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March 21-23, 2022
Virtual meeting

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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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TABLE OF CONTENTS

SUMMARY

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1998 with the aim of collecting and analyzing the biological, chemical, and physical field data that are necessary to:

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

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 Department of Fisheries and Oceans, Canada (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, aspects of ocean acidification were included. In 2022, the AZMP scientists reconvened by teleconference from March 21 to 23rd with limited scope compared to the usual face-to-face annual meetings to review oceanographic conditions that prevailed in 2021 within the zone and draft a summary as a Science Advisory Report (SAR).

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. With the travel restrictions still imposed by the COVID-19 pandemic, a teleconference was held March 21—23 instead of the usual face-to-face meeting. As was the case in 2020 and 2021, the scope of the meeting was restricted to reviewing the state of the ocean conditions that prevailed in 2021 and to drafting a summary of these conditions as a SAR.

The SAR summarizes the information found within eight supported 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, and Labrador Sea.

Eight presentations were given of the material supporting the Research Documents. Two additional presentations were given addressing ocean acidification and zonal modelling. Then, the SAR summary bullets were reviewed and modified one-by-one by the group. The meeting was closed after a brief discussion of matters arising.

REVIEW OF PHYSICAL AND BIOGEOCHEMICAL CONDITIONS IN THE NORTHWEST ATLANTIC – SESSION 1

PHYSICAL OCEANOGRAPHIC CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELVES – FRÉDÉRIC CYR

An overview of physical oceanographic conditions in the Newfoundland and Labrador Region during 2021 is presented in support of the Atlantic Zone Monitoring Program. The winter North Atlantic Oscillation (NAO) index, a key indicator of the direction and intensity of the winter wind field patterns over the Northwest Atlantic, was negative after 7 consecutive years on the positive side (colder conditions), including a record high value in 2015. The large majority of the environmental parameters presented in this report were above normal (defined as the average over the 1991-2020 climatological period). The average annual air temperature at five sites around the NW Atlantic was above normal, including a record high in Bonavista. When considering the winter period, record-high warm temperatures were established at Iqaluit, Bonavista and St. John's, and the second-warmest winter on record was observed in Cartwright. The sea ice season volume and area across the Newfoundland and Labrador Shelf was at its third-lowest level (after 2010 and 2011) since the beginning of the time series in 1969. Only one iceberg was observed drifting south of 48°N. Ice-free season sea surface temperatures across the NW Atlantic were slightly warmer than normal. Observations from the summer AZMP oceanographic survey indicate that the CIL area along the Seal Island, Bonavista Bay and Flemish Cap sections was at its third lowest (indicating warm conditions) since 1950 (after 1965 and 1966). This contrasted with 2014-2017 when the volume was above normal (cold conditions). Spatially averaged bottom temperatures in North Atlantic Fisheries Organization (NAFO) divisions 3Ps (spring) and 2J3K (fall) were at their second warmest since 1980, including a record in 3Ps. The transport on the Scotian Slope in 2021 remained below normal for eight consecutive years at -1.4 standard deviations (SD). The Newfoundland climate index was at a record high in 2021 (tied with 2010 and 1966).

Discussion summary:

- In light of the low salinity observed at station 27 in 2021, a participant was expecting the Labrador Current transport to be strong since the presence of these fresher waters would explain the salinity signal. The speaker explained that the low salinities at station 27 were due to the inner shelf Labrador Current which is not part of the reported transport index. The low salinities of this current were likely due to the outflow from Hudson Strait, land runoff and melting sea ice, the latter two being increased because of warm winter temperatures.
- A participant was concerned that the normalization period of the North Atlantic Oscillation anomaly time series was not the same (1991—2020) as other variables because of the prevalence of negative anomalies. The speaker confirmed that the normalization is different because the standard way of calculating the North Atlantic Oscillation index already contains normalization relative to the 1950—2000 period.
- A participant asked if a sentence in the SAR relating Scotian Shelf transport with warm water intrusions in the Gulf of St. Lawrence (GSL) was based on new analyses of AZMP data. The speaker answered that it was based on other research (Jutras et al. 2020). AZMP time series could, however, be used to support this statement, i.e., by comparing Scotian Shelf transport and deep-water temperatures.
- The speaker's results showed that the transport of the Labrador Current on the Newfoundland Shelf is usually out of phase with the Scotian Slope water transport. A participant mentioned that during years (up to 2016) where it was reproducing well observed warm intrusions on the Scotian Slope, the BNAM model (Wang et al. 2018) did not reproduce the out of phase relationship between Newfoundland Shelf and Scotian Slope transports. This remains unexplained.

BIOGEOCHEMICAL OCEANOGRAPHIC CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELVES IN 2021 – DAVID BÉLANGER

Biogeochemical oceanographic conditions on the Newfoundland and Labrador Shelf are summarized using anomaly time series of standard AZMP indices derived from remote sensing and *in situ* measurements carried out during seasonal surveys. Satellite Ocean Colour data indicated early onsets and long duration of the spring phytoplankton blooms on the Northeast Newfoundland Shelf and in the Flemish Pass, which contrasted with the late and short blooms observed on the Grand Banks. Bloom magnitude was near to below normal across the region except for southern Labrador where spring production was above normal. Deep nitrate (50-150 m) inventories were highly variable across the region and notably high on the northern Grand Bank (Flemish Cap section) while chlorophyll-a biomass in the top 100 m of the water column was near or below normal. However, the reliability of interannual variations of surface chlorophyll-a concentration for 2021 is a concern because of limited sampling and restriction of field activities to the summer period when phytoplankton biomass is low. Abundances of copepods (including those of *Calanus finmarchicus* and *Pseudocalanus* spp.) and non-copepods were mainly below normal which, on the southern Labrador (Seal Island section), contrasted with the high abundances of the previous year.

Discussion summary:

- A participant suggested that large positive anomaly in abundance of *Calanus finmarchicus* at Flemish Cap in 2021 may be due to the missing fall survey, since the July survey would be close to the time of peak abundances of late stages for this taxon.

- The speaker mentioned a seeming contradiction between positive the zooplankton biomass anomaly and negative abundance anomaly of copepods in the Newfoundland region. A participant commented that this may be due to high abundance of larger *calanus* species (i.e., *glacialis* and *hyperboreus*) which would be consistent with the strong influence from the Labrador Shelf suggested by low salinity at Station 27. The speaker said that the abundance of many other taxa had been assessed, including these large *calanus* species, and that none of these accounted for the positive biomass anomaly. Another factor to consider is that the spring survey was earlier than usual, bringing concerns of biomass estimates being contaminated by phytoplankton. This was an issue in the early 2000s, when filamentous green algae affected the biomass estimates by amounts difficult to quantify. Changes in the teams responsible for these analyses— abundances done at the Maurice Lamontagne Institute (MLI) and biomass done in Newfoundland —could also affect these results. Decreases in the abundance of *Pseudocalanus* spp. and total copepod abundance also measured in parts of the Gulf of St. Lawrence which are most influenced by Newfoundland Shelf and Labrador Shelf waters (e.g., Eastern Gulf) should increase confidence in this signal observed over the Newfoundland region, despite reduced sampling for this region in 2021.
- A participant commented that there is coherence in zonal zooplankton results, although single-year and single-section abundance results may seem erroneous. For example, during 2015—2021 there has been a zonal decrease in *Pseudocalanus* spp. and overall copepod abundance, and an increase in *Calanus finmarchicus* abundance. Zonal biomass increased during the same period.
- Although this was not shown, a comparison of the abundance indices obtained using normal sampling with those obtained using only a summer survey was done by a participant. The indices using only summer surveys represented the long-term trends well, but were less representative of interannual variability. As such, 2021 local indices resulting from reduced sampling should be interpreted with caution.

PHYSICAL OCEANOGRAPHIC CONDITIONS IN THE GULF OF ST. LAWRENCE – PETER GALBRAITH

An overview of physical oceanographic conditions in the Gulf of St. Lawrence in 2021 is presented as part of the Atlantic Zone Monitoring Program. AZMP data as well as data from regional monitoring programs are analyzed and presented in relation to long-term means. The average annual freshwater runoffs of the St. Lawrence River measured at Quebec City and its combination with rivers flowing into the Estuary (RIVSUM II) were well below normal. The sea ice seasonal maximum volume was just shy of the series low record of 2010, and the January-April average was at a series record low. The winter mixed layer volume was the second lowest of the 1996-2021 time series for waters colder than -1°C and lowest for waters colder than 0°C. The August cold intermediate layer (CIL) average minimum temperature was the highest of the 1985-2021 time series and the seasonally averaged minimum temperature index was the highest since 1980. On the Magdalen Shallows, the bottom area covered by waters cooler than 1°C in August-September was at a record low. Sea surface temperatures (SST) averaged monthly over the Gulf were the highest of the satellite record (since 1981) in October and November. The May-November average SST for the Gulf was 3rd highest of the time series after 2006 and 2012. Deep-water temperatures have been increasing overall in the Gulf since 2009, with inward advection from Cabot Strait. Gulf-wide average temperature has hit new series record highs (since 1915) of 4.1°C at 150 m, 6.0°C at 200 m, 6.7°C at 250 m and 6.9°C at 300 m. Bottom area covered by waters warmer than 6°C was at a record high in all regions along the deep channels, with a notable increase in the Estuary.

Discussion summary:

- The speaker showed that runoff was low during the spring freshet and that this resulted in weaker-than-normal stratification at the Rimouski high-frequency sampling station. A participant noted that stratification was near-normal at the Shediac Valley high-frequency sampling station. The speaker answered that this could mean that the Gaspé Current was further offshore and did not bring the spring freshet water to the Magdalen Shallows. However, this should be confirmed by analysis of the Gulf of St. Lawrence circulation model. During the June mackerel egg survey in the southern Gulf, the highest abundances of *Calanus hyperboreus* were measured in the Bradelle Trough, offshore of the Shediac Valley station. This supports the hypothesis of a more offshore Gaspé Current during spring of 2021. Anecdotally, currents of strength comparable to the Gaspé Current were noticed over the Bradelle Trough during the March survey of 2022.
- A participant asked if stronger-than-normal winds could have caused the unusually deep surface mixed layer. The speaker answered that winds had not been considered, but that very strong storms are needed to affect the density structure deeper than 50 m. Such storms occur in the Gulf of St. Lawrence (e.g., hurricane Dorian in 2019), but did not occur in 2021. Another participant commented that weaker-than-normal winds had been modelled over the Gulf in October, as would be shown in a later presentation.
- A participant commented that the results shown by the speaker continue to describe large-scale changes in the Gulf of St. Lawrence and suggested that this could be the subject of a primary literature contribution. The upcoming ICES decadal conference, which calls for selected papers, could be a suitable outlet for this study.
- A participant commented that the unusually warm fall temperatures could correspond to a marine heat wave (temperatures greater than 90—95th percentile), and that this may be something to report on in the future. It could even be something to track via SST and provide online as public information. Reporting on marine heat waves has been suggested in the past, since it is commonly done elsewhere in the world.
- Although the warm fall temperatures were mostly discussed in terms of the St. Lawrence estuary, a participant commented that similar results were obtained for the western Gulf. This suggests that the warm event was not caused by circulation between areas of the St. Lawrence River, but were likely due to larger-scale phenomena.

BIOGEOCHEMICAL CONDITIONS IN THE GULF OF ST. LAWRENCE – STÉPHANE PLOURDE

Collaborators: M. Blais, P. S. Galbraith, C. Lehoux

We present an overview of the biochemical conditions in the Gulf of St. Lawrence in 2021. Deep (50–150 m) nitrate inventories were variable in the GSL in 2021. Nitrate inventories in 0-50 m and > 150 m layers were respectively lower and greater than normal. Annual chlorophyll-a inventories (0-100 m) were generally above or near normal. A positive trend in chlorophyll-a inventories (0-100 m) in the fall is observed in the Northeast and Southern GSL since 2005. Annual surface chlorophyll-a inventories assessed using satellite ocean colour data were well below normal throughout the GSL. The start of the bloom was generally earlier than normal, but was later than normal on Magdalen Shallows. Bloom duration, magnitude and amplitude were generally below normal throughout the region. Calanus finmarchicus abundance was near normal throughout the GSL while *Pseudocalanus* spp. and non-copepod abundance were above normal in the Estuary, Northwest and Southern GSL, and respectively below and near normal in central and eastern regions. The large-bodied *Calanus hyperboreus*, a dominant component of the zooplankton community in the region, showed abundance well below normal throughout the GSL with a record low anomaly being observed in the Northeast GSL. Zooplankton biomass anomalies were coherent with those in *Calanus hyperboreus* with mostly below normal values throughout the GSL with record or near-record lows being observed in several regions.

Discussion summary:

- Relative to the slight increase in dissolved oxygen concentration in the estuary, a participant commented that this was consistent with earlier speculations of newer water in the estuary, based on a fast increase of deep-water temperatures.
- A participant asked if there was a known bias of *in situ* chlorophyll-a measurements relative to values obtained from remote sensing (MODIS satellite). The speaker answered that limited coherence between both data products should be expected since the first consists of point sampling whereas the second integrates a large area over a certain amount of time. Another participant commented that the remote sensing chlorophyll-a data is calibrated against *in situ* measurements as much as possible, and noted that both data products seemed in good agreement at Rimouski station. Although it is not the focus of this meeting, the integration of both data products deserves its own peer review before becoming a regular data product reported on in the SAR.
- A participant noted that in the summer, the stage distribution of *Calanus finmarchicus* was close to the climatological mean but in the fall, late stages were more abundant than the climatological mean. The participant asked the speaker if this was interpreted as an additional generation successfully going back into dormancy or as additional copepods brought to the area by circulation. The speaker answered that abundance results this year were unusual, in that low abundance of *Calanus finmarchicus* is commonly associated with strong runoff. In 2021, there was low runoff and low abundance of *Calanus finmarchicus*. Prior studies have shown that circulation processes can influence the summer distribution of zooplankton in the Gulf of St. Lawrence (Lavoie et al. 2016; Maps 2009). Relative to the fall high abundance of *Calanus finmarchicus* stage CV, there has been a biweekly sampling of zooplankton at two depth layers at Rimouski Station during 2021. This should provide better understanding of the vertical distribution of zooplankton and further insights into this anomaly. In addition, this sampling protocol made it possible to estimate the lipid load of copepods, including those in diapause, starting in late summer. On average, lipid loads of *Calanus hyperboreus* were lower than when the same protocol was carried out in late 2000. This also suggests that something abnormal happened in 2021, possibly related to the abnormal oceanographic conditions in the Gulf of St. Lawrence, and particularly the Western Gulf and Estuary.
- The speaker commented that on first comparison between total copepod and *Pseudocalanus* abundances at Rimouski Station (positive anomaly) and in the Newfoundland Region (negative anomaly), his thought was that the negative anomalies were caused by the missing fall survey, resulting in no observations during a time of high abundance. However, since trends are similar in the Eastern Gulf and Newfoundland, and since oceanographic conditions were exceptional in the Western Gulf and Estuary, it is possible that the two signals were true, although contrasted.

BIOGEOCHEMICAL CONDITIONS ON THE SCOTIAN SHELF AND IN THE GULF OF MAINE – BENOIT CASEAULT

An overview of the chemical and biological oceanographic conditions observed on the Scotian Shelf and in the eastern Gulf of Maine in 2021 as part of the Atlantic Zone Monitoring Program is presented. Due to vessel unavailability, the Maritimes region spring survey on the core AZMP sections and the summer ecosystem survey on the Scotian Shelf in the eastern Gulf of Maine were both cancelled in 2021. As well, there were sampling gaps, mainly during winter and spring, at the high-frequency monitoring stations Halifax 2 (HL2) and Prince 5 (P5). As a result, care must be taken in interpreting the 2021 anomalies, especially for the indices characterized by a strong seasonality. Deep nitrate inventory anomalies were positive across most of the region in 2021 with the exception of station P5 and the Browns Bank section (BBL) where slightly negative anomalies were observed. The above-normal deep nitrate levels in 2021 represents a shift from the previous 5-6 years which were characterized by mainly negative anomalies across the region. Deep silicate and phosphate levels in 2021 followed a spatial pattern similar to that of deep nitrate with near-normal (phosphate) or above-normal (silicate) levels across most of the region with the exception of P5 and BBL. The *in situ* integrated chlorophyll-a inventory in 2021 was lower than normal at HL2 and P5, and near or slightly below normal on the core sections with the exception of BBL where a positive anomaly was recorded. In contrast, surface chlorophyll-a measured by remote sensing showed strong positive anomalies across most of the region in 2021 with the exception of P5 (slightly negative) and Georges Bank (normal). The abundance of diatoms was normal at HL2 and below normal at P5 in 2021, continuing trends of near or lower than normal levels since 2015 (HL2) and 2009 (P5). Continuing trends of higher-than-normal abundances were also observed in 2021 for ciliates (HL2 and P5), flagellates (HL2) and dinoflagellates (P5). The onset of the spring phytoplankton bloom was earlier on Cabot Strait and on the Scotian Shelf in 2021. The bloom duration was near or below normal across most of the region with the exception of the western Scotian Shelf where the record high value of 2013 was reached again in 2021. The bloom magnitude was above normal across most of the region owing mainly to the large bloom amplitude values, especially in the eastern Scotian Shelf where record high values were recorded for both metrics. The bloom amplitude and magnitude were both below normal on Georges Bank in 2021. Due to delays in the analysis of zooplankton samples, indices of the zooplankton community in 2021 focused mainly on conditions observed at HL2 which indicated lower-than-normal abundance of Calanus finmarchicus and total copepods, and lower-than-normal biomass of zooplankton. The abundance of non-copepods was normal while that of *Pseudocalanus* was higher than normal with strong seasonal variability (lower than normal levels in summer and higher than normal levels in fall). Sub-dominant species (e.g. *Metridia lucens*, *Oithona atlantica* and *Temora longicornis*), for which the abundance had been higher than normal in the previous 7-9 years, indicated negative anomalies at HL2 in 2021.

Discussion summary:

- Concerns were raised about bloom metrics obtained for boxes with very high chlorophyll-a values, but it was decided that this was outside the scope of this discussion.
- The speaker was asked if the large increase in abundance of *Calanus finmarchicus* between March and April was interpreted as a biological or transport signal. He answered that this increase was interpreted as a biological signal.
- A participant commented that it is interesting to see the same trends in copepod abundances across regions despite different circulation regimes and water masses. It was suggested that a change in phytoplankton community composition could explain abrupt

changes in certain abundance time series. For the speaker's region, there were no major changes in the phytoplankton community composition which could explain these changes.

- A participant commented that the Halifax 2 Station is close to shore and was likely more influenced—in terms of zooplankton taxa—by outflow of the Gulf of St. Lawrence than by Slope Water flowing onto the shelf.
- There have been discussions between regions to standardize remote sensing chlorophyll-a methods, but this an ongoing process. The boxes are not yet perfectly adapted to the observed ecosystem patterns. Although there is progress in this research, it was not ready to be included in this year's research document and will likely be presented next September for review. The final boxes will likely not be square and contain fewer coastal areas.
- A participant noted that although the boxes used for regions are fairly large, remote sensing data for stations is based on a circular area with a radius of 0.1° around the nominal location. This is useful when *in situ* observations are not available (e.g., cancelled cruise) but comparison to *in situ* data should be done since this is a new strategy and it is often based on only a few pixels.
- A participant asked if the low nutrient values could be due to the lack of a spring sampling survey. Sensitivity analysis was conducted to establish which indices on which sections were less reliable in the event of missing data. The result was that long-term trends and annual means were not very sensitive to the absence of one survey in a given year. The interannual variability was, however, less reliable when surveys were skipped. Results from the fall surveys were also found to be well correlated with the annual means.

REVIEW OF PHYSICAL AND BIOLOGICAL CONDITIONS IN THE NORTHWEST ATLANTIC – SESSION 2

PHYSICAL OCEANOGRAPHIC CONDITIONS ON THE SCOTIAN SHELF AND GULF OF MAINE– DAVID HÉBERT

In 2021, it was unfortunate that some of the normal sampling for the Maritimes AZMP could not be undertaken due to issues with vessel availability. There was no spring survey, but some of the core program was completed over the summer. There was no summer ecosystem trawl survey. The fall survey was very successful with additional stations in key locations sampled.

In 2021, air temperature anomalies were positive for Sydney, Sable Island, Halifax, Yarmouth, Saint John and Boston, with anomalies ranging from 1.0°C (1.3 SD) for Saint John to 1.4°C (2.0 SD) at Boston. Satellite-based sea surface temperature was above normal (1991-2020 average temperature), ranging from 0.6°C (1.3 SD) for 4Vn to 1.3°C (1.9 SD) for the eastern Gulf of Maine-Bay and Fundy regions; the warmest year on record. It was the 2nd warmest year for 4Vn, 4W and 4X on the Scotian Shelf and 3rd warmest for 4Vn. Coastal near-surface temperatures have been collected at Halifax and St. Andrews since the 1920s. Unfortunately, no data was collected in 2021 at St. Andrews. For Halifax, the temperature anomaly relative to the 1991-2020 climatology was +1.7°C (+2.8 SD), the 2nd warmest temperature on record.

Water temperatures at select sites were well above normal. Cabot Strait 200-300 m temperature was the second highest— 1.3°C (1.9 SD) —5 of the last 6 years were the warmest, 2020 being the record highest. Emerald Basin 250 m temperature was the sixth highest— 1.1°C (1.2 SD) — the last 6 years were the warmest, 2019 being the record high. Georges Basin, at 200 m, was the third warmest year— 1.1°C (1.6 SD) —2018 being the warmest. Also, the last 9 years were the warmest.

There were no July bottom temperatures for the shelf portions of the NAFO Regions 4Vn, 4Vs, 4W and 4X, or cold intermediate water volumes or temperature were due to lack of an available vessel for the ecosystem trawl survey.

Discussion summary:

- Missing values of deep temperature are of concern this year because the cumulative bottom water index is at a record high. It is possible that this would not be the case with complete survey coverage. This year's addition of Emerald Basin and Georges Basin deep temperatures to this cumulative index was noted to be timely, since values were available and they keep the index representative of the Scotian Shelf in spite of the missing surveys.
- A participant noted that in the Gulf of St. Lawrence, bottom waters have no clear seasonal cycle. Annual conditions can therefore be assessed using data from any time during the year. The speaker was asked if something similar could be done in the Maritimes Region, and answered that it would be difficult because of limits in the spatial and temporal coverage. Although there is no clear seasonal cycle of deep-water temperatures in the Maritimes region, there is variability at different times of the year, mostly due to differences in the Slope Water signal. The temperature anomaly at Halifax 2 could be used for this, but it is closer to shore than most of the region. The glider data could eventually be used this way when enough years of data are available to establish a reference climatology.
- A participant asked the speaker to expand on a comment about low Slope Water influence on the Louisbourg transect. The speaker answered that on all stations, these temperatures are above the climatology by a few degrees, but they were below the climatology by a few degrees in 2021. Since these data have been made available a short time before the meeting, it is, however, too early to tell if this is due to reduced Slope Water influence or to the change in climatology reference periods.

AN ABRUPT INTERRUPTION OF THE RECURRING LABRADOR SEA CONVECTION IN THE WINTER IN 2021 – IGOR YASHAYAEV

The Labrador Sea is the coldest and freshest basin of the North Atlantic to the south of the Greenland-Iceland-Scotland Ridge. There, the high surface heat losses incurred by the ocean during winter induce intense vertical mixing leading to the formation of a characteristic dense water mass, Labrador Sea Water, that consequently spreads across the ocean, ventilating its intermediate and deeper layers, which defines interannual and longer-term trends over these layers and contributes to the deep limb of the global ocean overturning circulation.

The most remarkable event in the entire history of oceanographic observations in the North Atlantic was the production of a record cold dense deep gas-saturated voluminous class of Labrador Sea Water between the late 1980s and mid-1990s. Over the 20 years that followed this well-documented water mass development, the strength of wintertime cooling notably declined, while the sea, especially at its mid-depth, was gradually warming and gaining more saline and less dense waters.

Another series of sea cooling events, accompanied by deepening winter convection and water-column ventilation, occurred in the Labrador Sea in the years from 2012 to 2018, inclusively, with the exception of 2013. In each of these years convection reached a greater depth than in the preceding winter, progressively deepening from 1400 m in 2012 to at least 2000 m in 2018, thus becoming the most extensive and deepest convection since the winter of 1994.

The recent development in recurrent winter convection was largely driven by higher-than-normal winter surface heat losses, which reached a 28 year (1994-2021) high in 2015. However, the

Labrador Sea convection continued to deepen in the three consecutive winters following the winter of 2015. The key factors that contributed to the further deepening of convective mixing during 2016-2018 include both the surface heat loss (reducing to near-normal during that period) and the residual effects of the past water cooling and convective mixing events on the vertical stratification over the top 2000 m of the water column. We define as convective preconditioning the ability of the sea to retain and accumulate the impacts of the previous winter events on its heat content and density stratification.

The multiyear persistence of deepening winter convection, continuing through the winter of 2018 when it exceeded 2000 m in depth, led to the formation of the most voluminous, densest, and deepest formation of Labrador Sea Water since 1994.

The tendency in recurrent convective developments changed again in 2019, with the depth of winter convection largely ceasing to exceed 1400 m in that and the following two years. The intermediate layer has been warming since 2019 with the seawater density trend eventually reversing to negative.

Even though in 2020 wintertime mixing reached marginally deeper than in 2019 (by 100 m or so), and the intermediate layer slightly cooled, the negative density trend prevailed.

The most remarkable recovery of the intermediate layer from the cold and dense state, achieved in a result of the recent development of recurrently deep winter convection, occurred in 2021. Despite the winter NAO index being near-normal, the Labrador Sea convection was exceptionally shallow that year, not exceeding the depth of 850 m, which made it the shallowest since 2011, and third shallowest in 32 or more years. Respectively, the winter air temperature was above normal and surface heat loss below normal, while annual sea ice area and extent were the lowest since 2011 and third lowest in at least 42 years. These mild winter forcing conditions, and, consequently, weak and shallow ocean convection in 2021, owe to a collapse of the Polar Vortex, and its relocation closer to Siberia. In turn, the misplaced weakened Vortex reduced the strength of the westerlies, if not reversing their direction. The deficit of cold continental air made the winter of 2021 anomalously mild. As a result, the deep ocean became slightly warmer and less dense than in the previous six years.

Overall, the changes in the depth of winter convection and intermediate layer properties between these years imply that the effect of the water column preconditioning on winter convection has weakened since 2018. Vertical distributions of dissolved oxygen and chlorofluorocarbons (CFCs) – CFCs and industrially Freons are the anthropogenic gases that are commonly used as tracers of convectively formed water masses spreading in the ocean – in the central Labrador Sea, based on quality controlled drift-corrected measurements assembled since 1990, follow very closely the multiyear events of recurrently persistent renewal of dense deep Labrador Sea Water in the Atlantic Ocean.

With respect to interdecadal variability, the Labrador Sea has recently completed a seven year (2012–2018) cooling phase of a full convective cycle, and switched to post-convective relaxation (2019-2021), resulting in water column warming. The recent cooling trend, followed by warming, resembles the cooling trends observed in the late 1950s and during 1987–1994, which similarly switched to warming trends. Each of these cooling events can be linked to strengthening of winter convection and production of large volumes of Labrador Sea Water in the same periods, while the trends of subsurface warming were associated with accumulation of relatively warm and saline Atlantic waters in the deep Labrador Sea reservoir.

Combining oceanographic data from all occupations of the Atlantic Repeat hydrography line 7-West (AR7W) carried by both DFO and international institutes, a set of annual seawater property sections was constructed for the entire period of observations, 1990-2020. The AR7W spatially gridded annual composite section collections were averaged to obtain full 30-year climatology for the key seawater properties (or oceanographic variables), including temperature, salinity, density, dissolved oxygen, silicate, phosphate and nitrate. The rate of change (slope of the trend) over the 1990-2020 period, and annual, pentadal and decadal anomalies with respect to the climatology were computed for these variables at each point of the AR7W line.

Discussion summary:

- The chair suggested that Labrador Sea convection depth should eventually be added to the SAR physical scorecard, since it is one of the key variables in interpreting the oceanography of the Labrador Sea and this would make it easier for readers to find.
- Regarding interpretations of the Labrador Sea oceanographic data in terms of meteorological data, the chair reminded that it has been the practice of the AZMP to avoid interpretation in the SAR bullets.
- A participant commented that in different sections of the presentation, figures showing meteorological data were shown as monthly and seasonal averages, and asked if the speaker had verified that his conclusions hold under selection of different time intervals. The speaker answered that this had been verified, and that the presented time intervals were chosen to because they are illustrative examples of the dynamics he discussed.
- The speaker showed anomalies for sea ice extent in the Labrador Sea. A participant asked if similar anomalies were found for sea ice volume. Sea ice volume anomalies had not yet been calculated since this year, ice variables were calculated by the speaker, instead of a recently retired research scientist. In time, sea ice anomalies will be calculated for the Labrador Sea if ice thickness data is available in this region.

BIOGEOCHEMICAL CONDITIONS IN THE LABRADOR SEA (AZOMP) – MARC RINGUETTE

The Atlantic Zone Off-Shelf Monitoring Program provides observations on biogeochemical properties and plankton, whose variability affects the ecosystems and climate at the regional and global scales. In 2021, multiple mechanical problems with *CCGS Hudson* delayed the mission that began on May 19th, which resulted in its cancellation on May 27th as the sailing time left before the crew change would have not allowed even a partial occupation of the Atlantic Repeat 7-West line. The Canadian Argo Program was not able to add new floats in the Labrador Sea, essential instruments that provide year-round observations of temperature and salinity.

Consequently, we were not able to provide any of the *in situ* indices for the year 2021 with the exception of spring bloom metrics, which are derived using ocean colour satellite observations. BGC-Argo floats sample biogeochemical variables and include a combination or all of the following measurements: dissolved oxygen (DO), pH, nutrients, chlorophyll-a fluorescence, backscattering coefficient (an index of suspended particles concentration), CDOM fluorescence and downward irradiance. They contribute significantly to the understanding of the biogeochemical cycles and biological production. Argo floats with T-S-DO were present in sufficient numbers in the Labrador Sea to provide enough data to compile a time series spanning 2016 to 2021. Analysis of DO measurements from the first 50 m of the water column derived from Argo floats showed a zone of higher-than-average concentration of DO along the Greenland Shelf and generally lower concentration than average along the Labrador coast and in the Southern Labrador Sea when compared with the 2016-2020 average. Phytoplankton bloom metric showed an early start and generally long duration compared to normal in all three regions of interest (i.e., Labrador Shelf, Central Labrador Sea, and Greenland Shelf). On the Labrador Shelf and Central Labrador regions, blooms were of large amplitude yielding a larger-than-average production, whereas the Greenland Shelf experienced a lower-than-average amplitude resulting in a normal bloom magnitude.

Continuous Plankton Recorder (CPR) data was reported for 2019, with the expectation that the final report will also include data from 2020 (2021 data will not be available until the end of 2022). The phytoplankton colour index was higher than average in all regions, while Diatoms and Dinoflagellates abundances were average or lower than average in almost all regions. *Calanus finmarchicus* abundance was generally higher than average in almost all regions with the exception of the Scotian Shelf.

Discussion summary:

- The chair commented that the dissolved oxygen anomalies calculated from the Argo data might be noisy because they are surface 20 m averages, and not because of insufficient data. Near the surface, dissolved oxygen is likely to remain close to saturation because of contact with the atmosphere. Deeper values might provide a clearer climate signal. Further, even regions with only one Argo float should be considered for reporting, since other AZMP sites (e.g., Shediac Valley) have been reported on in the past with very few occupations over the season.
- Concerns were raised that the spring bloom durations included fall blooms, because they were more than 180 days long. This would skew the mean and standard deviations for this variable. A participant suggested that years with blooms suspected of including a second fall bloom should be omitted. The speaker showed that there is no obvious one-size-fits-all solution because bloom patterns vary by region. In the central Labrador Sea during 2021, there was clearly one long bloom (about 200 days duration). In other regions there were clearly two blooms. It was suggested that in regions where there is usually a fall bloom, the spring bloom could be isolated by fitting only the chlorophyll-a data from the first 200 days of the year.
- Looking only at the chlorophyll-a curves, it is easy to forget that they represent large spatial averages of a patchy phenomenon which are mobile, and obscured by cloud cover. Identification of the bloom metrics is a complicated exercise that works 90% of the time. What to do with the 10% of cases where it does not work is a challenging question. Perhaps they should be discarded. A participant commented that at this stage, bloom fits need to be reviewed individually to ensure they are valid. They also need to be documented such that people can make their own opinion about their validity. This is not yet done but could be an addition to the research documents or be the subject of a dedicated document. The Labrador Sea bloom metrics present challenges particular to this region, but there is ongoing work to address these issues in the coming year.
- A difficulty in fitting the chlorophyll-a curves of the northern regions is that because of ice cover, there are no baseline values for spring; the first values of the year are high values which happen when the ice retreats. A participant suggested that since the Gaussian curve which is fit to the chlorophyll-a data is symmetric, the peak values could be used to identify the bloom timing. This method could be more robust, but duration and timing anomalies calculated this way should be compared with those calculated using a full Gaussian fit to validate their equivalence.
- Another problem with the bloom fits is the size and location of the averaged areas. It could help to use the same strategies as was done in the Maritimes region (i.e., self-organizing maps and clustering analyses) to better adjust the boxes to the bloom patterns. A technical

report is in production showing these results and it is planned afterwards to apply these tools to the Labrador Sea region. It would also likely improve the fits if input parameters of the PhytoFit application (Clay et al. 2021) were adjusted for each box— and perhaps for each year –instead of being kept consistent across the zone. This could be the subject of a dedicated primary publication or a research document.

- A participant suggested that once more detailed bloom metrics are available, reporting metrics of the fall bloom could be considered in regions where it often occurs.

ZONAL ACIDIFICATION CONDITIONS – FRÉDÉRIC CYR

Carbonate chemistry parameters, including total alkalinity (TA), dissolved inorganic carbon (DIC) and pH. Other parameters such as the calcium carbonate saturation states with respect to calcite and aragonite (Ω_{cal} and Ω_{arg}) can be derived from the measured variables. These are measures of ocean acidification that indicate the potential to precipitate/dissolve carbonate. Below the threshold of 1, the environment is considered undersaturated with respect to calcium carbonate and potentially corrosive to organisms that build biogenic carbonate shells. The Ω typically decreases with depth, and thus deep slope waters tend to have lower Ω than the bottom waters of the shallower shelves. From 2020 to 2021, near-bottom pH in the Gulf of St. Lawrence has shown a general decline, especially in the St. Lawrence Estuary. On the Newfoundland shelf, while the spatial extent the undersaturated state for aragonite that occurred in 2020 on the northern part of the Grand Banks and in the Avalon channel has reduced, two stations on the northeast part of the Grand Banks show a decline in Ω_{arg} and pH in 2021 compared to 2020. No data are available from the Scotian Shelf during the summer of 2021.

The lowest pH and Ω values were observed along the deep Laurentian Channel, especially in the St. Lawrence Estuary where the deep layer (>300 m) was undersaturated with respect to aragonite and calcite (pH values were below 7.6 throughout the Estuary, with a minimum of 7.44) and represents increased acidification relative to the conditions in 2020. In addition, oxygen saturation at many sampling locations is well below 20% (even close to 13% at some stations, and has generally declined compared to 2020. These correspond to new low oxygen concentration records for the Lower St. Lawrence Estuary.

Discussion summary :

- Concerns were raised that there were missing data in the dissolved oxygen time series at Rimouski Station since there were only three values during 2021, and this station was occupied on a weekly basis for much of the year. In light of the dates of the presented data, it was suggested that the data shown were those collected during the AZMP surveys, but did not include high frequency sampling. This was problematic because a record low of deep dissolved oxygen was presented by the speaker, but the Gulf of St. Lawrence biogeochemical research document shows a slight increase with respect to last year’s value. It was decided that these results should be verified before submitting the SAR.
- A participant noted that there were high values of surface dissolved oxygen at Rimouski Station during 2021. It was decided not to highlight this result because the values were high but not exceptional.

MODEL-BASED ENVIRONMENTAL CONDITIONS IN 2021 – JOËL CHASSÉ

Collaborators : Nicolas Lambert (Gulf), Dave Brickman, (Maritimes), Guoqi Han (Pacifique), Zeliang Wang (Maritimes), Diane Lavoie (Quebec), Olivier Riche (Quebec), Jacqueline Dumas (Quebec), Nancy Soontiens (Newfoundland) and Jared Penney (Newfoundland).

Ocean monitoring is typically conducted during specific months and locations. Therefore large data gaps often exist in the observational system and numerical models are useful to estimate missing data which supports the State of the Ocean reporting, ecosystem research, stock assessments, invasive species research, climate change research, etc. This work draws on national and international modelling expertise to provide a four-dimensional (4D) analysis, in space and time, of environmental variables from the atmosphere to the bottom of the ocean in Atlantic Canada. It aims to supplement the reporting based on observational systems, which is traditionally conducted under DFO's Atlantic Zone Monitoring Program.

Reanalysis from six atmospheric models were used to derive the atmospheric conditions over the ocean (ERA5, JRA_55, NCEP1, NCEP2, NARR and NCEP_CFSv2). All the ocean models used in the analysis are based on the NEMO modelling system. The GLORYS (Global Ocean reanalysis and Simulation) model is available at the MERCATOR-Ocean operational ocean forecasting centre. It is a global model at 1/12° resolution and it includes sea ice. The surface forcing is derived from atmospheric ECMWF reanalyses. Assimilated observations are *in situ* temperature and salinity profiles, satellite SST and along track sea-level anomalies obtained from satellite altimetry. The analysis period covers 1993-2021. The North Atlantic Ocean-ice Downscaling System (NAODS) consists of a 1/12° model for the Northwest Atlantic region nested to a 1/4° model for the North Atlantic. These coupled models are forced by the European Centre for Medium-Range Weather Forecasts Reanalysis (ERA5) products, and a hindcast simulation was carried out for the period from 1980 to 2021. The output from the Bedford North Atlantic Model (BNAM) is also used in the analysis. The BNAM domain covers the North Atlantic Ocean from 8°-75°N, 100°W-30°E, at a resolution of 1/12°. The simulation is driven by interannual surface forcing for the 1990–2021 period, derived from a combination of CORE and NCEP/NCAR reanalysis forcing. The modelling system includes runoff from major rivers. The CANOPA setup is also used at two different horizontal resolutions (1/12° and 1/24°) covering the GSL, Scotian Shelf and Gulf of Maine. The setups include ice cover, tides, oceanic surface momentum, heat and salt fluxes and runoff from 78 main rivers. Four simulations were conducted using CANOPA, including a simulation at 1/12° for the 1948-2021 period using the updated atmospheric conditions obtained from the National Centers for Environmental Predictions (NCEP), a 2006-2021 simulation at 1/24° using the Canadian Meteorological Center (CMC) forcing, a third simulation using NEMO 4.0 at 1/24° under the ERA5 forcing, and a fourth simulation (1/12°) with biogeochemical modelling (BGCM) using the hourly atmospheric forcing provided by the National Centers for Environmental Prediction (NCEP) Climate Forecast System Version 2. The BGCM simulation covers the 1997-2021 period.

Hindcasting simulations were made (or obtained) with each model and monthly averages were produced for all variables. We first presented the atmospheric variables and their anomalies followed by the oceanographic fields and derived calculations. We followed the standard AZMP method for the preparation of anomalies, i.e., the deviations from their long-term mean. The so-called ''normal conditions'' were calculated for the new standard 1991–2021 reference period whenever possible. These anomalies are further normalized by dividing by the standard deviation calculated for the standard reference period to produce scorecard tables with values within ±0.5 SD. Time series for both values and anomalies were presented for the ''Gilbert'' and NAFO boxes typically used in the AZMP reporting.

The BGCM incorporated methods to determine total dissolved nitrogen, spring bloom, annual primary production rate, dissolved O_2 saturation, atmospheric and surface water partial pressure of carbon dioxide (pCO2), total dissolved nitrogen (TDN) from river runoff, pH and aragonite/calcite saturation states.

Mean monthly anomaly values for several atmospheric variables (air temperature at 2 m, wind speed, etc.), based on monthly climatologies for the 1991–2020 period, calculated from the seven atmospheric reanalyses were presented. The atmospheric reanalysis appeared to be consistent across models, over the study area.

Ocean variables time series and anomalies were presented from the models. Ocean “ensemble” results were therefore available for regions where model domains are overlapping. For the presentation, we focused on temperature and salinity at the surface, at 300 m and near the bottom. Transport on several sections were also presented, followed by modelled biogeochemical variables.

The modelling work is still ongoing and a research document will be available in the coming year. The model results will be useful for time periods and areas when/where there are no observed data. Such long time series are also required for ecosystem research and will be made available upon request.

Discussion summary:

- Concerns were raised that there was a lot of spread in temperature values between the different models, and a considerable difference between the mean of all the models and the observations. Establishing why certain models are better at reproducing a given observation represents a lot of work. This is why many models are used, such that readers can decide how much the simulated values can be trusted.
- Cold intermediate layer and winter mixed layer metrics were not presented. It is planned to extract them in the future but for this year, there was no available staff to prepare these products. There is ongoing work in the Newfoundland region to compare simulated values of the CIL with observations.
- It was suggested that an interesting validation for zonal modelling would be to reproduce the SAR physical scorecard. The speaker specified that each model is somewhat independently validated. They are complementary in that they are good at representing different observations, for example CANOPA models are good at reproducing surface conditions whereas BNAM is good at reproducing bottom conditions.
- A participant asked if the surface CO_2 flux values were based on observations collected by Gulf region. No new flux observations were provided, but this could eventually be integrated to the Viking buoy sampling.
- Concerns were raised that the long time series of simulated data could be different before and after the 1990s because prior to this most models were forced by climatologies at their open boundaries. Afterwards, more model runs become available that were forced by downscaled global models. This could bias towards regional processes before the 1990s, whereas larger-scale dynamics are included afterwards. The speaker answered that older simulated values remain indicative of long-term trends, and that all anomaly values are calculated against the 1991-2020 period. Therefore, anomalies of recent data are calculated with respect to a reference period when models using both types of forcing are available for most years.

SUMMARY OF ZONAL SCORECARDS AND CHANGES MADE THIS YEAR. REVIEW AND AGREEMENT OF SAR BULLETS – PETER GALBRAITH

Figure changes:

The 3Ps box was not shown on any maps before. This box has been added to the box with the AZMP transects. It was decided that the 3Ps box would be drawn as is, but figures showing bottom temperatures at 3Ps should say that temperature data is cropped at 1000 m before calculating the box average, as is done in the Newfoundland and Labrador physical research document.

Regarding the physical stacked bar summary figures, in discussions leading to the State of the Ocean Report—of which many present at the meeting were co-authors—it was noticed that the data contained two groups of time series: those concerning warm water influenced by the Gulf Stream and those concerning cold water influence by the Labrador Current and the cold intermediate layer. The same was done for these figures using the labels cold and warm. To avoid complicated wording (e.g., warm anomalies of the cold water) and since these groups are not well defined by fixed depths over the entire zone, the decision was to use labels based their water mass content. Temperatures of Cabot Strait at 300 m, Emerald Basin and George Basin were added to the warm temperature index, which helps to make the index representative of the whole zone in the absence of the Scotian Shelf groundfish survey temperature data.

In the physical scorecard, the Labrador Current row was renamed “transport” to better reflect that transport along the Scotian Shelf is not part of the Labrador Current. Labrador Sea convection depth was added to this figure.

Bullets:

SST and stacked bar figure: No discussion.

Transport: To match the Newfoundland and Labrador physical research document, the label was changed from “Labrador and northeast Newfoundland slope” to “Newfoundland and Labrador slope”. It was decided to refer to transport along the Scotian Slope transport as “transport along the Scotian Shelf break”, because this transport is not necessarily moving Slope Water and for consistency with the definition of the Scotian Slope which is different in other organizations (e.g., Natural Resources Canada). For internal consistency of the SAR, the label was also changed to transport at the “Labrador Shelf break” for that region.

Sea ice: Labrador Sea ice should eventually be merged into this result.

Surface chlorophyll-a: A moderation note was included in the bullet stating that interannual variability may not have been reliably represented by this metric for the Scotian Shelf and Newfoundland and Labrador regions because sampling was restricted to summer, when phytoplankton biomass is low. This type of text is usually avoided in the SAR, but was included in this case because of low confidence in the presented values.

Ocean colour: The Labrador Sea boxes should eventually be included to the figure associated with this bullet. A participant commented that since the map of ocean colour showed well-defined spatial patterns but the scorecards showed strong variability, maybe the averaging regions should be made larger. A participant from the ocean colour working group answered that large boxes do not well represent this variable because phytoplankton is too patchy, i.e., *in situ* values are not well represented by averages over large areas. The averaging regions need to match the scale of the phytoplankton blooms. However, the tradeoff is that small boxes are limited by cloud cover. There is ongoing work to better match the averaging regions with recurrent patterns of high chlorophyll-a concentration, which should reduce the variability seen in the scorecard figures.

Bloom metrics: Discussion about wording.

Abundances: A participant suggested that the top row of the abundances figure should concern categories of taxa and the bottom row should contain the taxa specific abundances. It was chosen not to highlight several records (Flemish Cap, Shediac Valley) because of low confidence due to insufficient observations. Confidence was, however, sufficient to discuss the record low at the Halifax 2 line. Again, although this type of text is usually avoided in the SAR bullets, a note was included to explain that the missing values in the Scotian Shelf region were due to limited sampling opportunities and delays in processing.

Biomass: No discussion.

Acidification: The original bullet focused only on data at Rimouski station. It was decided to add a statement about long-term trends in the deep water of the Gulf of St. Lawrence. In the future, it could be interesting to add an average anomaly of these parameters for deep waters of the Gulf of St. Lawrence.

Labrador Sea physical: No discussion.

Labrador Sea biogeochemical: This bullet was meant to highlight that these data were not available for 2021 due to a cancelled survey. There was discussion about including more details about the cancelled survey, but this was considered outside the scope of the SAR, which must be focused on science. An objective statement was chosen to explain only how this cancellation affects the ability of the AZMP to interpret its results and evaluate the state of the ocean in Atlantic Canada.

Sources of uncertainty: A bullet was proposed which described in more detail how cancelled and delayed surveys in the last decade have increased the uncertainty of several oceanographic indices presented in the SAR. This paragraph was moved to the SAR section dedicated to sources of uncertainty to emphasize that it is a scientific statement, and not a political one.

WRAP-UP, WORKPLAN AND 2023 MEETING DATES

Publication timetable:

A summary was presented of recently published research documents and submitted but not yet published research documents. The publication delay of AZMP research documents for last year was usually from 2 to 4 months. The chair asked authors about the state of research documents expected to be published by now, but still being processed by the Canadian Science Advisory Secretariat (CSAS). The modelling research document still needs some work, but is expected to be submitted in 2022.

The chair showed the group the new AZMP web page, which contains links to all the research documents published by the AZMP. Documents not yet published by CSAS are available on this page, but the links point to the CIOOS web site. Versions of the research documents stripped of their CSAS headers have been made available upon submission to CSAS through this outlet in recent years.

The last 3 AZMP annual meetings were held virtually and with reduced scope, focusing on reviewing the research documents and drafting the SAR. Prior to this, the in-person meeting also included workshops for logistics, data management and arising issues, as well as presentations about new research done by AZMP scientists. There has been discussion in this meeting and past meetings, about moving this portion of the scope to a second annual AZMP meeting which would be held in person during fall over 2—3 days. There was a consensus among the group that it should be possible to hold such a meeting in 2022 without major complications due to the COVID-19 pandemic, and that this meeting should be held in Montreal. Choosing dates was a challenge because many AZMP scientists participate in fall sampling cruises, leaving few dates where all are available. The chair suggested that an online poll should be formed to find the best dates, in terms of the availability of key participants (e.g., logistics and data management). It was also suggested that the meeting dates change from year to year such that attendance is not always difficult for the same people.

Participants expressed appreciation of the virtual format with 3 half-days for the CSAS portion of the annual AZMP meeting.

The chair described how participants should edit the SAR draft, made available online as a collaborative document.

A participant asked if there are CSAS publication guidelines that the group could use to pressure CSAS into shortening the publication delay of the SAR (usually about 3 months). The guidelines are not rigid enough that they can be used for this purpose.

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APPENDIX I – TERMS OF REFERENCE

Twenty-Fourth Annual Meeting of the Atlantic Zone Monitoring Program (AZMP)

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

March 21-23, 2022
Virtual meeting

Chairperson: 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:

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

The program sampling strategy is based on:

1. Seasonal and opportunistic sampling along sections to quantify the oceanographic variability in the Canadian Northwest Atlantic shelf region;
2. Higher-frequency temporal sampling at more accessible fixed sites to monitor the shorter time scale dynamics in representative areas;
3. Fish survey and remote sensing data to provide broader spatial coverage and a context to interpret other data; and
4. Data from other existing monitoring programs such as 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

1. 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.
2. Synthesize the multidisciplinary information gathered over the course of the program.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Documents

Expected Participation

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

APPENDIX II – LIST OF MEETING PARTICIPANTS

Name	Affiliation
Bélanger, David	DFO, Science – Newfoundland and Labrador Region
Boivin-Rioux, Aude	DFO, Science – Quebec Region
Brickman, David	DFO, Science – Maritimes Region
Casault, Benoit	DFO, Science – Maritimes Region
Caverhill, Carla	DFO, Science – Maritimes Region
Chassé, Joël	DFO, Science – Gulf Region
Clay, Stephanie	DFO, Science – Maritimes Region
Cogswell, Andrew	DFO, Science – Maritimes Region
Cyr, Frederic	DFO, Science – Newfoundland and Labrador Region
Devred, Emmanuel	DFO, Science – Maritimes Region
Dumas, Jacqueline	DFO, Science – Quebec Region
Fife, Jack	DFO, Science – Maritimes Region
Galbraith, Peter	DFO, Science – Quebec Region
Hebert, Dave	DFO, Science – Maritimes Region
Johnson, Catherine	DFO, Science – Maritimes Region
Lambert, Nicolas	DFO, Science – Gulf Region
Lehoux, Caroline	DFO, Science – Quebec Region
Maillet, Gary	DFO, Science – Newfoundland and Labrador Region
Penney, Jared	DFO, Science – Newfoundland and Labrador Region
Pepin, Pierre	DFO, Science – Newfoundland and Labrador Region
Plourde, Stéphane	DFO, Science – Quebec Region
Riche, Olivier	DFO, Science – Quebec Region
Ringuette, Marc	DFO, Science – Maritimes Region

Name	Affiliation
Shaw, Jean-Luc	DFO, Science – Quebec Region
Starr, Michel	DFO, Science – Quebec Region
Yashayaev, Igor	DFO, Science – Maritimes Region

APPENDIX III – MEETING AGENDA

24th Annual meeting of the Atlantic Zone Monitoring Program - 21-23 March, 2022

Virtual meeting via MS-Teams - Chairperson Peter Galbraith (QC)

Review of physical and biogeochemical conditions in the Northwest Atlantic		
March 21st AM - Session 1 (Rapporteur : Jean-Luc Shaw)		
08:00 – 08:05 EDT	Peter Galbraith	Welcome and Introduction
08:05 – 08:25 EDT	Frédéric Cyr	Physical oceanographic conditions on the Newfoundland and Labrador Shelves
08:25 – 08:50 EDT	David Bélanger	Biogeochemical conditions on the Newfoundland and Labrador Shelves
08:50 – 09:00	**Health Break**	
09:00 – 09:25 EDT	Peter Galbraith	Physical oceanographic conditions in the Gulf of St. Lawrence
09:25 – 09:50 EDT	Stéphane Plourde	Biogeochemical conditions in the Gulf of St. Lawrence
09:50 – 10:00	**Health Break**	
10:00 – 10:25 EDT	Benoit Casault	Biogeochemical conditions on the Scotian Shelf and in the Gulf of Maine
March 22nd AM - Session 2 (Rapporteur : Jean-Luc Shaw)		
08:00 – 08:25 EDT	Dave Hebert	Physical oceanographic conditions on the Scotian Shelf and in the Gulf of Maine
08:25 – 08:50 EDT	Igor Yashayaev	Physical, chemical and biological conditions in the Labrador Sea (AZOMP)
08:50 – 09:00	**Health Break**	
09:00 – 09:25 EDT	Marc Ringuette	Biogeochemical conditions in the Labrador Sea (AZOMP)
09:25 – 09:50 EDT	Frédéric Cyr	Zonal acidification conditions
09:50 – 10:00	**Health Break**	
10:00 – 10:25 EDT	Joël Chassé	Zonal modelling

AZMP SAR		
March 23rd AM - Session 3 (Rapporteur : Jean-Luc Shaw)		
08:00 – 08:50 EDT	Peter Galbraith	Summary of Zonal Scorecards and changes made this year. Review and agreement of SAR bullets.
08:50 – 09:00	**Health Break**	
09:00 – 09:50 EDT		Review and agreement of SAR bullets (continued)
09:50 – 10:00	**Health Break**	
10:00 – 11:00 EDT	Peter Galbraith	Wrap-up, workplan, 2023 meeting dates. Close.