Northwest Atlantic Fisheries Organization

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SCIENTIFIC COUNCIL MEETING - SEPTEMBER 2004

REPORT OF SCIENTIFIC COUNCIL SPECIAL SESSION *"THE ECOSYSTEM OF THE FLEMISH CAP"*

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.

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. The following represents a summary of the proceedings.

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 Newfoundland and 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 (http://www.nodc.noaa.gov/OC5/WOD01/pr_wod01.html) and the Reid-Mantyla Dataset obtained from: http://dss.ucar.edu/datasets/ds543.0/data/ 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 (http://e450.colorado.edu/realtime/global_realtime/geovel.html). 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.

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.

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.

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. Greenland halibut <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.

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 of Maine) would be useful as follow-up work from this Symposium.

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.

SYMPOSIUM SCHEDULE

Wednesday, 8 September 2004

0900-0930 Registration

0930-1000 Introduction (Scientific Council Chair and co-conveners)

SESSION 1: THE PHYSICAL ENVIRONMENT

Paper #	**Time**	
Session Chair: Manfred Stein		
1.1	1000-1100	**Invited Paper:** SHAW, J. Palaeogeography of Atlantic Canadian continental shelves, from the last glacial maximum to the present.
Break	1100-1130	
1.2	1130-1230	**Invited Paper:** COLBOURNE, E.B. Hydrographic Variability and Circulation of the Waters on and Adjacent to the Flemish Cap.
Lunch	1230-1330	
1.3	1330-1350	HAN, G. Seasonal and interannual circulation variability and its implications in the Flemish Cap region: A modelling study.
1.4	1350-1410	STEIN, M. Oceanography of the Flemish Cap and Adjacent Waters.
Discussion	1410-1430	
Break	1430-1500	

SESSION 2: DESCRIPTIVE ECOLOGY

Session Chair: Joanne Morgan

2.1	1500-1520	MORGAN, M. J., and G. R. LILLY. The impact of condition on reproduction in Flemish Cap cod.
2.2	1520-1540	SABORIDO-REY, F., M. J. MORGAN, and R. DOMÍNGUEZ. Estimation of reproductive potential for Flemish Cap cod
2.3	1540-1600	SABORIDO-REY, F., D. GARABANA, and R. DOMINGUEZ. A review of redfish life history, biology and ecology in Flemish Cap.
2.4	1600-1620	SKULADOTTIR, U., U. G. PETURSSON, and S. BRYNJOLFSSON. The Biology of Northern Shrimp (*Pandalus borealis* Kr.1838) at Flemish Cap.
2.5	1620-1640	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.
2.6	1640-1700	MARTÍNEZ-LEYENDA, P., and I. MUNILLA-RUMBAO. The summer seabird community of the Flemish Cap in 2002
Discussion	1700-1730	

Thursday – 9 September 2004

SESSION 3: THE ECOSYSTEM IN SPACE

Session Chair: Antonio Vázquez

Paper #	**Time**	
3.1	0900-1000	**Invited Paper**: DE CÁRDENAS, E. Relative isolation of the Flemish Cap cod population.
3.2	1000-1020	GONZÁLEZ, D., X. PAZ, and X. A. CARDOSO. Persistence and Variation in the Distribution of bottom-trawl Fish Assemblages over Flemish Cap.
3.3	1020-1050	DE CÁRDENAS, E., H. MURUA, R. ALPOIM, and J. M. CASAS. Bathymetric distribution of deep water species in Flemish Pass.
Break	1050-1110	
3.4	1110-1130	HENDRICKSON, L., and A. VÁZQUEZ. Changes in the spatial distribution of dominant fish species on the Flemish Cap during July.
3.5	1130-1150	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.
3.6	1150-1210	GARABANA, D., and F. SABORIDO-REY. Relationships between Flemish Cap and adjacent redfish populations: Is Flemish Cap an isolated population? A morphometric approach.
3.7	1210-1230	IGASHOV, T. M., and S. E. LOBODENKO. The effect of oceanographic conditions on dynamics and distribution of Greenland halibut stock in the Flemish Cap area in 1988-2001.
Lunch	1230-1330	
3.12	1330-1350	CASAS, J. M., and J. L. DEL RIO. Northern shrimp (*Pandalus borealis*) on Flemish Cap: 1988-2002.
3.9	1350-1410	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?

3.11	1410-1430	MORGAN, M. J., and W. R. BOWERING. Is there mixing of American plaice populations in the Flemish Pass?
Discussion	1430-1450	
Break	1450-1510	

SESSION 4: TROPHIC ECOLOGY

Session Chair: Dave Orr

4.1	1510-1530	ROMÁN, E., C. GONZÁLEZ, and E. CEVALLOS. Food and feeding of most abundant fish species in Flemish Cap.
4.3	1530-1550	GONZÁLEZ, C., E. ROMÁN, and X. PAZ. Condition and feeding of American plaice (*Hippoglossoides platessoides*) in the North Atlantic with emphasis in Flemish Cap.
4.4	1550-1610	ROMÁN, E., C. GONZÁLEZ, and X. PAZ. Condition and feeding of Greenland halibut (*Reinhardtius hippoglossoides*) in Flemish Cap and other areas.
Discussion	1610-1630	

Friday – 10 September 2004

SESSION 5: THE ECOSYSTEM IN TIME

Session Chair: Bill Brodie

5.2	0900-0920	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.
5.3	0920-0940	BRODIE, W.B. Canadian trawl surveys on Flemish Cap (NAFO Division 3M) from 1949-2004.
5.4	0940-1000	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.
Break	1000-1030	
5.5	1030-1050	CERVIÑO, S., and A. VÁZQUEZ. Recruitment variability on main species on Flemish Cap and adjacent areas.
5.6	1050-1110	MURUA, H., and F. GÓNZALEZ. A review of the Fishery and the Investigations of Roughhead grenadier (*Macrourus berglax*) in Flemish Cap and Flemish Pass.
5.7	1110-1130	VÁZQUEZ, A. The cod fishery on Flemish Cap.
5.8	1130-1150	KULKA, D. W., and D. ORR. Evolution of a fishery for Shrimp on the Flemish Cap.
5.9	1150-1210	SHEPHERD, I., J. CHESWORTH, G. LEMOINE, and N. KOURTI. Improving Fisheries Monitoring and Control in Oceanic Regions.
Lunch	1210-1330	
5.10	1330-1350	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.
5.11	1350-1410	CERVIÑO, S., J. GIL, and R. SANCHEZ. Changes in Flemish Cap cod distribution and its relationship with environmental changes
Discussion	1410-1430	
Break	1430-1500	

SESSION 6: DISCUSSION/SUMMING UP

Session Chairs: Antonio Vázquez and Joanne Morgan

Discussion 1500-1600

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