño, S. and A. Vázquez – Recruitment variability on main species on Flemish Cap and adjacent areas

Murua, H. and F. Gónzalez – A review of the Fishery and the Investigations of Roughhead grenadier (*Macrourus berglax*) in Flemish Cap and Flemish Pass

Vázquez, A. – The cod fishery on Flemish Cap

Kulka, D.W. and D. Orr – Evolution of a fishery for Shrimp on the Flemish Cap

Shepherd, I., J. Chesworth, G. Lemoine, and N. Kourti – Improving Fisheries Monitoring and Control in Oceanic Regions

Borovkov. V.A., A.A. Vaskov and A.L. Karsakov – The role of fisheries and water circulation in the dynamics of redfish and cod stocks on the Flemish Cap

Cerviño, S., J. Gil and R. Sanchez. Changes in Flemish Cap cod distribution and its relationship with environmental changes.

Discussion

Symposium Session 6: Discussion/Summing Up

Discussion

IX. PARTICIPANTS

Antonio Vazquez (Convenor),	Instituto de Investigaciones Marinas, Vigo, Spain
Joanne Morgan (Convenor),	Dept. of Fisheries and Oceans, St. John's, NL, Canada

<u>Keynote Speakers:</u>

John Shaw,	Geological Survey of Canada (Atlantic), Dartmouth, NS, Canada
Eugene Colbourne,	Dept. of Fisheries and Oceans, St. John's, NL, Canada
Enrique de Cardenas,	Institute Español de Oceanografia, Madrid, Spain

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Eugene Colbourne,	Dept. of Fisheries and Oceans, St. John's, NL, Canada
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Dave Kulka,	Dept. of Fisheries and Oceans, St. John's, NL, Canada
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Unnur Skúladóttir,	Marine Research Institute, Reykjavik, Iceland
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Ralph K. Mayo,	NMFS/Northeast Fisheries Science Center, Woods Hole, MA, USA

X. INFORMATION FOR PREPARING MANUSCRIPTS FOR NAFO SCIENTIFIC PUBLICATIONS

1. Introduction

The manuscript should be in English. The sequence of the material should be: title page, Abstract, text including Introduction, Materials and Methods, Results, Discussion and Acknowledgements and References. Number all pages, including the title page, consecutively with arabic numbers in the center of the top margin. There is usually no page limitation or page charge for accepted publications.

2. Content of Manuscript

Title page

This page should contain the title, followed by the name(s) and address(es) of the author(s) including professional affiliation, and any related footnotes. The title should be limited to what is documented in the manuscript and be as concise as possible. Where necessary the scientific names of species should be included.

Abstract

An informative abstract must be provided, which does not exceed one double-spaced page or about 250 words, the ultimate length being dependent on the size of the manuscript. The abstract should concisely indicate the content and emphasis of the paper. It should begin with the main conclusion from the study and be supported by statements of relevant findings. The scientific names of species where necessary should be included here. It is important that the abstract accurately reflect the contents of the paper because it is often separated from the main body of the paper by abstracting and indexing services.

Text

In general, the text should be organized into Introduction, Materials and Methods, Results, Discussion, Acknowledgments and References. Authors should be guided by the organization of papers that have been published in the NAFO Journal or Studies and by such authorities as the Council of Biological Editors Style Manual (CBE, 9650 Rockville Pike, Bethesda, MD 20814, USA).

The **Introduction** should be limited to the purpose and rationale of the study. The article should begin with a clear description of the subject (include where necessary the scientific names of species), stating the hypothesis and/or defining the problem(s) the research was designed to solve.Define the time of the study, along with literature review and other information limited to that is relevant to the problem.

The **Materials and Methods** should provide the framework for obtaining answers to the problems which concern the purpose of the study. Describe in sufficient detail the materials and methods used so as to enable other scientists to evaluate the work or replicate the work.

The **Results** should answer the questions evolving from the purpose of the study in a comprehensive manner in an orderly and coherent sequence, with illustrative tables and figures. Ensure only relevant information is presented to substantiate the findings. Avoid any confusion between facts and inferences and the restatement of table and figure captions in the text.

The **Discussion** should give the main contributions from the study, with appropriate interpretation of the results focussing on the problem or hypothesis. Compare with those of other authors. Speculation should be limited to what can be supported with reasonable evidence. In the case of short papers, it may be useful to combine Results and Discussion to avoid repetition.

The **Acknowledgements** should be limited to the names of individuals who provided significant scientific and technical support, including reviews, during the preparation of the manuscript, and the names of agencies which provided financial support.

The **References** represents the list of references cited in the text listed alphabetically. Good judgment should be used in the selection of references, which should be restricted largely to significant published literature. Unpublished data and documents, manuscripts in preparation, and manuscripts awaiting acceptance to other journals may be noted in the text as unpublished data or personal communications, with full contact addresses. Literature references cited in the text must be by author's surname and year of publication, e.g. (Collins, 1960). The surnames of two authors may be used in a citation, but, for more than two authors the citation should be (Collins et al., 1960). The citation of mimeographed manuscript reports and meeting documents should contain the abbreviation "MS", e.g. (Collins *et al.*, MS 1960). All papers referred to in the text must be cited in the References alphabetically by the first author's surname and initials, followed by the initials and surnames of other authors, year of publication, full title of the paper, name of the periodical, volume and/or number, and range of pages. Abbreviations of periodicals should, if possible, follow the "World List of Aquatic Sciences and Fisheries Serials Titles", published periodically by FAO (Food and Agriculture Organization of the United Nations). References to monographs should, in addition to the author(s), year and title, contain the name and place of the publisher and the number of pages in the volume. Reference to a paper in a book containing a collection of papers should also contain the page range of the paper, name(s) of editor(s), and actual title of the book. The accuracy of all references and their correspondence with text citations is the responsibility of the author.

Comments on Tables and Figures

All tables and figures must be mentioned or discussed in the text. Tables and figures must be numbered consecutively in arabic numerals, which correspond with the order of presentation in the text. The required position of the tables and figures in the text should be indicated in the left margin of the relevant page. List the captions of figures after the list of references (under the heading "Figure Captions").

Tables. Each table – including its caption – must be submitted as a separate file in a Word format.
NOTE: A well constructed table can eliminate elaborate text descriptions. Each table should be carefully constructed to be easily read and understood. Each column and row must be concisely headed ensuring relevant units of the values are given (usually within parentheses). Each table should have a complete but concise descriptive heading.

Figures.

Each figure must be submitted as a separate file in a graphic format (preferably eps, ai, ps; we also accept tiff, pct, jpg, bmp or gif but advise to pay special attention to quality with these formats). Coloured figures will only be accepted if colour contributes to the content of the figure and is unavoidable (for reasons of consistency, this policy is valid for both the printed and the electronic Journal).
Note that readability of figures on the screen is of key importance: In general, text elements should be proportional to size to the figure size. However, for very small or large figures the choice of a relatively large font size in proportion to figure size might be preferable to (a) ensure readability of small figures and/or (b) allow reduction of a large figure size without compromising readability of its inherent text.
Each figure should be carefully constructed and labelled to be easily read and understood. Each vertical and horizontal axis (e.g. x and y axes on a graph or latitude and longitudes on a map) must have a concise header with relevant units (usually within parentheses). Note that any reference to geographic areas relevant to the study should be shown in a figure (or map) form. Mathematical equations and formulae must be accurately stated, with clear definitions of the various letters and symbols. If logarithmic expressions are used, the type of function (e.g. log, ln, log_{10} or log_e) must be clearly indicated.

Key words: Authors are requested to include suggested key words based on standard search engines for scientific papers.

Manuscript Submission

The NAFO Secretariat receives manuscript submissions, in a computer electronic form. The manuscript submissions may be done by e-mail (with a hard copy and disk also forwarded by mail), or by mail (one hard copy and disk). All texts, Tables and Figures should be formatted using Word or WordPerfect (Word is preferred), with each Figure saved in a separate file (eps (preferably), tiff, pct, jpg, bmp or gif).The Secretariat may request alternative formats as publication technologies develop.