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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.

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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, inter-annual, and decadal scales.
2. Provide multidisciplinary data sets that can be used to establish relationships among the biological, chemical, and physical variables.
3. Provide adequate data to support the sound development of ocean activities.

AZMP scientists usually 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 DFO Atlantic Science Directors Committee. The year 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 1999, to identify trends or changes, and to provide a critical assessment of the information available. In 2014, the Atlantic Zone Offshore Monitoring Program (AZOMP) began providing an overview of the oceanographic conditions in the Labrador Sea.

In 2019, AZMP scientists met in Montreal from March 19 to March 22 for workshops and to review oceanographic conditions measured within the zone during 2018. Ocean acidification was included to reported conditions for the first time. A draft of the Science Advisory Report summarizing these conditions was written.

INTRODUCTION

The AZMP principal investigators, logistics and data management personnel usually meet once a year to discuss internal matters, resolve issues, present new results that may feed into eventual state of the ocean reporting, and lastly review the state of the ocean conditions that prevailed during the prior year and formulate a state of the ocean report, formulated as a Science Advisory Report (SAR).

The SAR summarizes the information found within supporting Research Documents, each detailing either the physical or the biochemical oceanography conditions in one of the Atlantic Zone regions: Scotian Shelf and Gulf of Maine, Gulf of St. Lawrence, Labrador and newfoundland Shelf, Labrador Sea.

The meeting consisted of a first day dedicated to a scientific workshop to advance the scientific basis that supports our state of the ocean reporting, a second day dedicated to logistics, ocean chemistry advances and miscellaneous presentations, and a third day and fourth half-day to present regional state of the ocean presentations, review and agree on the contents of the zonal SAR.

AZMP SYNTHESIS WORKSHOP SESSION 1 – BIOGEOCHEMISTRY

Rapporteur – Carla Caverhill

A YEAR OF TESTING THE FLUOROSEA SUBMERSIBLE MICROSCOPE – Marc Ringuette

There are a limited number of sensors available for the characterization of biological parameters, let alone their community structure. The FluoroSea submersible fluorescent microscope was developed by the 4deep company around the idea of using particle size and fluorescence at several wavelength (405, 505, 540 nm) to detect Harmful Algal Blooms (HAB) as an early warning system for the aquaculture industry. Our objective is to use these parameters, i.e., size and fluorescence to identify individual phytoplankton cells and classify them within large taxonomical groups thus enabling us to describe in detail the phytoplankton community structure through space and time. To reach our objective, we collected samples in the Bedford Basin to estimate the seasonal variation and deployed the FluoroSea on the underway systems during the AZMP and AZOMP missions in spring and fall, thus capturing both spatial and seasonal variability in the phytoplankton community structure. We also took advantage of ancillary measurements collected during these cruises for calibration and ground truthing of results from the FluoroSea.

Preliminary results indicate that the instrument is capable of counting individual phytoplankton cells and describing rapid changes in cell abundance in a timely manner, in particular when compared to light microscopy methods. The use of clustering techniques enabled us to separate at least four large groups of cells with different mean size and fluorescence characteristics with reasonable confidence. The next step will be to use ancillary measurements such as pigment composition and concentration measured by HPLC, flow cytometry and classic microscopy to validate these grouping.

Discussion summary:

Cell counts from Bedford Basin were not yet available to compare with FluoroSea results. It was asked how much power the instrument uses. The speaker was not sure how much power it needed, but to get a sample of good quality requires 10-15 minutes. The laser is power hungry

and the battery pack doesn't last very long. Using it on a powered Viking buoy might be possible but self-powered on a mooring would be problematic.

The speaker was asked to compare FluoroSea to FlowCam. FlowCam gives taxonomic information but it is much more expensive. The FluoroSea costs 45K$ with a full battery pack and camera and there are cheaper prototype versions.

The speaker was asked to compare FluoroSea to Julie Laroche's camera. Her camera is holographic while FluoroSea is fluorescence based, and thus does not provide images. Classic taxonomy is not output. One could dig into the data and get images. This instrument could be used to see how community structure changes with depth. It could be mounted on a rosette and the results compared with bottle samples. FluoroSea has a 2000 m pressure rating, but sampling rate is slow. It would be necessary to stay for 3-5 minutes at each depth. It would not be possible to compare results with a continuous trace.

OCEAN ACIDIFICATION VARIABILITY IN THE LABRADOR SEA AND ALONG THE SCOTIAN SHELF – Steve Punshon

A comparison of temporal variability and trends in ocean acidification parameters was drawn between newly ventilated Labrador Sea Water (NVLSW, Stations 13-20, depths between 150-500 m, on the annual AR7W line occupation) and the four core AZMP monitoring sections (Cabot Strait, Louisbourg, Halifax and Brown's Bank lines) occupied in spring and fall. For measurements of NVLSW between 1996-2016, linear regression trends of 0.83 µmol kg^{-1} y^{-1} (R^2 = 0.89) for total dissolved inorganic carbon, -0.002 y^{-1} (R^2 = 0.76) for pH_{total} and -0.004 y^{-1} (R^2 = 0.38) for aragonite saturation state, Ω_{Ar}, closely matched predicted trends calculated from atmospheric CO_2 data. In the case of AZMP data acquired between 2014 and 2018, a mean section value for spring and fall was calculated using measurements from all depths at every core station. There were declining trends in both pH_{total} and Ω_{Ar} for all four sections over the monitoring period, although none of the trends were statistically significant. Temporal variability for both parameters, assessed by standard error of the regression, was much higher in all the sections than for the Labrador Sea due in part to a strong seasonal temperature component. Spatial variability in Ω_{Ar} and temperature increased from Cabot Strait to Brown's Bank.

Discussion summary:

Predictions of trends were based on Hawaii atmospheric CO_2 time series; it was suggested that measurements from a closer CO_2 monitoring station could be used.

It was also stated that plotting results against only temperature may not be optimal and it would be best to look at different water masses. A participant commented that the standard error of such a short time series in AZMP should be compared to a similar time series (4 years) for AZOMP. It was noted that Brown's Bank shows the most variability. For the Cabot Strait Line, it could be a good idea to look at stations separately, or look at shallow and deep water independently.

The values for Ω_{Ar} are derived with an equation that uses temperature. Therefore, it should not be surprising that Ω_{Ar} varies with temperature. The derivation is however complicated by including the carbonate ion. If everything else remains constant, changes in aragonite would follow changes in pH, but the non-linear relationship with temperature can make it change much differently.

On the Scotian Shelf there is a long term decline in pH of approximately 0.003 $year^{-1}$. The speaker was asked if the trend shown matches this value. The trend is similar on the Halifax

Line and Louisbourg Line, but not on the Cabot Strait Line. Off-shelf influences affect Brown's Bank, making the trend different there.

It was announced that this year there will be an ocean acidification section in the SAR and in the national State of the Ocean report. It was suggested that this could be a summary of conditions and trends. It was also suggested that different regions should get together after this session to draft this section.

SIZE-SPECTRA INDICATORS OF ZOOPLANKTON COMMUNITIES IN THE NEWFOUNDLAND AND LABRADOR SHELVES – David Bélanger and Pierre Pépin

The size spectrum of an ecological community characterizes how the abundance of individuals within the community vary with body size. Size-spectrum can be used to assess human- and environmental-driven impacts on the size-structure of a community without taxonomical considerations. Recent work comparing different methods for fitting size spectra to data suggested that the maximum likelihood estimate (MLE) method using a power-law distribution fitted to the probability density function (pdf) of body sizes produces the most accurate results. MLE method was applied to zooplankton data from the Newfoundland Shelf to quantify the shift in community size-structure observed in recent years. Annual size spectra were modeled for the period 1999-2017 using individual weight of eight abundant and widely distributed copepod taxa on the Flemish Cap and the Bonavista Bay AZMP sections. Patterns of variation in annual size spectra estimates within location (shelf and slope) and season (spring, summer and fall) were not consistent with the larger scale shift observed in zooplankton community size structure in the region. Most individual body size distributions for the subsamples did not meet the power-law distribution assumption of the MLE method, thus limiting the ability of the method to accurately reflect the temporal changes in the size-structure of the zooplankton community highlighted by in situ measurements of abundance and biomass. Overall, analyses showed that annual MLE-derived size-spectra are poor indicators of regime shifts in zooplankton community size-structure at a local scale.

Discussion summary:

It was noted that there may be a difference in phenology between different years of the presented time series. It was also noted that there are few adult copepods in summer which truncates the size distribution of the zooplankton community.

It was suggested that instead of using the power law, relative abundance of small vs. large could be used. Other size distributions than the power law used with the same methods may also better reflect changes in the zooplankton size-spectrum.

It was suggested that a segmented model based on size could be used but this would make the method less informative in a general sense.

Data availability was limited (10 stations per season), but using together data from different seasons (spring, summer and fall), and sections (Flemish Cap and Bonavista Bay) did not improve results.

It was noted that looking at size or weight should give the same result since the power-law function describes the probability of encountering a particle of a given size or weight rather than the relationship between size and weight. The method proposed by Edwards et al. (2017) should pick up shifts in community structure, but it did not. This is likely because these data did not fit the assumptions of Edwards et al. (2017) i.e., the probability density function of zooplankton size did not follow a power law distribution. Under these circumstances, changing the size bins would not improve the outcome.

SPATIAL CLIMATOLOGY AND INTERANNUAL VARIABILITY IN CALANUS SPECIES ABUNDANCE AND BIOMASS IN SUPPORT TO THE NARW MANAGEMENT – Stéphane Plourde, Catherine Johnson, Véronique Lesage, Caroline Lehoux and Kevin Sorochan

The North Atlantic right whale (NARW), *Eubalaena glacialis*, feeds on zooplankton, and copepods of the genus *Calanus* are its primary source of prey. Here, we presented a synthesis of the analyses performed using DFO's archived zooplankton data in order to (1) describe a spatial climatology of *Calanus* biomass distribution in Canadian waters and (2) describe interannual variations of *Calanus* populations abundance level across the northwest Atlantic. Firstly, more than 4800 historical *Calanus* spp. water-column-integrated samples as well as 221 depth vertically-stratified sampling stations were used to create a four dimensional (latitude, longitude, seasons, vertical) climatology of *Calanus* spp. biomass densities for Spring and Summer-Fall when NARW are feeding in Canadian waters. We then combined this 4-D preyscape with bio-energetic considerations to highlight new potentially suitable NARW foraging habitats in the region. Secondly, we quantified interannual variation in anomalies of abundance and biomass of *Calanus* spp., and near surface and bottom ocean temperature and salinity from 19 sub-regions spanning the Gulf of Maine-Georges Bank, Scotian Shelf, Gulf of St. Lawrence, and Newfoundland and Labrador Shelves. We analyzed time series from 1977-2016 in GoM-GBK, 1982-2016 in southwest GSL, and 1999-2016 in remaining areas. Results were discussed in the context of *Calanus* biology and NARW distribution and habitat use and showed the value of long-term zooplankton historical data and on-going monitoring programs.

EVALUATION OF GSBM OUTPUT FOR POTENTIAL INCLUSION INTO THE ANNUAL REPORTING – Diane Lavoie, Nicolas Lambert, Olivier Riche

A demonstration of the skill of the coupled CANOPA-GSBM numerical model at reproducing the observation was done to evaluate if its output can be used to supplement the data reporting done each year. A Taylor diagram was used to summarize the model skill. The correlation coefficient of the different variables presented (nitrate, dissolved oxygen, dissolved inorganic carbon, alkalinity, pH, etc.) varies between 0.6 and 0.92. The normalized standard deviation and normalized root mean square error also show that the model performs very well. It gives a good representation of the spatial and temporal variability of the system. A comparison was also done with the scorecards built from the observations. The comparison is very good for March but there are more discrepancies in June. However, this is not a direct comparison (e.g. differences in sampling, timing, climatological mean was done on different period, etc.). Some more work needs to be done to refine the comparison with the products presented but overall the numerical model is considered developed enough to be used as an additional tool for reporting.

Discussion summary:

It was noted that the comparison between model output and data anomaly should use the same reference period (2006-2018).

It was suggested to only compare surface water in March such as to exclude intrusive layers. Since the March survey is not based on transects, but rather irregularly spread stations, it was also suggested maps made from data should be compared to model output, rather than AZMP transects.

The 50-150 m layer includes outflow along the southern side of Cabot strait which will increase the variability of integrated nitrate for the East Gulf Box. In NE Gulf, there is convection in winter which brings nitrate to the surface. A participant stated that dividing the Gulf into different areas, i.e., by adding a small box that covers the outflow region southeast of Cabot Strait would result

in better representation of Gulf dynamics. In any event, there should be a mention that the East Gulf Box also includes the outflow region at Cabot Strait and that it presents a different dynamic than the NE Gulf.

The speaker noted that though transects cross different water masses, there are only a few transects and it would be difficult to represent a large region with only one transect. This is why a few transects were grouped over the large East Gulf Box.

A participant asked if the model chlorophyll was compared only with satellite chlorophyll or also with *in situ* chlorophyll. The speaker answered that *in situ* values were included in the previous Taylor diagram but that the model values did not compare well to *in situ* values. The speaker also notes that point to point comparison of model and in situ chlorophyll is not expected to produce a good result.

Rapporteur – Steve Punshon

NUTRIENT VARIABILITY ON THE SCOTIAN SHELF – D.C. Reed, C. Buchwald, P. Yeats, C.L. Johnson

Changes in nutrient inventories have significant impacts on marine ecosystems, and reduced flux of nutrients from subsurface waters into the euphotic zone can attenuate phytoplankton production. Previous work showed a decline in deep (50-200 m) nitrate on the Central Scotian Shelf between the late 1970s and 2000s, while apparent oxygen utilization showed a gradual increase. These nutrient trends were associated with a decline in temperature and salinity, consistent with a shift from a greater influence of nutrient-rich warm slope water (WSW) to lower-nutrient Labrador slope water (LSW) on the deep Scotian Shelf. The objective of this analysis was to characterize trends in subsurface nutrients on the Scotian Shelf and to understand the processes driving changes. Anomalies in temperature, salinity, nitrate, phosphate, and silicate in the 60-200 m depth range were calculated from a depth- and yearday-specific climatology in each of five subregions (eastern, central, and western Scotian Shelf, slope water, and Northeast Channel) to reduce bias from uneven sampling. LOESS curves were fit to the anomaly time series for each variable and subregion to visualize the trends and variability. On the Central Scotian Shelf, temperature, salinity, and all three nutrients declined between the late 1970s and 2007, with similar patterns in the other subregions. Although temperature and salinity increased after 2007, there was little change in nitrate anomalies while silicate and phosphate anomalies declined further. A similar pattern was seen in the other subregions. The analysis indicates that the relationship between nutrients and water mass properties changed around 2007. The next phase of the project will focus on determining the processes driving this change, including a change or dilution in nutrients in upstream waters that form the WSW.

Discussion summary:

A participant asked for clarifications on the speaker's hypothesis concerning greater nutrient concentration in Gulf of St. Lawrence water. The speaker answered that more deep, cold, nutrient-rich water implies changes upstream; a reduced influence of Labrador Slope water.

A participant asked whether the Gulf Stream nutrient content changed over time and whether the Gulf Stream position had an effect on the Slope water mass nutrient content. The speaker answered that these points will be examined in the future.

AZMP SYNTHESIS WORKSHOP SESSION 2 – PHYSICS

Rapporteur – Steve Punshon

FREQUENCY AND CAUSES OF EXTREME BIOLOGICAL PRODUCTIVITY – Igor Yashayaev

Exceptional physical properties and processes (e.g., ocean-wide low temperature and salinity, freshwater storage, deep convection and ventilation, water mass formation and circulation) cause the spring phytoplankton blooms of the Labrador Sea to be the highest in the subpolar North Atlantic. The chlorophyll-a concentrations observed in the Labrador Sea in May of 2015 were the highest in at least twenty years. Overall, there is a strong relationship between the intensity of the spring blooms and wind direction and speed, the northern Labrador Sea off-shelf ice extent, surface salinity and temperature, depth of winter convection, sea level height and gradient, eddy kinetic energy, and key climate indices. This confirms our main hypothesis that the physical processes are essential in controlling the rate and geography of primary production in the area. However, since most of the physical variables analysed here are not independent (high correlations), the task of choosing one that exerts most direct influence on phytoplankton is not trivial. To rank the physical factors by influence on biological productivity, we further examined the exceptionally strong and widespread phytoplankton bloom spanning the Labrador Sea during May of 2015. It was preceded by an extreme winter ocean cooling (high positive NAO) and one of the deepest winter convection in more than 20 years. Supposedly, convective mixing plays a very important role in preconditioning a spring bloom – nutrients pumped to the upper layer then get readily utilized by the growing biomass. However, while winter convection has not gotten any weaker since 2015, the bloom rebounded to the pre-2015 levels in the next year. This implies that increased convection does not always cause an extreme bloom, like in 2015. A further analysis of the multi-variable dataset showed that the most intense spring blooms occur when sea-ice cover and meltwater expand southward in the northeastern Labrador Sea filling its upper layer with anomalously fresh, oxygenated, and vertically-stratified water, favouring stronger and more sustained spring blooms. The increased accumulation of ice and freshwater and their expansion offshore are in turn caused by strong persistent northwest winds blowing water off the Greenland coast. All these factors peaked in 2015 triggering the most remarkable mega-bloom on record.

Additionally, the same strong and persistent westerly-to-northwesterly winds developed an interesting circulation pattern transporting biologically productive waters to the interior basin while increasing eddy kinetic energy to an all-time high. Small eddies formed at the boundaries of these energetic currents and convergence of the surface waters at their fronts led to concentration of biomass into highly active areas along the currents and fronts, also resupplying important nutrients in the upper layer through upwelling of deeper nutrient-rich waters.

Therefore the intense, massive and widespread 2015 spring phytoplankton bloom was primarily caused by anomalously strong and persistent westerly-to-northwesterly winds piling ice and accumulating productive meltwater in the northeastern section successively spreading it across the sea by the strong gyre-like current systems spanning a significant part of the Labrador Basin. A further advance in understanding the causes and wide-spread consequences of environmental changes and shifts in the key productivity area will help improving skills of ecosystem prediction under imminent climate change.

Discussion summary:

A participant asked if the water become stratified by the start of the bloom, and the speaker answered that yes, it is already capped by a warm layer at the initiation of the bloom.

A participant asked if it is possible to estimate the thickness of the surface layer in 2015. The speaker answered this could be done using Argo data, but the nutrient gradient is more important than the surface layer thickness. The depth of convection is not of primary importance in nutrient supply in this context.

A participant asked about the mechanism of bloom initiation. The speaker answered that stratification, nutrients and light are the required conditions.

A participant asked if the timing of AZOMP spring sampling is designed to match that of the spring phytoplankton bloom. The speaker answered that it is but, that the bloom timing varies from year to year. It usually occurs in May or June but sometimes as early as April, as was seen in 2015.

A participant asked if the chlorophyll distribution is related to the presence of fronts between water masses. The speaker answered that this cannot be verified because there are not enough fine scale measurements to distinguish fronts from zones of convergence or divergence. It was also noted that stronger currents generate more mixing, which results in higher chlorophyll concentrations.

A participant asked if jets and mesoscale features such as those presented by the speaker also occur in the Scotian Shelf region. The group discussion indicated that similar features are not uncommon along the Scotian Shelf. It was also noted that the orientation of the current is a determining factor of bloom parameters; it controls how much nutrient rich water from the boundary region is transported to the central basin.

COMPLEMENTING THE AZMP; MODEL BASED OCEANOGRAPHIC CONDITIONS IN 2018 – Joël Chassé

We presented the recent progress related to the development of a three-dimensional ice-ocean modeling system for the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine (GSL-SS-GOM). The goal of the study is to produce an ice-ocean hindcast, covering 1948-2018, to fill the data gaps in the observational system to support the State of the Ocean reporting (SOTO) ,fisheries studies, stock connectivity studies, invasive species research, bio-geochemical modeling, climate change, etc. Such a hindcast would be routinely updated every year.

The hydrodynamic model (NEMO-OPA) is coupled to an ice model (LIM) and is driven with the NCEP atmospheric forcing interpolated to the model grid. The grid horizontal resolution was increased from 1/12° to 1/24°. The model also includes tidal forcing and freshwater runoff of the 78 main rivers within the domain. All of the data required to force the model from 1948 to 2018 have been collected and assembled. Boundary conditions were fine tuned to reproduce the main circulation features of the study domain. These circulation features include the cyclonic circulation in the GoM, the Nova-Scotia coastal current, the along-slope Scotian Shelf current, circulation around Western Bank, the Anticosti Gyre and the Gaspé current. The model results compare very well with observed Sea Surface Temperature (SST) and observed temperature and salinity profiles. The modeling approach is proving to be useful in filling data gaps for the GSL-SS-GOM. The model results were formatted to present monthly anomalies that are complementary to the State of the Gulf of St. Lawrence for time periods when there are no observed data. Typical variables are salinity, currents and transport on sections which are not available from observations. Such long time series are very useful for ecosystem research.

Discussion summary:

A participant asked if it would be best if it would be best to discontinue usage of current regional models (e.g., CIOPS-E) in favor of a zonal modal incorporating data from multiple regions. The

speaker answered that this would first require a model with a long baseline run time and a demonstration of effectiveness. Another participant noted that such a model should include biogeochemistry. It was noted that a larger zonal model may lead to a reduced resolution trade-off for upstream parameters.

A participant asked if Environment Canada models use AZMP data. The speaker answered that Environment Canada are more concerned with surface data and air sea interactions rather than depth profile data.

It was suggested that a 2-3 day workshop should be planned to discuss how to combine outputs from different models. A zonal model going back to 1980 would be optimal. The workshop would discuss the incorporation of biogeochemistry.

A participant asked if the low runoff shown both by the model and data in the 1960s was related to reservoir construction for hydroelectric dams. The speaker answered that the low runoff was related to reservoirs being filled but also to the north Atlantic oscillation (NAO).

PREDICTABILITY OF SEA ICE IN THE GSL AT SEASONAL TIMESCALES – Dave Brickman, Brendan DeTracey, Roger Pettipas, CanSIPS team

Preliminary ideas and results were presented on the predictability of the space-time occurrence of sea ice in the Gulf of St. Lawrence based on model hindcasts and forecasts, compared to ice data. The model is a version of NEMO on the Maritime Canada domain.

The model hindcast runs from 1999-2015; the forecast from 2016-2018. The forecast (or training) period (TP) contains an ensemble of 20, 12 month long forecasts, issued monthly, based on output from the CanSIPS atmospheric seasonal forecast system. Monthly model hindcasts are also available for the TP. Two metrics were used to assess model skill: the overlap index (OI: a measure of the degree to which the model simulation spatially overlaps the data) and the percentage correct (PC: the percentage of grid cells, over a fixed area, for which the model prediction – ice or no ice – matches the data). Model skill is compared to the skill of a climatology based on the ice data.

For both metrics, model skill is higher than climatology throughout the entire simulation. For the TP, forecast skill is higher than climatology but lower than the model hindcast. The OI skill metric shows a seasonal pattern of lower skill during the ice growth and retreat phases. These preliminary results suggest that there is some limited skill in seasonal forecasting of ice occurrence in the GSL, warranting further investigation.

Discussion summary:

It was suggested that a different parameter, for example “distance to ice edge” may be a better parameter to report than ice coverage. A participant noted that the RIOPS model was also inaccurate in regard to ice extending along the Nova Scotia eastern shore and that seasonal effects such as wind transport of ice were not captured.

A participant asked what temperature and salinity data set was used as input for the model and also asked if the speaker believed using more recent temperature and salinity data would change the conclusion of their experiment. The speaker answered that this would hopefully lead to better skill in long term forecasts rather than short term.

It was suggested that remote sensed data could be incorporated into the model. In comparison, the present RIOPS model uses a variety of sources for short term forecasting. This prediction model however, is more concerned with long term forecast.

DFO COASTAL OCEAN GLIDER GROUP (COGG) – Melany Belzile, Dave Hebert and Clark Richards

New technology was purchased to enhance the monitoring programs (e.g., Maritimes Halifax line) and other science programs. A description of the process to request use of a glider was presented. It was noted that this process is evolving. A summary of glider activities was presented starting with data management in February 2017, before the arrival of the gliders. A system for handling near real-time and delayed mode was decided for all DFO gliders. Near real-time data is handled by MEDS after it is received at the glider facilities and distributed on the GTS. Delayed-mode data will be handled by the glider facilities. In 2017, the glider facility set up training on the use of the gliders and tests in the Bedford Basin were done. Several missions on the Halifax line were started in March 2018. One mission on the Bonavista line was done during November/December. A total of 14 missions were completed resulting in 206 days at sea, 4410 km travelled and 7108 CTD profiles.

For 2019-2020, three proposals were recommended; three occupations of the Bonavista line, up to ten missions on the Halifax line, and testing of a passive acoustic sensor payload bay.

Discussion summary:

A participant asked why the 50 m depth is critical for glider turnaround. The speaker answered that this is to avoid influence of big swells and waves. The glider alarm is activated if it is programmed to descend but a wave carries the glider upwards.

UPDATE ON VIKING BUOY OPERATIONS, UPGRATES AND TRUE COSTS – Peter Galbraith

The presentation made in February at the OSOM Face-to-face meeting was shown. It detailed past deployments in number of days at sea and number of casts performed. New real-time outputs available on the DFO intranet were shown that are used to monitor the correct state of operations of the various deployments. The 2018 additions to buoy capability were described (CTD deployment extended to 260 m and then to 320 m at Rimouski Station in 2018; Fluorescence (Turner Cyclop-7F) and dissolved oxygen (Oxygen, JFE Advantech Co. Rinko Aro-FT) added to at Rimouski station in late summer 2018). True costs of operations were shown for each buoy, averaging about 25K$ per year for those with satellite comms and 21K$ per years when cellular connectivity is possible. Deployment and recovery challenges were presented, including the complete loss of the IML-7 buoy to early sea-ice. We are working with CCG to add Viking buoys as Synthetic AIS to their network.

Discussion summary:

A participant asked how instrument addition and maintenance on Viking buoys should be financed. It was suggested that data clients could be billed to recover costs. For example, ocean acidification data clients could pay for pH and pCO_2 sensors. Sensors would have to be removed if the data are not being utilized and Ottawa is under-funding the project, since proper maintenance and calibration could not be paid for.

A participant asked if there should be a contingency fund for catastrophic failures. The speaker answered that major repair costs need to be identified at the regional level, similar to what is done for lost moorings. The regular operating budget cannot cover unforeseen catastrophic failures. We should have a list of frequently replaced parts and their costs readily available at short notice and a director ready to push our case to Ottawa. We need to collectively decide that

the Viking project is part of AZMP and act accordingly to support them even when funding doesn't cover 100% of expenses.

AZMP BUSINESS MEETING – SESSION 3

Rapporteur – Marjolaine Blais

WELCOME AND INTRODUCTION – Peter Galbraith

The chair opens the meeting and thanks the out-going chair Pierre Pepin for serving two consecutive terms for a total of 6 years. The chair elaborates on matters arising, including delays in the translation of some state of the ocean research documents, leading to delays in publication. One solution would be to take AZMP out of the CSAS process and publish results either as technical documents or possibly even simply on-line. This will be discussed at the Permanent Management Coordination Committee (PMCC) meeting at the end of the day.

Round table presentations are made.

REGIONAL SUMMARY OF ACTIVITIES (MARITIMES) – Andrew Cogswell:

Fixed station sampling in 2018 was similar to recent years with occupations of: Halifax 2 (20), Prince 5 (12), and Shediac Valley (8). Shediac Valley occupations were slightly lower than normal, and Maritimes region was not responsible for any of the sampling due to weather, logistics and personnel issues. The seasonal shelf surveys aboard the CCGS Hudson (April 6-24 and Sep 15–Oct 5) were successful and completed all of the scheduled operations with minimal downtime. The same was true for the Labrador Sea survey (April 25–May 22). The ecosystem trawl surveys were heavily impacted by ship availability. The winter survey charter (only 1 week) did not have additional capacity for oceanographic staff, so no stations were occupied. The Teleost was called in to replace the Needler during the summer survey (July 13–28) but only 14 days on the ship were possible. This meant that far fewer hydrographic stations (92) than normal (137--264) were occupied over the duration of the mission.

Available oceanographic platforms continue to adversely impact the surveys. This is a problem that is not expected to be entirely resolved in the foreseeable future, but chartering solutions to mitigate program impacts continue to be investigated. In particular, a supply arrangement consultation with industry is underway, with the hopes that a database of approved vessels will be compiled that will match scientific requirements with suitable vessel specifications. The 2018 field season for the shelf surveys were well accommodated by the CCGS Hudson, but the 2019 Hudson refit has resulted in less than optimal chartering results for the spring and fall surveys. For the 2019/20 field season the Coriolis II will service the spring and fall shelf surveys and the Amundsen will service the AZOMP survey scheduled for June. There are significant pressures placed on the fall AZMP program to support the acoustic mammal survey mooring work. This additional work was not envisioned during the draft of the request for proposals. Nonetheless, support from the Office of Partnership and Collaboration in Ottawa and collaboration between the regions has been critical in meeting this additional demand posed by the chartering process. It is expected that the CCGS Hudson will be available to meet the demands of the AZMP spring and fall surveys in 2020/21.

A review of capital spending was provided for each region for the 2018/19 fiscal year. This was the final year of the Monitoring Programs Capital funding that has been critical in modernizing our monitoring equipment over the last 5 years. In the Maritimes region, ~$160 K was allocated to the purchase of a flow cytometer (in partnership with the Centre for Offshore Oil and Gas

Environmental Research – COOGER), 2 new SBE 25+ CTDs and a portable SBE 55 mini rosette system.

The status of the HLX-2 Viking buoy was discussed during the Tuesday logistics meeting but not in the regional logistics summary on Wednesday. The buoy was deployed in early October at 44° 20.859' N, 063° 18.352' W at 135 m depth. It functioned well through very rough weather in late October and early November and was instrumental in capturing upwelling phenomenon during an intrusion of shelf water into the basin on October 24th. The number of Viking CTD profiles declined each month after deployment (Oct: 25, Nov: 20, Dec: 9, Jan: 7) as conditions continued to cool, until the Viking mast likely submerged in water in early February due to icing, rendering the buoy unresponsive. The Buoy was recovered later that month and our Ocean Engineering and Technology group has since amassed a list of components for replacement or servicing. Our BIO Technicians have consulted with IML to determine which components are available in their supply pool and have them shipped to BIO. Upon conclusion of the spring shelf survey, the team will meet again to obtain an update on the status of the buoy and the costs and timeline to make it operable. If possible, we'd like to deploy the buoy this summer for recovery in late fall. Finally, based on our experiences during the 2018/19 field season, we proposed a more realistic budget of between $20K and $25K, similar to other regional projections.

During the 2018/19 fiscal year, ~$15K was committed to finalizing the design phase and initiating the prototype production phase of the new wireless block design. The new design was shown to the logistics committee during the Tuesday meeting. More money will be invested into this project in 2019 to complete the fabrication of the blocks and displays. As well, $13.5K was allocated to the Nova Scotia Current Mooring which is now covered annually by the Maritimes AZMP program.

In 2018, the AZMP Maritimes spring and fall surveys acted as a platform for 14 ancillary projects. Of these, 4 were highlighted and include: the acoustic mammal survey which involves the deployment and recovery of passive acoustic moorings at strategic locations on the Scotian shelf and slope; the collection of nutrients and hydrography across the Northeast Channel and Gulf of Maine in support of a cooperative agreement with the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS); recovery of an oceanographic mooring array in and near the St. Anns Bank MPA; and the collection of CTD water samples for Dr. Erin Betrand of Dalhousie University to assess how organic and organometallic micronutrients influence primary productivity and phytoplankton community structure on the Scotian Shelf.

Discussion summary:

A participant commented that sampling frequency at Shediac Valley station has been low and that almost all of it was done from ships of opportunity with only one dedicated sampling cruise performed by IML.

REGIONAL SUMMARY OF ACTIVITIES (QUEBEC) – Félix St-Pierre:

All four surveys were done successfully in 2018. Even though the Quebec Region was affected by Coast Guard ship issues, the quick mobilisation of the Coriolis II saved the June survey for which no Coast Guard ship was available. After 2 years of conducting the March survey from CG ships, sampling could again be done from a helicopter. More than 100 temperature/salinity cast were collected down to 200 m. The new and faster aircraft in combination with the new winch/block system helped sample the winter mixed layer nutrient loading prior to the spring bloom. The June survey was done onboard the Coriolis II. It included 65 regional mackerel survey stations in the southern Gulf and 49 right whale/zooplankton stations throughout the gulf and estuary. A bird observer and 2 marine mammal observers were also present. In August,

110 stations (36 full AZMP, 72 partial rosette and 2 CTD only) were done on the multi-species survey aboard the Teleost. This survey included the collection of many additional variables (e.g., eDNA, pH, methane and hydroacoustic). The fall survey, was conducted onboard the Hudson, making it possible to work in heavier weather and reducing the impact bad weather conditions on the program. All the 46 AZMP transect stations were sampled but only 7 complementary oceanographic stations could be done. This was the result of growing complexity of logistic on this mission, caused by the increased number of buoy and mooring deployment and recovery operations that needed to be done. Because of the biological timing, the first 10 days of the mission were used for the right whale/zooplankton project but should have been used to mitigate delay caused by weather and other issues. Except for some minor issues, the 3 AZMP Viking buoys managed by IML staff performed very well and all of them collected more than 300 profiles per season.

A logistics issue worth reporting is the difficulties encountered with biological sampling at the Shediac Valley high frequency station. The site was only visited eight times in 2018 (seven by IML, and one during the multi-species southern gulf survey). The Gulf region has acquired equipment and it is hoped that they can start covering this station to some extent during the upcoming 2019 season but are still understaffed and lack a small vessel. The Viking buoy at V.A.S. mitigates problems caused by low sampling frequency but does not solve them. Another issue is the lack of a CG buoy tender vessel to support Viking buoys. A solution to this could be to make the Viking buoys operate as navigational aids. Lastly, the CG is less and less able to support the science programs resulting in the chartering of different vessels. This results in increasingly complex logistics as well as a lot of pressure on the logistics team and the science equipment.

Discussion summary:

There was a discussion on Shediac Valley station. It should be possible to add about 10 sampling cruises per year through Gulf region sampling. There is also the possibility to use a chartered boat to sample Shediac Valley, but because of BIO policies, it might be impossible for the concerned staff to get on this ship. We should then send other staff, and BIO staff could only go if sampling is done onboard a CCG ship. There were discussions about the possibilities of using a small coast guard vessel for Shediac Valley sampling, but this either means borrowing it from fish surveys or paying for it. Moreover, when borrowing a ship, you can only go sampling on that specific day. Sampling then becomes dependent on good weather. The best would be to have the same as what is used at Rimouski station, i.e. a vessel that is entirely available for BIO's crew and would allow sampling on good weather days.

IML seems to be the only region to use the available envelope for the maintenance of small craft boats and ships. The CCG Beluga is brought in once a year for maintenance. There are a lot of funds available at CG for maintenance of small ships. OSOM or OSCC should investigate to make sure there is equal access to these funds across the regions.

Quality control for pH sensors is poor. Calibration is crucial otherwise the output of these sensors cannot be trusted. There are also regular problems with these sensors that Seabird do not seem to be able to fix, but IML staff (Anthony Ouellet and Michel Rousseau) have compared sensor data with bottle data and the comparison was surprisingly good. It does not always work, but when it works, it works well.

REGIONAL SUMMARY OF ACTIVITIES (GULF REGION) – Renée Allain:

The Gulf region's oceanographic program under the AZMP is complimentary to the Quebec and Maritimes regions activities in the southern Gulf of St. Lawrence (sGSL). The September multi-

species survey is the main official AZMP oceanographic survey in the region, but other monitoring activities include CTD profiling, water sampling (for carbonate chemistry) and annual bottom water temperature monitoring. These monitoring activities are typically added on to other fish surveys or conducted in small bays and estuaries. In 2018, a total of 875 CTD profiles and 686 water samples were collected by 8 groups covering nearshore, coastal and offshore sites. All data and samples were transferred to IML for verification, processing and archiving. The collected data were also included in a new repository database at the Gulf Fisheries Center. The Gulf region is also responsible for the high frequency profiling Viking Buoy AZMP-ESG. The 2 Viking buoys (counting AZMP-VAS) were deployed in the southern Gulf of St. Lawrence (near Shediac Valley and off of Souris, PEI) by IML with provision of funding for buoy servicing and parts by the Gulf Region. In addition, two moorings were deployed from July to October at each end of the Northumberland Strait to monitor water entering and leaving the Strait and to calibrate and validate numerical models. There was a decrease in occupations at the Shediac Valley fixed station in 2018 due to inclement weather and lack of government vessel availability. To increase occupations in 2019, a contract for a charter vessel is currently being prepared and training of employees for sampling the Shediac Valley station is planned as there is no oceanographic technical staff in the Gulf Region. A plankton sampling project with the collaboration of snow crab fishermen is also scheduled during the 2019 fishery whose goal is to collect 200 samples during an 8 week period. The 2018 funding was allocated towards the purchase of acoustic releases, a water analyzer and CO_2 sensors to equip the two Viking buoys in the sGSL.

Discussion summary:

The speaker elaborated on the plankton sampling project in collaboration with fishermen. They will be called on to conduct a minimal sampling protocol. This collaboration will allow collection of 40 samples per week during 6 to 7 weeks, mostly in snow crab fishing area 12 (sGSL). The fishermen seem motivated. This program is supported by Ottawa so there is no financial pressure on AZMP. The zooplankton nets will be equipped with temperature sensors.

REGIONAL SUMMARY OF ACTIVITIES (NEWFOUNDLAND) – Stephen Snook:

The Newfoundland region completed their standard AZMP surveys in 2018 with varying success rates. The spring survey, TEL185, took place from April 6 – 24, 2018 and 82% of the planned sampling was completed. In addition to this, one mooring in the LC-AOI was recovered, refurbished and redeployed, and one acoustic listening mooring was deployed in the Flemish Pass in support of the marine mammals research group. The summer survey, COR011, took place on a charter vessel, R/V Coriolis II, over July 15 –August 2, 2018 and 100% of the planned sampling was completed. In addition 2 moorings were recovered, refurbished and redeployed in support of the OSNAP program, one AZFP mooring was recovered at S27, and the AZMP-STA27 Viking Buoy was deployed at S27. The fall survey took place during November 11 – December 2, 2018 and 85% of the planned sampling was completed. In addition to this one AZFP mooring was deployed at S27, one acoustic listening mooring in support of the marine mammals research group was recovered in the Flemish Pass, one glider was recovered on a test transect on BB line, eight ARGO floats were deployed in collaboration with BIO and IFREMER, and two drifters were deployed in collaboration with météo France. Due to ongoing issues with the CCGS Teleost the 2019 NL spring and summer AZMP surveys have lost 25 days (15 in spring, 10 in summer). 2019 NL Fall AZMP survey will take place on RRS James Cook due to CCGS Hudson VLE. Multispecies surveys in the region were highly successful in 2018 with 479 trawl CTDs and 19 XBTs collected. With two ships operating in the fall, we collected 613 trawl CTDs and 30 XBTs.

At the NL high frequency station S27 there was a slight increase in sampling in 2018. The region is facing ongoing challenges with access to a suitable platform for winter occupations, and lack of a small boat in the section/branch leaves limited options. In addition to regular sampling, there has been a T-S mooring at S27 since 2014 with regular, yearly redeployments. The NL region has also deployed a Viking buoy and AZFP mooring at S27 since 2017 with regular, yearly redeployments to fill the gaps left from reduced sampling. Unfortunately the Viking buoy operations were halted because of damage sustained in rough weather and despite multiple attempts, the NL region staff were unable to fix the buoy. While this provides more data, some observables are missing from lack of water samples.

The NL region performed the first successful glider deployment and recovery in NL during the 2018/19 field season. A researcher from the NAFC coordinated the deployment from a DFO C&P vessel, and recovery was performed by the CCGS Hudson during the fall AZMP survey. Planning is underway to deploy the glider on 3 transects during the 2019/20 field season.

The 2018/19 ISN equipment renewal fund provided $120k to the NL region. Using this fund, the region was able to purchase two SBE37SMP microcat CTDs, one VINDTA $CaCO_3$ analysis system, and 2 Teledyne Benthos R2K acoustic releases to replace aging, lost or damaged equipment.

Discussion summary:

All the issues with CCG must be raised with senior managers since CCG does not consider impact on science operations in their decisions. For them to consider it, everything needs to be related to cost, either gain or losses. We must define the cost and impact it has on our clients when we cannot deliver. We must revisit our relationship with CCG, that is the solution. We need to document the impact of having to do more with less resources. How does it affect reporting? Does it increase uncertainty or inability to track trends? For instance, when we spend 2 weeks of an AZMP cruise completing an NAWR survey, we do not collect as much samples as we should for AZMP. One of the suggested ways to achieve this is to do analyses removing data from dataset to show what it does when you remove certain data. Trends can be reversed and seasonal patterns can be missed. This strategy is very informative.

People who face challenges with CCG should try to summarize the different issues and the meeting's Chairperson could summarize and present it to the appropriate leaders (**action item**). Logistics and PIs should meet to clearly highlight their issues.

The other possible solution is the use of chartering. However, it would facilitate the work if we knew in advance what were the chartering possibilities. At the moment, we really know about the opportunities at the very last moment. Regarding moving towards more charter based solutions all options are still considered, but it will help if we know in advance their solution to improve planning. If we move to long-term chartering, we will perhaps be able to get ships modified to accommodate science operations. This can likely be done with most ships. Doing that would remove the need to build science containers for CCG ships and save costs.

Regarding the questioning about the usefulness of Viking buoys and the lack of money to maintain them, it was proposed that we need to define the way data will be reported in AZMP. We need to know how the equipment is to be maintained, where the money will come from and how data management will be handled. These are issues that would deserve a national plan.

A problem particular to BIO is that there is so much equipment that keeping an inventory is a challenge. Available replacements for broken or damaged equipment may available but not used for this reason.

A Participant asked why buoys should be managed differently from moorings and suggested the difference comes from the available funds for replacing equipment. When equipment is lost from a mooring, replacing it is not a priority but with buoys it becomes a priority. At IML, spare structural parts (e.g., super-structure, controllers, solar panels, etc.) are stocked for replacement but not science equipment.

Part of the problem is that the amount of money needed to maintain the buoys is not known in advance. If a buoy loses equipment, it should still be deployed half working. If it really stops working, then it should be removed and not redeployed until it is fixed.

A solution would be to incorporate the buoy data in reporting and emphasize ways in which these high-frequency systems allow us to better inform clients. Once this is shown, many of the issues brought up will be easier to solve.

A participant noted that the information gathered by buoys will be very different between regions. Objective need to be set for the use of Viking buoys. If they are only to be used in safe conditions, the results will not be as meaningful as if they can be deployed with risk of loss or damage (e.g., to sample the spring bloom).

A participant noted that fixing the buoys is not that expensive (e.g., it cost 35 000$ to fix BIO's buoy that was damaged by freezup) for a region if they make use of the available funding.

REPORT ON LOGISTICS WORKSHOP AND DISCUSSION – Stephen Snook, Andrew cogswell, Félix ST-Pierre, Renée Allain and Jack Fife:

Vessels continue to be an issue. In particular, the Hudson VLE leaves science without a dedicated oceanographic vessel, and regions are responsible to submit an RFP request through Ottawa in order to obtain a ship. In 2018 a total of 40 days at sea were lost in the Atlantic zone, with an additional 44 days spent on non CCG charter vessels. Not only does this present a logistical issue to mobilize an unknown vessel, but also financial pressure, safety concerns, and timing constraints for the region that is obtaining a charter. NCR has proposed a solution of forming a pool of pre-qualified vessels, but the realistic usefulness of this is uncertain.

Increased ancillary program pressure has placed a lot of demand on AZMP surveys, and is now impacting the ability to meet AZMP's core mandate. In particular, the Atlantic right whale initiative and the development of new MPAs are creating pressure on the AZMP program. Details of this impact need to be carefully documented in order to present to management.

Staffing remains an issue in most regions. Regions are experiencing loss of experienced staff, lack of overlap between new and departing staff, and the difficulty associated with recruiting qualified staff. In particular, there is a lack of seagoing staff in most regions.

Responsibility for sampling high frequency stations such as Shediac Valley are shifting from BIO to other regions. This shift may make biological analysis at the high frequency station more difficult due to the lack of trained oceanographic staff in the Gulf region. Regions are to continue protocol standardization across regions and update the original protocol (Mitchell et al. 2002).

If regions are expected to charter vessels long-term, should an effort be made to containerize the seagoing operations? Currently, no clear answer has been provided from NCR, and feedback is rare. Since there is no defined plan, the resources to obtain containerized units are unavailable.

Each region is facing financial pressures associated with the current budget allocation for the Viking buoy project. The chairperson has presented a realistic cost breakdown to OSOM that could help alleviate these pressures. The relationship between DFO and MTE must continue in order to successfully achieve the deliverables associated with this program. Other questions

and concerns with the Viking buoy project relate to data management, reporting projects, governance, and long-term feasibility.

REMOTE SENSING UPDATE – Carla Caverhill

The SST and ocean colour products created by BIO are available on the website. The images on the website can also be downloaded from an ftp site. Statistics for the North Atlantic statistical boxes for each product can be downloaded here. There are plots that are updated when each new semi-monthly composite is produced for VIIRS and for AVHRR SST. Unrefined statistics for VIIRS chlorophyll are now available near real time in files ending in viirs-chlor_a_unrefined.stat. Spring bloom metrics for several sensors can be found here. The ftp directory is for near real time imagery including quarter-month unrefined VIIRS chlorophyll maps and daily NOAA SST maps and for large and single-user requests. Files on this directory could disappear after 60 days.

Discussion summary:

A participant asked if is possible to obtain SST box averages prior to 1997. The speaker answered that it is possible using NOAA's Pathfinder SST product (from 1981 onwards), but not using data from the BIO remote sensing group's data.

A participant asked if the SST data currently stored in unpublicised ftp servers could be made public and publicised (e.g., via a link on their website).

It was noted that the new monthly SST composite is computed with daily anomalies and daily climatologies, and was developed at the chairperson's request. Most users however, look at semi-monthly composites and not the monthly ones.

DATA MANAGEMENT PROGRESS AND ISSUES OVERVIEW – Mathieu Ouellet, Laure Devine, Brian Boivin, David Fishman, Shelley Bond, Diana Cardoso

References to the AZMP website to new instruments such as Viking buoys and gliders were added at the relevant AZMP fixed stations and section pages. The website's source for AZMP sections and fixed stations is Johnson et al. (2014). An error on BB01 position was fixed in December 2018. The document is missing 5 regularly sampled Newfoundland sections, who as a result are not shown on the website. A document hosted by the St. Lawrence Global Observatory website lists all AZMP Gulf and St. Lawrence Estuary section stations nominal positions and depths, but there are some discrepancies with the 2014/047 ResDoc. At the moment there does not seem to be an authoritative list of AZMP section stations. The website was also updated with information on the latest available SAR (2017), however, input from scientists would be required to update other document lists, such as primary publications.

The Ocean Data Management Sub-Committee (ODMSC) made progress on a converting moored ADCP data files in CF-compliant netCDF format, and BIO converted other data types to the same format. IML designed a quality control package for vertical CTD profiles measured by Viking buoys, and quality controlled over 8000 profiles from 6 buoys (2016-2018). The committee presented a proposal to the Oceans Science Coordination Committee to request funding for a national position located at IML to continue implementing solutions for all Viking buoys nationally and other data types collected by those buoys. Progress was also made in the management of real-time glider data, making netCDF files available on the Ifremer/EGO GDAC and DFO FTP server in near real-time. As for international data exchange, an agreement with the Clivar Carbon Hydrographic Data Office resulted in them acquiring some DFO data (Line P) from a website. A process was also developed to reformat ocean acidification data from BioChem bottle data in the format required by the Ocean Carbon Data System for a request

from the Intergovernmental Oceanographic Commission. Some OSDMC members also joined the newly established Canadian Integrated Ocean Observing System working groups. Work is underway at BIO to continue reviewing and loading data in BioChem, and using the QC package developed by IML.

ODMSC also reported on their objectives for next year, including continuing the netCDF conversion of moored ADCP and other data types, as well as hosting these files on a public server, establishing a data flow to OCADS from each region using a similar process where relevant, and explore options to add other institutes (BIO, NAFC) CTD data to the IML CTD database, who should become publicly accessible in the next year. Work will also continue on solutions for Viking buoys, glider data, oceans protection plan data support, international data exchange with other bodies, BioChem, and rationalizing the distributed mooring archives.

Discussion summary:

A participant noted BIO has different variable names than IML in ODF files. Different names is not such a problem however, as long as the same coding is used for each variable when it is transformed into netCDF.

A participant commented that the Climate database lacks metadata and that for many users, storing the metadata with the data is more convenient.

A participant commented that ODF format is not convenient for all users since it provides the data split into multiple files. Many users prefer having all the data in one single file (e.g., netCDF).

AZMP BUSINESS MEETING – SESSION 4

Rapporteur – Andrew Cogswell

CARBONATE AND O_2 OBSERVATIONS ON THE NEWFOUNDLAND SHELF – Olivia Gibb and Frederic Cyr

Ocean acidification (OA) parameters are monitored as part of the AZMP since fall 2014. In addition to pH, the carbonate saturation states with respect to calcite and aragonite (Ω_{cal} and Ω_{arg}) are measures of ocean acidification that indicate the potential to precipitate/dissolve carbonate. Below the threshold of 1, the environment is considered undersaturated and potentially corrosive to organisms that build biogenic carbonate shells. Newfoundland region have agreed to gather all existing AO data collected as part of AZMP since 2014. An overview of these data are presented in order to start a discussion on how these data should be reported in the future

Discussion summary:

There was a question about the availability of the 2015 data in the GSL. It was thought that total alkalinity data quality was lacking in 2015 but pH data quality was good. IML will make sure these data are quality controlled before sending them to the NL region.

All pH sensor are factory calibrated, but in situ calibrations are also required. This in situ calibration is done by NL and IML staff but not by BIO staff. There were plans to correct all of the CTD pH data for this in NL, but they lost their data manager and it was not done. Steve Punshon have been collecting water samples matched with every cast such that an empirical calibration may be obtained but these are not archived yet.

IML calibrated pH data have not yet been loaded into the BioChem database. Ideally, the whole dataset would be used to for sensor calibration. There is a backlog on analysis of pH data at IML and 2015 GSL data were not yet analyzed. Once the pH data are analyzed IML staff should send them to NL staff to help with sensor calibration.

The pH sensors are useless unless calibrated. The Ocean Carbon Data System (OCADS) still want these pH data, but it is low priority. OCADS will accept calibrated or uncalibrated pH data but it has to be flagged properly. It is generally agreed however that it is better not to send these data to OCADS without calibration.

2018 CHEMISTRY CONDITIONS IN THE LABRADOR SEA AND ON THE SCOTIAN SHELF – Steve Punshon

2018 results were presented for transient tracers (CFC-12 and SF_6), total dissolved inorganic carbon (DIC) and pH_{total} from the AR7W Labrador Sea section, and the ocean acidification parameters pH_{total} and aragonite saturation state (Ω_{Ar}) from the core Maritime AZMP sections occupied in the spring and fall. For Newly-Ventilated Labrador Sea Water (NVLSW), mean SF_6 concentration was 2.69 ± 0.18 fmol kg^{-1} and mean CFC-12 concentration was 2.39 ± 0.06 pmol kg^{-1}. The concentration of CFC-12 in NVLSW has levelled off in recent years while in the same period there has been a steady rise in SF_6 concentration, consistent with the atmospheric trends. The mean NVLSW DIC concentration was 2166.5 ± 3.2 µmol kg^{-1} while pH_{total} was 8.016 ± 0.019. These values are in line with the 20 year linear trends of 0.86 µmol kg^{-1} y^{-1} for DIC and – 0.003 y^{-1} for pH. For the Maritime AZMP sections of Cabot Strait, Louisbourg, Halifax and Brown's Bank, mean surface water pH_{total} ranged from 8.046 – 8.072 in spring and 8.004 – 8.013 in fall while bottom water values were 7.843 – 7.984 in spring and 7.815 – 7.951 in fall. Surface Ω_{Ar} ranged from 1.24 – 1.82 in spring and 1.73 – 2.50 in fall and 1.03 – 1.41 in spring and 1.00 – 1.36 in fall for bottom water. For all sections, pH_{total} was higher in spring than fall in both surface and bottom water, and surface water Ω_{Ar} values were higher in the fall by 0.5 or more with higher fall temperatures likely being at least partially responsible for the latter. The lowest Ω_{Ar} values of around 1.0 were seen in bottom water on the Cabot Strait and Louisbourg sections in both spring and fall.

Discussion summary :

It was suggested that deep values should be excluded. Many comments also suggested separating shelf and offshore data in reporting. A participant suggested data from the AZOMP passage on the Halifax line (collected one month later) should be included in these analyses. Reporting calcite saturation as well as aragonite saturation may be relevant, in particular for research on corals.

OCEAN CHEMISTRY CONDITIONS IN THE GULF OF ST. LAWRENCE – Michel Starr

A summary of Ocean Acidification (OA) state in the Estuary and Gulf of St. Lawrence was presented. Selected datasets were considered in detail including seasonal and annual comparisons of underway surface and bottom waters pCO2, pH, carbonate saturation states from AZMP (March, June and November) and ground fish (August-September) surveys, two high-frequency SeaFET pH sensors moored in the Estuary and southern Gulf, and a10-years of weekly carbonate system measurements from the Lower St. Lawrence Estuary (LSLE). These latter observations were also compared to historic data to evaluate how pH and saturation levels have evolved in the St. Lawrence Estuary. Several persistent zones of corrosive bottom waters with under-saturated aragonite levels were found in the Estuary and Gulf of St. Lawrence, and

notably at the head of the Laurentian, Anticosti and Esquiman Channels. These latter zones correspond to the hypoxic waters previously documented by Gilbert et al. (2005). The pH in the LSLE bottom waters decreased nearly by 0.1 units over the past decade, with a mean value of 7.56 in 2017. This decline is much higher than the global average of 0.02 pH units per decade. As a consequence, the saturation states of the bottom waters of the LSLE decreased with respect to calcite and aragonite during the last decade. Today, the bottom waters in the LSLE are not only under-saturated with respect to aragonite but also in calcite. Surprising, under-saturated waters with respect to both aragonite and calcite were also found in the shallow southern Gulf of St. Lawrence at the end of summer of 2017. The potential impacts on marine fauna and mechanisms that control the spatio-temporal variability of pH and saturation states with respect to calcite and aragonite have been discussed.

DISCUSSION ON OCEAN CHEMISTRY SECTION IN SAR: OA, HYPOXIA – Pierre Pepin

No abstract available.

Discussion summary:

A participant noted that there is a saturation rebound in 2018 and asked if this was due to water warming in the last decade. The speaker answered that this may just be part of the variability and caution should be taken before reporting a rebound. A participant asked if there was a similar trend for oxygen data at the Rimouski station and someone answered the trend has been the same since 2017.

A participant asked if a drop in oxygen had been measured from 2008 to 2010, matching the drop in pH, but the speaker said this was not measured.

A participant commented that saturation states and oxygen should also be reported.

A participant commented that presenting all the details is not relevant for the SAR. Focus should be kept on trends and select variables that meet the client's needs (e.g., pH and saturation).

It was commented that on the Halifax line water measured at the bottom can be from the shelf or from deeper waters depending on position along the shelf.

A participant asked if total alkalinity is influenced more by biological or atmospheric factors and the speaker answered that it was not affected much by atmospheric changes. The participant also commented that score card plots for dissolved inorganic carbon and alkalinity would be good additions to our reporting.

A participant suggested there should be a distinction between measurements (e.g. TA, DIC) and estimates like saturation.

A participant suggested that acidification data of different depth ranges should be presented separately. In particular, there should be sections for bottom conditions, depths less 500 m, and the deep ocean data. It was also brought up that separating deep water and shelf data on the Halifax section is important.

It was commented that next year, the ocean acidification section in the SAR should present dissolved oxygen data and report patterns noted across the sections. Score card plots or maps of seasonal averages could also be presented.

A participant suggested that a short summary of geographical patterns observed in each BioRegion (NL, GSL, SS) since the start of the time series should also be reported. Another

participant added that if BioRegions were emphasized in acidification reporting, perhaps we should frame the SAR in terms of BioRegions for uniformity.

It was suggested that a technical report should be written to document the methods of sampling and processing that build the acidification results. There was discussion of who should lead the production of this report, who should contribute and how.

COMPARISON OF DISSOLVED OXYGEN METHODS ACROSS REGIONS – Laure Devine and Marjolaine Blais

Following the objective to homogenise O_2 sampling and calibration procedures among regions, every region shared their whole procedure. A list of similarities and differences was compiled and a comparison of calibration methods was performed. Despite a few differences in the calibration procedure, corrected Soc values determined by BIO and NAFC were nearly identical to those determined by IML during this exercise, suggesting that there is no need for the regions to make major changes in the way oxygen sensors are calibrated. It seems that the most critical factor to ensure proper calibration is to cover the range of dissolved oxygen concentrations encountered and to space sampling throughout the mission to determine if the sensor behaved the same way from beginning to end. Main recommendations include : 1) the use of Winkler titrations to calibrate CTD sensor rather than portable dissolved oxygen meters; 2) perform standards, blanks and duplicate samples on a regular basis; 3) perform calibration of the CTD O_2 sensor using the upcast.

Discussion summary:

A participant commented that one of the summary slides could be used to update the sampling protocols in Mitchell et al. 2002. There was discussion on methodology changes (e.g., closing of bottles, Winkler titration vs dissolved oxygen meters).

The necessity of following protocols for stops during rosette measurements was brought up. These are important to avoid errors due to the time needed by water of a given depth to reach each sensor. This delay can be up to 8 seconds as noted by the Maritimes region staff. It was mentioned that hysteresis correction is not performed on AZOMP data, rather an alignment is done which minimizes the noise and that is variable between sensors and pumps.

It was noted oxygen sensors calibration drifts over time. Oxygen data calibration should therefore also be a function of time.

A participant commented that there are sometimes large increases in oxygen attributable to poorly executed laboratory manipulations. The precision of the Winkler method is dependant on the quality of the manipulations. The GO-SHIP protocol (Uchida et al. 2010) should be followed.

I was noted that the Maritimes region staff stopped making their seawater property standards for these analyses in 2012 and instead started purchasing them from the company OSIL. They found this to reduce the uncertainty in measurements and recommend other teams do this as well.

OPEN DISCUSSION ON A COLLABORATIVE HYDROGRAPHIC (T,S) DATASET PAPER FOR THE AZMP REGION – Frédéric Cyr

Newfoundland region have been mirroring a large part of DFO's east coast data available through MEDS. Based on initial work with this database it is proposed here to generate a zonal Temperature, Salinity and Depth product for the Atlantic Zone. All available CTD casts for each region should be gathered and processed/cleaned using a standard and transparent quality

control. It is proposed to convert this hydrographic database to Network Common Data Format (NetCDF) and archive it on a public repository using a Digital Object Identifier

Discussion summary:

A participant asked why spatial coordinates (longitude and latitude) were dependent on time in the presented data set. The speaker answered that this was necessary because data were not gridded, but scattered in space and time. Data are available at different spatial coordinates for every time step.

This data set is in use for reporting in the NL region. The speaker asked if a similar T-S product should be developed for the Atlantic zone. A participant asked how big this data set would be. The speaker estimated the file size at 5 GB, and noted that since loading netCDF data implies only reading the file metadata, this data set would load instantly. A participant noted that a similar T-S data structure is also used for the Labrador Sea reporting.

OCEANOGRAPHIC MONITORING PROGRAM AND DATA MANAGEMENT AT IOS – Di Wan

An overview of the Oceanographic data and the data management in the Pacific Region is presented. The oceanographic data in the Pacific Region are managed by the Ocean Sciences Division. The main data types are: CTD, bottle files, current meters, surface drifters, and plankton data. There are over 70,000 CTD profiles from 1965 to present, over 30,000 bottle profiles from 1930 to present, 300 moored CTD and Current Meter/ADCP time series. All data can be accessed publicly through a Graphic-User-Interface web portal. The profile and time series data are uploaded to CIOOS pacific server in netCDF format as well. Observational data from Viking Buoys are also shown and discussed.

PHYTOPLANKTON BLOOM FIT: EVALUATION OF METHODS AND RECOMMENDATIONS – Emmanuel Devred

The shifted Gaussian method has been the preferred approach to retrieve phytoplankton spring bloom metrics (i.e., initiation, duration, amplitude and magnitude) in several regions of the Northwest Atlantic. Here, we tested and discussed three approaches namely, the shifted Gaussian, the threshold, and the rate of change to assess the impact of the method on the retrieval of the spring bloom metrics. We found that all three methods provided similar results, but the shifted Gaussian was the most robust to change in parameterization, did not require any pre-processing of the data and was able to deal with gaps in the data. For these reasons, we recommended the shifted Gaussian model as the best approach for the retrieval of bloom parameters for the AZMP.

Discussion summary:

It was noted that a box averages require 10% pixel coverage. Participants also noted that chlorophyll observations were patchy in space and that the box placement should be optimized. It was commented that these results should be used to reach a consensus on the methods used for reporting bloom metrics. The speaker agreed to organize a working group with a participant from each region to coordinate this.

A participant asked if, instead of box averaging, maps of bloom metrics (e.g., magnitude, duration) could be used for reporting. The speaker answered that at a 4 km spatial resolution this was not possible. This could be done by averaging several pixels together but the speaker did not know how coarse the resolution would need to be in order to get good results. This is worth pursuing as maps may be more patchy but more accurate.

It was noted that the GUI shown in the next presentation was used to for these analyses.

PHYTOFIT: AN R APP FOR PHYTOPLANKTON SPRING BLOOM FITTING – Chantelle Layton

R shiny allows a user to build interactive applications that can be for personal use on a local machine, or can be hosted as a standalone application on a webpage. The coding structure of a shiny application is very similar to a webpage with two main components, the front end, or here the user interface, which defines everything that the user will see, and the back end, or the server, where analysis takes place and uses the input from the user interface. For this shiny example, the application allows a user to interactively test various methods for finding parameters that define a spring bloom for defined boxes across the Atlantic region. Here, users are able to visualize daily MODIS level 3 binned chlorophyll satellite data from 2003 to 2017 for a selected region, see details for the selected box, which includes a more detailed image with a histogram of the data for a chosen day. From here, users can interactively control various data processing methods on the daily data which includes the minimum percent data coverage, outlier removal methods, and whether to use a daily average or median. From here, users can then test out various bloom fitting methods, which includes the shifted Gaussian, threshold, and rate of change method. Currently, the code to run the application is available here which includes detailed instructions on how to install and run the application.

Discussion summary:

The speaker commented that she can provide web links to those interested in running the application, as well as instructions. It was suggested that a working group or at least a discussion group should be formed to find applications for this new tool.

AZMP DATA IN OPERATIONAL OCEAN MODELS AND PRODUCTS – Patricia Pernica, Yvonnick LeClainche, Corinne Bourgault-Brunelle

The DFO Service Desk for Operational Oceanography (SeDOO) acts as the DFO hub for the application of operational ice-ocean prediction systems. These operational systems, such as the Global Ice-Ocean Prediction System (GIOPS) and the Regional Ice-Ocean Prediction System (RIOPS), depend on in-situ observational data, including data collected by the AZMP project. These data will become increasingly important when the Coastal Ice-Ocean Prediction System – East (CIOPS-E) becomes operational, targeted for summer 2019. This presentation will outline the importance of AZMP data in SeDOO activities: from data assimilated to produce the GIOPS/RIOPS analysis that is used to create forecasts and products to the AZMP data included in verification metrics of international global ocean models.

Discussion summary:

A participant asked what data formats can be submitted for data assimilation in these models, and how they should be organized. The speaker answered that the preferred format is netCDF organized following the Integrated Global Observing System (IGOS) framework. To provide a new data set for assimilation, send it to MEDS or CMEMES.

It was noted that NL and MAR regions already send data in IGOS format but IML does not. Data managers at IML should be invited to send data in IGOS format.

A participant asked if all AZMP data was used in CIOPS reanalysis runs from 2007 onwards. The speaker was not sure.

The speakers were asked if their team's models were used to produce hindcasts or reanalysis data products. They answered that they were not since their mandate is very operational, but they could inquire to find if this is done by someone else.

REVIEW OF PHYSICAL AND BIOGEOCHEMICAL CONDITIONS IN THE NORTHWEST ATLANTIC – SESSION 5

Rapporteur – Benoît Casault

PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS IN THE LABRADOR SEA (AZOMP) IN 2018 – Marc Ringuette and Igor Yashayaev

Physical conditions:

The Atlantic Zone Off-Shelf Monitoring Program (AZOMP) provides observations of variability in the ocean climate and plankton affecting the regional climate and ecosystems off Atlantic Canada as well as the global climate system. In May of 2018, the Atlantic Repeat 7-West (AR7W) line was occupied by the Bedford Institute of Oceanography for the 31st time since 1990. Additionally, the network of profiling Argo floats provided temperature and salinity data to 2000 m used for monitoring of year-round variability of the oceanographic conditions in the Labrador Sea. However, the number of the floats within the Labrador Sea during 2018 were just marginally sufficient to resolve sub-monthly variability.

The extreme losses of oceanic heat to the atmosphere occurring in the Labrador Sea during winter on most years result in the formation of relatively dense water masses spreading through and consequently ventilating the intermediate and deep layers in the North Atlantic Ocean. Recurrent production of dense waters also makes the Labrador Sea a principal co-driver of the global ocean overturning circulation.

In the winter of 2017-18, as in the previous two winters, the mid-high latitude North Atlantic experienced a more moderate heat loss to the atmosphere than in the winter of 2014-15 (which had the highest surface heat loss in more than two decades). The cumulative surface heat losses in the Labrador Sea were also the lowest since the winter of 2013-14. Despite the reduction in winter heat losses, the depth of winter convection has been steadily increasing since 2014-15, forming the most significant class of Labrador Sea Water (LSW), in terms of volume, depth and density since 1994. Persistency in LSW development, seen as the deep cold water cascading in the time evolution of vertical temperature and salinity profiles happens because of water column preconditioning, maintained over the previous years. The temperature and salinity profiles obtained by the Argo floats show that the winter mixed layer, and hence convection in the central Labrador Sea, reached and even exceeded 2000 m in 2018, continuing the deepening tendency of the winter mixed layer observed over the past seven years. This suggests that certain properties, such as low temperature, weak vertical stability and weak overall stratification, imposed on the water column by the stronger-than-usual convective mixing in the previous years, had resulted in preconditioning that facilitated further development of deep convection this year. A reservoir filled with this newly ventilated, record deep, cold and fairly fresh LSW is evident in our seawater property sections. The 2018 vintage of LSW is associated with low temperature (< 3.3°C) and salinity (< 34.86) between 1000 and 2000 m. The winter convection in the recent time period, 2015-2018, especially in 2017-18, is arguably the deepest since the record-deep cooling that reached 2400 m in 1994. The present LSW year class is one of the largest ever observed outside of the early-1990s.

The progressive cooling of the top 2000 m, and deep and intense winter mixing during the five consecutive winters of 2013-14 through 2017-18 have interrupted the general warming and

stratification-building trends that have persisted in the intermediate waters of the Labrador Sea since the mid-1990s.

Interannual variability in Labrador Sea ocean heat content and cumulative surface heat loss during the cooling seasons indicates that anomalously strong winter atmospheric cooling associated with the North Atlantic Oscillation is continuing to drive the recurrent convection. In turn, recurrent deep convection is contributing to decadal-scale variability in deep-water properties and transport across and from the subpolar North Atlantic (by the ocean's western boundary and interior pathways) and potentially in the Atlantic Meridional Overturning Circulation.

Both upper, 0-200 m, and deeper, 200-2000 m, layers have been cooling since 2010. However, the freshening trend seen in the newly-formed or newly-ventilated LSW between 2011 and 2016, reversed in 2016, making the LSW formed in the winter of 2017-18 the densest since the mid-1990s.

The strong winter convection in the winter of 2017-18 further increased gas (dissolved oxygen, anthropogenic gases, and carbon dioxide) uptakes and consequently increased gas concentrations in the Labrador Sea in the lower part of the 0-2000 m layer

Biological conditions:

Most indices in the Labrador Sea were lower than normal in 2018, a trend that coincides with the return of very deep winter convection in 2014. The temperature of the top 100 m of the water column, corresponding to the phytoplankton and mesozooplankton habitat, showed negative anomalies in the Labrador Basin and on the Greenland Shelf but positive anomaly on the Labrador Shelf/Slope, which can be explained by intrusion of waters from the Labrador basin.

In May 2018, anomalies of *in situ* chlorophyll-*a* concentration were negative on the Labrador Shelf/Slope and in the Labrador Basin but slightly positive on the Greenland Shelf/Slope. Remotely-sensed ocean color data complemented the *in situ* measurements for the rest of the bloom season. With the exception of the Greenland Shelf, it was again a challenging year for satellite remote sensing, essentially because of heavy cloud cover that enveloped the entire Labrador Sea in spring preventing data collection. More than half of the weekly composite images of the Labrador Shelf/Slope statistical box presented less than 10% of coverage between February and July 2018. The re-occurrence of a fall bloom in 2018 seems to indicate that this feature is becoming the new norm rather than the exception. Abundance estimates of large centric diatoms and foraminifera from the 200 µm plankton net were both lower than average, although the climatology was computed using a shorter time series than for other parameters since these measurements were initiated 10 years ago.

Calanus finmarchicus, a key subpolar species of the North Atlantic, shows regional year-to-year variations in abundance that are generally related to differences in the timing of the life-cycle events and environmental conditions. In 2018, *C. finmarchicus* abundances were below average on the Labrador and Greenland Shelves/Slopes. The Labrador Basin region was an exception with a higher than average abundance of the three large Calanidae (*C. finmarchicus*, *C. glacialis* and *C. hyperboreus*), *Pseudocalanus* spp. and the Hyperiid amphipod *Parathemistho* sp..

Discussion summary:

Comments were made regarding the potential bias associated with the sampling of stage-specific *Calanus* species with respect to the depth (shallow *vs* deep) of the net tows performed in the Labrador Sea. An analysis of the data suggested that the proportions of the three main

Calanus species (*C. finmarchicus, C. hyperboreus and C. glacialis*) are not stage dependent but rather follow a regular pattern when comparing shallow and deep casts. Multinet sampling was suggested as an attempt to remove the bias associated with casts depth. Such a protocol modification would ideally require replicating net tows during day and night periods which would prove logistically difficult to implement.

The reporting of AZOMP conditions has so far focused exclusively on the Labrador Sea conditions. It was suggested that conditions observed on the extended Halifax line be also included in future AZOMP reporting. A suggestion was also made to include sea level as part of future AZOMP reporting. Data products for both the extended Halifax line and sea level should become part of the Science Advisory Report in the near future. In addition, a research document summarizing AZOMP activities and observed conditions must be produced imminently as this is a CSAS requirement that has not been fulfilled in the last recent years.

PHYSICAL OCEANOGRAPHIC CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELVES –Frédéric Cyr and Guoqi Han

Physical environment conditions on the Newfoundland and Labrador Shelves for 2018 (large-scale atmospheric forcing and hydrographic response) were presented. Although the North Atlantic Oscillation (NAO) index was high, annual air temperature average was normal for five cities around the Labrador Sea. This however masked a warmer than normal winter (especially March) and a colder than average spring (May and July) caused by abnormal patterns in the sea level atmospheric pressure fields in the northern hemisphere. Driven by these air temperatures, sea ice volume near Newfoundland was below normal from early March to mid-April, and close to normal for the rest of the season. The annual sea surface temperatures were colder than normal in offshore regions around Newfoundland and Labrador, a tendency observed since 2015. The cold intermediate layer core temperature (defined as the minimum temperature within the monthly average profile) was about normal, but continued its cooling trend since about 2012. This recent cooling was preceded by a warming period that started after the cold conditions between the mid-1980's to the mid-1990's and driven by the winter NAO. Bottom temperatures in 3KLNOPs (spring) and 2J3KLNO (fall) were slightly above average. At the coastal Station 27, integrated temperature over the water column (0-176 m) was normal, but the salinity exhibited its largest negative (fresh) anomaly since the beginning of the time series in 1948.

Discussion summary:

Comments were made regarding the NAO and its perceived relationship with physical variables measured on the Newfoundland and Labrador Shelves. The NAO is an important index although it does not convey all the relevant information such as the relative position of the high and low pressure centers. Shifts in the relative position of the high/low pressure centers could have been responsible for the warmer winter but cooler spring and summer conditions observed in the NL region in 2018. A look at historical data suggests that variations in the relative position of the high/low pressure centers compared to the traditional pattern are being observed and becoming a more common phenomenon. There are also different ways to calculate the NAO which have been shown to affect how it relates to the CIL, for example. Station specific NAO calculations might be advisable to account for spatial variability in relating the NAO to physical variables.

Ice conditions on the Newfoundland and Labrador Shelves showed large ice volume in 2018 which was attributed mostly to transport into the region. A suggestion was made to include an index of sea ice retreat in the Science Advisory Report. It was noted that the recent cooling conditions observed on the Newfoundland and Labrador Shelves were in line with those

observed in the Labrador Sea. Discrepancies were noticed in the anomaly values of the CIL index as reported in previous SARs compared to the ones calculated this year. This was attributed to the calculation of the core temperature of the CIL which was never reported in previous years.

BIOGEOCHEMICAL CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELVES – David Bélanger and Pierre Pépin

An overview of the biogeochemical oceanographic conditions on the Newfoundland and Labrador shelves in 2018 was presented. Phytoplankton spring bloom indices derived from Ocean Colour satellite data indicate below normal total production of the phytoplankton spring bloom and near normal conditions of bloom peak timing and duration. *In situ* nutrient measurements during seasonal AZMP oceanographic campaigns show that deep silicate and deep nitrate inventories have remained mostly below normal across the region since 2009. Deep nitrate concentration, which had consistently increased since the time series record low observed in 2013, significantly decreased across the region in 2018. Integrated chlorophyll-*a* concentration in the first 100 m of the water column was above normal across the region for the first time since 1999, but is expected to decrease in 2019 due to low nitrate concentration. An increase in total zooplankton biomass, driven by positive biomass anomalies of larger planktonic organisms, was observed in 2018, although total biomass remained mostly below normal for a 7th consecutive year. Trends in the abundance of the large calanoid copepods in recent years differed among species with a general increase since 2015 for *Calanus finmarchicus*, an important decrease since a time series record high in 2016 for *C. glacialis*, and consistent high abundances since 2016 for *C. hyperboreus*. The abundance of small *Oithona* spp. and *Pseudocalanus* spp. copepods has greatly increased in recent years, especially in the fall, which is unusual for *Pseudocalanus* spp. whose abundances normally peak in summer. Overall, primary and secondary production indices indicate limited productivity at lower trophic levels across the Newfoundland and Labrador shelves.

Discussion summary:

Comments were made regarding the observed increase in the fall abundance of *Pseudocalanus* spp since 2016. A possible explanation could be the development of a second generation of *Pseudocalanus* spp. in the fall although this has not been observed in the phenology plots. Alternatively, this could also be attributed to the contribution of the different species grouped under *Pseudocalanus* spp.

A brief discussion also took place regarding the potential drivers of the low deep water nutrients concentrations observed on the Newfoundland and Labrador Shelves. A possible explanation could be a lower productivity at the surface resulting in reduced downward export and regeneration at the bottom. Another possible explanation could be water intrusion onto the shelf although a water mass analysis currently underway shows no indication to that effect. Intuitively, overall dilution resulting from freshwater input should not be overlooked.

Modifications are needed on the plots of the climatological conditions for the different indices as they appear to be shifted by a half of a month.

PHYSICAL OCEANOGRAPHIC CONDITIONS IN THE GULF OF ST. LAWRENCE – Peter Galbraith

An overview of physical oceanographic conditions in the Gulf of St. Lawrence (GSL) in 2018 was presented. AZMP data as well as data from regional monitoring programs are analyzed and presented in relation to long-term means. The annual average freshwater runoff of the St.

Lawrence River measured at Québec City and its combination with rivers flowing into the Estuary (RIVSUM II) were both above normal. Sea-ice maximum volume was 9th lowest since 1969, but the winter mixed layer volume was near-normal. The August cold intermediate layer (CIL) showed warmer than normal minimum temperature (+1.6 SD) and less than normal volume of water colder than 1°C (-1.7 SD), and the seasonally averaged minimum temperature index was also warmer than normal. Near-surface water temperatures were at a record low in November, below normal in spring and fall and only above in August and September. The May to November average was near-normal, but the coldest since 2002. The timing of summer onset and post-season cooling of the surface layer were respectively later than normal (+0.8 weeks) and near normal. Deep water temperatures have been increasing overall in the Gulf, with inward advection from Cabot Strait. Gulf-wide average temperatures at 150 and 200 m are lower than the 2015 record highs but remain above normal at 3.0°C and 5.0°C. New series record highs (since 1915) were set at 250 and 300 m, at 6.1°C and 6.4°C respectively. The bottom area covered by waters warmer than 6°C remained quite high in 2018 in Anticosti Channel, Esquiman Channel and Central Gulf, and increased sharply in the northwest Gulf to reach a series record.

Discussion summary:

Bottom temperatures observed at the Rimouski station have been above normal since 2012 and have reached a record high in 2018. This is linked with the general warming of bottom conditions observed in the Gulf of St. Lawrence and the estuary resulting from the inward propagation of warm bottom water from the Laurentian Channel (observed at Cabot Strait). The timescale for this propagation from Cabot Strait to the estuary is on the order of three years and therefore consistent with the high anomalies observed at Rimouski in the recent years.

BIOGEOCHEMICAL CONDITIONS IN THE GULF OF ST. LAWRENCE – Marjolaine Blais and Stéphane Plourde

An overview of chemical and biological oceanographic conditions in the Gulf of St. Lawrence (GSL) in 2018 was presented. AZMP data as well as data from regional monitoring programs are analyzed and presented in relation to long-term means in the context of a strong warming event that began in 2010. Oxygen levels at 300 m reached their lowest concentration measured so far in all GSL regions during 2018. The oxygen diminution was particularly strong from Cabot Strait to Northwest GSL regions, while it stayed relatively stable in the Estuary in comparison with 2017. Nitrate inventories in the surface layer (0–50 m) and mid-layer (50–150 m) were generally below normal everywhere in the GSL during summer and fall, but were near normal in the surface layer during wintertime. Again in 2018, nitrate inventories were above normal in deep waters of eastern GSL (eGSL), which has been observed since 2012 and is associated with intrusions of warm and salty waters. The annual anomalies of vertically integrated chlorophyll *a* (chl *a;* 0–100 m) were above normal in all regions, mostly due to strong chl *a* concentrations during fall. In wGSL, the summer and annual chl *a* anomalies are record highs of the time series. The large nitrate drawdown between March and June suggest that a strong spring bloom occurred in all regions. In accordance with this result, satellite observations show that spring bloom lasted longer and had above-normal magnitude in most regions, with the exception of northeast GSL. Also, for a third year in a row, the bloom start was earlier than normal. In contrast with our in situ observations, however, satellite imagery indicates that summer and fall surface chl *a* concentrations were below normal in all regions. A recently published new algorithm for ocean color in the coastal waters of the GSL, combined with output from biogeochemical models (Canopa-GSBM) in the GSL, could improve our ability to describe the seasonal nutrient and phytoplankton dynamics in this region.

In 2018, zooplankton biomass was below average almost everywhere in the GSL, although generally not as low as it has been in 2016-2017. In most regions, large calanoid abundance was also below normal in 2018, mostly due to *Calanus hyperboreus* at Rimouski station and to *Calanus finmarchicus* in eastern and southern GSL. *Pseudocalanus* spp. and small calanoid abundances were generally above normal in western and southern GSL and near normal in eastern GSL, in agreement with the trend observed since 2014. Abundances of warm-water associated copepods was above normal in western and southern GSL, but near normal in eastern GSL. In this latter region, cold-water associated copepod abundance was higher than the long-term mean for the fourth consecutive year. Phenology of *Calanus finmarchicus* at Rimouski station suggests an on-time arousal from diapause and development into adult. However, the peak of early copepodite stages was long lasting and reached its maximum abundance in July, which represents the latest peak of CI-CIII stages since 2005.

Discussion summary:

Oxygen conditions in the Gulf of St. Lawrence will be reported for the first time in the research document to be published in 2019 (i.e. for conditions up to and including 2018). Winkler as well as CTD oxygen data are used for data analysis so that spatial coverage is not restricted to transects and fixed stations but extends across the different subregions.

A discrepancy was noted regarding surface chlorophyll measured by remote sensing. Two datasets were available for the Gulf of St. Lawrence: a dataset resulting from a recent research paper by Laliberté et al. (2018) and the BIO dataset that has so far been widely used by all regions. Although apparently based on the same sensor data, anomalies of surface chlorophyll appear in contradiction between the two datasets over the recent years: BIO's data showing mostly negative or slightly negative anomalies while Laliberté's data showing mostly positive anomalies. Comments suggested that Laliberté's dataset is based on a more rigorous processing algorithm (e.g., accounting for light and other corrections) and also on a more thorough calibration against *in situ* observations. The Laliberté dataset thus appears to be a better data product for use in the Gulf of St. Lawrence region.

Anomalies of *Calanus* abundance indices in 2018 were less negative than previous years, following a similar behaviour as that observed in the Newfoundland and Labrador region. Moreover, an increase in the abundance of *Calanus* species was observed in the fall, which is also consistent with observations from the Newfoundland and Labrador region. For phytoplankton, the patterns of diatoms and dinoflagellates abundance show different trends in the Gulf of St. Lawrence compared to the Scotian Shelf.

REVIEW OF PHYSICAL AND BIOGEOCHEMICAL CONDITIONS IN THE NORTHWEST ATLANTIC – SESSION 6

Rapporteur – Jean-Luc Shaw

PHYSICAL OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS ON THE SCOTIAN SHELF AND IN THE GULF OF MAINE – Dave Hébert and Dave Brickman

The locations of the AZMP sampling during the spring and fall missions were presented in order to show the additional stations beyond the core AZMP stations. Air and water temperatures were present for several representative areas in the Maritimes Region. In 2018, air temperature anomalies were positive for all sites, ranging from +0.2°C (+0. SD) at Saint John to +0.8°C (1.3 SD) at Boston. Satellite-based sea surface temperature was above the 1981-2010 average temperature, except at Cabot Strait, ranging from -0.4°C (-0.6 SD) for Cabot Strait to 1.3°C (1.0 SD) in the Bay of Fundy. Annual surface temperature anomalies at St. Andrews and Halifax

were +0.6°C (+0.8 SD), a decrease of 0.2°C from 2017, and +1.0°C (+1.0 SD), a decrease of 0.2°C from 2017. Water temperatures at select sites and depth ranged from 0.7°C (1.2 SD) to 2.0°C (3.7 SD) above normal with a record high for Georges Basin at 200 m and second highest values for Lurcher Shoals at 50 m and Emerald Basin at 250 m. The July bottom temperatures for the shelf portions of NAFO region 4X was 1.4°C (2.0 SD) above the 1981-2010 average values. No data was collected in regions 4Vn, 4Vs and 4W. Region 4X was the 5th warmest year, 0.7°C lower than the 2012 record year.

Discussion summary:

A participant asked if the density gradient maps which were shown used data from the cruises only. The speaker clarified that all available data were used. Normally this means data is available for only 2-3 months in any region but since the gliders are deployed data is sometimes available every month.

It was brought up by a participant that it would be interesting to have seasonal information (e.g. duration, onset time, etc.) about the change between the winter mixed regime and the summer stratified regime. The speaker clarified that data for the area of interest are usually only available in February, July, April, and September. The temporal resolution is therefore currently insufficient to provide these details.

BIOGEOCHEMICAL CONDITIONS ON THE SCOTIAN SHELF AND IN THE GULF OF MAINE DURING 2018 – Catherine Johnson and Benoit Casault

Ocean nutrient and plankton conditions on the Scotian Shelf and in the eastern Gulf of Maine were assessed in the context of continued warmer than normal surface and near bottom ocean temperatures in 2018, a pattern that started in 2008. Overall in 2018, deep nitrate inventories were lower than normal over the whole region, although they were higher than the record low year 2017. Deep phosphate and silicate were also lower than normal across the region, continuing a pattern started in 2013. Spring bloom metrics varied across the Scotian Shelf, with a late, short, intense bloom on the eastern Scotian Shelf, more typical bloom on the central Scotian Shelf, and low bloom on the western Scotian Shelf. Observations in 2018 indicate a continuation of the persistent plankton community change in recent years. The abundance of large phytoplankton, including diatoms, continued to be lower than normal, especially in summer at Halifax-2. Zooplankton biomass and *Calanus finmarchicus* abundance also continued to be lower than normal, while non-copepod abundance was higher than normal on the central and eastern Scotian Shelf. The abundance of arctic *Calanus*, a cold water zooplankton indicator, continued to be lower than normal on the Scotian Shelf, a trend that started in 2013. Higher than average abundances of *Oithona atlantica* and warm offshore copepods suggest a greater influence of offshore waters in recent years.

Discussion summary:

A participant noticed that one of the speaker's scorecards had more missing data than those of a participant from the same institution. The speaker clarified that the other participant's analyses use data from the trawl survey, which has a wider spatial distribution, while her analyses rely more on data from the transects.

It was discussed that *calanus* were more present than usual at Prince 5. Because they are an unusual category this is not reported on. It may be an important observation however as these and some of the other non-copepod species are indicators of different processes taking over. Making scorecards reflective of occurrence rather than abundance level has been attempted. Highlighting unusual catches would be another way of reporting these changes, but as samples

are not screened for all different species, they may go unnoticed. Another participant added that copepod taxa (*clausocalanus*, *nanocalanus*) typical of the warm core and the Gulf Stream are more often recorded of late, especially in the Cabot Strait line.

A participant asked if these may be introduced by ship ballast waters, but another argued that if this was the case, they would have been sighted before. There is no new shipping traffic and shipping volume has remained constant. The species are therefore really associated with warm water signals.

The speaker mentioned during the talk that year to year comparison of chlorophyll-a data derived from remote sensing may be problematic because the satellite sensors have changed. Another participant commented reprocessing of this data will be conducted in the following year by the remote sensing group because they have noted high chlorophyll-a values that have not been screened by NASA. It is believed that after reprocessing the high bloom values noted by the speaker (2008-2012) will likely decrease. The more recent values should be believed.

BEDFORD BASIN MONITORING PROGRAM – Andrew Cogswell

The Compass Station or HL_00 (44° 41' 37" N, 63° 38' 25" W) has been occupied weekly as part of the Bedford Basin Monitoring Program (BBMP) since 1999. Regular occupations consist of a CTD equipped with a standard suite of sensors and a vertical net tow for zooplankton identification and enumeration using AZMP protocols. Water samples are collected in Niskin bottles for a variety of analyses at 2, 5, 10, and 60 m. Only zooplankton samples from 1999–2002 and 2010–2018 have been analyzed and entered into the BioChem database; thus, only the CTD sensor and bottle data are reported upon in this summary of 2018 conditions.

For ease of interpretation, surface conditions are expressed as the mean conditions at 2, 5, and 10 m. There is a strong seasonal agreement between these depths for the physical and chemical conditions being measured and generally a minor difference in magnitude.

Surface conditions in 2018 were slightly warmer (+0.28 SD) than normal compared to the climatology (2000–2015) and this continues a trend of warmer than normal conditions over the past 3 years. Surface water was generally more saline than normal throughout the year (+0.23 SD), while density was near normal. Monthly anomalies for surface temperature in 2018 showed near normal conditions in January followed by warmer-than-normal conditions from February to May. After a cooler than normal June (-0.74 SD), conditions from July to October were above normal. In fact, surface conditions in September were the warmest on record for the time series (+2.21 SD). Surface conditions in late October cooled suddenly, resulting in the 2nd coolest conditions over the time series for both November and December (-2.00 and -1.54 SD). The length of time surface waters (2 m) remain at 13°C or higher continues to expand over the time series. The annual time of initiation for 13°C surface temperatures has remained relatively constant over the time series, but the seasonal end of these conditions continues to extend at a rate of ~1.3 weeks/decade.

2018 marks the end of 5 years of normal, or lower-than-normal annual surface nitrate. As surface nitrate in the basin is largely reflective of shelf influences, this positive anomaly (+0.5 SD – the second highest in the time series) likely reflects a change in conditions on the nearby shelf. Annual Silicate concentrations were also slightly positive for the first time since 2014. Nonetheless, nitrite, ammonia and phosphate all continued the trend of decreased annual surface concentrations. For phosphate, this is the 8th straight year of negative annual anomalies (-1.17 SD), with April, July and September being the lowest monthly anomalies of the time series. This drop in concentration is mostly driven by 2 factors: 1) two primary water treatment facilities began operations in 2008, and 2) in 2010, new rules came into effect that reduced the concentration of phosphate in detergents from 2.2% to 0.5%. Surface phosphate concentrations

in 2018 are consistent with conditions observed since 2011; further evidence that local basin sources are largely influencing the regime shift. This continues to underscore the importance, and relative contributions of, shelf and basin source waters that modulate nitrate and phosphate concentrations in the Bedford Basin (Petrie and Yeats 1990).

In 2018, annual bottom temperature and salinity anomalies were above normal (+1.00 and +1.02 SD) and these warmer than normal conditions were persistent from February to December. In fact, it was the warmest month of April of the time series (+2.13 SD). As with surface nitrate/silicate, bottom nitrate/silicate anomalies were above normal (+0.72 SD and 0.77 SD). Nitrite, ammonia and phosphate anomalies are all below normal, with phosphate continuing a 6 year trend of lower than normal concentrations.

Bottom conditions are generally stable within the basin unless otherwise perturbed by periodic intrusions of shelf water (Kerrigan et al. 2017). Two of these events were observed in 2018 (late October and late November) which altered deep basin temperature, salinity and oxygen conditions. The first of these 2 events was observed on October 22nd in near real time, by a Dalhousie University benthic pod deployed by the Marine Environmental Observation Prediction and Response (MEOPAR) network, which showed a dramatic increase in oxygen concentrations from ~0 ml/l to 4.49 ml/l in less than 4 hours. This event was preceded by coastal upwelling driven by sustained intense southwesterly along shore winds (Petrie et al. 1987 and Greenan et al. 2004) that pushed 30-60 m water from the shelf towards Halifax Harbour. These upwelling conditions were observable from the HLX-2 Viking buoy that was positioned at 44° 20.859' N, 063° 18.352' W at 135 m depth.

Results were also presented from a preliminary study demonstrating the ability of the k-means clustering method to identify weekly basin occupations over the duration of the program representing intrusion or turn-over events. Using averaged 50-70 m CTD oxygen, salinity and temperature sensor data from weekly occupations, it was demonstrated that 2 distinct patterns exist at 2 different times of the year. Sixteen "intrusion" events were identified (81% between September and December), where 50-70 m temperature and oxygen increased on average 1.77°C and 2.62 ml/l. In contrast, 23 "turnover" or "intrusion" events were noted (primarily from January to April – 91%) where temperature declined (-1.22°C) and oxygen increased (2.61 ml/l).More work will be done over the coming months to refine these results by introducing additional parameters (e.g., deep nitrate concentrations) that are also affected by intruding shelf water.

Finally, the Bedford Basin Monitoring and Research Program meeting held on January 14-15 was discussed. This year, more effort was placed on engaging local stakeholders, with over 60 participants from the city, province, Dalhousie University, Nova Scotian Community College and NGO's in attendance. Planning for a 2020 international meeting focussed on coastal monitoring efforts is already underway.

Discussion summary:

A participant asked how often the identified intrusions of warm water happen. The speaker answered that they happen on a near annual basis. Sometimes twice a year as in 2018. The methods used however are not a perfect identification tool. A typical intrusion results in an increase in temperature and oxygen, but some events have been recorded where temperature decreases and oxygen increases. Nitrate concentration would be a strong addition to the identification tool as they drop consistently during intrusions and rise afterwards from nitrification. Using nitrate concentrations as well would help discriminate between intrusions and other physical processes such as turn-over events.

The cluster analysis was done using 20 years of data. There have been 15-16 identifications of fall intrusion events and 23 later year intrusion or turn-over events, but these numbers are likely underestimated by 10-20% and will increase once the identification tool is improved.

A participant mentioned that Dalhousie researchers have shown interest in higher frequency and higher density of measurements from within the basin to offshore.

AN SST BLEND FOR AZMP – Peter Galbraith

Two different methods were applied to merge three Level-3 AVHRR SST products into a homogenized blend covering the time period from 1982 to present over the Northwest Atlantic. The products are Pathfinder 5.3 (4 km resolution), the archived 1982-2013 product from IML (1 km resolution), and the operational 1.5 km resolution product from BIO which is available going back to 1997. Weekly and monthly SST composites were constructed not by averaging all available temperature within each time period, but by first calculating daily anomalies, then averaging those within each time period and adding the result to the climatological mean for the period. This approach reduces biases that would otherwise be introduced from missing data during a strong warming/cooling period.

Discussion summary:

This process includes many complicated steps that motivate comprehensive documentation. The methods will either be a section of the speaker's research document for the coming year or a complete technical report.

The speaker commented that this work came about because he and some participants were worried about discrepancies between remote sensing SST products and model outputs. Models were showing warm water in some regions and SST product based anomaly were showing the opposite. This effect had been attributed to data being available only in cold portions of that region, which were addressed by average daily anomalies to construct time composites, rather than averaging temperatures.

The good news is that, apart from a lot of the missing data due to ice mass in winter and due to cloud cover in the summer, resulting in less than 5 days of data in some locations, existing SST products look similar to the SST blend.

A participant asked if the distribution of the required 5 days within a month was taken into account in forming this product. The speaker answered that it would obviously be best that 5 days be spread out evenly within the month, but no statistics were collected on the matter and the method does not currently take this into account.

A participant argued that an alternative approach would be to conduct a harmonic fit of the time series and use it to fill in missing values. The speaker was concerned that this may introduce noise and not preserve some features of the dataset such as fronts.

A participant asked the speaker to elaborate on the differences between this product and the current SST products used. The 5 day requirement generates missing data, but only does so in months where very little data is available. The main difference is that presently, monthly composites are used that average all available data, but if data is missing at a time where temperature changes it affects the end result. These temperatures are used to compute anomaly. In the SST blend, anomaly is computed first on a daily basis and a monthly average is computed from the anomaly. In recent years, both products are similar because data coverage has been good.

The speaker was asked if the Pathfinder data quality flags were taken into account. They are not currently (Editor's note: QC flags were in fact used). A participant added that one of the reasons that Pathfinder flags upwelling areas is because it cannot discriminate between them and fog.

The question was raised of the need spatial resolution. If 25 km resolution were used, the amount of unavailable data due to clouds would be reduced. This resolution has been tried in the past but for the St. Lawrence estuary, it decreases the quality of spatial products. It does however work well for box average products.

SUMMARY OF ZONAL SCORECARDS REVIEW AND AGREEMENT OF SAR BULLETS – Peter Galbraith and Pierre Pépin

Discussion summary:

Apart from discussions concerning wording or conventions, some SAR bullets raised the following issues about presentation and analyses.

SST scorecard bullet: Concern was raised current SST box average limits leave out some variability particularly in the southern gulf. In context of the ecosystem approach, the Gulf of St. Lawrence will be divided into new boxes. Presumably next year in the SAR, reporting could use the new set of boxes, but this is left as-is for this year.

Concern was raised as to the stratification scorecard being skewed towards negative anomaly. This was attributed to the use of the 1981 to 2010 climatology.

Main physical anomaly stack: Concern was raised that stacked bar plots are not normalized to account for missing anomaly data. To resolve this, it was proposed to show only the sum of bars, sacrificing region discrimination. It was also proposed that it could be standardized by number of indices. It was decided in the end to explain this issue in the figure caption instead of changing the figure.

Scorecard for high frequency physical: Concern was raised that the record low salinities at Prince 5 and station 27 are brought up in the bullets but not supported by the figures. It was decided to omit their mention from the bullet.

WRAP UP – SESSION 7

Rapporteur – Renée Allain

REVIEW OF DRAFT SCIENCE ADVISORY REPORT (SAR)

Ocean acidification:

There was a comment about clarifying why there was an under-saturation on the Newfoundland and Labrador Shelf (not only because of the cold water); water coming from the Arctic is very different (more acidified). There are many reasons why we are seeing an under-saturation (not just temperature).

A participant noted that the map for this bullet is for spring 2018 and asked if it should be changed for the fall 2018 map since it is available. Another participant said changing to the fall map was best and proposed the same change was applied to the oxygen map.

CSAS delays:

There is growing frustration with CSAS delays. The chair showed the example of the only research document from the previous year's meeting that was published to date, which was submitted in late May 2018 and published in mid-November 2018. While CSAS policy is to publish a research document within 10 working days of reception of the final document, there is no policy in the time elapsed between submission of our final document and their production of a final PDF and web links (about 100 days in the case above). Another research document has been in CSAS hands with no feedback for two months. Two research documents from the Maritimes region have their translation on hold because funds available for translation have been expected for the fiscal year, and AZMP would have to pay about 3000$ for each translation.

However, the chair explained that previous success stories of AZMP included the ACCASP climate change trends assessment and the soon-to-be published Atlantic State of the Ocean report. The next high visibility usefulness of AZMP will come with the implementation of the Ecosystem Approach to fish stock assessments, which are part of the CSAS process. That requires AZMP documents to be part of CSAS, and so the AZMP Permanent Management and Coordination Committee decided earlier in the week to remain with the CSAS framework.

Climatology:

Soon it will be time to shift the climatological period used from 1981-2010 to 1991-2020. While this could be done as early as the 2020 state of the ocean, there are reasons to hold off and perhaps stick with international standards. The recent warm period will be folded into the climatology and will have the effect of normalizing its occurrence.

Work plan:

Remaining tasks for completing the SAR were delegated. It was suggested that figures be sent with translations for each caption and that an external reviewer should review the document. A participant mentioned that he had asked CSAS for information regarding how much the AZMP meeting proceedings were being downloaded to assess the importance of writing a proceedings document for this meeting. CSAS was unable to provided this information (e.g., number of downloads). Future discussions should be had about whether of not proceedings should be published but for this year proceedings must be written. A participant encouraged to place presentation files of the talks given at this year's in a dedicated Google Drive folder.

There were discussions about hosting a mid-year meeting. Many participants were interested. Some responsibilities in organizing this meeting were delegated. Favorable dates for next year's annual meeting were discussed. The last week of March was suggested but a participant noted that another science meeting was already planned that week which many participants would likely attend. It was decided to choose a week for next year's meeting at a later date.

A participant suggested that the Tuesday workshop and Wednesday logistics summary events of the meeting should be held in future annual AZMP meetings as they were found beneficial.

CLOSING REMARKS

The chair acknowledged people who have or are soon retiring (Eugene Colborne and Dave Senciall (NL), Roger Pettipas (MAR), Laure Devine (QC)) and new people that have come on-board (Fred Cyr and David Bélanger (NL), Chantelle Layton (MAR), Marjolaine Blais, Félix St-Pierre, Brian Boivin, Jean-Luc Shaw (QC) and thanked the rapporteurs.

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APPENDIX I – TERMS OF REFERENCE

21st Annual Meeting of the Atlantic Zone Monitoring Program (AZMP)

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

March 19-22, 2019
Montreal, QC

Chair: Peter Galbraith

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:

- Characterize and understand the causes of oceanic variability at the seasonal, interannual, and decadal scales;
- Provide multidisciplinary data sets that can be used to establish relationships among the biological, chemical, and physical variables; and
- Provide adequate data to support the sound development of ocean activities.

The program sampling strategy is based on:

- Seasonal and opportunistic sampling along sections to quantify the oceanographic variability in the Canadian Northwest Atlantic shelf region;
- Higher-frequency temporal sampling at more accessible fixed sites to monitor the shorter time scale dynamics in representative areas;
- Fish survey and remote sensing data to provide broader spatial coverage and a context to interpret other data; and
- Data from other existing monitoring programs such as Continuous Plankton Recorder (CPR) lines, sea level network, near shore 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.

Objectives

- Assess the biological, chemical and physical oceanographic conditions since 1999 through a peer review of the outcomes of monitoring activities in the four Atlantic regions.
- Synthesize the multidisciplinary information gathered over the course of the program.
- 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 2018 and assess business, operational, logistical, database and remote sensing activities that require regional/zonal intervention, enhanced coordination or that need the attention of Science Directors.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Documents

Expected Participation

- DFO Ecosystems and Oceans Science
- Environment and Climate Change Canada

- Academia

APPENDIX II – MEETING AGENDA

Annual meeting of the Atlantic Zone Monitoring Program

19-22 March, 2019

Tuesday 19-March-2019 Delta Hotel, 475 Avenue Président Kennedy, Montréal, QC

AZMP Data Management workshop *"Paganini" Meeting Room*
Logistics Working Group *"Chopin" Meeting Room*
AZMP synthesis workshop *"CONCERTO" Meeting Room*

AZMP synthesis Workshop Session 1 – Biogoechemistry		
Rapporteur – Carla Caverhill		
09:00 – 09:10	Peter Galbraith	Welcome and Introductions
09:10 – 12:00	• Marc Ringuette – A year of testing the FluoroSea submersible microscope • Stephen Punshon - CO2 system variability in the Labrador Sea and Scotia Shelf • David Bélanger and Pierre Pepin - Size spectra indicators of zooplankton communities in the NL bioregion • Stéphane Plourde - Spatial climatology and interannual variability in Calanus species abundance and biomass in support to the NARW management • Diane Lavoie and Olivier Riche - Evaluation of GSBM output for potential inclusion into the annual reporting • Catherine Johnson – Nutrient variability on the Scotian Shelf	
12:00 – 13:00 Lunch Break		
AZMP synthesis Workshop Session 2 – Physics		
Rapporteur – Steve Punshon		
13:00 – 16:20	• (morning overflow) • Igor Yashayaev - Frequency and Causes of Extreme Biological Productivity in the Labrador Sea (30 min) • Joël Chassé - Complementing the AZMP; Model based oceanographic conditions in the GSL in 2018 • Dave Brickman - Predictability of sea ice in the GSL based on seasonal forecasts • Dave Hébert and Fred Cyr – 2018 Glider Operations in support of AZMP • Peter Galbraith – Update on Viking Ops, upgrades and true costs	
16:20 – 16:30	Peter Galbraith	Summing up

AZMP Business Meeting and Review of Environmental Conditions – Chair P. Galbraith (QC)

Wednesday March 20, 2019 *"CONCERTO" Meeting Room*

Session 3 – AZMP Business meeting		
(*Rapporteur : Marjolaine Blais*)		
09:00 – 09:15	Peter Galbraith	Welcome and Introduction / Acceptance of Agenda Outline of meeting goals Matters arising
09:15 – 10:30	Stephen Snook, Andrew Cogswell, Félix St-Pierre, Renée Allain	Regional summaries of activities and logistics Report on logistics workshop and discussion.
10:30 – 10:50 Health Break		
10:50 – 11:00	Carla Caverhill	Remote Sensing Update
11:00 – 12:00	Mathieu Ouellet, Laure Devine, Brian Boivin, David Fishman, Shelley Bond, Diana Cardoso	Data Management Progress & Issue Overview
12:00 – 13:00 Lunch Break		
Session 4 (Rapporteur: Andrew Cogswell)		
13:00 – 13:20	Frederic Cyr	Carbonate and O_2 observations on the Newfoundland Shelf
13:20 – 13:40	Steve Punshon	2018 chemistry conditions in the Labrador Sea and on the Scotian Shelf.
13:40 – 14:00	Michel Starr	Ocean chemistry conditions in the Gulf of St. Lawrence
14:00 – 14:20	Pierre Pepin	Discussion on Ocean Chemistry section in SAR: OA, hypoxia
14:20 – 14:40	Laure Devine and Marjolaine Blais	Comparison of dissolved oxygen methods across regions.

14:40 – 14:50	Frédéric Cyr	Open discussion on a collaborative hydrographic (T,S) dataset paper for the AZMP region.
14:50 – 15:10 Health Break		
15:10 – 15:30	Di Wan	Oceanographic monitoring program and data management at IOS
15:30 – 15:50	Emmanuel Devred	Phytoplankton bloom fit: evaluation of methods and recommendations.
15:50 – 16:10	Chantelle Layton	Phytofit: an R app for phytoplankton spring bloom fitting.
16:10 – 16:30	Patricia Pernica, Yvonnick LeClainche, Corinne Bourgault-Brunelle	AZMP data in operational ocean models and products
16:30 – 17:00		General Discussion – Matters Arising – Is CSAS a good fit for AZMP?
17:00	**Close**	
17:00 – 18:30	**Permanent Management Coordination Committee**	

Thursday March 21, 2019 – Chair P. Galbraith (QC)

"CONCERTO" Meeting Room

Review of physical and biogeochemical conditions in the Northwest Atlantic		
Session **5 (*Rapporteur : Benoit Casault*)**		
09:00 – 09:10	Peter Galbraith	Welcome and Introduction
09:10 – 09:50	Marc Ringuette Igor Yashayaev	Physical, chemical and biological conditions in the Labrador Sea (AZOMP) in 2018
09:50 – 10:10	Frédéric Cyr and Guoqi Han	Physical oceanographic conditions on the Newfoundland and Labrador Shelves
10:10 – 10:40	David Bélanger and Pierre Pepin	Biogeochemical conditions on the Newfoundland and Labrador Shelves
10:40 – 11:00 Health Break		

11:00 – 11:20	Peter Galbraith	Physical oceanographic conditions in the Gulf of St. Lawrence
11:20 – 11:40	Marjolaine Blais / Stéphane Plourde	Biogeochemical conditions in the Gulf of St. Lawrence
11:40 – 12:40 Lunch		
Session 6 (***Rapporteur: Jean-Luc Shaw***)		
12:40 – 13:00	Dave Hebert / Dave Brickman	Physical oceanographic and meteorological conditions on the Scotian Shelf and in the Gulf of Maine
13:00 – 13:20	Catherine Johnson and Benoit Casault	Biogeochemical conditions on the Scotian Shelf and in the Gulf of Maine
13:20 – 13:30	Andrew Cogswell	Bedford Basin Monitoring Program
13:30 – 14:00	Peter Galbraith	An SST blend for AZMP
14:00 – 14:20 Health Break		
14:20 – 15:00	Peter Galbraith and Pierre Pepin	Summary of Zonal Scorecards Review and agreement of SAR bullets
15:00 –		Breakout groups (Physical/Biogeochemical/LabSea) to start review and edit draft SAR text

Friday March 22, 2019

"CONCERTO" Meeting Room

Session 7 – Wrap-up (*Rapporteur: Renée Allain*)		
09:00 – 09:30	Peter Galbraith	Summary of action items/issues identified from logistic, data management and workshop meetings
09:30 – 10:30	Pierre Pepin and Peter Galbraith	Review of draft SAR
10:30 – 10:50	**Health Break**	

10:50 – 11:45	Matters Arising [1] CSAS delays. [2] 1981-2010 or 1991-2020 climatology? Work plan for 2019-20 [1] Zonal SAR (Completion date) [2] Research Documents to be produced [3] Any other publications [4] Abstracts (5 April 2019) [5] Rapporteur Notes (12 April 2019) [6] Proceedings (Relevant?) [7] PDF copies of presentations Meeting Format 2020 Mid-term Meeting? – possible dates/location Proposed dates (24-27 March, 2020) Alternate (17-20March, 2020) [1] Tuesday workshop? [2] Wednesday for logistics or return to prior format
11:45 – 12:00	**Close**

APPENDIX III – LIST OF MEETING PARTICIPANTS

Name	Affiliation
Allain, Renée	DFO, Science – Gulf Region
Bélanger, David	DFO, Science – Newfoundland and Labrador Region
Blais, Marjolaine	DFO, Science – Quebec Region
Boivin, Brian	DFO, Science – Quebec Region
Bond, Shelley	DFO, Science – Maritimes Region
Bourgault-Brunelle, Corinne	DFO, Canadian Meteorological Centre – Dorval
Brickman, David	DFO, Science – Maritimes Region
Cardoso, Diana	DFO, Science – Maritimes Region
Casault, Benoit	DFO, Science – Maritimes Region
Caverhill, Carla	DFO, Science – Maritimes Region
Chassé, Joël	DFO, Science – Gulf Region
Cogswell, Andrew	DFO, Science – Maritimes Region
Cyr, Frederic	DFO, Science – Newfoundland and Labrador Region
Devine, Laure	DFO, Science – Quebec Region
Devred, Emmanuel	DFO, Science – Maritimes Region
Fife, Jack	DFO, Science – Maritimes Region
Fishman, David	DFO, Science – Gulf Region
Galbraith, Peter	DFO, Science – Quebec Region
Hebert, Dave	DFO, Science – Maritimes Region
Johnson. Catherine	DFO, Science – Maritimes Region
Lavoie, Diane	DFO, Science – Quebec Region
Layton, Chantelle	DFO, Science – Maritimes Region
LeClainche, Yvonnick	DFO, Canadian Meteorological Centre – Dorval
Ouellet, Mathieu	DFO, Science – Ottawa
Pepin, Pierre	DFO, Science – Newfoundland and Labrador Region

Name	Affiliation
Pernica, Patricia	DFO, Canadian Meteorological Centre – Dorval
Plourde, Stéphane	DFO, Science – Quebec Region
Punshon, Stephen	DFO, Science – Maritimes Region
Riche, Olivier	DFO, Science – Quebec Region
Ringuette, Marc	DFO, Science – Maritimes Region
Shaw, Jean-Luc	DFO, Science – Quebec Region
Snook, Stephen	DFO, Science – Newfoundland and Labrador Region
St-Pierre, Félix	DFO, Science – Quebec Region
Starr, Michel	DFO, Science – Quebec Region
Wan, Di	DFO, Science – Pacific Region
Yashayaev, Igor	DFO, Science – Maritimes Region