Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2014/016

Newfoundland and Labrador, Québec, Maritimes and Gulf Regions

Proceedings of the 15th Annual meeting of the Atlantic Zone Monitoring Program (AZMP)

March 18-21, 2013
Montreal, Québec

Chairperson: Pierre Pepin
Editor: James Meade

Fisheries and Oceans Canada
Northwest Atlantic Fisheries Centre
PO Box 5667
St. John's, NL A1C 5X1

July 2014

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1701-1280

Correct citation for this publication:

DFO. 2014. Proceedings of the 15th Annual meeting of the Atlantic Zone Monitoring Program (AZMP); 18-21 March, 2013. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2014/016.

TABLE OF CONTENTS

SUMMARY

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1998 with the aim of collecting and analyzing the biological, chemical, and physical field data that are necessary to (1) characterize and understand the causes of oceanic variability at the seasonal, interannual, and decadal scales, (2) provide multidisciplinary data sets that can be used to establish relationships among the biological, chemical, and physical variables, and (3) provide adequate data to support the sound development of ocean activities. Atlantic Zone Monitoring Program scientists meet annually to review the activities of the Program and assess business, operational and logistic issues that need regional/zonal intervention, or that must be brought to the attention of the Fisheries and Oceans Canada (DFO) Atlantic Science Directors Committee. 2009 marked the 10th anniversary of ocean observation by AZMP. In March, 2010 AZMP scientists initiated an effort to synthesize and integrate the oceanographic conditions observed in the Atlantic Zone since 2000, identify trends or changes, and provide a critical assessment of the information available. In 2013, they reconvened in Montreal from March 18 to 21 to continue work on the synthesis, discuss logistic and operational issues, review recent oceanographic conditions within the zone, update the plans for the integration and synthesis exercise, and finalize the workplan for the current year.

Compte rendu de la 15e revue par les pairs zonale du Programme de Monitorage de la Zone Atlantique (PMZA)

SOMMAIRE

Le Programme de monitorage de la zone atlantique (PMZA) a été mis en œuvre en 1998 afin de recueillir sur le terrain et analyser les données biologiques, chimiques et physiques nécessaires pour : 1) caractériser et comprendre les causes de la variabilité océanique à des échelles saisonnières, interannuelles et décennales; 2) constituer des ensembles de données multidisciplinaires qui peuvent servir à établir des relations entre les variables biologiques, chimiques, et physiques et 3) fournir des données adéquates pour assurer le développement adéquat de projets en milieu marin. Les scientifiques du PMZA se réunissent annuellement pour revoir les activités du Programme et identifier les enjeux relatifs à ses opérations et à la logistique qui requièrent une intervention régionale/zonale ou qui doivent être portés à la connaissance du Comité des directeurs des sciences de la zone atlantique du MPO. Le PMZA a complété sa première décennie d'observations océaniques en 2009. En mars 2010, les scientifiques du Programme entreprirent de synthétiser et d'intégrer les conditions océanographiques observées dans la zone atlantique depuis 2000, d'identifier les tendances ou les changements survenus et d'effectuer une évaluation critique de l’information disponible. Ils se sont réunis à nouveau à Montréal du 18 au 21 mars 2013 pour continuer les travaux concernant la synthèse, revoir les enjeux logistiques et opérationnels, discuter des conditions océanographiques récentes dans la zone, évaluer la progression des efforts de synthèse et d'intégration et finaliser le plan de travail pour l'année en cours.

SESSION 1 – AZMP SYNTHESIS WORKSHOP, 18 MARCH 2013

Rapporteur – Gary Maillet

Overview of objectives and agreed approach (Phase I – synthesis of zooplankton data)

Presenter - Pierre Pepin

Abstract

Overall objective of synthesis is to provide integrated perspective of state of the Western Atlantic or Regions based on physical, chemical and biological oceanographic conditions. The analyses should be based on identifying the fundamental relationships between drivers (processes) and response (state) variables. Phase I focussed on zooplankton distributions and environmental relationships. The objectives were to [1] combine data from zooplankton collections from NLS (Newfoundland and Labrador Shelves), GSL (Gulf of St. Lawrence) and SS (Scotian Shelf) from Spring and Fall surveys, [2] develop an Atlas of species distributions, [3] investigate patterns in community structure and similarity/dissimilarity among areas using unconstrained analytical tools (Principal Components Analysis) as an exploration of broad scale patterns in species composition and using constrained analytical tools (Redundancy Analysis) to determine role of environmental variables on species composition. The biological data were to be supplied and combined by June but were completed by late July and revised in August; the physical data were completed sometime in late 2012.

There were issues with the data. Taxa that were present at less than 3 % of sites were removed. A few observations appeared to be outliers and were removed. For the physical data, missing observations in one or several variables at each site resulted in some loss of information. We also removed aspects of near bottom conditions because ~ 20 % had missing observations (particularly in GSL). Missing O_2 inventories (0-50 m) were replaced based on linear relationship with temperature, otherwise loss of ~ 10 % of observations.

Overall results indicate that the broad scale distribution of zooplankton determined primarily by bathymetry, temperature, salinity and “deep water nutrient inventory” signal (silicate- spring; nitrate- fall). Regional signals were important but were probably not important at the biogeographic scale. Non-linearity and inhomogeneity of variance in abundance probably affect our ability to identify smaller scale patterns of variation based on the combined information from the three regions. Despite these limitations, the overall patterns appear to be robust.

Discussion/Questions

Data reporting issues using higher level groupings instead of species in some regions resulted in some unusual fall observations and were removed from the analysis. It was suggested to drop unspecified zooplankton taxa from the analysis in the principal component analysis (PCA).

It was noted that a threshold value of 0.2 correlation was used in the PCA, any value lower was not included in the components analysis. It was also noted that rare species are not sampled effectively and must be kept in mind in interpreting the results.

A question regarding the relative importance of depth stratification in the PCA was raised. The response indicated that depth-integrated tows should still differentiate in most cases given the strong bathymetric signal that were apparent in the zonal results.

Some of the hypothesized drivers of biogeographic shifts in zooplankton community composition across the Atlantic Zone were highlighted such as spatial temperature/salinity

gradients related to bathymetry, water mass indicators such as nutrient inventories, and the timing of seasonal production cycles of zooplankton taxa. Currently, only the transect data were used in these analyses. Hypotheses are being further developed and explored in relation to a series of potential environmental drivers for both the AZMP standard transects and the fixed stations.

Each PCA axis is worth further exploration given the strong structure in the spring and fall periods.

It was suggested to conduct the PCA on each of the separate standard transects in addition to the entire zone. This reduced spatial scale may be informative by increasing the information content of the analysis compared to the zonal overview.

Non-linear processes have not been investigated to date given the large numbers of variables that are currently being used in the PCA. Further consideration is needed to reduce the number of environmental variables in the PCA analysis.

A question was posed as to the local adaption of zooplankton taxa to specific water masses across the zone. Given the preliminary results of the large scale distribution of common species throughout the zone, one might only expect this to be the case at the extremes of northern versus southern boundary zones.

The workshop participants agreed that the data analysis should be extended to focus on regional (e.g. GSL, SS, and NL) dynamics in addition to the current zonal perspective.

The utility of using indicator species was briefly discussed but would likely be difficult to interpret due to circulation and environmental parameters plus their wide-spread distribution across the AZMP area.

Further detailed examination of regional water mass characteristics was discussed to evaluate the possibility and use of secondary signals and distinctions beyond typical Temperature/Salinity (T/S) properties that are currently used.

A regime shift in the circulation pattern within the GSL was noted in modelling results that may offer some further insights into zooplankton dynamics within this region and will be discussed further later in the workshop.

Consideration for the inclusion of deep water hypoxia was raised since the current analysis only used integrated levels within the upper 50 m. Perhaps, the use of presence/absence of deep water hypoxia could be included into the analysis. This may have more direct relevance in the GSL regional analysis but may also be important in some of the deep basins along the SS and into the GoM (Gulf of Maine).

Interannual signals (trends) from SPERA (Strategic Program for Ecosystem-based Research and Advice) project / zooplankton atlas

Presenter - Catherine Johnson

Abstract

Changes in oceanic gyres and continental shelf circulation can result in regional changes in pelagic habitat characteristics such as temperature, productivity, seasonal timing, or availability of appropriate prey, due to shifts in frontal and biogeographic boundaries. These changes can either reduce or enhance the productivity of fisheries at regional scales. The objective of this project is to develop methods to succinctly communicate information gathered by AZMP about large-scale shifts in pelagic habitat status to clients, focusing on environmental response to large-scale climate forcing, lower trophic level response to climate-driven environmental

variability, and conditions relevant to forage fish production and distribution. Standard data products were generated from the three AZMP regions, including 51 zooplankton taxa in spring and 56in fall and 14 environmental variables. Climatological spatial distributions of zooplankton taxa were summarized in an atlas, and patterns of species association were explored with PCA. The general patterns of variation were similar in spring and fall in terms of spatial distribution of "similar" communities, with the first principal component (PC) associated with depth, the second PC loosely associated with west-east community gradients, and the third PC loosely associated with differences between the Gulf of St. Lawrence and open shelf communities. In PCAs of environmental variables in spring, depth and deep water nutrient concentrations were associated with the first PC, while temperature metrics were associated with the second PC. The opposite was true for fall environmental PCAs. Redundancy analyses (RDA) are in progress to evaluate the variation in zooplankton communities associated with environmental variability. Relationships between potential environmental indicators and metrics of herring recruitment, distribution, and condition were evaluated by comparing herring metrics to the annual, transect-specific zooplankton and environmental PC scores and a suite of other environmental metrics, using correlograms. Preliminary results indicate positive spatial correlations of herring condition among the Scotian Shelf sub-regions and positive correlations among distribution metrics (percent positive tows) for the Central and Western Scotian Shelf and outer Bay of Fundy, but a negative correlation between herring distribution on the Eastern Scotian Shelf and herring condition on the Scotian Shelf. Relationships between biomass and recruitment and between condition and recruitment were found only in the eastern Gulf of Maine and Bay of Fundy locations. The strongest correlations between herring and environmental metrics were for Scotian Shelf herring condition and the first two environmental PCs in the fall. Eastern Scotian Shelf herring distribution also had a strong negative correlation to the second environmental PC in spring, and condition on the Central Scotian Shelf had a strong negative correlation to bottom temperature. Although the influence of environmental variability on herring recruitment, distribution, and condition is complex and likely non-linear, these correlation analyses provide information on the conditions associated with enhanced herring condition.

Discussion/Questions

Questions were raised about how might different life history strategies of zooplankton such as diapause and vertical migration behaviors in some species influence the observed seasonality and distribution patterns. Recirculation gyres may also be at play along with the influence of large-scale current variability. Further detailed analyses along these lines were suggested.

The issue of the skill level of the analyst in taxonomic analyses was raised which may further contribute to the variance and uncertainty in the data analysis.

Further support for dropping the non-identified species in the analysis was raised although one might want to examine the results with inclusion/exclusion of these data to evaluate the relative influence of these changes.

The PCA loadings on the environmental variables can be used to further explore relationships with the lower trophic levels although caution was raised about the use of many input variables that might result in spurious correlations. The use of core metrics identified in the preliminary results such as T/S, nutrient inventories along with additional descriptors of water mass characteristics, bathymetry, ice dynamics, etc., rather than to include the entire suite of environmental variables.

It may be useful to explore certain environmental time series such as ice dynamics that has varied considerably during the zonal monitoring program along with additional evidence of the impact of these changes on higher trophic levels such as keystone species (e.g. capelin).

The use of station-based data versus annually-averaged broad-scale metrics was briefly mentioned. Although the use of station-based indicators may be useful in some circumstances, the reality is fisheries assessments are taking place over large areas over a given year. Sources of error may be of concern for the station based biological indices which should be kept in mind.

Additional support for the inclusion of deep environmental variables into the analysis for the Gulf of St. Lawrence Region but this should also be addressed for the other areas.

It was suggested to examine the deep nutrient inventories and excess inventories of silicate and phosphate in relation to T/S properties of water masses.

It was pointed out that the excess nutrient signals can be noisy and variable. Seasonality is easier to capture at the fixed stations compared to the standard transects across the zone.

A publication submission on multivariate patterns in zooplankton using the unconstrained/constrained analysis, presence/absence, and distance methods was suggested.

A research document is in preparation for the lower trophic levels with the herring assessment on the Scotian Shelf and should be available shortly. A Letter of Intent is currently under consideration to expand the analysis to other fish populations with focus on the environmental signals in 2012 which was considered to be near extreme levels on the Scotian Shelf and GoM areas.

Publication of the zooplankton atlas was mentioned but the type of publication is still under consideration.

The need to revisit the major themes of the zooplankton synthesis is needed to refocus additional efforts.

It was suggested to produce regional animations although complicated by missing observations in some regions in certain years.

Lastly, data management issues were raised that require further attention. How do we effectively get this information made available to all stakeholders via the AZMP web site was briefly discussed.

SESSION 2 – AZMP SYNTHESIS WORKSHOP, 19 MARCH 2013

Rapporteur – Stéphane Plourde

Progress to date on coupled biogeochemical model of GSL and overview of ACCASP projections of nutrient trends

Presenter - Diane Lavoie

Abstract

Many improvements were made to the coupled model in 2012-13. Improvements were brought to the physical model (transport, surface fluxes, penetration of shortwave radiation) to obtain a better fit between observed and simulated sea ice and to obtain a better vertical structure of the temperature and salinity fields in the Gulf of St. Lawrence. A mask, isolating the GSL from the more oceanic part of the model was implemented to apply specific parameterization of light use by the phytoplankton to obtain correct timing of the bloom over the whole domain. Nitrate was added at the Quebec City boundary and open boundary conditions for the oceanic domain were redone after some problems were detected. The oxygen subroutine was added to the model. The database for the validation of model output (AZMP transects) was extended to the Scotian Shelf and new Matlab validation scripts were prepared (different grid, indices). After many problems with the servers this year, we were finally able to perform a 6-years simulation with the coupled model. The preliminary results were very encouraging and the observed discrepancies between model and observations (phytoplankton growing at greater depths than observed in some regions, bloom too strong in slope waters) should be much reduced after adjustment of the biological model parameterization. Future nutrient (nitrate) trends for the Northwest Atlantic obtained from 5 global climate models were also presented. The multi-model ensemble mean shows a decreasing trend over the next 50 years. However, some model results diverge and the standard deviation of the multi-model ensemble mean is higher than the mean trend. The confidence in these results is thus low.

Discussion/Questions

A participant asked which physical model was used and if it has been validated. The speaker specified that the OPA (Ocean PArallelise) model adapted by DFO was used and it has been validated.

A participant wanted to have some precisions on how the model was seeded with the ‘krill-like’ particles. The speaker mentioned that particles were seeded in all model cells from the bottom to surface according to observed vertical distribution and the results were presented as the integrated number of particles in the water column.

The speaker was asked about the main forcing agent explaining the general circulation pattern (seasonal shift in summer) observed. The answer was the pressure gradient between the freshwater discharges from the St. Lawrence River and the water intrusion at the Strait of Belle Isle.

The speaker pointed out that modification to the transport just south of Newfoundland improved simulation of sea ice, a modification that caught the attention of several participants. During the same discussion, it was pointed out that the marked difference in simulated *chlorophyll a* biomass between the Scotian Shelf and the Slope Water region should have been caused by parameters in the nutrient, phytoplankton, zooplankton, and detritus (NPZD) model since the physical model has shown relatively coherent results with observations.

A participant asked if the goal of the 12 years simulation is to simulate AZMP period. The speaker answered that the ultimate goal is to support integration of field data and investigate the processes responsible for observed trend and/or interannual variability

A participant asked if results obtained with the coupled NPZD model have been compared with field data collected on AZMP lines. The answer was affirmative and the speaker mentioned that differences between the model results and field observations will be pointed out in the Research Document.

A participant mentioned that nutrients levels at the Gulf Stream boundary could explain the much higher chlorophyll *a* biomass simulated in the Slope Water region. The speaker noted that the boundary conditions with the Gulf Stream are problematic and that we need more data at these boundary conditions.

A participant suggested doing the scorecards with modeled results. The speaker (and participants) agreed it would be interesting and useful to target problems, and to highlight the good results.

The speaker brought the issues with Shared Services and the modeling capacity as the modeling group in the Quebec Region experienced several problems over the last year. The speaker mentioned that they are in search of a real solution with Shared Services, but it is not easy. A general discussion about computing capacity needed to run simulations with a full 3D bio-physical NPZD model and the possibility of using Centre for Ocean Model Development for Applications' (COMDA) High Performance Computers at Bedford Institute of Oceanography (BIO) followed. This would however lead to new problems as the model output need to be transferred to IML for post-processing and the internet connections are very slow (could take up to 5 days to transfer results).

A participant asked if the advection of sea ice through the Strait of Belle-Isle was taken into account in the model. The speaker and some participants answered that this is not the case, that the sea ice in the Mecatina Trough region is formed locally. The addition of a sea ice boundary condition at Belle-Isle would represent a minor improvement to the simulated sea ice in the GSL.

General model result and analyses of seasonal cycle variability

Presenter – David Brickman

Abstract

The presentation included 3 main sections:

1. a report on simulations on a model domain that includes the NL shelf regions – the Atlantic Canada (AC) domain;
2. a simulation of the AZMP years (1999-present) was achieved on the AC domain. However, due to various factors, this simulation constituted a preliminary result; and
3. refinements of AC domain simulations will continue in FY 2013-14.

Results of model simulations on the Maritime Canada (MC) domain for 1999-2012, including data assimilation were summarized. The simulation this year benefited from a more complete set of TS profiles for years 2005-2012 obtained from Roger Pettipas increased the data assimilated for these years from approximately 250 to about 6000 profiles/yr. Two analyses from this simulation were presented. An analysis of seasonal cycle variability at the fixed stations in the GSL/SS: The model simulations at the 6 fixed stations was analyzed to determine the day-of-year (DOY) of the temperature minimum and maximum and the duration of the seasonal cycle (DOY(Tmax-Tmin)) on an annual basis. The slope of the duration was

determined over the 14 year period, for the surface, mid-depth and bottom of the water column. Results: Only 4 of the 18 possible calculations showed non-zero slopes. No obvious pattern was evident. Of these 4, surface temperature at Hfx-2, P5, and Rimouski stations showed decreases in the duration of the seasonal cycle of 17, 22, 27 days/decade respectively. The slope of the duration showed an increase in seasonal cycle duration of 20 d/decade for the bottom depth.

Analysis of model transports through the Cabot Strait, Halifax, and Bonavista Bay sections: Nearshore transports were computed as a measure of flow through the system from the southern GSL to the GoM. Shelfbreak transport was computed for the Hfx section. Standardized anomaly plots were constructed for these 14 y timeseries which will be included in the SS Research Document.

Discussion/Questions

A participant asked about the forcing of the physical model (for the AC domain), in particular about freshwater river runoff. The speaker answered that there was no river runoff in the model but he was not sure if the St. Lawrence River was also not considered.

The speaker was asked if comparisons between some modeled results have been done similar to modeled information included each year in the State of the GSL. The speaker answered that such comparisons have not been carried out yet (for the AC domain).

A participant wanted to have some explanation about the physical processes driving the changes in seasonality of the different temperature indices. The speaker responded that to that point, no clear answer was possible and multiple forcings are likely involved.

Participants and speaker then discussed about some issues associated with determining DOY min/max at bottom at Shediac station.

A participant pointed out that de-correlation at surface appeared relatively small in the regional model relative to the physical coherences in AZMP indices such those observed on the Flemish Cap and Bonavista AZMP lines. The speaker mentioned that the model calculations removed the seasonal cycle, leaving correlated responses at daily timescales, whereas AZMP analyses are influenced by longer (seasonal) timescales.

A participant pointed out that more comparisons with transports (currents) data would be useful for the model validation. The speaker mentioned that the model has been already validated. A participant mentioned that additional Acoustic Doppler Current Profiler (ADCP) data might be available on Halifax line. Another participant suggested using ADCP on ships, but the speaker and the participants agreed that such data would provide only a snapshot and that data treatment would be difficult.

The speaker was asked about the potential extension of the model over the entire Atlantic Canada domain in the context of data availability to define boundary conditions to the north (Seal Island transect). The speaker answered that such data are still mostly limited and it represents a problem when considering extending the model domain to include the Newfoundland and Labrador shelf.

The speaker pointed out that the lack of velocity/transport data at the Strait of Belle Isle is another problem that limits model performance/validation. A participant informed the attendance that an ADCP has been moored in the Strait of Belle Isle over the last few years, and mentioned that data should be available through Quebec Region data service. Another participant pointed out that tidal gages located in the Strait of Belle Isles could help calculating transport. The speaker pointed out, and the audience agreed, that quasi real-time monitoring of this region would be most important.

A question was then asked about the potential of using satellite altimetry for estimating inflow at the Strait of Belle Isle. A participant answered that the spatial resolution of satellite is not good enough at this short spatial scale. The success in using this technology to estimate transport in the North East Pacific (Kushiro Current) was mentioned, although applying this approach in offshore locations such as the Labrador Current and the Tail of Grand Banks would be more difficult.

A participant asked if the speaker was confident with the modeled transports in the Northeast Channel and on the Browns Bank line. The speaker answered that these results were highly reliable.

Investigating the connectivity between AZMP fixed stations

Presenters - Joel Chassé and Nicolas Lambert

Abstract

The spatio-temporal connectivity of AZMP fixed stations is investigated using virtual particles (VPs) released in a 3D hydrodynamic model of GSL-SS-GOM. The goal of the study is to determine the origin of the water passing by a 10 km x 10 km box centered on each fixed station and calculate the e-folding distance, i.e. the connectivity kernel.

VPs were released every two-weeks and everywhere in the model domain and then followed in time for up to two to six weeks. Simulations were covering six years (2006-11) and results were analysed by season. The VPs passing by each fixed station were identified for 2, 4 and 6 week periods and the distance from the VP release position was calculated. Distances were then binned by 5 km intervals and the e-folding distance calculated for each season. Concentration plots of the origin of particles were made.

At Rimouski fixed station the e-folding distances for (Winter, Spring, Summer, Fall) are (71, 100, 109, 76) km on average during the six years simulated for VPs followed over a time period of 2 weeks. The Gaspe Current fixed station shows larger spatial scales with (232, 178, 264, 219) km while the Anticosti Gyre station has shorter scales calculated as (58, 56, 57, 65) km. At Shediac Valley fixed station, in the Southern Gulf, the spatial scales are (64, 56, 136, 113) km. On the Scotian Shelf, Station 2 exhibits relatively large scales with values of (247, 148, 98, 184) km. The shortest scales are calculated for Prince 5 station in the Fundy Bay with values of (30, 33, 34, 32) km.

The spatial scales don't seem to have much sensitivity to the length of time the VPs are followed as shown by the calculation of the e-folding distance calculated over 4 and 6 weeks.

Discussion/Questions

A participant asked the depth at which connectivity was evaluated. The speaker answered that they used the 3 m depth as an indicator of the surface layer.

A participant mentioned that the connectivity estimated at longer time scales (4-6 weeks), which corresponded to the generation time or development time at surface of several zooplankton species, appeared to cover broader spatial scales. The speaker answered that the differences in e-folding distances estimated after 2, 4 and 6 weeks were not tremendous.

A participant pointed out that these results indicated a relatively high degree of connectivity among fixed stations in the GSL, which would also contribute to the comparison exercise performed among the fixed stations to be presented later during the workshop.

A participant mentioned that it could be difficult to infer impacts of connectivity on zooplankton population dynamics based on this method due to variable vertical distribution and diel vertical migrations among individuals and/or development stages and species.

Short-term variability in environmental conditions at S27

Presenter - Eugene Colbourne

Abstract

The results of a diel study at Station 27 during July of 2012 indicate that tidal effects are important in the top 100 m of the water column during the summer when temperature and salinity gradients are significant. The vertically averaged 0 to 50 m temperature/salinity ranged from 4 -6 °C and 0.2 PSU between tidal cycles. Thermocline displacements of 10 m were observed due to vertical wave velocities associated with barotropic tides that amounted to 1.7 m/hr. The depth of maximum fluorescence also varied by up to 15 m between tidal cycles indicating that biochemical measurements at fixed depths may also be effected. There was no apparent effect on zooplankton sampling or other full depth integrated variables. Comparison to similar measurements in the offshore indicates that tides are major source of noise in water property measurements both inshore and offshore with observed variability of the same order as climatological variability. Advection also plays an important role especially in offshore waters where horizontal currents are strong. It is suggested that some of the high frequency variability present in time series of physical variables may be due to tidal effects.

Discussion/Questions

A participant wanted to know how far from the shore is located the station. The speaker answered that the most important feature to consider was the strong bottom slope and much higher velocities at the station relative to a site located on a flat bottom.

A participant pointed out that the observed dynamics suggests problems in describing indices at fixed sites when using only few observations. The speaker and other participants acknowledged that temporal resolution of sampling relative to the tidal cycles is one on these potential problems.

A participant noted that it would have been interesting to explore the impacts of high frequency forcing events over variables averaged over greater depth intervals (ex: ‘shallow’ and ‘deep’ waters). The speaker agreed and suggested this could be explored over the next year.

The participants proposed that performing a similar analysis at other fixed sites would be useful and could contribute to the interpretation of bio-chemical data collected at these sites. A participant mentioned that while assessing the impact of sampling the Rimouski station every two weeks instead on a weekly basis they have noticed a tendency of consistent bias in sampling during some years that could have been associated to the tidal cycle.

A participant mentioned that using modeled tidal amplitude could be useful for the exercise and was asked if it would be possible to do it for other depths. The participant answered that it would be easy.

General Discussion

These presentations were followed by a discussion about three topics:

1. assessment of how representative fixed site conditions are of broader scale conditions;
2. model survey inter-comparison (probably for the longer term could include gap analysis); and
3. T/S, nutrient, chlorophyll data among regions.

The participants agreed that models are at a stage of development showing their potential to help results integration, but not yet in a stage that would allow their use in a general and holistic way.

A participant asked if the model could be used to fill the spatial and temporal data gaps as part of an ACCASP (Aquatic Climate Change Adaptation Services Program) project aiming at exploring the potential effects of bio-physicval environmental conditions in 2012 on herring. Another participant pointed out that more than 3500 conductivity-temperature-depth (CTD) profiles have been already assimilated in model simulations for 2012, but of course additional data could contribute to improve and have a more complete simulation. They agreed to have further discussions if the project funded in 2013-14.

The group discussed the potential of reconstructing AZMP data (fill the gaps) with the models. The conclusion was that the models were not there yet. Physical and bio-chemical model are improving but they are not yet operational.

The discussion about models development was followed by a discussion about field data availability to support this development. A participant pointed out that there are more CTD data available than those posted on the AZMP website. The group agreed that there is an urgent need to make field data necessary for model development and validation more easily available, a point that has been noted by Data Management representatives from different regions. All participants concluded that making these field data more easily accessible to DFO scientists is a high priority (to be discussed later on during the workshop).

SESSION 3 – AZMP BUSINESS MEETING, 19 MARCH 2013

Rapporteur – Benoit Casault

Overview of Data Management - Identifying Ways Forward

Presenter - Laure Devine

Abstract

The AZMP data management subcommittee is composed of the following members: M. Ouellet (Integrated Science Data Management – ISDM), S. Bond (BIO), D. Senciall (Northwest Atlantic Fisheries Centre – NAFC), and L. Devine (Institut Maurice Lamontagne – IML). The responsibilities of the data management subcommittee include:

- to maintain an inventory and to inform on the current status of collected data;
- to perform quality control (QC) of CTD and bottle data;
- to archive data;
- to facilitate access to data;
- to publicize the existence of data; and
- to exchange data with other data centers.

The main issues and challenges faced by the subcommittee with respect to its mandate are summarized as follows:

1. Inventory and current status of collected data:

Keeping an up-to-date data inventory seems simple, yet only two of the three regions have completed this task. All regions are encouraged to complete a data inventory and make it available to all AZMP personnel. Data inventories are currently available on the Virtual Data Center (VDC) and/or the AZMP website. However, due to issues with both the VDC (functionality, low participation) and the AZMP website (outdated status), it is suggested that a Wiki site would be the best forum for hosting a complete data inventory in the future. It is recommended that all regions complete a data inventory starting in 2012 and moving backward. Individual data inventories should consist in spreadsheet-like documents including details such as cruise identifier, dates, scientist in charge, type and status of data collected.

2. Quality control of CTD and bottle data:

All labs have been provided with QC procedures that have been used by IML for over 10 years. Some preliminary work has been done by looking at tests and adapting procedures in order to standardize QC across regions but there has been no concrete progress at this time. QC of plankton data remains challenging for reasons such as species name standardization (e.g. use of WoRMS (World Register of Marine Species) aphia names and ID) and the identification of new species. Data QC involves a great deal of effort, has a high priority, and has had very little success. The little success attributed to QC is mostly because it is a difficult process to implement at first, which process, however, becomes easier over time.

3. Data archiving:

Problems with data archiving stem essentially from:

i) archiving of non-QC data;

ii) archiving of QC but undocumented data;

iii) archiving of backlogged data; and

iv) archiving of plankton data.

BIO and IML regularly archive bottle and plankton data in BioChem and send CTD data to ISDM. NAFC sends CTD and bottle data to ISDM on CD-ROM about once a year. Only data from IML include quality flags that can be traced back to documented quality tests performed on the data. IML is currently working with NAFC to start QC and loading of bottle data to BioChem. Data archiving involves a great deal of effort, has a high priority, and has had moderate success.

4. Access to data:

All AZMP data are available but from several sources. These sources are either: i) freely accessible (AZMP website); ii) special request (ISDM archives); or iii) registered user access (BioChem, BIO's Climate, IML's ODMS). The ultimate goal is to ensure easy data availability while avoiding duplication of effort in providing data access. Only the CTD and bottle data from AZMP stations and sections at ISDM are available by direct query; for data collected at other locations or prior to AZMP, a form must be filled, which results in a query that must be run by ISDM personnel with a few business days delay. The AZMP website needs to be redesigned to make it more efficient and easier to maintain. Consideration is also given to abandon value-added products from the website that are hard to update and of little use. The BioChem database also requires a few updates:

i) need to complete the documentation;

ii) need for a corporate address to the application for questions and comments;

iii) need for mapping BioChem species codes to WoRMS aphia ID to resolve taxonomic names issues and to facilitate taxa grouping; and

iv) need to increase data accessibility through common queries (e.g. residing on a Wiki site) while avoiding the use of the quirky BioChem query application. Data access involves a great deal of effort, has a high priority, and has had moderate success.

5. Data discovery:

Data discovery is not a high priority and is adequately handled. The program is publicized on the AZMP website and is included in the National Metadata Entry and Search Tool currently only accessible within DFO.

6. Data exchange:

Data exchange with other data centres is handled by ISDM (exchange with US NODC/IODE, WMO-GTS, EC, ICES) and BIO (CCHDO, CDIAC). The exchange of real-time temperature and salinity data on the GTS during AZMP sampling has generally improved in 2012 compared to 2011, except along the Halifax and Louisbourg sections due to logistic reasons.

The main hurdles that explain some of the problems associated with data management can be summarized as follows:

i) Lack of dedicated data management personnel

ii) Desire to QC data before loading

iii) Sheer volume of data to be loaded considered overwhelming

iv) Data loading procedures are unclear

v) Lack of expertise with software involved in data loading

vi) Inexistent funding for the upgrade/maintenance of the AZMP website

vii) Data management not treated as a priority across regions

The short term priorities identified by the data management subcommittee consist in:

i) complete the data inventory;

ii) implement data quality control in noncompliant regions; and

iii) continue efforts toward data archiving. Some of these priorities were addressed in a breakout session for which a summary is presented in this document.

It is unanimously recognized that all steps of the data management process, from data collection, processing, archiving to data access, are vital to the AZMP program. It is also acknowledged that the overall data management process is not working in an optimal manner which has to be addressed on a priority basis and across all regions. The main challenge is to convince regional directors that issues with data management must be pursued and sustainable solutions must be identified and supported by regional directors. The potential impacts of deficient data management on the delivery of other programs also add to the urgency of implementing solutions to this persistent problem.

Breakout Discussion - Data Management

Shelley Bond

The breakout discussion on data management included the following participants: M. Ouellet (ISDM), L. Devine (IML), D. Brickman (BIO), D. Hebert (BIO), C. Johnson (BIO), J.-F. St-Pierre (IML), B. Casault (BIO), P. Pepin (NAFC), and S. Bond (BIO). The goal of the breakout session was to focus on identifying “pinch points” relating to data management and suggesting solutions to address these issues.

The discussion focussed on the following primary issues:

1. Data access from ISDM:

The AZMP website provides physical and biological oceanographic data at only the fixed AZMP stations and the AZMP sections. To access other data, users need to fill a data request form which takes a few business days to process. There is a strong need to enable data users to access the data themselves through live queries on all data archived at ISDM with a faster turnaround. This is not just an AZMP problem, but a national science data management problem because the data archived at ISDM are not just collected for and used within AZMP. A resolution to this issue will require a great deal of resources and efforts to be expended within ISDM. The recommendation of the group is to have pressure put on ISDM from above in order to raise this as a priority. There are two possible avenues to have this brought to the forefront of priorities, through the National Science Data Management Committee (NSDMC) representatives or through the National Science Directors Committee (NSDC).

2. AZMP website:

The AZMP website was developed in 1999. The approach used at the time was to generate the contents and web pages offline, and present them on the web as a group of static pages. This technology is not appropriate for many reasons, one being the fast evolution of web standards required by the Treasury Board. As a result, many urgent fixes were applied through the years to make the website more dynamic and enable edits for standards compliance. These fixes now sum to a considerable technical debt. The content generation component of the website also accesses a server whose connectivity with other servers is jeopardized as IMTS are moving to virtual machines. The web content generation procedure presents several points of failure due to these connectivity issues, and due to the increasing sheer volume of data to process over the years. The website also requires manual updates and hands-on data reformatting for datasets which

are updated on a quarterly and yearly basis, and this remains as an additional strain on the resources. This has resulted in a website that is no longer sustainable. A great deal of effort is expended toward updating the site and applying fixes in order to make the site work. This results in frustration for both the users and the current site maintainer, especially since no other resources at ISDM are directed to solve this issue because the current website is seen as functional. Pressure needs to come from outside of ISDM to resolve this issue and to have a replacement site developed. Once developed, ideally a trained webmaster would be available to maintain the site, removing this task from M. Ouellet and allowing him more time to focus on the data itself. This issue should be brought forward to the NSDMC and NSDC.

3. Data management/throughput:

There are a variety of issues in each of the regions regarding data management. These include personnel attrition and lack of knowledgeable resources. NAFC in particular is suffering from a serious lack of skilled technical resources in order to deal with the data. The recent loss of CS staff to IM&TS also impacts the ability to perform the required work. NAFC has in the past provided bottle data to IML for processing and loading to BioChem and will do so again in an effort to move forward. However, the current resource for dealing with these data is on maternity leave and there is concern regarding the future of data management in this region. Also discussed were the differences between regions on the quality control procedures utilized. IML has provided a suite of scripts and templates currently used at that lab to both BIO and NAFC. BIO plans on implementing these as part of their standard quality control procedures. It appears that a number of the same issues regarding data management are raised every year. In an effort to address this, the data management subcommittee will develop a project plan. This plan will include milestones, effort estimates, and perceived priorities. The plan will be submitted to the AZMP management committee for their input and final approval. Members of the subcommittee will also communicate regularly in order to maintain focus, improve communication, and share knowledge. One of the goals of these meetings will be to offer support, to identify best practices, and to facilitate improvement in all areas of data management pertaining to AZMP.

4. Access to BioChem Data:

It was brought up that the BioChem query application does not fully meet user needs. For example, a query to return all data from one mission did not in fact provide all of the data, and it took six months to get a response back on this issue from ISDM. It was agreed that other methods to retrieve data should be explored. B. Casault has developed Matlab scripts to get bottle and plankton data archived in BioChem for analysis and that group is happy with the results. During 2013-14, S. Bond will be performing an analysis of the current BioChem content to look for issues and identify solutions. As part of this exercise, data products (Oracle views) will be developed to facilitate data access by DFO users. Ultimately these views may be accessed through the Virtual Data Centre (VDC), once rolled out.

5. Communication:

Participants agreed that there must be an improved method for communicating and sharing methods and processes relating to data management. The use of a Wiki site was agreed upon. ISDM has one available but it requires a username and password. The VDC was also mentioned as an option although it is not currently in production. GCPedia was also mentioned as a possible solution and this Wiki site is available to the entire Government of Canada

Issues Facing Logistics Group and Continued Operations

Gary Maillet

Abstract

The AZMP logistics subcommittee is composed of the following members: J. Spry, BIO; F. Villeneuve, IML; and G. Maillet, NAFC. The responsibilities of the logistics subcommittee consist of reviewing the main challenges and priorities for field and laboratory activities along with options and recommendations to ensure efficient running of the program.

The main issues for logistic operations include:

1. **Staffing:**

   The loss of key personnel through attrition and retirement along with its associated extensive knowledge base may have significant impacts on future operations. Solutions envisaged for minimizing potential impacts of personnel loss include:

   i) collaboration with other groups although this has proven challenging at times (e.g. Maritimes region);

   ii) overlap between affected and incoming staff to ease the transfer of knowledge; and

   iii) igathering of relevant information (e.g. methods/procedures documentation) prior to termination or reallocation of affected staff.

2. **Equipment renewal:**

   The renewal of major equipment for field and laboratory operations is necessary in order to maintain and sustain zonal operations. The equipment and instrumentation now in use across the Atlantic Zone were largely inherited from earlier science programs, have now well exceeded their normal life expectancy in many cases, and are susceptible to failure. Solutions proposed to ensure equipment availability include:

   i. continued efforts in seeking funds for equipment renewal through various channels (e.g. yearly “unused” funds, ISN submission); and

   ii. acquisition of versatile equipment (e.g. mini rosette) that can accommodate other programs/platforms sampling activities.

3. **Sampling:**

   Sampling of the AZMP fixed stations at some remote locations during winter has been challenging in some regions due to a lack of properly equipped CCG platforms for gear deployment and availability of vessels during this period. Different options are being explored to resolve access to vessels for occupations of the fixed sites and they include: i) planning for fixed stations occupations to be part of sea trial expeditions; ii) use of remote platforms for fixed stations sampling; and iii) reassess the status of designated stations from fixed to transect stations (see Québec’s proposal below) .

   Another issue faced by the logistics subcommittee is the end in 2012 of the funding allocated to the Continuous Plankton Recorder (CPR) program. Failure to secure CPR funds in the future will results in gaps in the existing data time series.

   As part of its regular activities, it was suggested that the logistics subcommittee be responsible for the following tasks: i) prepare documentation of the various measurement methods used in AZMP; ii) oversee the distribution of tools for data access and processing; and iii) investigate the possibility of securing external sources of funding (e.g. Department of National Defense).

Major equipment for field and laboratory operations is critical to the delivery of the AZMP program. The priority for the logistics subcommittee with respect to equipment renewal is to clearly identify in what ways equipment availability and or equipment limitations affect the delivery of the AZMP program as well as that of other groups (either clients or collaborators). The issue of equipment renewal was addressed in a breakout session for which a summary is presented in this document.

Update of Major Capital Submission

Pierre Pepin

Abstract

An Investment Summary Note (ISN) was submitted in 2012 for the acquisition of new equipment. The ISN seeks a fund of $2.5 M to be spread over a five year period. A decision is expected in the near future and if accepted, will require a plan of action to be put together by the logistics subcommittee.

Remote Sensing, Data Products, Issues

Pierre Larouche

Abstract

Oceans are facing intense forcing by climate change that will impact all components of the ecosystem. Many spatial and temporal scales are present in the oceans making difficult the comprehension of the ecosystem based on in-situ localized measurements. In order to monitor such a complex environment, DFO needs a comprehensive approach making use of all available tools. Remote sensing is one of the best tools to study spatial variability and a very good one to study temporal variability.

Remote sensing can provide important information about physical, biological, chemical and geological parameters. A general overview of the various sensors available to oceanographers was presented along with applications in each of the above fields. In particular, sensors were presented for the following parameters:

- Ice distribution and volume
- Sea surface temperature
- Sea surface salinity
- Surface currents
- Phytoplankton biomass
- Habitat characterization
- Colored dissolved organic matter (dissolved organic carbon)
- Total suspended matter

A list of major websites available for data access was presented with special mention of the NASA website.

Some of the main issues associated with remote sensing were identified as:

Many products only work well in the open ocean. However, there is a need for better knowledge of coastal waters optical properties to better use remote sensing products.

Spatial resolution is a concern for near shore studies.

Arctic (subarctic) waters have different biological/optical properties that need specific solutions for some parameters such as the phytoplankton biomass that is prone to errors due to the contamination of the radiometric signal due to freshwater.

Sensors have short life span (5-10 years) meaning that merged data sets are necessary for the generation of long time series.

The use of remote sensing is recognized as a valuable tool in complementing the AZMP in-situ sampling activities. In order to take advantage of the wealth of remote sensing data and derived products, it is necessary to identify those that are relevant to AZMP and at the same time easily accessible. It is also necessary to implement measures that ensure optimal use of remote sensing data/products (e.g. adopting of a data format convenient to data access/sharing; validation against local in-situ measurements). Such issues were addressed in a breakout session for which a summary is presented in the next section of this document.

AZMP Remote Sensing Products

Carla Caverhill

Abstract

The most striking feature noted in the satellite data for the Atlantic Zone in 2012 was the high sea surface temperature (SST) anomalies indicative of a very warm year. In many areas where the SST anomaly was high, the chlorophyll anomaly was negative. The chlorophyll anomaly is now calculated as a normalized anomaly by dividing by the standard deviation of the climatology. Normalized anomalies are not yet offered on the website but are available on the ftp server.

Medium Resolution Imaging Spectrometer (MERIS) Reduced Resolution (1 km) Algal-1 bi -weekly composites for the North Atlantic have been created and are another source of ocean colour data for AZMP. The images are posted on the BIO website and the statistics are available on the ftp server. As with MODIS (Moderate Resolution Imaging Spectroradiometer), GEOTIFF format is also an option. The MERIS mission started in 2002 and the satellite died in April 2012.

Last year, it was noted that MODIS chlorophyll estimates were unreliable for 2011 and part of 2010 due to sensor drift. There was a reprocessing of MODIS ocean colour data in May 2012, after which all the AZMP composites and statistics for the MODIS mission were recalculated. The reprocessed data resulted in higher chlorophyll values in 2011. The most dramatic changes were seen in spring and fall.

MODIS calcite (8-day 4km resolution) values have been summarized for the satellite boxes for the duration of the MODIS mission (2002-present). These values will be available on the ftp server. Also, spring bloom fitting has been completed for the satellite boxes using MODIS and SeaWiFS (Sea-Viewing Wide Field-of-View Sensor) data. It is recommended that SeaWiFS data be used for the 2003-2007 period, after which MODIS data should be used. We also plan to fit the MERIS dataset, as well as fall blooms for the three missions. The fitting was done with a Gaussian curve superimposed on a constant background, assuming the bloom to start and end when biomass reached 20% of the peak. The approach is similar to that used by Zhai *et al*. (Phytoplankton phenology on the Scotian Shelf. ICES Journal of Marine Science (2011), 68(4), 781–791), except that the parameter βt is not used. The “20 %” parameter affects the calculation of the timing and duration of the bloom but not the bloom magnitude.

A primary production calculation has been completed for 1998-2010 for all Canadian waters. It is a monthly estimate on a 4 km spatial grid. It uses SeaWiFS chlorophyll data and Pathfinder 5.2 SST data as input, as well as ship-based measurements of the vertical distribution of

phytoplankton and its photosynthetic response to light. It was found that the Pathfinder 5.2 data have lower values than the SST data that were used in the previous primary production estimate. The lower temperatures result in lower PI parameters being retrieved from the archive and hence lower primary production values. This is still an evaluation dataset, and will be released after further testing and validation.

The MODIS ice flag is being evaluated. It appears that the turbidity and shallow water flags also have to be used in order to give realistic ice values, but this is still being tested and compared with ice values from the Canadian Ice Service.

Many improvements have been rolled out onto the BIO website. The additions include the SeaWiFS 4 km weekly dataset for the expanded region, MERIS RR semi-monthly composites, and anomaly and climatology maps for all products. The address for the ftp server (formerly starfish) has changed.

Plans for 2013 include making the new products available on the website and ftp server and beginning a comprehensive satellite/in-situ data matchup and validation. We have also submitted a proposal to begin providing ocean colour products (chlorophyll and primary production) for all Canadian waters to the St. Lawrence Global Observatory website.

Regional Summary of Activities

Gary Maillet, Jeff Spry and Peter Galbraith

Abstract

Newfoundland and Labrador region

The 2012 seasonal oceanographic surveys resulted in good coverage of the standard transects during spring and fall, with good success at collecting hydrographic, bottle and plankton data. As in previous years, sampling at Station 27 was low during winter but also slightly lower than usual during summer. The spring (April-June) and fall (October-December) multi-species bottom trawl surveys also resulted in good coverage and consideration is being given to expand sampling on future trawl surveys through the implementation of new equipment. The overall sampling program for the Newfoundland and Labrador region for 2012 was considered successful.

Sample analysis in the Newfoundland and Labrador region is faced with two main issues: i) limited expertise in the analysis of phytoplankton samples; and ii) significant portion (~ $ 40 K) of the overall budget spent on the analysis of zooplankton samples.

Maritimes region

The 2012 spring oceanographic survey was cancelled due to the unavailability of the Hudson. This also impacted the Labrador Sea mission which took place aboard the Martha Black but for which sampling on the extended Halifax transect was also cancelled. The fall survey resulted in good coverage of the core transect stations as well as additional areas (e.g. Gully, Peter Smith Line). Sampling at Station 2 and Prince 5 was also good with 20 and 12 occupations, respectively. The winter (February-March) and summer (July-August) multi-species bottom trawl surveys also resulted in good coverage, with the Halifax transect being sampled in late March (i.e. about one month earlier than typically done during the spring AZMP surveys) to compensate for the cancelled spring survey. The overall sampling program for the Maritimes region for 2012 was considered adequate considering the loss of the spring survey.

Sample analysis in the Maritimes region is also faced with two main issues: i) limited personnel resource for the analysis of phytoplankton samples with the consequence that only fixed stations samples are being analyzed; and ii) significant portion of the overall budget spent on the analysis of zooplankton samples. As stated above, the end in 2012 of the funding allocated to the Continuous Plankton Recorder (CPR) program is also a significant issue for the Maritimes region.

The outlook for 2013 suggests that the winter multi-species bottom trawl survey will be shortened compared to previous years but the other sampling activities should proceed as anticipated.

Québec region

This last year has seen many changes in personnel affected to AZMP duties in the Québec Region. Michel Harvey (analysis and interpretation subcommittee; responsible for zooplankton analysis and production of the annual research document) went on sick leave and was replaced by Stéphane Plourde. Alain Gagné (Regional logistics lead) has retired and was replaced by François Villeneuve. Jacques Gagné (Regional lead) has retired and Peter Galbraith, the only remaining PMCC member from the region, has taken on this role.

Good sampling coverage was achieved in 2012 at the fixed stations (Rimouski: spring to fall; Gaspé Current; Anticosti Gyre; and Shediac: shared with Maritimes), the spring and fall AZMP surveys, and the fall (September-October) bottom trawl survey. Extra year-end funding was made available for the March helicopter survey which resulted in extended sampling coverage. Moreover, extra sampling coverage was also achieved during the fall AZMP survey.

The Québec region will be using this year's meeting to present analyses showing that the Gaspé Current and Anticosti Gyre fixed stations are sampling the same general physical and zooplankton properties as at the more accessible Rimouski station. The Québec region is proposing to drop these fixed stations and officially adopt Rimouski as the region's unique fixed station with an attempt to sample it year round. It is important to note that both the Gaspé Current and Anticosti Gyre stations are to remain part of the region's standard transects and will be sampled at about the same frequency as in recent years. It was pointed out that sampling at the Rimouski station was never funded directly by AZMP but under other programs.

SESSION 4 – REVIEW OF PHYSICAL AND BIOGEOCHEMICAL CONDITIONS IN THE NORTHWEST ATLANTIC, 20 MARCH 2013

Rapporteur – Laure Devine

Review of physical and biogeochemical conditions in the Northwest Atlantic

Presenter – Blair Greenan

Abstract

The North Atlantic Oscillation (NAO) index for the 2011–12 Dec-Jan-Feb (DJF) period was strongly positive (12 mbar). This followed two years of negative NAO, with the 2009–10 value being a record low n the time series. The NCEP (National Center for Environmental Prediction) reanalysis of surface air temperature for this period indicated below normal conditions with an anomaly of 0 to -2 °C in the Labrador Sea during the winter period; for the summer period, the anomaly was positive with a range of approximately 1–3 °C; the fall period is characterized by a strong positive anomaly of 4–6 °C in the Baffin Bay/Davis Strait area north of the Labrador Sea. Sea surface temperature (SST) anomalies in the Labrador Sea followed the pattern observed in the air temperature, being negative (0 to -1 °C) in the winter and positive (1 to 3 °C) in the summer. The Labrador Shelf ice anomaly was below normal in Jan-Feb 2012 (reference period: 1979–2000). Sea ice conditions on the northern Labrador Sea/Davis Strait area were well above normal in March 2012.

The annual AZOMP (Atlantic Zone Off-Shelf Monitoring Program) survey of the AR7W Line in the Labrador Sea took place on CCGS *Martha Black* during the period of 2–17 Jun 2012. This survey typically takes place on the CCGS *Hudson*, but that vessel was unavailable due to scheduling of its refit. This survey also normally includes sampling of the Extended Halifax Line (XHL) to monitor variability on the Scotian Rise in the deep western boundary flows of the NW Atlantic and to obtain additional information on oceanographic and lower-trophic-level variability of the Slope Water affecting the Scotian and adjacent shelves; however, this did not take place in 2012 due to the limited time available on the CCGS *Martha Black*.

Physical oceanography measurements along AR7W indicate that the winter convection in the central basin of the Labrador Sea occurred to approximately 1400 m depth in 2012; this is consistent with the observation of below normal air temperatures in the winter period. Wintertime convention was very limited in 2010 and 2011 due to warm winter conditions. The depth of the 2012 convection is the deepest observed since the event of 2008. The lack of winter convection was also confirmed from Argo drifter profiles in the Labrador Sea during the winter 2012. Composite time series were presented using ship and Argo temperature and salinity data for the period 2003–present. The depth-averaged temperature for the range 1000-1500 m demonstrates that the temperature of this layer has been rising since the start of the Argo program; this trend was interrupted in 2008 and 2012 due to winter convection events that caused a sharp decrease of 0.2 and 0.1 °C, respectively. Salinity in 2012 in the upper 50 m of the Labrador Sea was the lowest since the beginning of the Argo record; the source of this increased freshwater has not been determined, but possible processes affecting this include changes in the input of Atlantic water to the Labrador Sea as well as increased input from the Arctic and Greenland ice melt.

The Argo program is providing important year-round monitoring of the Labrador Sea temperature and salinity in the upper 2000 m. This provides very complementary information to the annual shipboard survey. In addition to the CTD data, an analysis of the drift rate of the floats at the parking depth of 1000 m provides estimates of currents at that depth. The result

indicates that the flow in the boundary currents is much stronger during the period of 2008-13 as compared to the earlier period of 2000–07.

Total inorganic carbon (TIC) and pH in the 150–500 m depth range for stations in the central part of the Labrador Basin has been monitored over the period 1996–2012. Total inorganic carbon shows an upward trend ($r^2 = 0.8$) during this period, while pH has decreased ($r^2 = 0.72$). In previous years of this time series, pH was calculated using the dissolved inorganic carbon (DIC) and total alkalinity (TA) measurements. In 2012, pH is provided as a direct measurement because of a failure of the instrument used to collect TA data.

Systematic biological measurements have been made along the AR7W line since 1994 and include major components of the lower trophic level (bacteria, phytoplankton, and zooplankton abundance or biomass) metabolic rates (bacterial and phytoplankton productivity and respiration on occasion) and total biogenic carbon. All biological components exhibit high interannual variability.

Time series of surface chlorophyll and SST from the MODIS satellite (2002 -12) indicate that SST was above normal and the chlorophyll was below normal on the Labrador Shelf in 2012 while in the central Labrador Sea both variables were normal. On the Greenland Shelf, SST was normal and chlorophyll was below normal.

On the Labrador Shelf, *C. finmarchicus* abundances were low in spring between 1996 and 2012 and there were few young stages from the new years' generations, with the exception of 2011, which had a much higher abundance of young stages, more typical of an early summer population. Between 1996 and 2012, total abundances in spring showed an upward but insignificant trend on the Labrador Shelf. This is probably because spring phytoplankton blooms were starting progressively earlier over the same period. In the Central Labrador Sea, total *C. finmarchicus* abundances were relatively low in spring between 1996 and 2012, and numbers of young stages were generally low, except in 2007 when—although the total *C. finmarchicus* abundance was low—the proportion of young stages was much higher than usual. In the Central Labrador Sea in summer 1995, total abundance was relatively high and young stages were dominant, but both were lower in the summers of 1999 and 2002. There was no trend in springtime (May) total abundances between 1996 and 2012 in the Central Labrador Sea. *C. finmarchicus* abundances were generally higher in the eastern Labrador Sea (the area most influenced by the Irminger Current) than farther west in spring, because the spring bloom generally starts earlier. Although abundances were generally higher in summer than in spring, the highest concentrations occurred in spring 2012. In 2012, sampling occurred in mid-June, which may explain why the community had an abundance and stage structure similar to a summer population.

Discussion/Questions

The speaker repeated that there were problems with pH and alkalinity measurements in 2012. One participant remarked that the convection to 1400 m was deep but didn't last long. The speaker replied this event did appear to be shorter in duration than the 2008 deep convection event and that this likely produced a smaller volume of Labrador Sea; more information on this could be provided by another scientist involved in the work (Igor Yashayaev).

Another participant wondered why there was emphasis on the 1000 m depth; the answer was that that is the Argo "parking depth." One participant pointed out that Argo floats supply important information on the currents, and that this information is available in the Argo current atlas entitled ANDRO.

Physical oceanographic conditions on the Newfoundland and Labrador Shelves

Presenter – Eugene Colbourne

Abstract

The North Atlantic Oscillation index, a key indicator of climate conditions on the Newfoundland and Labrador Shelf, after being in the negative phase for two consecutive years, increased to 1.3 standard deviations (SD) above normal in 2012, the highest since 1989. As a result, arctic air outflow to the Northwest Atlantic during the winter increased over the previous year, causing a significant decrease in winter air temperatures over much of the Labrador Sea area. Annual air temperatures, however, remained above normal at Labrador by 1.4 SD (1.8 °C at Cartwright) and Newfoundland by 2.3 SD (1.9 °C at St. John's). The annual sea ice extent on the NL Shelf remained below normal (0.7 SD) for the 17th consecutive year, an increase of 1 SD over the record low in 2011. As a result of these and other factors, local water temperatures on the Newfoundland and Labrador Shelf remained above normal in most areas but decreased significantly over 2011 values. Salinities on the NL Shelf were lower than normal throughout most of the 1990s, increased to above normal during most of the past decade, but decreased to fresher-than-normal conditions in many areas from 2009-12. At a standard monitoring site off eastern Newfoundland (Station 27), the depth-averaged annual water temperature decreased to 1 SD (0.4 °C) above normal from the record high of 3 SD (1 °C) in 2011. Annual surface temperatures at Station 27 increased to 1.5 SD (1 °C) above normal while bottom temperatures (176 m) decreased to 1.1 SD (0.4 °C), down from the record high of 3.4 SD (1.3 °C) in 2011. The annual depth-averaged salinities at Station 27 were below normal for the 4th consecutive year. The area of the cold intermediate layer (CIL) water mass with temperatures < 0 °C on the eastern Newfoundland Shelf (Bonavista Section) during 2012 increased to 0.5 SD below normal from the record low value at 2 SD below normal in 2011, implying a continuation of warm conditions, while off southern Labrador it was 0.5 SD below normal. On the Grand Bank, the CIL was about normal during the summer of 2012. Spring bottom temperatures in NAFO Divs. 3Ps and 3LNO during 2012 were above normal by an average of about 1 °C, a moderate decrease over 2011 conditions. During the fall, bottom temperatures in 2J, 3K, and 3LNO decreased from 2, 2.7, and 1.8 SD above normal in 2011 to 1.1, 1.2, and 0.2 SD above normal in 2012, respectively, a significant decrease. The volume of CIL (< 0 °C) water on the NL shelf during the fall was close to normal. A composite climate index derived from 27 meteorological, ice, and ocean temperature and salinity time series show a peak in 2006, a declining trend in 2007 -09, and a sharp increase in 2010 and 2011, to the 2nd and 4th highest, respectively, indicating warmer than normal conditions throughout the region. In 2012 it decreased to the 8th highest in the 63 year time series.

Discussion/Questions

One meeting participant wondered why there was a shallower mixed layer depth at Station 27; the speaker noted that it was because of less wind influence.

A participant asked how often this occurs, and the speaker noted that it was quite frequent.

Biogeochemical conditions on the Newfoundland and Labrador Shelves

Presenter - Gary Maillet

Phytoplankton production inferred from ocean colour imagery declined in 2012 throughout the Newfoundland and Labrador Shelves compared to above-average levels observed in recent years (2008 -11). The timing of the spring bloom was earlier by several weeks on average, although the duration has been in decline in recent years. The trend in deep inventories of

silicate and nitrate has continued to decline over the past decade and in recent years. The ratio of macronutrients such as phosphate and nitrate shifted around 2004, indicating reduced levels of phosphate over the Newfoundland and Labrador Shelves. Phytoplankton standing stock also declined in 2012 based on the seasonal oceanographic surveys along the standard ocean sections, which is consistent with satellite imagery. Calanoid copepods remain high in 2012 and remained stable for the past decade based on the seasonal oceanographic surveys. The overall abundance of different copepod species has trended upwards during the time series, particularly on the Grand Bank and northeast Shelf. Decadal changes in the dominant CPR taxa indicate increased standing stocks of phytoplankton and zooplankton during the 2000s and recent years (2010–11), although certain cold-water-adapted calanoids (*C. glacialis* and *C. hyperboreus*) and macro-zooplankton such as euphausiids have declined on the Grand Bank.

Discussion/Questions

A meeting participant brought up the idea that the increasing silicate levels were due to inflow of Pacific waters via the Arctic.

It was noted that there is more water of Pacific origin in the Gulf of Maine, so this seems a likely scenario. In addition, phosphate signals could also be related to Pacific water intrusions.

Another participant wondered if the abundance of stage I copepods was related to the spring bloom. The shorter spring bloom duration in 2012 could have resulted from the low nutrient levels; this trend was only seen in the deep waters, not the surface water. Satellite and ship data on bloom dynamics agree.

It was mentioned that it is hard to relate the short-term bloom decline to nutrient levels, and that it may be related to secondary production.

Another participant noted that the shallow mixed layer depth could lead to nutrients being used up more rapidly.

Finally, it was stated that the composition of the phytoplankton community is important to know to determine what is going on. However, it was noted that phytoplankton samples are very expensive to analyze.

Physical oceanographic conditions in the Gulf of St. Lawrence

Presenter - Peter Galbraith

Abstract

An overview of physical oceanographic conditions in the Gulf of St. Lawrence in 2012 is presented as part of the AZMP deliverables. AZMP core data are analyzed as well as data from regional monitoring programs. August air temperature was warmest at eight stations since at least 1945 and the exception, Blanc Sablon, held that record for the month of July. The August average over all stations was the warmest since at least 1873. Averaged over the entire year, 2012 was third warmest since 1945, and the warmest on record (1909) at Port aux Basques. May–November sea-surface temperature averaged over the Gulf was second warmest after 2006. Sea ice reached a maximum seasonal volume that was fourth lowest since 1969. The summer CIL volume was the lowest since 1985. The CIL minimum temperature index for the Gulf was the highest since 1980. At Rimouski station, it was at a monthly record high (since 1993) starting from July until the end of the sampling season in November. Deep waters are warming overall in the Gulf. At 200 m, the warmest temperature on record (1915) was observed at Cabot Strait. At 300 m, salinity reached a record high (1915).

Discussion/Questions

A participant noted that the change in the extent of the CIL allows warmer water to enter the Laurentian Channel. This same phenomenon has been seen on the Scotian Shelf with the decreasing CIL. The speaker noted that there is interannual “memory” in the CIL, and that water below the CIL is variable and plays an important part. In 2012, the thermocline was higher than the halocline, so the GSL held more warm salty water, leaving less room for the CIL. Warm waters are also seen to be entering the Gulf at depth through Cabot Strait. Dissolved oxygen should be lower with this phenomenon, but Winkler data have not revealed any marked change at this time.

Biogeochemical conditions in the Gulf of St. Lawrence

Presenter - Stéphane Plourde

Abstract

The late winter (March) nitrate concentrations measured during the helicopter survey were relatively high and close to the long-term climatology for most regions of the GSL, with the exception of the coastal area in the southern GSL. The analyses of satellite-based chlorophyll *a* biomass in different sub-regions revealed a spring bloom slightly stronger and occurring earlier than normal, with evidence of high biomass in winter in the Shediac and Magdalen Shallows areas. Chlorophyll *a* biomass showed a positive anomaly from March to July, but lower than normal phytoplankton biomass was observed from August to December in all sub-regions. In 2012, abundances of small and large calanoids in the western, southern, and eastern GSL regions were close to or slightly above the long-term normal following 3–4 years of negative (large calanoids) and positive (small calanoids); these changes in calanoid copepods were mostly caused by similar changes in the abundance of *Pseudocalanus* (small) and *Calanus hyperboreus* (large). The potential of using new indices such as the abundance of arctic species, the timing of recruitment of *C. finmarchicus*, or the body size of target species was illustrated with the long-term (1992–2012) Rimouski station time series. All indices showed marked variations between 1990s (cold) and 2000s (warm).

Discussion/Questions

A participant asked how the *Calanus finmarchicus* and *C. glacialis* were identified; the speaker replied that the taxonomist measured prosome length to distinguish them.

Another participant noted that it could be interesting to use indices based on the abundance of arctic species and phenology to identify variability. Increased prosome length could be an indication of the quality of food affecting body size.

Physical oceanographic and meteorological conditions on the Scotian Shelf and in the Gulf of Maine

Presenter - Dave Hebert

Abstract

In 2012, the North Atlantic Oscillation index was above the 1981–2010 mean (+ 11.8 mb, + 1.3 SD [standard deviation]). Two years after the lowest NAO index, 2012 was the 4th highest. Mean annual air temperatures were from 1.3 $^{\circ}$C (Saint John, New Brunswick) to 1.7 $^{\circ}$C (Shearwater [Halifax], Sable Island, and Sydney, Nova Scotia), 1.8 to 2.5 SD, above normal in 2012 and higher than those found in 2011. There has been essentially no ice on the Scotian Shelf from December 2009 until the end of the season in May 2012. The ice volume during 2012 was the fourth lowest in the 51 year long record. Only 1969, 2010, and 2011 had lower coverage and volume; the differences between these three years are not significant. Positive

SST anomalies prevailed throughout the region during 2012, with representative values of about + 1.7 to 2.5 °C (+ 1.4 to + 3.2 SD). Long-term coastal monitoring sites at St. Andrews (New Brunswick) and Halifax (Nova Scotia) recorded positive annual SST anomalies, 1.8 °C (+ 3.2 SD) and 1.0 °C (+ 1.4 SD) in 2012, and were 1 °C and 0.5 °C above that observed in 2011. At selected sites across the region, annual water temperature anomalies were positive in 2012: + 0.9 °C (+ 2.7 SD) for Cabot Strait 200–300 m (the warmest in 61 years), + 1.3 °C (+2.0 SD) for Misaine Bank 100 m (2nd warmest year), +0.7°C (+0.9 SD) for Emerald Basin 250 m, + 3.4°C (+ 4.3 SD) for Lurcher Shoals 50 m (warmest year), and + 0.5 °C (+ 0.9 SD) for Georges Basin 200 m (the previous two years had the highest temperatures). Bottom temperature anomalies in Northwest Atlantic Fisheries Organization areas 4VWX were all positive in 2012 and ranged from + 0.5 °C (+ 1.2 SD) in 4Vn to + 2. °C (+ 3.0 SD) in 4X. Average stratification on the Scotian Shelf strengthened significantly compared to 2011, reaching a value near that seen in 2010 and the fourth strongest stratification in the record. This increase in stratification from 2011 to 2012 was due mainly to an increase in surface temperature. Since 1950, the stratification has slowly been increasing on the Scotian Shelf due mainly to a freshening of the surface waters. A composite index consisting of ocean temperatures from surface to bottom across the region indicated that 2012 was the warmest of 43 years, with an averaged normalized anomaly of + 2.8 SD relative to the 1981–2010 period.

Discussion/Questions

In 2010, the NAO showed in the deep Labrador Sea, but not on the Scotian Shelf because it didn't make it around the tail of the Grand Bank. A glider operated by OTN (Ocean Tracking Network) at Dalhousie, in cooperation with DFO, that has been monitoring conditions on the Scotian Shelf had not measured Labrador Sea water on the shelf as of late 2012.

A participant noted that the deep convection observed off Labrador had not shown up on the Scotian Shelf; the presenter thought that maybe it would show up in the data this spring.

Biogeochemical conditions on the Scotian Shelf and in the Gulf of Maine

Presenter - Jeff Spry

Abstract

In 2012, anomalously warm ocean temperatures throughout the water column on the Scotian Shelf and eastern Gulf of Maine influenced the chemical and biological conditions of the region. Stratification was higher than average on the Scotian Shelf. At the Halifax-2 fixed station, upper water column (0-50 m) nitrate was lower than normal throughout 2012, while deep water (50 -150 m) nitrate concentrations were much higher than normal, suggesting that stratification may have inhibited nutrient mixing into the upper water column. Deep water nitrate concentrations were also higher than average throughout most of the region. Spring bloom initiation timing at Halifax-2 was about average, and the bloom was average in magnitude but short in duration, but winter chlorophyll concentrations were higher than average. Satellite ocean color observations also indicated high winter chlorophyll concentrations and early and/or short spring bloom timing across much of the Scotian Shelf. Although chlorophyll concentrations were about average following the spring bloom at Halifax-2, light attenuation was high, cell abundances were low, and diatoms and dinoflagellates were less relatively abundant and flagellates and ciliates more relatively abundant than normal, suggesting a shift to a smaller-sized phytoplankton community, possibly including higher than average concentrations of picoplankton. At the Prince-5 fixed station, the seasonal chlorophyll cycle was similar to normal, but chlorophyll values were higher than average in July and August, when chain forming diatoms (July) and dinoflagellates (August) were abundant. Satellite ocean colour indicated

higher than average surface chlorophyll across the eastern Gulf of Maine in August and September.

Zooplankton biomass was very low at Halifax-2 throughout 2012, and it was also low on all shelf sections in fall. At Prince-5, zooplankton biomass was mostly low in the first half of the year but rebounded in the fall. At both fixed stations, *Calanus finmarchicus* abundances were low everywhere throughout 2012. *C. finmarchicus* production was likely impacted by its low abundance at the end of 2011 and high temperatures experienced by the dormant stock during the fall and winter of 2011/2012. At Halifax-2, a short phytoplankton bloom and low diatom abundance may have also contributed to low abundances of *C. finmarchicus* and *Pseudocalanus* spp. during 2012. Transient high abundances of small-particle-feeding zooplankton taxa (appendicularians, salps, pteropods) were observed both on the Scotian Shelf and at Prince-5. Cold-associated immigrant species (Arctic *Calanus*) were less abundant and warm offshore species generally more abundant than average in 2012, consistent with warmer temperatures and model estimates of changes in circulation. Overall, lower trophic level changes in 2012 suggest poor feeding conditions for planktivores on the Scotian Shelf, but the late summer-early fall bloom in the eastern Gulf of Maine and Bay of Fundy may have been favorable for some higher trophic level species.

Discussion/Questions

One participant wondered if the 2012 seeding population of *Calanus finmarchicus* was too low and too shallow, and was not overwintering. Another replied that the overwintering took place in Emerald Basin, so the population was from there.

P5 and the Wolves

Presenter - Jennifer Martin

Abstract

Sampling for salinity, temperature, and turbidity was initiated at Prince 5 in 1924 and continues today (with the addition of phytoplankton, zooplankton, and nutrients in 1999). A phytoplankton monitoring program was initiated in southwest New Brunswick in 1988 in response to a rapidly growing aquaculture industry and concerns about environmental impacts and harmful algal blooms (HABs). Earlier results on the paralytic shellfish poisoning (PSP) producing organism, *Alexandrium fundyense*, and its distributions in the Bay of Fundy showed that Prince 5 was not the best indicator site for *A. fundyense* population dynamics studies whereas sampling at the Wolves Islands gave a better representation of offshore phytoplankton populations and their transport to the inshore regions. As a result, the long-term phytoplankton sampling site at the Wolves Islands was initiated and continues to be monitored.

Sampling at the Wolves site occurs at weekly intervals between April and late October (monthly during winter) and has resulted in 662 total visits from 1988 to 2012 whereas Prince 5 samples are collected monthly, resulting in 252 samplings during the same time period. Sampling at the Wolves includes CTD casts and secchi depth, and phytoplankton species abundance and nutrients at the surface, 10 m, 25 m, and 50 m; sampling at Prince 5 is at the surface, 10 m, 25 m, 50 m, and just above bottom (approximately 90 m). Phytoplankton samples from the Wolves are collected from each of the discrete depths every week during bloom periods whereas at Prince 5, 100ml from each depth is integrated into one sample during the mid-month sampling. Phytoplankton samples are analyzed from the Wolves at SABS using the Utermöhl settling method and those from Prince 5 are analyzed using the freeze transfer method. Since the phytoplankton samples from the Wolves separate the surface from those collected at depths, higher numbers of most species that tend to concentrate in the surface layers are

captured whereas the integrated sampling at Prince 5 shows higher numbers of species such as pennate diatoms that can concentrate in the deeper waters. The integrated sample also underestimates total biomass.

A comparison between concentrations of total phytoplankton, diatoms, dinoflagellates, and “other” species (smaller zooplankton, silicoflagellates, and ciliates) from the Wolves and Price 5 shows similar trends for the total phytoplankton and diatom densities for the two sites, but significantly lower concentrations of dinoflagellates and “other” species. From late August and through the remainder of 2012, phytoplankton densities tended to be much sparser than other years.

Archived data from zooplankton samples collected with a 573 µm mesh net (15 min stepped oblique tows) from Prince 5 and the Wolves Islands sites from 1935–70 showed similar species diversity, abundance, and trends. Zooplankton sample collection was initiated again in 1999 at Prince 5 and in 2010 at the Wolves Islands. Further sample and data analyses are required to perform a comparison between the two sites to determine whether the earlier trend continues.

As with other locations within the AZMP sampling area, temperatures in 2012 were above normal at both locations.

Discussion/Questions

A participant asked whether the 200 µm mesh net was used at the Prince 5 station. The participant pointed out that the net should be deployed from bottom to surface, according to AZMP protocol.

Summary of Zonal Scorecards

Presenters - Peter Galbraith, Catherine Johnson and Pierre Pepin

Zonal SARs will give a sense of environmental variables across the zone, but it is also necessary to report regional differences. It is important to note trends over the AZMP time frame, but also changes in the last year.

Zonal summary of physical conditions

Abstract

Temperature and salinity at fixed stations were generally coherent across the zone and conditions were warm across the board in 2012. Sea surface temperatures averaged over ice-free months were at record levels in nearly all areas of the zone, and at near-record levels in areas where they weren’t. Cold intermediate layer temperatures, areas and volumes were warmer and thinner than normal in the Gulf of St. Lawrence and the Scotian Shelf. However, CIL conditions returned to near-normal on the Labrador and Newfoundland shelf, somewhat consistently with the NAO winter index which has rebounded to positive values in 2012 (usually indicative of colder conditions). Bottom temperatures were above-normal everywhere in the zone except in NAFO area 3LNO on the Newfoundland shelf. T

They were at record-high values (since 1980) on the Scotian Shelf (both in areas 4W and 4X).

Discussion/Questions

It was noted that stratification at HL2 appears normal on the Zonal scorecard, but it was reported as higher than normal. Could this be due to a difference in reference period, or a difference in the index from north to south.

It was noted that we are in a period of above normal CIL temperatures, except for Newfoundland. There are regional differences, with no link between CIL values up north and those values further south.

The only salinity panels in the scorecard are for fixed stations. A possible improvement would be to have separate pages for temperature, salinity and stratification.

Air temperature will not be reported since SST values are good and air temperature is just a proxy for SST. Also, air temperature is an Environment Canada product, not DFO's responsibility.

Regional differences in the relative temperature of seasons and timing of warming should be mentioned in text, since changes in which seasons are considered warm depends on region.

Winds will not be reported, since Sable Island wind data showed no trends. Large trends in NAO need to be reported. There have been more easterly and southeasterly winds lately that could explain certain changes. The suggestion is to report regionally first. If we can demonstrate an effect then we can try it elsewhere.

It was suggested that the Labrador Current transport be included on the scorecard. There is no longer a one year delay in data availability. If we add Labrador Current data from 1992-2012, distinct regional patterns could explain why Labrador Shelf responds to NAO but Scotian Shelf does not.

It was noted that deep convection in the Labrador Sea is linked to increased cooling and an increase in zooplankton.

Zonal chemical and biological scorecards

Abstract

The method of reporting with scorecards needs to be standardized across topics. Because of the large number of variables used to assess biogeochemical conditions across the zone, the group struggled to decide which variables were to be included in the SAR. For the first zonal overview, consensus was reached to have separate summaries for nitrate, chlorophyll, and two major groups of zooplankton as well as two key species. A decision was also needed on the order of stations and whether to mix fixed stations and transects. Two opposing suggestions were tabled: the first was to report fixed stations in a separate panel (as they do in physical scorecards), the second was to include fixed stations with the transect data. The latter was adopted.

An agreement was reached that the two sets of Cabot Strait stations should be combined, rather than have Maritimes' spring and fall stations reported separately from the Quebec stations.

General Discussion of Environmental Conditions and Plans for Zonal SAR

It was noted that 1999 was a very strange / extreme year for zooplankton; the pattern was opposite to following years. Recently, other data from 1999 have been found that agreed with these values, so it really was an anomalous year.

The reference period 1999-2010 was agreed upon.

A comment was made that satellite box information is very important, and it was suggested that everyone get the data from the BIO remote sensing unit so that Maritimes doesn't have to compile it. For ocean colour data, if a time-series longer than the life of one sensor is needed, the recommendation is to use SeaWiFS data from 1997-2007, then MODIS data for

2008-present. Data from different satellites could be merged to increase the length of the time series, but data from different sources should be identifiable for reprocessing purposes.

One participant suggested that the Gulf of St. Lawrence be divided into three regions instead of considering each of the seven transects individually, with the aim of simplifying the analysis. It was proposed that an initial analysis of the three regions be compared to the current analysis to see if this gives satisfactory results.

A participant commented that there could be bias due to timing of cruises rather than signal, and perhaps it would be better to show fixed stations rather than transects. Another participant noted that sections tie in better to perception, for example the area of southern Gulf behaves differently from the rest of the Gulf. The recommendation was made to try generating scorecards (separating fixed stations from transects) to see if there are significant differences.

If there is only one cruise for the year, we don't present an annual anomaly; however, some sections are only sampled once a year. Each region can deal with challenges separately. Dropping one season really doesn't change results as long as you are consistent. Seal Island was only sampled once a year until recently, and adding another season did not change results. If however we miss a season that is normally sampled, leave out that year's annual anomaly. Modelled abundances can be used to fill in gaps if sampling is too infrequent.

It was recommended that excess silicate and excess phosphate should be explored in the future, to get a sense of what it means.

Station 27 is missed frequently so winter nitrate values have too much variability. It was decided to leave winter nitrate in for other regions.

It was noted that eastern and western Gulf sample different populations of zooplankton.

The zonal SAR must be comprehensive but not overwhelming; we should focus on major aspects. *Calanus glacialis* abundance is down in all regions: this can be mentioned in the text and we can think of creating an indicator for next year; not everything has to be in the scorecard. SAR gives a broad-brush view of ecosystem changes in zone. If we see coherent patterns or differences, we need to investigate why.

Zooplankton dry weight analysis shows unusual pattern in time series, but not for this year. There is concern about Newfoundland data, which are showing strange results. However, Quebec is seeing the same pattern. Maritimes noted that most of the strange database values were in zooplankton wet weight data. Such strong patterns in some of the usual things we report on make a good story; we can leave subtle changes for later.

Action items

Peter Galbraith will draft the physical SAR and Pierre Pepin will draft the biological / chemical SAR. The drafts will be ready before proceedings. The objective is to have the document out in 2 months.

All meeting participants were asked to ensure that the reference periods for biological and chemical data scorecards were 1999-2010.

Surface and deep nitrate, winter nitrate and deep silicate should be explored, if possible.

Spring bloom fitting is complete for the satellite boxes. It was requested that the fits also be run for fixed stations. BIO's method of fitting was accepted. If the *in situ* sampling is considered to provide an unbiased view, then this should form the basis of the estimation; otherwise, satellite data were to be used.

SESSION 5 – ENHANCEMENTS AND OUTCOMES FROM AZMP, 20 MARCH 2013

Rapporteur - Carla Caverhill

pH measurements in AZMP

Presenter- Stephen Punshon

Abstract

This presentation began with an overview of ocean acidification and the importance of pH to marine organisms. Methods for seawater pH measurement including spectrophotometric determination, potentiometric methods, Field Effect Transistor (FET) sensors and glass probe CTD sensors such as the SeaBird 18 were discussed in the context of two different pH scales (NBS and Total). A time series of pH sensor profiles collected from Shediac during 2012 and corrected to pH calculated from measurements of TIC and TA was shown.

Discussion/Questions

One participant asked if FET is only meant for moored applications, or if it can be used for profiles. The speaker replied that he does not know the depth limit of the instrument, and the only results he has so far seen are from the surface.

The comment was made that a spectrophotometer is the best tool for calibrating the CTD pH sensor.

When asked if samples have a shelf life. Dickson's *Guide to Best Practices* doesn't describe storage protocol so they try to measure the samples quickly. Other groups have used mercuric chloride to preserve samples prior to analysis. Amber glass bottles affect pH during storage time by up to .05 units so you need to be careful about which sample bottles are used. Borosilicate glass bottles with greased stoppers poisoned with mercuric chloride are stable for alkalinity and TIC, so should be stable for pH, but Dickson has not yet given pH values for CRMs (certified reference materials) for calibration.

A participant asked whether the high temporal variability seen in pH can also be expected for other carbonate system parameters. The speaker indicated that as one parameter changes then so should the other three as a new equilibrium is established. However, kinetics may limit how the proportions of carbonate parameters can re-adjust over short time scales, particularly in the case of pCO2. When asked if the Scotian Shelf showed a lot of variability in pH the speaker replied that he hasn't seen Helmut's results. However he speculated that deep water upwelling and freshwater influx would cause huge variations in pH.

A proposal to augment the August multispecies surveys – Indices and the possible use of ZooImage

Presenter - Stéphane Plourde

Abstract

We present a semi-automated method to analyze zooplankton samples that could potentially provide zooplankton indices to support several of DFO's management initiatives mainly based on spatially explicit data collected during the multi-species survey realized in August in the northern Gulf of St. Lawrence (nGSL), a period and region not covered by AZMP sampling in the Quebec Region. Zooplankton samples were collected following the AZMP protocol during these surveys since 2006, and we used a subset of these samples (n = 52) to compare the performance of the semi-automated analysis approach and the analysis done by the taxonomists. Several improvements have been done since the first try (Plourde et al. 2008),

including an increase in image resolution from 600 to 2400 dpi (dots per inch) and an objective optimization of the training set (classifier) leading to an overall classification success of 70 -75 % (Fernandez et al. 2009). Abundances obtained with the semi-automated approach for categories Total copepods, Small and Large Calanoids, Cyclopoids and Invertebrate Larvae compared reasonably well (r^2 between 0.67 and 0.89) with those obtained with standard taxonomic analysis. However, the performance of the semi-automated analysis generally decreased at higher taxonomic resolution, with the notable exception of *Calanus finmarchicus/glacialis*, *Temora*, *Oithona* and krill eggs. Examples of the potential using these indices in order to map their spatial distribution in the GSL were shown. We proposed that this cost-efficient semi-automated approach to analyze zooplankton samples could be used to implement the AZMP in Quebec Region and provide useful spatially-explicit information to management.

Discussion/Questions

A participant commented that this would be an excellent tool for archiving samples that need to be culled. The speaker replied that this is what he plans to do with Gulf samples, whether they have been counted or not.

Another participant commented that on the calibration curves many slopes were significantly different than 1. The speaker replied that this is not a problem; negative values are treated as zero and use of the tool is restricted to items that work well.

It was suggested that rather than classify as large/small they could look at biomass spectrum. This metric could be more stable and less susceptible to errors in calibration; the metrics could show more coherence.

Maritimes used to provide biomass plots of spring/fall multispecies surveys. These data are still collected but not reported. Newfoundland doesn't do this.

Maritimes is trying to extract more information from groundfish surveys, starting with the July cruise which is more consistent for nutrient, chlorophyll and zooplankton. PED will be asked to make information from these surveys more accessible. The speaker confirmed that AZMP protocol is used on the groundfish cruises.

Comments were made about raising the profile and relevance of AZMP. Following ERI sessions with fisheries and PED managers who are potential clients for AZMP data, it was clear that they didn't know much about the program. A discoverable site with data inventory, including expert calculations (value-added products) that are calculated for res-docs could raise the profile.

The following suggestions for managing data products were made: there may be some redundancy in data processing of biological and chemical samples that could be eliminated, and scorecard numbers should be made available in text and GIS format.

Regional comparison of the Rimouski, Gaspé Current and Anticosti Gyre fixed stations

Presenter - Peter Galbraith

Abstract

After more than a decade of sampling the AZMP fixed stations Gaspé Current and Anticosti Gyre in the northwest Gulf, physical oceanographic and zooplankton properties are compared with those of the regional monitoring station north of Rimouski to determine whether sampling the multiple sites is worth pursuing.

For physical oceanographic conditions, since sea-surface temperatures are well correlated at large spatial scales and the same is true of deep water conditions that are slowly advected-in from the continental slope, cold intermediate layer (CIL) conditions were compared at the three sites with those of the Gulf. The August CIL minimum temperature at Rimouski station is highly correlated ($R^2 \geq 0.82$) with regional areal averages from large scale surveys, as well and with values at the two AZMP fixed stations. Of the three fixed sites, the CIL minimum temperature at Rimouski station is best correlated with the Gilbert & Pettigrew (1997) bulk index for the Gulf. None of the fixed stations fares particularly well at predicting the overall volume of the CIL within the GSL; the best is surprisingly Gaspé Current. The Gaspé Current and Anticosti Gyre stations are not particularly well suited to mirror the CIL conditions of the Gulf as a whole while Rimouski stations do well for minimum temperature but not so for overall volume (an effect likely associated with the estuarine circulation entraining the CIL into the estuary).

For zooplankton, simulations realized with a 3-D bio-physical model of *Calanus finmarchicus* showed a high connectivity among the three fixed sites. This high connectivity was also demonstrated using an analysis showing very similar zooplankton communities in the deep regions of the estuary, northwest GSL and south of Anticosti Island in August 2006 and 2007. The long-term seasonal pattern in abundance of several key copepod species as well as for general zooplankton categories at Rimouski station were similar to those obtained at the two fixed sites in the northwest GSL. Although the comparison of averaged abundance annual values is of limited value due to the short length of comparable data series, the interannual pattern of some taxa did show similarities among sites. Finally, we showed evidence that sampling the Rimouski station in late Fall and Winter would likely improve correspondence among the sites.

Given that we haven't been able to sample Gaspé Current and Anticosti Gyre stations close to a two-week recurrence and that this analysis shows that the three stations all sample the same portion of the Gulf, we propose to drop the Gaspé Current and Anticosti Gyre fixed stations (which will still be sampled within AZMP transects at nearly the same frequency as in recent years), and officially adopt Rimouski Station as our AZMP station and do our best to sample it year round.

Discussion/Questions

When asked if Shediac station was not included in this evaluation because the CIL was weak the answer was that it just was not part of the evaluation. Québec Region will try to do a similar analysis for the Shediac Valley station and present it at next year's meeting.

The proposal is to drop two fixed stations: Gaspé Current and Anticosti Gyre. They will still be sampled as part of transects, but not reported on separately.

The plan is to write a separate Research Document outlining the rationale to drop these stations.

Application of Environmental Indices in the Provision of Advice Dealing with Population Assessments

Presenter - Eugene Colbourne

Abstract

Information was presented detailing the effects of climate variability on shrimp, snow crab and northern cod in the Newfoundland and Labrador waters. The presentation highlighted the application of AZMP results in the provision of advice to resource population assessments. The results indicate that shrimp are associated with relatively warm Labrador slope water in the

2 -4 °C range and indices of abundance (CPUE, biomass) are positively correlated with habitat indices of temperature and negatively correlated with sea ice, CIL and NAO. Strong correlation at 0-Lag indicate a potential effect on the shrimp fishery while strong correlations at 3 -5 year lag indicate potential effect on early life stages of shrimp. The results also indicate that the temperature limit for shrimp in Newfoundland and Labrador waters has probably not been reached. The information for snow crab indicate that up to 80 % of small crab < 40 mm CW in NAFO divisions 3LNO are associated with bottom habitat where the temperature is < 20 °C. It was noted that the area of the habitat defined by this temperature range has decreased in recent years particularly in divisions 2J and 3K but increased in 2012 as bottom temperatures cooled compared to 2011. Indices of crab production are negatively correlated with temperature indices at lags of 6-10 years and directly correlated with habitat area indices. Strong lag correlations with temperature indicate an effect on early life stages of snow crab and offer some predictive capability. Finally, the results indicate that northern cod may be more productive when water temperatures are warm. The numbers of cod at age 3 from the surveys and R/SSB are positively correlated with climate indices at lags of 3 years indicating a possible climate effect on recruitment. Relationships between indices of cod recruitment and *C. finmarchicus* are weak but show a positive association over the short time series. The *Calanus* abundance anomalies for 2010-12 suggest relatively stable standing stocks of this important prey for future recruits.

Discussion/Questions

One participant noted that since fishable biomass shows early correlation with climate, it might be better to look at fish larvae data. The answer was that most fisheries look at 1 and 2 year class data, which is good, reliable data and the inferences that biologists are deriving from this physical data is very useful.

The presenter was asked how he became involved with stock assessment. He replied that he has been presenting overviews of oceanographic conditions to the stock assessment group for more than 20 years. Later he started working with stock assessment biologists, and now his group is requested to attend the meetings.

A participant asked whether it was likely that there would be more significant relationship with invertebrate fisheries rather than fin fishery. The speaker noted the high level of variability in many invertebrate stocks whereas recent changes in many of the region's fish stocks has been limited.

Another participant noted that the temperature association for snow crab is well known, and asked if anyone has looked at bottom temperature and shrimp? The presenter answered that Ken Drinkwater did this for snow crab 10 years ago, but not for shrimp. The catch data only go back to ~ 1995.

The presenter was asked if they have looked at *C. hyperboreus*. The answer was that just *C. finmarchicus* had been considered but they would like to go back and look at AZMP zooplankton indices.

Zonal CIL and deep water co-variability (or lack thereof) : ACCASP outcome

Presenter - Peter Galbraith

Abstract

A summary is presented of an ACCASP report on zonal comparisons of Cold Intermediate Layer and deeper waters done to identify past long terms trends, if any, and to identify zonal co-variability patterns. The presentation focuses on co-variability. CIL properties are only partly

cross-correlated throughout the zone. The high correlation of CIL volumes in the Gulf and on the Scotian Shelf (R^2 = 0.51) is consistent with advection from the Gulf to the Scotian Shelf. Similarly, high correlations between Seal Island and Bonavista (R^2 = 0.56), Bonavista and Flemish Cap (R^2 = 0.29) suggests southerly advection along the Labrador and Newfoundland and shelves. Deep and bottom water properties in the GSL and Scotian Shelf vary widely in decadal timescales depending on the mix of warm and salty Slope Water, to cold and relatively fresh Labrador Slope Water. Highest coherence was found between Emerald Basin and Georges Basin (R^2 = 0.78), Hamilton Bank and station 27 (R^2 = 0.29), the GSL and Emerald Basin/Georges Basin (R^2= 0.21-0.23). While shifts have been related to the winter NAO Index, correlations are low (R^2 = 0.15-0.21 on NL shelves).

Discussion/Questions

Deep waters in Emerald and Georges only get replaced by dense water overflows, which may account for the low correlations with temperatures in the GSL. A comparison with shelf bottom water temperatures (higher up in the water column) will be attempted.

The Labrador Sea responds to the NAO but the Scotian Shelf does not, and a better variable to reveal this could be variations in the Labrador Current.

Timing of AZMP surveys in relation to seasonal bloom dynamics inferred from ocean colour imagery

Presenter - Gary Maillet

Abstract

In general, the current timing of AZMP Surveys are within a few days to 2 weeks of the peak timing of the spring bloom on the Newfoundland Shelf and Grand Bank. The southern and northern sections on the Labrador Shelf are occupied well after peak timing by 1-2 months. In addition, the late May-June Surveys in the GSL are > 1 month after the peak timing of the spring bloom on average. If the trend to earlier timing of the spring bloom continues, along with fixed timing of our surveys, we would expect an increasing temporal gap which should be taken into account in the analysis of our survey data.

Discussion/Questions

A participant asked if we should adapt our sampling to try to capture blooms. The speaker noted that survey times are very hard to change. He emphasized the importance of satellite data which allow us to look at surface dynamics based on ocean colour. We do capture sub-surface dynamics from survey data and the satellite data help interpret the survey data, telling us where we are in the production cycle.

It was also noted that since the zooplankton peak happens after the phytoplankton bloom, having later surveys allows us to sample zooplankton which cannot be measured by satellites.

Another participant stated that zooplankton stage information is more important than abundance, and changes in stage distributions seem to correlate with bloom timing.

Interannual-to-decadal Variations of the Labrador Current

Presenter - Guoqi Han

Abstract

The transport of the Labrador Current has substantial interannual-to-decadal variability that may significantly impact the ocean climate and marine ecosystem off Atlantic Canada and Northeast

United States. Nevertheless the alongshore coherence of the Labrador Current on the interannual-to-decadal scales has been a long standing question. Here we have used satellite altimetry data to study interannual-to-decadal variability of the Labrador Current over the period 1992-2011, in the context of the subpolar gyre of the North Atlantic. The subpolar surface gyre shows notable quasi-decadal oscillations that are significantly correlated with the winter NAO index at the zero lag ($r = 0.77$, $p = 0.00$). The gyre has also been weakening in the past two decades. Though the weakening trend is statistically significant at the 99 % confidence level, it is likely to be part of multi-decadal variability. The proxy Labrador Current transport that is estimated from altimetry data and model output has two distinct regimes, positively (0.46, $p=0.05$) and negatively (- 0.34, $p = 0.16$) correlated with the winter NAO index (with the transport lagging by one year) in the north (the Labrador Slope) and in the south (the Scotian Slope), respectively. The transports over the Labrador Slope and the Scotian Slope are out of phase ($r = - 0.5$, $p = 0.03$); while those over the Labrador Slope and the northeast Newfoundland Slope are in phase ($r = 0.71$, $p = 0.00$). The proxy Labrador Current transport declines at 0.27-0.44 Sv/decade ($p = 0.0$) (1 Sv = 10^6 m^3/s) over the Labrador Slope and increases at 0.15-0.37 Sv/decade ($p = 0.02$) over the Scotian Slope. The interannual-to-decadal variability of the Labrador Current transport is much smaller than the mean transport over the Labrador Slope, and comparable to or even dominant over the mean transport over the Scotian Slope.

Discussion/Questions

A participant asked if the speaker had looked at the four tracks that cross the Greenland shelf. The speaker said no, but he would like to.

Another participant asked why it appears that the sub-polar gyre has weakened in intensity, when an earlier presentation based on Argo floats showed that boundary currents have intensified. It was answered that Argo floats are at 1000 m and this is surface circulation from satellite altimetry; surface and 1000 m probably have coherence. It was further noted that the difference in results could be due to inter-annual variation; the Argo presentation just showed an increase in the last few years; while the weakening trend of the Labrador Current is for the past two decades. German researchers recently published a paper based on data at 53N that shows similar results to this presentation, but short-term. The speaker noted that he had reviewed a paper combining the basin-scale model and observations from 1970s to 2000s, and their results are similar.

Now that there is no longer a 1-year lag before results are available, it was suggested that the two Labrador Current indices be added to scorecards.

Note: A comparison of the Labrador Current index over the Labrador Slope with the Argo data for the same periods shows that they are consistent, that is, there was partial rebounding from 2000 -07 to 2008 -12.

SESSION 6 – MATTERS ARISING

Rapporteur – Jeff Spry

The group reviewed the recommendations from the data management, logistics and remote sensing breakout groups to evaluate what further actions would be required. Summaries of the breakout group sessions are included in the subsections of Session 3.

Following discussion with the participants from National Capital Region (NCR), the Chair proposed to undertake a discussion with the Director of Ocean Sciences concerning the erosion of resources and capacity for AZMP across all Atlantic regions, and the increasing issues dealing with data management. The Chair expressed his intention to request an opportunity to present AZMP's concerns to the National Science Directors Committee (NSDC), or at least to the four Atlantic Directors. Emphasis would be placed on:

1. Data management needs and their significance of those issues to efficiency and accuracy of the advisory process;
2. Current funding levels (O&M) and the impact of reductions of 1998 funding levels; and
3. The importance of Capital renewal (rust-out) of equipment and the consequences to operational capacity.

For each topic, the Chair agreed to outline the nature of the issues, their impact on Science Branch's ability to respond to operational and client needs, and propose solutions and outline needs that would have to be addressed to redress the problems.

Issues identified during the discussions include:

1. Data Management

- T/S database no longer updated or readily accessible online
- No national standard that ensures that all available data are archived
- AZMP Website design obsolete
- BioChem (bottle and plankton data) not user-friendly and accessed principally by data managers, not users.
- Allocation of resources for Data Management uneven among regions
- Loss of efficiency because data assembly from diverse sources and quality issues take up 60-80% of researchers time (e.g. ACCASP) rather than focusing on analysis and interpretation
- Increased potential for inaccuracies because individuals are maintaining their own archives rather than relying on single Authoritative and Quality Controlled source
- Significant implications for our ability to respond to Departmental (e.g. ACCASP) and client (e.g. advisory, academic) requests for information in a timely manner

2. Operations and Maintenance

- Operational funding is a small fraction of total spent on AZMP when contrasted with funds spent on ship time and salaries
- Taxes and increased operational costs leading to inefficiencies because AZMP leads are having to supplement with external resources
- Real costs for AZMP are in post survey sample processing (e.g. chemistry, taxonomic identification), and (very) basic equipment maintenance

- Real costs cannot be dealt with through “efficiencies” (contract, supply costs have increased by 60-100% since 1998)
- Program designed was designed to meet minimum requirements in 1998
- Survey coverage reduced throughout Zone and demands for information have increased
- Further reduction in coverage will result in permanent loss of information and lead to increased uncertainty
- Further reductions will impact contributions to: Operational Oceanography (Ocean Services), Ecosystem Approach to Management, Climate Change Adaptation, Baseline monitoring, data access and research, DFO commitments to university partners

3. Capital Resources

- Most AZMP equipment is far beyond normal operational life time
- Increased burden on limited O&M resources in order to maintain obsolete equipment
- Results in reductions in effective use of vessels because of at-sea breakdowns
- Likely to result in reduced capacity to contribute to significant DFO-backed collaborative initiatives as well as meet other client needs

The data management subgroup agreed to develop an interim action plan that would serve to guide regional activities in an attempt to address some of the elements that require immediate attention but for which longer term solutions would require substantive investment of resources and personnel.

Research documents summarizing the physical, chemical and biological oceanographic conditions for the Newfoundland, Maritimes and Quebec regions will be prepared for submission to the Canadian Science Advisory Secretariat, as will a Science Advisory Report of the State of Oceanographic Conditions in the Atlantic Zone. In addition, a research document summarizing the results from the SPERA project will be submitted.

The Chair agreed to take the lead on preparing the outcome of the zooplankton synthesis analyses for submission before the next meeting of AZMP.

The next Zonal meeting is tentative scheduled for the week of 17-21 March, 2014.

At 12:00 p.m., the meeting was concluded and the Chair thanked the participants for the effort, dedication, and quality of work they had provided throughout the year.

APPENDIX I – TERMS OF REFERENCE

Fifteenth Annual Meeting of the Atlantic Zone Monitoring Program (AZMP)

Zonal Peer Review – Newfoundland and Labrador, Québec, Maritimes and Gulf Regions

March 18-21, 2013
Montreal, QC

Chairperson: Pierre Pepin

TERMS OF REFERENCE

Context

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1998 with the aim of collecting and analyzing the biological, chemical, and physical field data that are necessary to (1) characterize and understand the causes of oceanic variability at the seasonal, interannual, and decadal scales, (2) provide multidisciplinary data sets that can be used to establish relationships among the biological, chemical, and physical variables, and (3) provide adequate data to support the sound development of ocean activities.

The program sampling strategy is based on (1) seasonal and opportunistic sampling along sections to quantify the oceanographic variability in the Canadian NW Atlantic shelf region, (2) higher-frequency temporal sampling at more accessible fixed sites to monitor the shorter time scale dynamics in representative areas, (3) fish survey and remote sensing data to provide broader spatial coverage and a context to interpret other data, and (4) data from other existing monitoring programs such as CPR (Continuous Plankton Recorder) lines, sea level network, nearshore long-term temperature monitoring, toxic algae monitoring, or from other external organizations (e.g., winds and air temperatures from Environment Canada) to complement AZMP data.

The collected data are edited and archived in databases managed by DFO's Integrated Science Data Management (ISDM) Branch.

Objectives

Assess the biological, chemical and physical oceanographic conditions during 2012 through a peer review of the outcomes of monitoring activities in the four Atlantic regions;

Conduct a workshop aimed to develop a multidisciplinary synthesis of the information gathered over the course of the programme;

Evaluate and develop new data products aimed at meeting client needs based on regional input;

Review the activities of the Atlantic Zone Monitoring Program during 2012 and assess business, operational, logistical, database and remote sensing activities that require regional/zonal intervention or that need to be brought to the attention of Science Directors.

Expected Publications

- Science Advisory Report
- Research Documents
- Proceedings

APPENDIX II – AGENDA

15th Annual meeting of the Atlantic Zone Monitoring Program

18-21 March, 2013

Delta Hotel, 475 Avenue Président Kennedy, Montreal, QC

"Brahms" Meeting Room

AZMP synthesis workshop

Part A – Review of work planned in 2012 (March 18)

Rapporteur – G. Maillet

Time	Presenter	Description
13:00 – 17:00	P. Pepin	Welcome
-	-	Overview of objectives and agreed approach (Phase I – synthesis of zooplankton data)
-	-	Data synthesis process and limitations
-	-	Progress to date and review of results
-	C. Johnson	Interannual Signals (trends) from SPERA project
-	-	Zooplankton Atlas
-	-	General discussion of next steps re: zooplankton synthesis

AZMP Business Meeting and Review of Environmental Conditions

Part B – New avenues for synthesis (March 19)

Chair - P. Pepin; Rapporteur – S. Plourde

Time	Presenter	Description
08:30 – 12:00	D. Lavoie	Progress to date on coupled Biogeochemical model of GSL and overview of ACCASP projections of nutrient trends (30 min)
-	D. Brickman	General model result and analyses of seasonal cycle variability (30 min)
-	J. Chassé	Model results of connectivity among fixed sites (30 min)
-	E. Colbourne	Short-term variability in environmental conditions at S27
-	-	General discussion Possible topics: [1] Assess how representative fixed site conditions are of broader scale conditions [2] Model survey inter-comparison (probably for the longer term? Could include gap analysis) [3] T/S, nutrient, chlorophyll data among regions

AZMP Business meeting (March 19)

Rapporteur - B. Casault

Time	Presenter	Description
13:00 – 13:10	P. Pepin	Welcome and Introduction / Acceptance of Agenda
13:10 – 13:30	L. Devine	Overview of data management – identifying ways forward
13:30 – 13:50	G. Maillet	Issues facing Logistics group and continued operations
-	P. Pepin	Update of Major Capital submission
13:50 – 14:10	G. Maillet J. Spry P. Galbraith	Regional summary of activities (5 minutes each)
14:10 – 14:30	P. Larouche	Remote sensing, data products, issues
14:30 – 14:50	C. Caverhill	AZMP remote sensing products
14:50 – 15:10	-	Health Break
15:10 – 16:20	-	Breakout discussions for Data Management, Logistics, Remote Sensing: [1] Identify issues [2] How/what to move forward [3] What to stress to Regional Directors
16:20 – 17:00	-	Summaries from subgroups General discussion
17:00 – 18:00	-	Permanent Management Committee

Review of physical and biogeochemical conditions in the Northwest Atlantic; Enhancements and Outcomes from AZMP (March 20)

Rapporteur – L. Devine

Time	Presenter	Description
09:00 – 09:20	B. Greenan	Physical, chemical and biological conditions in the Labrador Sea (AZOMP)
09:20 – 09:40	E. Colbourne	Physical oceanographic conditions on the Newfoundland and Labrador Shelves
09:40 – 10:00	G. Maillet	Biogeochemical conditions on the Newfoundland and Labrador Shelves
10:00 – 10:20	P. Galbraith	Physical oceanographic conditions in the Gulf of St. Lawrence
10:20 – 10:40	-	Health Break
10:40 – 11:00	S. Plourde	Biogeochemical conditions in the Gulf of St. Lawrence
11:00 – 11:20	D. Hebert	Physical oceanographic and meteorological conditions on the Scotian Shelf and in the Gulf of Maine
11:20 – 11:40	J. Spry	Biogeochemical conditions on the Scotian Shelf and in the Gulf of Maine
11:40 – 12:00	J. Martin	P5 and the Wolves
12:00 – 13:00	-	Lunch
13:00 – 13:30	P. Galbraith & P. Pepin	Summary of Zonal Scorecards
13:30 – 14:00	-	General Discussion of Environmental Conditions and Plans for Zonal SSR
14:00 – 14:20	S. Punshon	pH measurements in AZMP
14:20 – 14:40	S. Plourde	A proposal to augment the August multispecies surveys – Indices and the possible use of ZooImage
14:40 – 15:00	-	Health Break
15:00 – 15:30	P. Galbraith	Regional comparison of the Rimouski, Gaspé Current and Anticosti Gyre fixed stations
15:30 – 15:50	E. Colbourne	Application of environmental indices in the provision of advice dealing with population assessments
15:50 – 16:10	P. Galbraith	Zonal CIL and deep water co-variability (or lack thereof) – ACCASP outcome

Time	Presenter	Description
16:10 – 16:20	G. Maillet	Variations in the timing of production in the AZMP area
16:20 – 16:40	G. Han	Interannual-decadal variability of the Labrador Current
16:40 – 17:00	C. Johnson	Indicators of Pelagic Habitat Status

Integration and Synthesis (March 21)

Rapporteur – J. Spry

Time	Presenter	Description
09:00 – 10:00	P. Pepin	Work plan for 2013-14 [1] Zonal SAR [2] Research Documents [3] Bulletin ?
10:00 – 10:40	-	Summary of Action plans: [1] Data Management [2] Logistics [3] Remote Sensing [4] Synthesis
10:40 – 11:00	-	Health Break
11:00 – 11:45	-	Matters Arising and General Discussion
11:45 – 12:00	-	**CLOSE**
12:00 – 13:00	-	Permanent Management Committee Wrap-up

APPENDIX III – LIST OF PARTICIPANTS

- Pierre Pepin – NL (Chair) - Northwest Atlantic Fisheries Centre
- Gary Maillet – NL - Northwest Atlantic Fisheries Centre
- Eugene Colbourne – NL - Northwest Atlantic Fisheries Centre
- Guoqi Han – NL - Northwest Atlantic Fisheries Centre
- Peter Galbraith – QC - Institut Maurice Lamontagne
- Stéphane Plourde – QC - Institut Maurice Lamontagne
- Michel Starr – QC - Institut Maurice Lamontagne
- Laure Devine – QC - Institut Maurice Lamontagne
- Jean-François St. Pierre – QC - Institut Maurice Lamontagne
- François Villeneuve – QC - Institut Maurice Lamontagne
- Pierre Larouche – QC - Institut Maurice Lamontagne
- Diane Lavoie – QC - Institut Maurice Lamontagne
- Joël Chassé – GULF - Gulf Fisheries Centre
- Catherine Johnson – MAR - Bedford Institute of Oceanography
- Dave Hebert – MAR - Bedford Institute of Oceanography
- David Brickman – MAR - Bedford Institute of Oceanography
- Jeff Spry – MAR - Bedford Institute of Oceanography
- Shelley Bond – MAR - Bedford Institute of Oceanography
- Benoit Casault – MAR - Bedford Institute of Oceanography
- Carla Caverhill – MAR - Bedford Institute of Oceanography
- Jennifer Martin – MAR - St. Andres Biological Station
- Blair Greenan – MAR - Bedford Institute of Oceanography
- Stephen Punshon – MAR - Bedford Institute of Oceanography
- Mathieu Ouellet – NHQ - ISDM, National Capital Region
- Paul Lyon – NHQ - National Capital Region
- Michael Ott – NHQ - National Capital Region