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Proceedings of the zonal advisory meeting of the Twenty-third Annual Meeting of the Atlantic Zone Monitoring Program (AZMP).

March 25-26, 2021
Virtual meeting

Chairperson: Peter S. Galbraith
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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 time-scales;
2. Provide multidisciplinary data sets that can be used to establish relationships among 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 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 2021 the AZMP scientists reconvened by teleconference on March 25 and 26th with limited scope compared to usual face-to-face annual meetings to review oceanographic conditions that prevailed in 2020 within the zone and draft a summary as a Science Advisory Report.

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 travel restrictions still imposed by the COVID-19 pandemic, a teleconference was held March 25—26 instead of the usual face-to-face meeting. As was the case in 2020, the scope of the meeting was mostly limited to reviewing the state of the ocean conditions that prevailed in 2020 and to drafting a summary of these conditions as a Science Advisory Report. A session also included discussions on logistics and data management.

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 modeling. 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

Rapporteur – Catherine Johnson

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

Co-authors: S. Snook, C. Bishop, P.S. Galbraith, N. Chen and G. Han

An overview of physical oceanographic conditions in the Newfoundland and Labrador Region during 2020 is presented. 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 positive for a 7th consecutive year (since 2012, only 2013 was negative). While this positive NAO phase led to colder than normal conditions for a short period (2014-2017), most ocean parameters are now back to warmer than normal. SSTs were above normal and sea-ice was below normal for the first time since 2014 and 2013, respectively. Observations from the summer AZMP oceanographic survey indicate that the volume of the cold intermediate layer (CIL, <0°C) was below normal in the 2018-2020 period. Bottom temperatures were also warmer than normal in during the same period. The Labrador Current transport index along the NL slope was normal in 2020 for the second year in a row, but the transport along the Scotian slope was below normal (ongoing phase since 2014). The NL climate index was normal in 2020 for a 5th consecutive year.

Discussion summary:

- A participant noted that the NAO index since about 2012 was in a similar, positive phase as in the cold period in the 1990s and asked why the ocean's response was different. Although the phase was similar, the winters have not as been as cold, reducing the volume of cold water that is generated in the winter, and summers have been warmer; therefore, the ocean response is not the same.

BIOGEOCHEMICAL CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELVES – DAVID BÉLANGER

Biogeochemical oceanographic conditions on the Newfoundland and Labrador Shelf are presented and interpreted against long-term (1999-2020) mean conditions in the region. Satellite ocean colour data indicated a trend of earlier, longer, and more productive spring blooms on the Grand Banks since ~2017, as opposed to comparatively late, short, and less productive blooms on the northeast Newfoundland and Labrador shelves during the same period. *In situ* data from seasonal surveys show an increase in integrated nitrate (50-150 m) and chlorophyll-a (0-100 m) inventories across the region since 2015 and 2017, respectively, after several years of negative anomalies in the early 2010s. Zooplankton abundance and biomass also showed overall increasing trends since ~2010 and have remained mostly above normal since 2015. Changes in the zooplankton community structure since ~2010 resulted in fewer large, energy-rich *Calanus finmarchicus*, and more small *Pseudocalanus* spp. copepods. However, the high small-to-large copepod ratio has weakened in recent years. Additionally, changes in zooplankton biomass seasonality characterized by a weaker spring and stronger summer and fall signals since 2016 suggest an ongoing shift in zooplankton community composition and size structure.

Discussion summary:

- A participant questioned whether or not zooplankton biomass should be reported for station 27 as it would be based on samples from only 3 occupations. The zooplankton sampling protocol has changed: paired samples are collected with bongo nets. Biomass measurements are done in the NL region, but taxonomic analysis is done by the Atlantic Reference Centre and IML, and the latter is not yet completed.
- A participant asked if the speaker knows what is driving the variability patterns of deep nitrate. Changes in deep nitrate may be related to different patterns in water circulation, e.g., arctic water export. Examining the ratio of nutrients may help to answer this question.
- A participant asked what species are responsible for the shift in zooplankton biomass in the summertime. There was an increase in abundance of *C. finmarchicus*, but also a shift in the timing of their production. The increase in summer biomass is likely related to a change in timing of *C. finmarchicus* production, but also due to the *Calanus hyperboreus*. Fall abundances of *Pseudocalanus* and *Temora longicornis* have gone up quite a bit as well.
- NL region zooplankton community structure seems to be shifting away from the conditions observed in the mid-to late-2010s, but zonally the community structure still resembles the pattern recently reported in the SAR.

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

Co-authors: J. Chassé, J.-L. Shaw, J. Dumas, C. Caverhill, D. Lefaivre, and C. Lafleur

An overview of physical oceanographic conditions in the Gulf of St. Lawrence (GSL) in 2020 is presented as part of the Atlantic Zone Monitoring Program (AZMP). AZMP data as well as data from regional monitoring programs are analysed and presented in relation to long-term means. The annual average freshwater runoffs of the St. Lawrence River measured at Québec City and its combination with rivers flowing into the Estuary (RIVSUM II) were above normal. Sea-ice maximum volume was below normal, but the winter mixed layer volume was near normal. The August cold intermediate layer (CIL) was warmer than normal but the seasonally averaged minimum temperature index was near normal. Surface water temperatures in the Estuary reached an unusual series record in July. The upwelling and mixing that occurs at the head of the Laurentian Channel that usually keeps its surface water cool was somewhat shut down in July. The overall seasonal average May-November SST for the Gulf was near normal in spite of an above normal seasonal August maximum (+0.7°C, +0.9 SD). Surface water temperatures were then at a record low in September in the Estuary and Northwest Gulf, caused by strong vertical wind mixing. This mixing warmed the bottom waters of the Magdalen Shallows such that the area covered by water with temperatures <1°C in September decreased to a near record low. Deep water temperatures have been increasing overall in the Gulf, with inward advection from Cabot Strait. Gulf-wide average temperature at 150 m was lower than the 2015 record highs but remain above normal at 3.7°C (+1.6 SD). New series record highs (since 1915) were set at 200, 250 and 300 m, at 5.7°C (+1.2°C, +1.9 SD), 6.6°C (+1.1°C, +2.5 SD) and 6.8°C (+1.1°C, +2.7 SD) respectively. Bottom area covered by waters warmer than 6°C was at a record high in the Northwest Gulf, the Northeast Gulf, and in Centre and Cabot Strait, and some 7–8°C habitat appeared for the first time in the Northeast Gulf.

Discussion summary:

- A participant asked if the July warming event coincided with neap or spring tide. The warm event lasted all of July, making the event much longer than the 14-day spring-neap tidal time scale. This suggests the warming event was not related to neap/spring dynamics. It is more likely related to winds, which were notably strong in that period and unusually from the Northeast, driving downwelling along the North shore of the Estuary. The media reported (Gallant, L. 2020) that a diver experienced 9°C waters at a depth of 30 m on the North shore during this period. The hypothesis is that the winds pushed warm waters over the mixing and upwelling zone at the head of the Laurentian Channel, capping it off, and preventing cold water to reach the surface.

BIOGEOCHEMICAL CONDITIONS IN THE GULF OF ST. LAWRENCE – MARJOLAINE BLAIS

Co-authors: P.S. Galbraith, S. Plourde, L. Devine, C. Lehoux, E. Devred and S. Clay

An overview of chemical and biological oceanographic conditions in the Gulf of St. Lawrence (GSL) in 2020 is presented as part of the Atlantic Zone Monitoring Program (AZMP). 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. Due to the COVID-19 pandemic, there was no early summer oceanographic campaign in the GSL, and high-frequency monitoring stations were not sampled between early spring and July. Thus, one must be careful when interpreting 2020 anomalies of variables showing strong seasonality (i.e. nutrient and chlorophyll-a a concentrations, as well as zooplankton biomass and abundances). Besides that, numerous changes were incorporated into this year's report, including the addition of late summer datasets to the typical AZMP dataset for the GSL (covering winter, early summer and fall) and the use of a recently published algorithm (Laliberté et al. 2018) for deriving chlorophyll-a estimates from ocean colour in the coastal waters of the GSL, as well as modification of the parameters allowing the calculation of spring bloom metrics.

Oxygen levels at 300 m reached their lowest concentration measured so far in the Estuary and in Cabot Strait during 2020. In the Estuary, the oxygen loss of nearly 6 µM (ca. 2% oxygen saturation) in a single year was among the strongest declines observed so far. Nutrient inventories in the surface layer (0–50 m) were generally near normal everywhere, except in the Estuary and NW GSL where nitrates and phosphates were slightly above normal. Nitrate, phosphate and silicate mid-layer inventories were all above normal in northern and central GSL, while they were generally near normal in southern regions. At 300 m, nutrient positive anomalies were encountered at Cabot Strait, in central GSL and NE GSL. Silicates were also above normal in the NW GSL and in the Estuary, but nitrate and phosphate concentrations were near-normal in these latter regions. Deep nitrate positive anomalies have been observed since 2012 in Cabot Strait and central GSL in association with intrusions of warm and salty waters. There was a strong positive anomaly of vertically integrated chlorophyll-a (chl *a;* 0–100 m) during fall in the Estuary; the same occurred in central GSL to a lesser extent. This latter region has mostly been associated with chlorophyll-a a positive anomalies during fall since 2014. Elsewhere, vertically integrated phytoplankton biomass was close to the normal, except in Cabot Strait where it was below normal. In contrast, phytoplankton biomass derived from satellite data showed both annual and fall negative anomalies in most of the ocean colour boxes. Spring bloom metrics were mostly near normal, except for high bloom amplitude and magnitude in Magdalen Shallows and Cabot Strait boxes.

In 2020, zooplankton biomass was close to normal almost everywhere in the GSL; it was only below normal in the Central GSL/Cabot Strait region, and at Shediac Valley station (where n = 2). Large calanoid abundance, *Calanus finmarchicus* and *Calanus hyperboreus* followed the same pattern, but *C. hyperboreus* abundance was above normal in NW GSL. Small calanoid abundances were near-normal everywhere despite below-normal abundance of *Pseudocalanus* spp. in Magdalen Shallows, and to a lesser extent, in NW GSL and at Rimouski station. Abundances of both warm-water associated copepods and cold-water associated copepods tended to be above normal in most regions. The absence of sampling during spring does not allow adequate characterization of *Calanus finmarchicus* phenology at Rimouski station this year.

Discussion summary:

- The missing Shediac winter nutrient sample could perhaps be estimated from the samples collected on either side of the station during the March GSL survey, since nutrient distributions in the sGSL are fairly uniform at that time of year.
- A participant questioned whether Shediac biochemical properties should be reported when there are only 2 or 3 station occupations. There was consensus that these data should not be reported.
- **Action item:** remove 2020 Shediac biochemical properties from SAR reporting, since they add noise that is not informative to the time series.
- Evidence presented in both the NL and QC biochemical presentations suggests that the statement about zooplankton community structure in the draft SAR bullets should be reassessed.
- **Action item:** Reassess zooplankton community structure statement in the draft SAR bullets and text.
- A participant asked which satellite was used for the remote sensing chlorophyll-a biomass estimate. This year, only MODIS was used to remove the biases introduced by using 3 different satellites.
- A participant asked if there is a relationship between low bottom oxygen and stratification or reduced mixing, i.e., could the reduced mixing reported earlier at the head of the Laurentian Channel (leading to exceptionally warm surface waters in the Estuary in July) contribute to low bottom oxygen? In the biogeochemical model, suppressing mixing can contribute to a reduction of bottom oxygen concentrations. Another participant interjected that mixing was

likely still present at the head of the Laurentian Channel, but the cooled surface waters were likely capped off with warm waters driven by the northeasterly winds.

PHYSICAL OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS ON THE SCOTIAN SHELF AND THE GULF OF MAINE – DAVE HEBERT

Co-authors: C. Layton, D. Brickman and P.S. Galbraith

In 2020, air temperature anomalies were positive for all sites, with anomalies ranging from +0.6°C (+0.7 SD) for Sydney to +1.2°C (+1.8 SD) at Boston. Satellite-based sea surface temperature was near normal (1982-2010 average temperature), except at eastern Gulf of Maine and Bay of Fundy +0.7°C (+1.3 SD), for region 4W +0.5°C (+0.8 SD) and for region 4Vs +0.7°C (+1.2 SD).

Water temperatures at select sites and depth ranged from near normal to well above normal. Cabot Strait 200-300 m temperature was at a record high +2.1°C (+6.3 SD), and 4 of the last 5 years were the warmest. Emerald Basin 250 m temperature was the fourth highest, +1.6°C (+1.9 SD), and the last 6 years were the warmest, with a record high in 2019. Georges Basin 200 m temperature was the sixth warmest +1.1°C (+2.2 SD), with 2018 being the warmest. The last 8 years were the warmest.

The July bottom temperatures for the shelf portions of NAFO regions 4Vn, 4Vs, 4W and 4X were above the 1981-2010 average values. The anomalies ranged from +0.9°C (+1.2 SD) at 4X to +1.6°C (+2.1 SD) at 4W, the fourth warmest year, and +0.9°C (+2.3 SD) at 4Vn, the third warmest year.

A composite, consisting of 22 ocean temperature time series from surface to bottom across the region, indicated that 2020 was the 3rd warmest of 51 years (2012 was the warmest and 2016, 2017 and 2018 were the 2^{nd}, 4^{th} and 5^{th} warmest), with an average normalized anomaly of +2.0 SD relative to the 1981-2010 period.

Discussion summary:

- The glider data made a good contribution to filling in missing observations.
- **Action item:** It would be worthwhile to add a sentence in the SAR stating that the glider data are being used in reporting.
- A participant asked if the speaker knew why the surface waters are getting fresher. The freshening signal could be coming from the Gulf of St. Lawrence outflow. There is a trend toward higher freshwater runoff indicated by the higher RIVSUM index. Freshwater runoff is highly related to stratification at the Rimouski station, but it is not clear if it is related to stratification on the Scotian Shelf. Long-term trends in the Halifax-2 time series stratification could be added to SAR reporting to help clarify this question. Although Halifax-2 stratification has been reported in the Maritimes biochemical research document for a number of years it could also be reported in the Maritimes physical research document.
- **Action item:** Consider including Halifax-2 stratification to the Maritimes Physical research document and to the SAR.
- A participant asked if Scotian Shelf stratification is related to RIVSUM. This has not yet been examined. In the circulation model, changes in freshwater flux had an effect on the Scotian Shelf, especially in the Nova Scotia Current, and it is felt as far away as the Gulf of Maine. September and October are the time periods with the strongest outflow.

- It is not impossible that there are signs of glacial melt in the freshwater signal on the Scotian Shelf. The latest measurements of Greenland glacier melt are getting higher. But S27 stratification and salinity does not seem to be changing that much.
- Although there has been some freshening at S27, the transport from Labrador Current to Scotian Slope is decreasing, potentially reducing the upstream influence of this source on the Scotian Slope and Shelf. This may be due to transport along the shelf, and not at the shelf break.
- In an ensemble of models there is an increase in salinity not only at the surface but also at depth. The Scotian Shelf is becoming more salty in both deep and surface water, but stratification is increasing due to the difference in salinity change between the two depths. This pattern of change is not shown in the data, however.

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

An overview of the chemical and biological oceanographic conditions on the Scotian Shelf and in the eastern Gulf of Maine in 2020 is presented as part of the Atlantic Zone Monitoring Program (AZMP). Due to the COVID-19 pandemic, the Maritimes region spring survey was cancelled on the core AZMP sections in 2020. As well, there was no sampling from mid-March until early July at the high-frequency monitoring stations Halifax-2 (HL2) and Prince-5 (P5). As a result, care must be taken in interpreting the 2020 anomalies, especially for variables showing strong seasonality. Deep nitrate inventory anomalies were mixed in 2020, with near-normal or positive anomalies in the central and eastern areas, and negative anomalies in the western areas. Slightly positive (Cabot Strait section, CSL) and positive (Halifax section, HL) anomalies were driven by higher than normal nitrate levels in fall 2020 at the eastern stations of CSL (5 and 6) and the slope stations of HL (6 and 7). Record low deep nitrate inventory was observed on Browns Bank section (BBL). Deep silicate and phosphate inventory annual anomalies were near-normal or negative across the region in 2020. The integrated chlorophyll-a inventory was lower than normal at the high-frequency monitoring stations and normal on the core sections. Near-zero annual anomalies on the core sections are a direct result of the absence of spring sampling. The onset of the spring phytoplankton bloom was later than normal on the Scotian Shelf boxes (eastern, central and western Scotian Shelf) but earlier than normal for Cabot Strait and Georges Bank. A record late bloom onset was observed for the central Scotian Shelf while a record early onset was observed for Georges Bank. Late blooms mainly translated into near or shorter than normal bloom duration while early blooms mainly translated into near or longer than normal bloom duration. A record long duration was observed for Georges Bank. The bloom magnitude was variable in 2020 with a record low observed for the central Scotian Shelf. Annual anomalies of the abundance of *Calanus finmarchicus* were mixed in the Maritimes region in 2020. A record high abundance was observed for the Halifax section although it is likely biased by sampling having occurred at a reduced set of stations (3) on HL in fall 2020 only. The abundances of *Pseudocalanus*, copepods and non-copepods in 2020 were all near or below normal levels in the eastern and central areas, and near or above normal levels in the western areas of the Maritimes region. Record low abundances were observed for *Pseudocalanus* (CSL), copepods (HL) and non-copepods (HL2) while record high abundance was observed for non-copepods at P5. Zooplankton biomass remained mainly near or below normal levels across the Maritimes region in 2020 although a weak change toward positive anomalies was observed for HL2 and BBL in the last two years.

Discussion summary:

- A participant asked what groups were responsible for the trend in non-copepod abundance, similar to the trend in NL, since 2012. The speaker had results which answered this question but they were part of a different presentation. There were also changes in non-copepods in QC, and it would be useful to add this in the SAR as well. There are trends in the anomalies of certain copepods groups as well.
- In the Maritimes, there were increases in small-particle-feeding non-copepod groups in some of the past recent years, but it has not been a consistent trend. Once such group, the Larvaceans (Appendicularians) are the most abundant non-copepod group for the Maritimes. They are favored when there are phytoplankton blooms outside of the spring bloom period.
- There was an increase in appendicularian abundance during the whole year, January through December, at S27 and no relationship with seasonality of the blooms
- A participant suggested adding non-copepod community information to the SAR this year. This was rejected because it needs more careful consideration, and moreover NL would not be able to contribute this year.
- A change in community structure in phytoplankton can also be seen in HPLC data, and it is continuous and strong. This could be added to the SAR to raise awareness, at least for Regions that have the data.
- Rather than have a scorecard or indicator for SAR for ancillary community metrics, we should be cautious and think carefully about how it can be done.
- **Action item:** Development of community metrics or other reporting could be a topic for a mid-term meeting.

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

Rapporteur – Marjolaine Blais

PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS IN THE LABRADOR SEA (AZOMP) – IGOR YASHAYAEV

In the Labrador Sea, intense vertical mixing induced by high surface heat losses in winter results in the formation of a characteristic dense water mass, Labrador Sea Water, which consequently spreads across the ocean ventilating its deep layers and essentially driving 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 about 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 gaining more saline and less dense waters.

Starting in the winter of 2014, a year before the Labrador Sea incurred the highest heat loss in more than two decades, and ending in the winter of 2018, winter convection progressively deepened from 1600 to 2000 m, becoming the deepest since the winter of 1994.

In the winter of 2020, the Labrador Sea convection reached the depth of 1600 m and possibly deeper, exceeding the depths observed a year ago. The deepening of convective mixing and slight cooling of the deep mixed layer are mainly attributed to increases in the North Atlantic Oscillation index and net cumulative surface cooling from the previous winter. However, despite the NAO index being relatively high, the convection depths were noticeably shallower than the depths reported for the 2015-2018 period.

Similarly to the previous year, in 2020, the upper, 15–100 m, layer of the central Labrador Sea had its temperature above normal and salinity about normal. The intermediate, 200–2000 m, layer reached its warmest state since 1972 in 2011, and then started to cool. The cooling of the intermediate layer that followed was a direct result of persistently deepening convection during the winters from 2012 through 2018. The warming of the upper and intermediate layers of the Labrador Sea in 2019 and 2020 concurs with the reduced heat loss and shallowed convection in the winter of 2019.

With respect to interdecadal variability, the Labrador Sea has recently completed a seven-year (2012–2018) cooling cycle resembling the cooling trends that occurred through 1987–1994 and in the late 1950s. 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 climate normals for the key seawater properties (or oceanographic variables), including temperature, salinity, density, dissolved oxygen, silicate, phosphate and nitrate. The rate of change (slope of trend) over the 1990-2020 period, and annual, pentadal and decadal anomalies with respect to the climate normals were computed for these variables at each point of the AR7W line.

Discussion summary:

- It was pointed out that it would be interesting to present time series of convection depth and it was decided that it will be incorporated to the main physical scorecard of the Labrador Sea this year.
- There was a question regarding the mention of lateral heat flux, as to whether it meant vertical flux instead. The presenter really meant lateral fluxes as he calculates them in opposition to vertical fluxes.
- There was a discussion about how the profiles are being corrected using machine learning. Part of this machine learning correction is done by knowing the historical deviation of some profile parameters over time.

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

Co-authors: E. Devred, K. Azetsu-Scott, C.-E. Gabrielle, S. Clay and E. Head

In 2020, the AR7W line, divided into three regions, i.e., Labrador Sea (LS), Central Labrador Sea (CLS) and Greenland Shelf (GS), was sampled in late July-early August. This is the latest year on record since 1995, about 2 months later than the usual date of the cruise, which makes the interannual variability challenging to distinguish from the seasonal cycle. Following recommendations from last year, we divided our time series in two subsets around June 19th, with missions happening before this date representing spring conditions and missions happening after this date corresponding to summer conditions. Ocean colour from remote sensing provides year-round measurements of the superficial layer of the ocean but is impaired by cloud cover. The phytoplankton blooms recorded by satellites started late and were shorter than normal in all regions, continuing a trend that started in early 2010s. They were of large amplitude yielding a larger-than-average production in the LS & CLS region but not on the GS. Dissolved inorganic carbon concentration (DIC) and pH collected from the twilight zone (150-500 m, not affected by the surface biological activities) have continued their respective monotonic trend with an increase in DIC and decrease in pH that started in the mid-90's. Surface in-situ measurements of temperature, nutrient concentrations, chlorophyll-a concentration and zooplankton were representative of summer conditions as measurements were collected well passed the spring bloom. However, when compared to previous summer data, 2020 surface temperatures (0-100 m) were above average in the CLS and GS and were slightly lower than average in the LS region. All nutrients within the surface layer and at depth were below their seasonal average in agreement with the characteristics of post-bloom nutrient drawdown by primary producers. Integrated chlorophyll-a concentration was below the seasonal reference average in CLS and LS and above the seasonal reference average in GS. At the time of the AZMP Annual meeting (i.e., 25th to 26th of March), mesozooplankton data were not all processed due to laboratory access limitations under COVID-19 restrictions.

Discussion summary:

- There was a discussion about how it will be possible to report on biochemical indices from the Labrador Sea for this year considering that the sampling was late in 2020. One suggestion was to present two different scorecards, one including years where observations were made during spring/early summer, and the other including years where observations were made later in the summertime.
- There was a question regarding the seasonality of pH as to whether it would be influenced by the late sampling of this year. However, since the Labrador region reports on deep pH only, it should not really be influenced by the late timing.
- A clarification was asked about the ecological meaning of SF6 and CFC indices. They are used as water mass tracers.
- It was highlighted that there was a problem in the calculation of temperature anomalies since almost the whole time series presented negative anomalies. The figure was corrected.

ZONAL ACIDIFICATION CONDITIONS – OLIVIA GIBB

Co-authors: F. Cyr, K. Azetsu-Scott, J. Chassé, P.S. Galbraith, G. Maillet, P. Pepin, S. Punshon and M. Starr

In the Atlantic Zone, the spatial and temporal variability of carbonate parameters, which are measures of ocean acidification, reflect changes in both physical (temperature, salinity) and biological (plankton photosynthesis and respiration) parameters. Since fall 2014, the AZMP has included the collection of carbonate parameters in seasonal surveys and two high resolution stations. These parameters include total alkalinity (TA), dissolved inorganic carbon (DIC), and pCO2, which allows for the calculation of pH and the carbonate saturation states with respect to calcite and aragonite (Ω_{cal} and Ω_{arg}). We assembled and analyzed spatiotemporal variation in the physical (temperature, salinity, oxygen saturation), biogeochemical (nutrients), and carbonate parameters.

The carbonate parameters suggest the occurrence of three oceanographic regimes across the Atlantic Zone. The highest Ω_{arg} and pH values are associated with the warm, saline shelf surface waters. Lower Ω_{arg} and pH values, along with reduced TA and DIC, characterize cold waters influenced by the Labrador Current or within the Cold Intermediate Layer. The deepest areas of the warmer Gulf of St. Lawrence are undersaturated with respect to aragonite (Ω_{arg} <1) and present the lowest pH values in the Atlantic Zone. Given their restricted ventilation, these waters are hypoxic and have accumulated DIC through the decomposition of organic matter. Undersaturation also occurs in the bottom waters of the southeast Scotian Shelf and southern Newfoundland Shelf particularly during the fall due to the remineralization of plankton blooms, and in surface waters of the St. Lawrence Estuary due to low TA (low salinity) and DIC.

These analyses present the baseline of carbonate parameters required to assess future changes in carbonate chemistry due to increased warming and atmospheric CO_2 evaluated within regional biogeochemical models. The assembled dataset and results will soon be submitted for publication, along with the sampling, analytical and computational methodologies.

Discussion summary :

- A first discussion aimed at deciding what figure products could be incorporated to the SAR to replace the map with different colour points that has been shown in previous versions of the SAR. There were two suggestions: 1) to present transect average anomalies, and/or 2) to present a time series of the fraction of each transect that became undersaturated. It was decided that this will part of discussions to be held during a mid-term meeting (along with discussions regarding the inclusion of O_2 data and phytoplankton community data to the SAR).
- It was then highlighted that all Regions are not measuring the same acidification variables. Most Regions are measuring DIC, total alkalinity (TA), but the measurement of pH has not been done consistently over the years and regions. When pH is not available, it is measured from DIC and TA. One of the problems with measuring pH is that you can only get a pH value at 25°C and cannot calculate it backward to *in situ* temperature.

ZONAL MODELLING – JOËL CHASSÉ

Co-authors: J. Chassé, N. Lambert, D. Brickman, G. Han and Z. Wang

Ocean monitoring is typically conducted during specific months and locations. Therefore large data gaps often exist in the observational system and numerical models are very useful to estimate the missing data to support the AZMP, State of the Ocean reporting (SOTO), fisheries studies, stock connectivity studies, invasive species research, bio-geochemical modeling, climate change, etc. This work provides model-based environmental information to supplement ocean observational systems in Eastern Canada. Relevant atmospheric information from re-analyses is also presented for the study area covered by AZMP.

Re-analysis from seven atmospheric models were used to derive the atmospheric conditions over the ocean (ERA_Interim /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) is available at the MERCATOR-Ocean operational ocean forecasting center. It is a global model at 1/12° resolution and it includes sea-ice. The surface forcing is derived from atmospheric ECMWF re-analyses. 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 1993-2020. 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. The models are forced by the European Centre for Median Weather Forecasts Reanalysis Interim (ERI) products. A hindcast simulation was carried out for the period from 1980 to 2020. 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 inter-annual surface forcing for the 1990–2020 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 based on the NEMO-OPA and includes ice cover, tides, oceanic surface momentum, heat and salt fluxes. Two versions of the modelling setup are used (1/12° and 1/24° horizontal resolution) for the GSL, Scotian Shelf and GoM. CANOPA also includes the runoff from 78 main rivers. Several simulations were conducted using CANOPA, including a simulation for the 1948-2020 period using the updated atmospheric conditions obtained from the National Centers for Environmental Predictions (NCEP) and a 2006-2020 simulation using the Canadian Meteorological Center (CMC) forcing.

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 1991–2020 reference period whenever possible. These anomalies are further normalized by dividing by the standard deviation (SD) calculated for the standard reference period to produced 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.

Mean monthly anomalies 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 re-analyses were presented. The atmospheric re-analysis appeared to be consistent, across models, over the study area.

Ocean variable 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, 300m and bottom. Transport on several sections were also presented.

The modelling work is still ongoing and a res-doc should be available during the current 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:

- In answer to a participant’s question, the speaker specified that the open boundary conditions of all models were specified by the GLORYS global model.
- There was a short discussion regarding the inclusion of biochemical model data to the modeling research document. There seems to have been a bit of confusion as to whether there was going to be an annual modeling report this year. So biochemical data will not be included in the first edition of the modeling report but should be included in future versions.
- Since these data will be part of the SAR, it was suggested that there could be a large external review of the AZMP SAR, not only for the new products to be included (models), but also for the indices we have been reporting on over years.
- Several models were included in the results presented and there was a discussion about the necessity to report on all these models instead of possibly picking the right one for each region. A suggestion is to present the average of all models, along with the variability among models, possibly in the form of anomalies. It is worth mentioning that all figures are produced with all models, so it can be provided for specific needs. It was also suggested to

compare the models with field data to validate them and this is something that is normally already done by the different modellers. We also need to keep in mind that models are not static over time and keep improving, this is also why it is interesting to keep them all under consideration.

- To improve the models, it was suggested to look at spatial patterns where models are the least well represented and best represented. Moreover, it would be interesting to look at where the salinity signal does come from.
- The purpose of integrating the model results to the SAR would be to complement field data when there are gaps, either seasonally or regionally.
- There are discussions for the development of a pan-Canadian model (that would include a biogeochemical module) that involves people from DFO, Environment Canada, and academics. There are also plans to add a biogeochemical module into the North Atlantic model (NAODS) led by Guoqi Han and Joël Chassé. The realisation and timeline for these initiatives will depend on funding availability (awaiting results of the recent DFO competitive fund request for NAODS). Biogeochemical results over the CANOPA domain should however be available for inclusion into the modelling report next year.

AZMP SAR

Rapporteur – Jean-Luc Shaw

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

Changes in figures:

- Changes to the figures since last year's SAR were first reviewed. The overview and SST maps were changed to include new averaging areas used in the Gulf of St. Lawrence. The ocean colour map was modified to show new averaging polygons in the Gulf of St. Lawrence, chosen to exclude land and coastal areas. A participant noted that the Avalon channel box was missing from the map. The Avalon channel box will be added, as well as the map extended northwards to include the Labrador Sea boxes.
- The SST scorecard has changed to reflect the new SST boxes. A region was called Magdalen Shallows in some analyses and Southern Gulf in others. It was decided to only use the name Southern Gulf. The main physical oceanography scorecard was also changed to reflect the changed SST boxes. Also, on the main scorecard, the average seasonal sea-ice volume was replaced by a new published (Cyr and Galbraith 2021) sea-ice index, bottom temperature in the Gulf were changed to use new Ecosystem Approach averaging areas, and the 300 m temperature at Cabot Strait was added.
- The stacked anomaly plots were changed to reflect the split GSL boxes but this does not change the stacked anomaly sum because they are area weighted. The new sea-ice index appears in the sea-ice index and CIL plots, as do the modified Gulf bottom temperature time series.
- A participant asked how to handle the change in climatology periods from 1981—2010 to 1991—2020. Data which seem normal this year may not have been normal last year. In the past, this has been done by writing a paragraph in the SAR that generally discusses the

effects of changing the reference period, rather than discussing the effects on each index individually.

Bullets:

- SST scorecard – The threshold of 15% coverage to include a box was brought down to 7% and 10% for monthly and weekly boxes based on the work shown in Galbraith et al. (2021). There was discussion about if explanations of conditions should be included in SAR bullets. The conclusion was that they should be excluded. The bullets are meant to provide a high-level view of conditions so they should be short and factual.
- Main physical scorecard – It was added to the bullet that Newfoundland and Labrador SST were above normal for the first time since 2014. The CIL record at White Bay was omitted from this bullet since it was the result of interpolation rather than normal *in situ* sampling. It was added that the sea-ice index was below normal for the first time since 2013.
- High frequency stations – Emphasizing that stratification on the Scotian Shelf was the lowest since 2011 was discussed but rejected.
- Biochemical scorecard – Shediac Valley was removed from these figures since the station was occupied only 3 times.
- Ocean colour scorecard – It was noted that the ocean colour time series are often difficult to interpret because they are so variable.
- Zooplankton scorecard – No discussion.
- Acidification – Text reformulation.
- Labrador Sea physical – Some explanations of conditions were removed to shorten the bullet in conformity with discussions about the SST scorecard bullet.
- Labrador Sea biochemical – Text reformulation.

WRAP-UP, WORKPLAN AND 2022 MEETING DATES

Status of research documents:

The lead on the modeling research document still needs to decide if a publishable document can be made for the current year or not. The Newfoundland biochemical research document for 2018 has been submitted and translated but the 2019 research document is not done yet. Combining the 2019 and 2020 research documents was discussed but this is complicated by the change in reference climatology between the two years. The Maritimes Region physical research document for 2020 has been submitted, translated and approved 5 months ago but has yet to be published. The Labrador Sea physical research documents for 2018 and 2019 have been submitted. A Labrador Sea biochemical research document combining 2019 and 2020 will be produced. The chair reminded research documents are available on the CIOOS website soon after they get chair approval, even if not officially published by CSAS.

Since writing the research documents takes a lot of time and the long publication delays are frustrating, a participant asked if publishing a research document each year was necessary. The research documents are important because they form the scientific basis for the SAR, but primary publications could serve this purpose. Other proposed alternatives were to publish a research document every two years or do an annual zonal research document led by a different PI every year. There was no consensus for changing to one of these alternatives.

Next meeting:

The chair proposes that future annual AZMP meeting be split into a virtual meeting at the end of the fiscal year to review the research documents and draft the SAR, and a mid-year in person meeting for science workshops, logistics and data management meetings, and discussion of internal matters. There could also be an optional third day to the mid-year meeting for workshops on arising issues. Dates for the March meeting are difficult to change since many participants have fieldwork planned before and after the usual dates. A difficulty with having the mid-year meeting in September is that the Maritimes fall survey would tie up the logistics leads. Having the logistics meeting virtually in March during the CSAS meeting may be more convenient for choosing dates and has the added benefit of getting some action items on the agenda early in the year. A participant asked if the chair envisioned inviting high level managers to one or the other of these meetings. The chair answered both have advantages. The March meeting “sells more” because it is very client oriented, but the in-person meeting is more effective at establishing personal relationships. Another possibility would be to have a smaller meeting of key AZMP members and NCR. This would allow better discussion of the issues laid out by the logistics leads than have these managers participate in the CSAS or science meeting. For the coming year, there was consensus that a September in person is likely to get cancelled because of COVID-19 travel and social distancing constraints and that it would be safer to plan an in-person or virtual meeting in March 2022.

REFERENCES CITED

Cyr, F. and Galbraith, P.S. 2021. A climate index for the Newfoundland and Labrador shelf. Earth Syst. Sci. Data, 13, 1807-1828.

Gallant, L. 2020 Jul 19. Des eaux exceptionnellement chaudes dans le Saint-Laurent. Radio-Canada

Galbraith, P. S., Larouche, P., and Caverhill. C. 2021. A sea-surface temperature homogenization blend for the Northwest Atlantic. Can. J. Remote Sensing. DOI: 10.1080/07038992.2021.1924645.

Laliberté J, Larouche P, Devred E, and Craig S. 2018. Chlorophyll-a Concentration Retrieval in the Optically Complex Waters of the St. Lawrence Estuary and Gulf Using Principal Component Analysis. Remote Sensing. 10(2):265.

Mitchell, M.R., G. Harrison, K. Pauley, A. Gagné, G. Maillet, et P. Strain. 2002. Atlantic Zonal Monitoring Program Sampling Protocol. Can. Tech. Rep. Hydrogr. Ocean Sci. 223: iv + 23 pp.

Pepin, P., Petrie, B., Therriault, J.-C., Narayanan, S., Harrison, G., Chassé, J., Colbourne, E., Gilbert, D., Gregory, D., Harvey, M., Maillet, G., Mitchel, M., et Starr, M. 2005. The Atlantic Zone Monitoring Program (AZMP): Review of 1998-2003. Can. Tech. Rep. Hydrogr. Ocean Sci. 242: v + 87 p.

Therriault, J.-C., Petrie, B., Pepin, P., Gagnon, J., Gregory, D., Helbig, J., Herman, A., Lefaivre, D., Mitchell, M., Pelchat, B., Runge, J., et Sameoto, D. 1998. Proposal for a northwest Atlantic zonal monitoring program. Can. Tech. Rep. Hydrogr. Ocean Sci. 194: vü+57 p.

APPENDIX I – TERMS OF REFERENCE

23rd Annual Meeting of the Atlantic Zone Monitoring Program (AZMP)

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

March 25-26, 2021
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:

- 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.

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

23rd Annual meeting of the Atlantic Zone Monitoring Program - 25-26 March, 2021

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

Review of physical and biogeochemical conditions in the Northwest Atlantic		
March 25th AM - Session 1 (Rapporteur : Catherine Johnson)		
08:30 – 08:40 EDT	Peter Galbraith	Welcome and Introduction
08:40 – 09:00 EDT	Frédéric Cyr	Physical oceanographic conditions on the Newfoundland and Labrador Shelves
09:00 – 09:20 EDT	David Bélanger	Biogeochemical conditions on the Newfoundland and Labrador Shelves
09:20 – 09:40 EDT	Peter Galbraith	Physical oceanographic conditions in the Gulf of St. Lawrence
09:40 – 09:50	**Health Break**	
09:50 – 10:10 EDT	Marjolaine Blais	Biogeochemical conditions in the Gulf of St. Lawrence
10:10 – 10:30 EDT	Dave Hebert	Physical oceanographic and meteorological conditions on the Scotian Shelf and in the Gulf of Maine
10:30 – 10:50 EDT	Benoit Casault	Biogeochemical conditions on the Scotian Shelf and in the Gulf of Maine

March 25th PM - Session 2 (Rapporteur : Marjolaine Blais)		
12:30 – 12:50 EDT	Igor Yashayaev	Physical, chemical and biological conditions in the Labrador Sea (AZOMP)
12:50 – 13:10 EDT	Marc Ringuette	Biogeochemical conditions in the Labrador Sea (AZOMP)
13:10 – 13:50 EDT	Olivia Gibb	Zonal acidification conditions (30 min + 10 min for questions)
13:50 – 14:00	**Health Break**	
14:00 – 14:40 EDT	Joël Chassé	Zonal modelling

AZMP SAR		
March 26th PM (Rapporteur : Jean-Luc Shaw)		
12:30 – 13:50 EDT	Peter Galbraith, Pierre Pepin	Summary of Zonal Scorecards and changes made this year Review and agreement of SAR bullets
13:50 – 14:00	**Health Break**	
14:00 – 14:50 EDT	-	Review and agreement of SAR bullets (continued)
14:50 – 15:00 EDT	Peter Galbraith	Wrap-up, workplan, 2022 meeting dates Close

APPENDIX III – LIST OF MEETING PARTICIPANTS

Name	Affiliation
Allain, Renée	DFO, Science – Gulf Region
Beazly, Lindsay	DFO, Science – Maritimes Region
Bélanger, David	DFO, Science – Newfoundland and Labrador Region
Bishop, Charlie	DFO, Science – Newfoundland and Labrador Region
Blais, Marjolaine	DFO, Science – Quebec Region
Boivin, Brian	DFO, Science – Quebec Region
Brickman, David	DFO, Science – Maritimes Region
Bujold, Luc	DFO, Science – National Capitol 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
Clay, Stephanie	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
Gaboury, Isabelle	DFO, Science -- National Capitol Region
Gabriel, Carrie-Ellen	DFO, Science – Maritimes Region
Galbraith, Peter	DFO, Science – Quebec Region
Gibb, Olivia	DFO, Science – Newfoundland and Labrador Region
Greenan, Blair	DFO, Science – Maritimes Region
Hebert, Dave	DFO, Science – Maritimes Region
Johnson, Catherine	DFO, Science – Maritimes Region
Lambert, Nicolas	DFO, Science – Gulf Region

Name	Affiliation
Lavoie, Diane	DFO, Science – Quebec Region
Layton, Chantelle	DFO, Science – Maritimes Region
Lehoux, Caroline	DFO, Science – Quebec Region
Lewis, Sara	DFO, Science – Newfoundland and Labrador Region
Maillet, Gary	DFO, Science – Newfoundland and Labrador Region
Ma, Zhimin	DFO, Science – Newfoundland and Labrador Region
Michaud, Sonia	DFO, Science – Quebec Region
Niven, Sherry	DFO, Science – Maritimes Region
Pepin, Pierre	DFO, Science – Newfoundland and Labrador Region
Plourde, Stéphane	DFO, Science – Quebec Region
Proudfoot, Maddison	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
Sun, Krista	DFO, Science – National Capitol Region
Tran, Anh	DFO, Science – National Capitol Region
Villeneuve, François	DFO, Science – Quebec Region
Wan, Di	DFO, Science – Pacific Region
Yashayaev, Igor	DFO, Science – Maritimes Region