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Central and Arctic Region

Proceedings of the Regional Peer Review on the Biophysical and Ecological Overview of the North Water Polynya and Adjacent Areas

Meeting dates: January 22–24, 2020
Location: Winnipeg, MB

Co-Chairpersons: Jason Stow and Tom Christensen
Editors: Kevin Scharffenberg and Elizabeth Worden

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December 2021

Canada

Foreword

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

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SUMMARY

In January, 2020, the Canadian Science Advisory Secretariat (CSAS) hosted a binational meeting to review the state of knowledge for the North Water Polynya at the request of DFO Strategic Policy and Marine Conservation and Planning sectors. A literature review was assembled from published scientific documents, reports and peer reviewed journals, as well as any documented Inuit Qaujimajatuqangit (IQ) and hunter/user knowledge for the region. Meeting participants reviewed the document to provide feedback and revisions, and commented on the general state of knowledge. This information was requested to help inform future collaborations related to the North Water Polynya, and to identify areas where scientific, Indigenous and hunter/user knowledge are lacking or undocumented.

Participants at the meeting included experts from DFO, Environment and Climate Change Canada, Parks Canada, the Department of Nature and Environment (Government of Greenland), the Inuit Circumpolar Council, Oceans North, the Qikiqtani Inuit Association, World Wildlife Fund Canada, Université Laval, the University of Alberta, the University of Manitoba, Memorial University, Aarhus University, and the Hamlet of Grise Fiord. These proceedings summarize the relevant discussions and key conclusions reached at the meeting. A Science Advisory Report and supporting Research Document resulting from this meeting will be published on the DFO Canadian Science Advisory Secretariat Website as they become available.

INTRODUCTION

OVERVIEW OF THE CSAS PEER REVIEW PROCESS

Presented by Joclyn Paulic, Fisheries and Oceans Canada

Summary

The Canadian Science Advisory Secretariat (CSAS) coordinates the scientific peer review and science advice for Fisheries and Oceans Canada (DFO). It is the process by which the department receives science advice and promotes science-based decisions for national and international activities. The goal of CSAS is to bring to the table all ideas and perspectives. As such, the products from this meeting will be used to provide science advice to management. Every individual at this meeting is a knowledge-holder who brings something to the table. During CSAS processes meetings are held regionally, locally, nationally. This CSAS is a regional meeting, since the North Water, historically referred to as the North Open Water (NOW) and more recently as Pikialasorsuaq, is clearly part of the Arctic region, but it is also bi-national (Canada and Greenland/Denmark). As part of this process, all results will be made publicly available.

In the past, CSAS was called the Canadian Atlantic Fisheries Science Advisory Committee (CAFSAC), and science and management were at same table providing advice. After the collapse of the Newfoundland Atlantic Cod Fishery, CAFSAC fell under scrutiny, and the Minister ended CAFSAC. It was thought that political influence on the scientific process was responsible for the collapse. It was also thought that they needed to expand their knowledge base. In 1997, they changed the group to the Canadian Stock Assessment Secretariat (CSAS) and became more inclusive by providing scientists, academics, and fishermen to present and confer, provided everyone brought knowledge. This was to prevent the perception that advice was being manipulated. Following the Oceans Act and SARA, CSAS took broader role changed name to the current Canadian Science Advisory Secretariat (CSAS).

CSAS usually follows a process. First there is a call for science advice. Client sectors (managers) have questions for science to answer, to help inform decision-making. Clients work with scientists to plan how to address questions, who to engage, and who are the end-users of advice. A steering committee is then formed. In this case, the steering committee contained representatives from Fisheries and Oceans Canada, academic institutes in Greenland (e.g., Greenland Institute of Natural Resources) and Canada (e.g., University of Manitoba), the Qikiqtani Inuit Association, the Inuit Circumpolar Council Canada, Parks Canada, and Environment Climate Change Canada.

Discussion

A participant noted that it is important to understand that CSAS is published peer-review science, but it is only one pillar in longer decision-making path, it is only one foundational document. There will be other pieces coming from communities and locals.

FISHERIES AND OCEANS CANADA (DFO) CONTEXT AND APPLICABILITY

Presented by Maya Gold, Fisheries and Oceans Canada

Summary

The North Water region has received significant interest over the last 10 years, including: Arctic Council attention (as an area of great ecological and cultural significance), an IUCN listing as one of 13 Arctic Super EBSA's, an International Conference (Kyhn and Mosbech 2019), an ICC report and recommendations (ICCC 2017), an Inuit-Crown Partnership Committee (ICPC) Joint Leaders Statement, and various other reports. This is a unique CSAS process due to the binational nature and collaborative effort in organizing, chairing and developing the Terms of Reference and scope of review. This process has incorporated published information sources, including Inuit Qaujimajatuqangit (IQ). However, more work is needed collect information from local knowledge holders to inform decision-making and management decisions. This will be done in a separate process.

Last year the ICPC put out a statement committing the Government of Canada and Inuit leaders to work in partnership together with the governments of Denmark and Greenland to protect Pikialasorsuaq. This underscored the unique nature of the region, and recommended a novel approach to management, led by Inuit and local users, across international boundaries. Many sources of information will be used to inform future collaborations and discussions about how to advance this conversation (including Indigenous and local knowledge, socioeconomic needs and opportunities, shipping intensity, mineral and resource assessments, risk analyses, fisheries feasibility assessments, and CSAS reports); this is only the beginning of the process. At the moment, international discussions have been initiated between Canada, Greenland and Denmark to advance a joint management framework for the North Water region, recognizing the shared interests, culture, dialects and history of the people and communities on both sides of the polynya. Within Canada, the Qikiqtani Inuit Association (QIA) is recognized as the designated rights holders for this region and DFO will support their leadership in advancing management recommendations.

GREENLAND/DENMARK CONTEXT AND PROCESSES

Presented by Inge Thaulow, Ministry of Nature and Environment, Government of Greenland

Summary

From the Danish perspective, interest in the North Water began in 2009 with a recommendation in the Arctic Marine Shipping Assessment (AMSA) (Arctic Council 2009) identifying areas of great ecological and cultural importance. In 2010, the Arctic Environment Ministers met in Illulissat, Greenland, and encouraged parties to identify areas of heightened ecological and cultural values that require protection against the effects of shipping. This initiated a national process in Denmark and Greenland. Using Particularly Sensitive Sea Areas (PSSA) criteria, Aarhus University and the Greenland Institute of Natural Resources generated reports on the identification of important and ecological vulnerable marine areas in Greenland. 12 areas were identified; the North Water was the highest priority. This was followed up by a study of three areas in more details in relation to shipping (The Kingdom of Denmark Arctic Strategy 2011–2020) and an overview report of areas of ecological and biological significance in West of South East of Greenland. Several important projects and reports have been generated since, including: the NOW Project at the University of Copenhagen, The White Paper (Kyhn and Mosbech 2019), The Pikialasorsuaq Commission Report (ICCC 2017), Christensen et al. (2019), and a special issue in the journal Ambio (Hastrup et al. 2018). A national steering committee has since been established and next steps are to meet with stakeholders and generate a conservation management plan based on their input. Previous meetings with hunting associations have highlighted the importance of understanding the economic value of an area for communities.

Discussion

A participant pointed out that from the Inuit perspective it is important to be sensitive to hunters and fishers. The participant also highlighted that people in Nunavut want to become more independent, by having access to their own resources and that some restrictions can be good, but some are not. Restrictions should not limit local's use of the land, and community members with different interests should have a say. The participant also noted the need to consider seasonal use. The tourism industry was used as an example, where high tourism in the summer months overlaps with seabird nesting in the bird sanctuary. Creating protections draws attention to an area, which can increase tourism and disturb wildlife. The participant also expressed concerns about oil exploration and the potential for collisions with icebergs. Another participant echoed that future directions must come from Inuit interests.

A participant reminded the group that the Tallurutiup Imanga NMCA has a boundary overlapping geographically with Pikialasorsuaq, so a piece of it is already protected. The participant also wanted to highlight that the boundaries of Pikialasorsuaq are not firm, but government boundaries are.

RESEARCH DOCUMENT PRESENTATIONS

METHODS AND PROCESS

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

When preparing the Research Document, a consultant (North South Consultants) was hired to pull together the literature review with guidance provided by DFO. Following this, the draft was looked over for inaccuracies, missing pieces, and errors. Some sections were distributed to experts for an initial review, including the Oceanography and the Fishes and Marine Mammal sections. Not all sections were reviewed prior to the CSAS meeting. Published Traditional/Local Knowledge (TK/LK) and IQ sources were included throughout the document, however there will be more phases to this process. QIA will lead on collection of additional TK/LK/IQ in future processes. Biologically important areas were included in the Research Document from the Christensen et al. (2019); see Danish North Water Report – Seasonally Important Areas).

Participants were reminded that this is not just a review of the Ecologically and Biologically Significant Area (EBSA), because EBSAs are only in Canada and this document also reviews the Greenlandic side of the North Water. Participants were also provided with an annotated bibliography on available TK/LK/IQ resources as a background piece. This bibliography was provided to highlight the broad range of already published references that speak to the local knowledge of the North Water region and could be helpful to future consultations and research. It was suggested that others could add to the document. The goal is to publish the bibliography within the DFO series at the same time as the Research Document.

Discussion

The group discussed the scale of the map to be included on the front page of the Science Advisory Report (SAR). Participants noted that Nares Strait should be included as primary production is expected to expand or move north. Areas that influence the polynya (e.g., the Lincoln Sea) should also be included. Other participants pointed out that there is a larger cultural zone than just the polynya, and perhaps Pikialasorsuaq should be viewed as a source of cultural continuity across the region into the Baffin area and in Greenland. They also noted

that representation should be viewed as fluid since the polynya does not have fixed boundaries over time. The group decided this would be best captured as a paragraph explaining larger regional relevance and identifying adjacent communities. The map on the SAR should not include management lines, only the scope of the study area for the CSAS reports.

A participant asked how Canada and Denmark came to their land claims agreements on the polar shelf in the North ocean. It was explained that based on the delineation of the continental shelf, claims were submitted to UN, but the process is still ongoing; there is a renegotiation of the border, and they are trying to modernize the agreement. Another participant noted that NRCan had some agreement on the science side with Denmark.

A participant brought up the idea of data harmonization, in terms of methods and protocols. They highlighted that this is a cross cutting piece with data from many places, collected and analyzed in different ways. The assessment of the nature of the data and the extent to which they are comparable would be important since they may inform management programs, joint initiatives, and indicators. It was decided that this may be listed as a knowledge gap and should be a consideration when discussing ideas throughout the meeting.

The group discussed the many terms used for the North Water and proposed two options: North Open Water (or North Water Region) and Pikialasorsuaq (to be used interchangeably). Participants discussed including the term ‘adjacent areas’ since marine mammals use coastal areas and fiords. The term ‘polynya’ should be reserved for times when it is a polynya. Additionally, the use of the word ‘open’ is restrictive to times when there is open water. However, it was pointed out that most scientific literature refers to it as the North Open Water (NOW). A participant noted that Pikialasorsuaq means ‘upwelling’, but the scientific community is not sure that upwelling is occurring, and that NOW is term used in Grise Fiord. Another participant agreed and suggested the term used in Grise Fiord, ‘Sikusuittuq’ (place that never freezes) makes more sense. A participant noted that including the word ‘region’ may be confusing since it is often used in political and/or management contexts. Consensus was reached that the terms NOW or North Water and Pikialasorsuaq could be used, as long as the document was consistent, but a description should be included to cover adjacent areas and the dynamic nature of the polynya. A participant added that the term Pikialasorsuaq may need to be revisited in the future since ‘Sikusuittuq’ may be more relevant for community members in Grise Fiord.

SEA ICE, BATHYMETRY, OCEANOGRAPHIC AND CLIMATE THEMES

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

Participants were presented with an overview of the Sea Ice, Bathymetry, Oceanographic, and Climate themes from the Research Document. First, the mechanisms of polynya formation, as outlined in the Research Document, were presented. This included a brief overview of atmospheric and oceanic conditions, latent heat mechanisms, the ice bridge, winds and currents, and upwelling along the Greenland Coast. A brief description of the climate section was presented next. Climate data have been collected in the Canadian Arctic Archipelago and Baffin Island region since the 1950, though there are no stations in the North Water. For the Research Document, a 30-year dataset was constructed using data from the closest climate stations to the North Water (Grise Fiord and the Thule Air Base) for the period of 1985–2015. An overview of the geology and bathymetry section was provided. This included historical glaciation and economic geology. Participants were asked to consider whether this section belonged in the Research Document. Next, the group was presented with key points relating to

oceanographic systems, including water masses (sources and water layers), general circulation, and model projections. This included figures of circulation patterns in the North Water and Baffin Bay. Sea ice themes covered in the Research Document were also presented. These included the ice bridge, formation and composition of sea ice, seasonal patterns, ice transport, glaciers, ice caps, ice bergs, and current and future trends. Finally, freshwater inputs were discussed, including runoff from glaciers and the Greenland Ice Sheet (including modeled results), sea-ice melt, river runoff, iceberg calving, and precipitation.

The inclusion of updated data from NCEP and NARR models, the inclusion of climate projections from AMAP and Paul Myers' work with NEMO, and the removal of the geology section were also proposed as discussion points.

Discussion

General

The group agreed to a restructuring of this section based on edits from the University of Manitoba. The proposed restructuring was as follows:

1. Climate Overview: Updated data from NCEP NARR model
2. Sea Ice, Ice bridge and formation of North Water Polynya
3. Overview of Oceanography (General circulation, freshwater transport, Tides, freshwater discharge, water masses/temperature salinity, nutrients)
4. Geology/Glaciation/Economic Geology
5. Climate projections

The group discussed inconsistencies with references throughout the section. In many places information that is no longer valid was presented as complementary information to current views. For example, some of proposed mechanisms for the formation of the polynya were outdated. Participants emphasized the importance of the ice bridge and winds (due to local geography) in facilitating the formation of this latent heat polynya. This should be made clear at the beginning of the Research Document and be outlined in plain language in the SAR. In other cases, data collected with different methods, over different timescales were often presented together. More emphasis should be made on when data was collected and what it represents. The group agreed to adding a section in the introduction of the Research Document examining the history of research in the area, and limitations of certain datasets. This would help reduce complication and clarify the current state of knowledge. It was decided that this could be included in the SAR as well.

There was concern about using absolute statements about the North Water being the "most biologically productive area North of Arctic Circle". This may be the true for open water, but to consider the polynya as only open water is restrictive. Additionally, the polynya may not be as productive as it once was. This led to a discussion about the dynamic nature of the polynya and it was decided that this would need to be captured in the document.

The group recommended using the concept of recurrence of low ice cover as a means to differentiate the polynya from leads and flaw leads (areas of open water that move). However, a participant pointed out that the recurrent nature of the polynya seems to be disappearing and the ice bridge did not form at all last year. This was related to the previous point (about declining productivity), and it was decided that the SAR would include a point stating that the polynya is evolving; it may have once been the most productive region, but it is no longer as recurrent as it once was. Another participant cautioned that in areas where data are sparse (such as the North

Water), care must be taken not to portray something that is a progressive unidirectional change when it may be a fluctuation. Apparent declines in productivity may be a knowledge gap rather than catastrophic change. The group agreed that there is enough knowledge to say that it is sensitive to the physical environment, but that natural fluctuations affect it and long-term changes are knowledge gaps the need to be addressed. This may be included in the SAR.

Formation of the Polynya

The group emphasized the Research Document and SAR need to be clear that it is a pairing of the ice arch and wind that make the polynya. Additionally, multiple ice bridges influence the extent and robustness of polynya. One participant pointed out that a polynya could still form without the bridge, but it would not be as large. The participant continued that the importance of wind needs to be highlighted. This area is prone to extremely strong winds because of pressure patterns and local geography (winds blowing through Smith Sound). This makes the region sensitive to climate driven changes in pressure patterns. On this, it was brought up that south winds break up the ice bridges. Another participant confirmed this with local observations in Grise Fiord.

The group discussed the importance of ice thickness and large ice features in the system. A participant mentioned that large ice features (especially grounded ice) can slow down ice floes, but there is a limited understanding of how this occurs. The nature of ice moving in from the Lincoln Sea may also influence formation, but how this occurs is also a knowledge gap.

The group briefly discussed the upwelling section of the document. A participant pointed out that information on upwelling of warm water is outdated and not worth including in the document. The information is from the early days of thermal remote sensing from aircraft and was probably due to fog. There is plenty of satellite imagery that does not support the data.

Climate

A participant pointed out that the difference between local weather stations can be very dramatic, so weather data from many of the stations used in the Research Document may not be relevant to North Water (even the Thule weather station is probably not relevant). Furthermore, the North Water polynya generates its own weather and weather patterns in the area are knowledge gaps. Precipitation is very difficult to determine accurately. Models can present wind climate well, but this data is not available on the internet and would need to be generated.

The group discussed removing the climate section altogether and weaving useful data into other sections. However, it was decided that large scale temperature and wind data could be presented but would need many caveats to make the context clear. Precipitation, cloud cover, and local climate should be listed as knowledge gaps. A participant brought up observations from Grise Fiord: wind and rain are increasing and Fall and Spring storms are now larger. The group decided to include a point in the SAR or Research Document on the ability of locally relevant climatic observations to identify and fill knowledge gaps.

Geology and Bathymetry

A participant stated that the economic geology should not be included in a minor way; it should be a bigger topic involving Natural Resources Canada or removed entirely. Other participants agreed, but felt it should be addressed as stressors (mining potential).

The group agreed that basic geography and topography were necessary, but could be included in the introduction. Participants stated that the glaciation section was important and needed to stay in the document, but historical glaciation should be distinguished from current glacial processes. Current glacial processes are critical to the North Water polynya and this section

should be expanded to include coastal and fjord processes. Ultimately, the group decided to remove the geology and historical glaciation sections; to include points about basic geography and topology in the introduction; to move the bathymetry section to oceanography; to add current glaciation to the large ice features section. The sources of trace elements affecting phytoplankton was an important point within the geology section that should be retained somewhere.

A participant stated that freshwater-marine coupling and nutrient upwelling were important. This is better studied on the Greenlandic side and remains a knowledge gap in Canada. It was decided that a freshwater-marine coupling section would be added to the freshwater discharge and plumes section.

A participant stated that bathymetry is poorly mapped on the Canadian side and should be added to the knowledge gaps.

Water Masses and General Circulation

A participant noted that recent observations of currents are different than what was shown in the Research Document and should be updated. Another participant added that the designation and terminology used to define the water masses was not well recognized. This is critical because the interaction of water masses is biologically relevant.

The group discussed the existence of new knowledge that has yet to be published. One participant had modeling work that could be used to update the current knowledge base, but it was not yet peer reviewed. The participant offered to write a subsection that would outline the modeled circulation data available in the literature and weigh the strengths and weaknesses of models. The group agreed.

Sea Ice

A participant recommended expanding the section on iceberg drift.

A participant said the references to Mundy (2000) to describe sea ice in general should be replaced with a classic sea-ice textbook. The participant offered to provide appropriate references after the meeting.

A participant described an event in 1965 in which a large tabular iceberg from Petermann Glacier blocked the strait and created a polynya. This sparked a discussion about the variability of the ice bridge. One participant stated the ice bridge is becoming increasingly variable and sometimes does not form. Another participant pointed out that there are only 15 years of data, so it is only safe to say the formation of the ice bridge is variable, it is potentially unstable, and the duration appears to be reduced. Some participants highlighted that climate change affects this process and it is important to recognize this. A participant added that people from Qaanaaq no longer travel across the ice bridge because it is no longer reliable and is unsafe. The group decided that the terminology used to describe ice bridge variability would be revisited when drafting the SAR.

The group recommended adding a section on landfast ice to the document, since it is important for marine mammals (e.g., Ringed Seal [*Pusa hispida*] pupping habitat). Most of the information on landfast ice was contained in the document but could be expanded with information from the Canadian Ice Service. This new section would go in the seasonal patterns section instead of the ice bridge formation section. Participants recommended adding information from the Qaanaaq perspective on the importance of sea ice to this section.

The group discussed glaciers and the movement and importance of icebergs in the area. The group recommended adding new references on circulation (e.g., Dalton et al. 2019) and a discussion on the importance of freshwater inputs from icebergs. One participant thought the

large ice features section was unbalanced with more discussion focused on the Greenland side; the SAR should include an overarching statement covering the entire region. Participants debated including extreme events (e.g., the ice island in 1965) in the SAR. One participant wondered if an ice island of that size could happen nowadays, while another stated that the Petermann Glacier could shed pieces large enough to block the strait and there are some very large tabular icebergs in Baffin Bay.

There was debate over the use of the term ‘trends’. A participant argued that a trend is a historical pattern, but when extrapolating these patterns into the future the term ‘projections’ should be used. Other participants stated that there is a difference between extrapolating historic trends into the future and using models to make projections. It was decided that the wording in the Research Document should be examined closely and care should be taken to identify when something is a trend, an extrapolation into the future, or a model projection. This highlighted the importance of understanding the difference between variability and trends in an area with so little data. It was decided that the lack of data to make conclusions about trends should be captured as a knowledge gap. One participant questioned the value of including projection analysis in the report at all. Other participants stated that while predictions may be more of a discussion than scientific facts, these discussions of change are interesting for managers and would be relevant for the SAR. The group decided that current and historic trends should be presented within each section where possible (e.g., sea ice trends in the sea ice section) and these trends would only be discussed where there was an understanding of variability. Modelled projections (for all relevant sections, not only sea ice) would be covered in a summary/future outlook section at the end of each chapter. This new section would also discuss the ways new projections are changing from old projections.

Freshwater Discharge and Plumes

The group recommended that further discussion on freshwater-marine coupling be included in this section. Context should be added to better explain the importance of freshwater and water densities to primary production.

This led to a discussion of summary points for the SAR that would capture the importance of stratification to primary production. Important points included: the circulation of water bringing up warm water to Greenland side, increased stratification on one side vs. the other, and the flux of freshwater coming down Nares Strait or through Lancaster Sound. These processes are not just moving nutrients to the surface, but also moving organisms up and down. It is important that the Research Document defines why temperature and salinity are important. A participant recommended using a Figure 1 to help to summarize this.

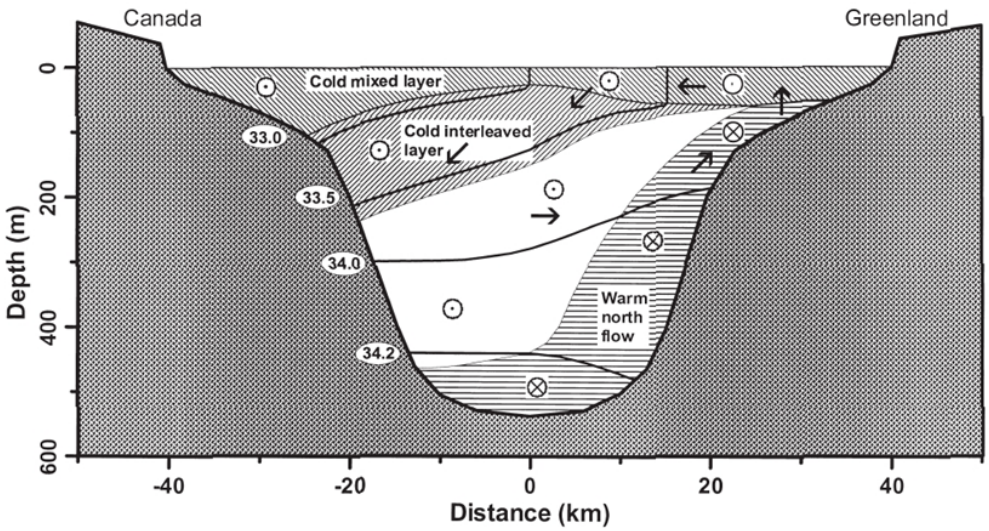

Figure 1. A cross-section of ocean currents in the North Water polynya region (Source: Melling et al. 2001).

A participant noted that there is often confusion between oceanographers and hydrologists when discussing freshwater; oceanographers often talk about freshwater transports without considering hydrologic inputs; there should be a discussion drawing the distinction between the two contexts. The participant also discussed other freshwater flux gaps in the report, for instance, the role of precipitation and advection (the polynya is a freshwater sink). The fluxes are difficult to get information on, but should be discussed conceptually because they are ecologically important.

A participant stated that in some places the Research Document takes direct quotes from publications, with numbers that are not always intuitive. The participant recommended converting these to something the reader can understand. The group decided to consider this on a case-by-case basis.

NUTRIENTS AND LOWER TROPHIC LEVEL THEMES (MICROBIAL, PRODUCTIVITY, ZOOPLANKTON, ALGAE AND BENTHOS)

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

Participants were presented with an outline of the Nutrient and Lower Trophic Level themes covered in the Research Document. The Research Document provided a description of the microbial community in the North Water (including ways the community contributes to productivity), as well as seasonal timing and spatial patterns, though most references were from the 2000s. Information on ice-associated algae for this region is still limited. Much of the information provided in the Research Document on phytoplankton blooms, community and size structure, and ice algae was based on the International North Water Polynya Study, conducted in 1997–99. Similarly, information on abundance and species diversity of zooplankton and ice-associated invertebrates is limited, and the Research Document drew heavily from the 1997–99 survey. The document also contained a description of production and limiting factors (i.e., light and nutrients). Historical data presented in the document showed total annual production is high, though there has been an observed decline in production in the North Water (Marchese et al. 2017), thought to be a product of changing climatic conditions that have resulted in physical

changes to the environment (e.g., increased stratification and reduced mixing and/or upwelling). Finally, the document provided an overview of the benthic community. This included community structure, spatial differences between sites, threats and indicators of change, and a brief discussion on benthic-pelagic coupling.

Discussion

Microbial Community

A participant stated there is a new paper in press and offered to contribute a paragraph on biodiversity in the benthos. Another participant pointed out that recent work has examined the pan-arctic distribution of phytoplankton and a summary statement on this work should be included. The participant offered to contribute this to the Research Document.

The group recommended revisiting the titles of the subsections since microbial refers to anything with one cell (the Research Document considered bacteria under the microbial section, and algae as its own section). New titles should be algae and microbial heterotrophic protists and other protists (or something similar). It should refer to the whole community not just diatoms. Additionally, the Research Document and SAR should emphasize the uniqueness of the microbial community and its genetic heritage, rather than absolute biodiversity. This uniqueness applies to the Arctic as a whole, but there are unique environments within the North Water that are unexplored. These likely contain unique microbial life as well, but this remains a knowledge gap. Expert participants offered to help revise the Research Document.

Ice-associated Algae and Phytoplankton

Participants discussed the tight coupling between primary productivity and zooplankton. This coupling is fundamental to support higher trophic levels, however, how this will change in the future is a knowledge gap. As seasonal productivity changes, we do not know if zooplankton will adjust their timing and if the link between production and the lower food web will remain. The timing and dynamics of blooms are not only seasonal, but also relate to the timing of ocean currents and when the polynya is open. Two additional references into coupling may provide some insight, but this remains a very important knowledge gap. Biophysical coupling is also important and a few more statements should be made in the Research Document. A participant offered to assist with revisions in this section of the Research Document. For the SAR, it is important to capture that the timing of primary productivity could be impacted by climate change and this would impact higher trophic levels.

The group discussed the definition of seasons and seasonality within the Research Document. This can be complicated since seasonality is defined differently in a biological setting (and depending on the organisms in question), a physical setting, and a human setting. The group recommended including a discussion on seasonality and its many definitions in the introduction. This discussion would include Inuit typology and the importance of seasons to the Inuit. Seasonality would be defined differently in each section according to need.

A participant commented that, while it is true there is not much knowledge on ice algae, there are two studies that should be referenced.

The group discussed whether the Research Document fully captures primary production. For instance, transects examining little auk prey found biomass at 40 m depth; this data is not captured by the satellite images used in the paper. This is an ongoing concern since satellite imagery is good at detecting maximum chlorophyll production at the surface but misses the primary production that occurs below. It can, however, provide a sense of interannual variability. The group decided the Research Document and SAR should be clear that there are knowledge gaps regarding primary production. One significant knowledge gap is the spatial and vertical

distribution of zooplankton linked to subsurface chlorophyll. This is important because stratification on the Greenland side is very different than the Canadian side. The coastal distribution of primary producers is another important knowledge gap. Participants made it clear that these knowledge gaps are important when discussing potential impacts, and that filling them is important to make informed policy decisions.

The group noted additional minor issues with the section. For instance, the total magnitude of primary productivity is probably underestimated in Figure 16 of the Research Document. The group decided to add “does not reflect subsurface chlorophyll maximum or ice associated production” to the figure caption. Table 2 in the Research Document is outdated and should be compared with more recent results, and the location should be more specific and identify the season.

Productivity and Limitations

A participant recommended removing all references to silicate as a potential limiting nutrient. It is now known that nitrogen is the limiting nutrient, and this should be the focus.

The group highlighted spatial connectivity of nutrients as an important piece missing from the section, especially given anticipated changes to climate. For example, water that comes from Pacific Ocean is nutrient rich, but highly susceptible to change. Similarly, nutrients entering from the Atlantic may be changing as water masses from the west Greenland current are moving further north and getting wider and deeper. The overall importance of nutrients entering the North Water through water flows and currents should be added to the Research Document.

The group discussed the use of data from a 1998 survey to describe productivity. 1998 was a special, highly productive year; those productivity levels have not been observed since (though satellite data shows it may be rising again). One participant noted this may have been due to the conditions of the Beaufort Gyre; more nitrate may have been available. This might have been a phase or a part of natural variation and should be made clear in the Research Document.

Participants recommended adding cloud cover and suspended/dissolved matter in coastal environments as knowledge gaps. These factor influence light, and thus, primary productivity in a major way.

A participant mentioned that they have recently submitted a paper showing more and more primary production (phytoplankton) is reaching the seafloor (based on fatty acid content of benthos). This has been increasing since the 1990s and the hypothesis is that there is a mismatch with zooplankton.

Phytoplankton Community Structure

Surveys completed in 1998 missed species smaller than 2 microns. New data is now available that can update the species lists in the appendix. This highlights that increased diversity in this category in recent years is due to the evolution of knowledge not increased diversity in the system.

The group noted inconsistencies in the level of details and missing context throughout this section. For example, statements in the Research Document made it look as though certain species dominate, when that may not be true for all seasons. This context is especially important when attempting to compare the Greenland and Canadian side since there is more variability on the Canadian side. Expert participants offered to work on the section.

Ice Algae

The group recommended moving the last paragraph on dimethyl sulfide to the gas fluxes section. Participants offered to provide additional papers that should be added to fill gaps in the section.

The group agreed that a statement that ice algae are not a significant contributor to the development of the phytoplankton bloom in the North Water (Tremblay et al. 2006) should be removed from the Research Document. Another statement referring to ice algae in Hudson Bay (Michel 1993) should also be removed.

Marine Macrophytes And Benthic Macroalgae

The group commented that almost everything in coastal areas is a knowledge gap. On the Greenland side there is some information on kelp (a participant offered to provide a reference), but there is no information for Canadian side. However, questions about changes in vertical distribution and timing can be inferred from other regions. It may be a knowledge gap here, but there is no reason to think things are any different in the North Water. For example, in other ice-covered regions there has recently been a documented shift towards smaller zooplankton. While there are uncertainties regarding the mechanisms, this has been largely linked to climate change and it could happen in the North Water. This would have major implications for productivity and the food web. The group recommended updating references in this section. One participant offered to provide references from nearby Disko Bay.

A participant suggested the Research Document should better emphasize the greater benthic diversity on the west side compared to the east side of the North Water. Additionally, the functional diversity of the North Water is important to highlight. Functional diversity is a component of biodiversity that addresses the range of niches within an ecosystem. This may imply some resilience within a system. Recent studies have shown functional diversity within the North Water is as high as Cape Bathurst. Notably, one species, usually found only in Southern regions was recently found the first time in the Arctic in the North Water.

Participants discussed threats and indicators of change with respect to benthic organisms in the North Water. Currently there is no commercial trawling in the North Water, but there may be interest in fishing in the future and this could represent a threat. It was suggested that the expansion of blue mussels could represent an indicator of change though the expansion of the species itself does not represent an ecological threat. Little information exists (especially in coastal areas) about benthic-pelagic coupling in the North Water, but increases could have positive impacts on reproduction and growth of some species (more food to the benthos). A participant offered to help add references and edit the benthic section.

The group noted that the Research Document is missing a section on holistic ecology. To avoid redundancies and a new section, they recommended including a simple food web figure showing ecosystem services. Points highlighting the ecosystem approach and associated knowledge gaps should be covered in the section on knowledge gaps and uncertainties.

MARINE FISHES

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

There is currently limited information available on the fish community of the North Water and surrounding waterbodies. Sculpins, cods, and eelpouts are among the more common taxa likely to be found in the North Water. The Research Document focused on four species: Arctic Char

(*Salvelinus alpinus*), Polar Cod (*Arctogadus glacialis*), Arctic Cod (*Boreogadus saida*), and Greenland Halibut (*Reinhardtius hippoglossoides*). Capelin (*Mallotus villosus*) are likely becoming more common in the North Water but were not discussed as a separate section in the Research Document. This section of the Research Document was reviewed internally by DFO scientists prior to the meeting.

Discussion

The group recommended explaining that these key species were chosen because of their ecological and economic significance.

Participants stated they would like to see more information presented on Greenland Shark (*Somniosus microcephalus*) and less on Capelin. Longline fisheries have an extremely high bycatch rate for Greenland Shark, representing an important stressor if commercial fisheries move into the North Water. Currently there is not enough data to include Capelin, but possible changes brought about by the expansion of boreal species (such as Capelin and Sand Lance) should be stated as a knowledge gap in the SAR.

A participant noted that statements about the ice association of Arctic Cod are not quite correct. Only young of the year cod are ice-associated, adults are not. Similarly, a statement about the importance of polar cod for Ringed seals may not be accurate. Ringed seals primarily feed on Arctic Cod, but would feed on Polar Cod if they were more numerous.

A participant stated that a change in abundance or distribution of cod could have a cascading affect, and this should be added to the SAR.

The group decided that more information on stock structure would be useful from a management perspective. A few references were highlighted as useful additions to the Research Document (e.g., Hussey et al. 2016), but there remain many knowledge gaps around the connectivity of fish movement. Greenland halibut were highlighted as a key species for which this is the case. There is currently a large commercial fishery for Greenland Halibut in Baffin Bay but stock delineation and the interconnectivity between coastal and offshore in the North Water is a major knowledge gap that should be highlighted. If a new fishery were to open in the North Water, it is unknown if they would be fishing a new stock, or the same southern stock. If southern fish move north, it could provide an advantage for northern fisheries; however, this advantage would be reduced if southern commercial fisheries also move north.

Participants expressed that the Research Document should include more information from and about local fisheries. For example, the Greenland Halibut fishery in Qaanaaq keeps length records and should be referenced. Statements about Polar Cod and Arctic Cod fisheries in the Research Document should clarify that these fisheries are much smaller scale than Greenland Halibut fisheries.

A participant noted that a statement referring to ‘the predicted northward movement of fish population distributions at a rate of 40 km annually’ is too precise and should be removed.

Participants noted that CAFF (2017) should be cited throughout this section.

A participant added that there are some maps of rivers from Greenland showing some Arctic Char distribution that should be added to the Research Document.

MARINE MAMMALS

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

The high biological productivity of the North Water attracts many marine mammals, while the fiords/coastal areas are used for protection, calving, and denning. The North Water provides important overwintering habitat for Beluga (*Delphinapterus leucas*), Narwhal (*Monodon monoceros*) and Bowhead whales (*Balaena mysticetus*). Polar bears (*Ursus maritimus*) also use many areas within and surrounding the North Water. The Research Document highlights Beluga, Narwhal, Bowhead, Bearded Seal (*Erignathus barbatus*), Harp Seal (*Pagophilus groenlandicus*), Hooded Seal (*Cystophora cristata*), Ringed Seal, Walrus (*Odobenus rosmarus*), and Polar Bear. Some occasional visitors to the North Water (e.g., Killer whales [*Orcinus orca*]) are not discussed. Much of the data presented from the Canadian side is from adjacent waters. Presentation of each species within the document covers similar themes including:

- general use of the North Water polynya and surrounding area;
- stock delineation and genetic analysis;
- description of available habitat use and movement studies (telemetry studies/surveys);
- available IQ or local knowledge of species;
- available data on population size and data deficiencies;
- foraging ecology;
- status (IUCN and COSEWIC listings); and
- climate impacts.

Discussion

General Comments

The group discussed adding the NAMMCO (2018a) workshop report for the small whales sections. Some participants were unsure if the report was specific to the North Water. The CAFF report (2017) was suggested, but it provides the same information as NAMMCO. The group decided to tie in the NAMMCO report where possible.

Participants stressed that missing information on abundance, distribution, movement, and ecology of marine mammals should be explicitly highlighted as knowledge gaps, rather than gaps in the report. These should also be highlighted the SAR. Additionally, there are some new references should be added to fill gaps in the report. For example, walrus dive and foraging data in shallow areas exists for the North Water (Garde et al. 2018).

Throughout discussions on the marine mammal section, participants recommended better maps. Suggestions included adding:

- a more accurate map of Beluga distribution (showing winter habitat close to shore of Coburg Island);
- seasonality maps for Narwhal and Bowhead, including summer and winter distribution maps for Narwhal;
- a more accurate map of Bowhead distribution (Bowhead have been sighted in Harbour Fiord, just west of Grise Fiord);
- better maps for the seal subsections; and
- an updated Polar Bear map.

A participant also suggested adding survey effort to maps for some species (e.g., Narwhal) to make it clear where data was absent vs. where animals are absent. It was explained that many maps are placeholders and the group agreed that most maps would be replaced before the revised Research Document is distributed. Several participants offered to provide new maps.

The group recommended that each species subsection begin with a brief description of the species, for consistency purposes.

Beluga

It was highlighted that in summer 2019 residents of Grise Fiord saw an increase in the number of Beluga whales near the community.

A participant was skeptical that 70–85% of Eastern High Arctic-Baffin Bay subpopulation of Beluga whales overwinter in the North Water and recommended the authors verify the reference.

Narwhal

A participant commented that the population estimate does not include estimates from Inglefield. The participant offered to provide a reference.

Participants discussed questions and concerns about Narwhal disturbances. Seismic exploration is a concern in many communities, but the Research Document did not address this issue. The group recommended citing studies detailing the general reaction of narwhals to seismic surveys to address this concern. Killer Whale presence is another potential disturbance. There have been observations of Narwhal habitat use shifts due to Killer Whale presence, though there are no peer reviewed reports for the North Water region. The group recommended citing papers from other areas that quantify the impact of Killer whales on Narwhal behaviour. This should include indirect impacts; Killer whales can affect Narwhal behaviour simply by being present. Similar papers exist for Bowhead.

A participant recommended adding shrimp to the list of prey items in the Narwhal diet. Shrimp were missing entirely from the Research Document; a participant offered to prepare a section referencing shrimp.

The group recommended removing a reference to Nielsen (2009) regarding Narwhal stock management since it is beyond the scope of the paper.

Bowhead

Participants recommended adding more context to discussion about harvest sustainability. For instance, currently there are only 3–5 harvests/year in Canada, while hunters in Greenland have not used their quota in the last 5 years.

Participants noted that the Research Document states that Bowheads probably leave Disko Bay when ice is removed to avoid Killer whales. However, Killer whales are rare in Disko Bay, so this is probably not the case. The group recommended removing this statement.

Harp Seals

The group recommended removing or clarifying the statement that “climate change may impact species more than what was assessed in previous studies” as it is referring to sea ice changes in Newfoundland, which is far from the North Water. A participant noted that residents of Grise Fiord have noticed that when Newfoundland had successful hunts, populations in Grise Fiord seem to be lower and vice versa.

A participant stated that residents in Grise Fiord have seen fewer Harp Seal over the past 5 years and asked if their food has declined. Other participants explained that based on

zooplankton data from 2006 to 2016 there is no trend, but there is interannual variability due to ice cover. Two years after high ice cover there are fewer adult Arctic Cod. This interannual variability may be responsible for the current number of Harp seals.

Hooded Seals

A participant noted there may be conflicting comments on the abundance of Hooded seals and recommended the authors review for clarity.

Ringed Seals

Participants noted that a statement that Ringed seals are preyed upon by 'terrestrial mammals' is only referring to scavenging by Arctic fox, and recommended revising to say this.

Walrus

Participants reiterated the importance of clarity when things are unknown. For instance, many of the potential threats outlined in the Research Document were taken from COSEWIC and apply to the Arctic in general. Identified threats should be specific to the North Water. This might highlight more knowledge gaps but would be more useful for the Research Document and SAR.

The group discussed population estimates and stock delineation. Population estimates were taken from different places and presented as a range in the Research Document. These were written with old stocks, but more specific estimates are available. A participant offered to provide these. At a recent NAMMCO (2018b) meeting, it was made clear that the high Arctic walrus population can be designated as three stocks, however, Greenland manages the population as one stock. This should be referenced in the Research Document.

One participant cautioned against using maps that highlight specific walrus haul-out sites as this could attract tourists and walrus are very sensitive to disturbance. The group discussed this comment. In some cases, haul out sights have already been published for the purpose of setting up buffer zones. The group agreed that no new maps would be made identifying haul-out sites, but previously published maps would be presented where necessary. Maps showing haul-out sites in Greenland are outdated (there are no longer any terrestrial haul-out sites in Greenland) and should be removed from the Research Document. The discussion highlighted the sensitivity of walrus to disturbance and participants recommended expanding on this for the SAR. Small vessels, including commercial vessels up to the tonnage limit, without AIS, were highlighted as a concern. Corridors and exclusion zones can be set, but enforcement for small vessels is difficult. Participants recommended including this as an important stressor.

Polar Bears

Participants recommended adding that declines in body condition in the area relate to long-term reductions in the availability of sea ice over time (including earlier break-up and later freeze-up). Additionally, high densities of Polar bears and Ringed seals have been observed in the Kane Basin area; this could be linked to high primary production due to glacial inputs (though more information is needed). A participant offered to add the above comments to the Research Document. In the SAR, participants recommended highlighting that many linkages noted previously are also relevant for Polar Bear (as a top predator).

BIRDS

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

14 seabird species regularly breed in the North Water region. Coburg Island in particular is an important nesting habitat, and one of the few known breeding sites for Atlantic puffins in the Arctic. Seabirds have been an important food source for indigenous people living near the North Water for hundreds of years. The Research Document focuses on three key species: the Ivory Gull (*Pagophila eburnea*), the Dovekie (or little auk; *Alle alle*), and the Thick-Billed Murre (*Uria lomvia*). Ivory gulls require partially ice-free habitat in late-May and early June, and nest in only five locations within Canada: Ellesmere Island (most colonies), Devon Island, Cornwallis Island, Seymour Island, and the Brodeur Peninsula of northern Baffin Island. They are listed as "endangered" in Canada (COSEWIC 2006). Dovekies nest in crevices on scree slopes, rubble at the foot of cliffs of coastal mountains, on the sides of fjords, and on rocky outcrops surrounded by glaciers. They arrive to the North Water in May. Northwest Greenland holds the largest known population of the species (approximately 80% of the world population). There are over 350,000 Thick-Billed Murre nests around the margins of the North Water. Foraging conditions differ on either side of the North Water; chicks from Coburg Island feed at a higher trophic level than chicks from Hakluyt Island. Threats to seabirds include hunting, disturbance at breeding locations, climate change, and contaminants in the food chain.

Discussion

General Comments

A participant recommended highlighting that the Carey Islands are very important for puffins (the largest colony in the region) in the Research Document.

The group recommended revising maps. A participant recommended including Coburg Island and the entrance of Jones Sound on maps of seasonally important areas since these are important places for seabirds that will eventually need protection.

The group recommended adding subsections on kittiwakes and common eiders. One participant added that black-legged guillemots overwinter on Coburg Island and fulmars fly over Hell's Gate.

A participant recommended highlighting in the SAR that regions of interest for seals, whales, bears etc. are also important for birds.

Ivory Gull

A participant highlighted that Ivory gulls are susceptible to contaminants (they are above the threshold for effects) because they are scavengers.

A participant noted that their range has contracted northward; their only nesting area is on Ellesmere Island, adjacent to the North Water. Declines in Ivory gulls were first noted by community members, prompting new studies that captured population declines. They are now absent on Baffin Island and Devon Island.

A participant asked whether hunting pressures are from humans or foxes. Ivory gulls are not hunted in Grise Fiord.

Dovekie (Little Auk)

The group emphasized that dovekies are absent as breeders in Canada (even though there are millions in Greenland). Dovekie numbers and occurrence are much higher on the Greenland side of the North Water. This speaks to the biodiversity and geographic extent of the North Water and should be highlighted up front. They do have a migration stop in Lancaster Sound, but the data is not published. Dovekie are important in bringing nutrients into the system.

A participant recommended rewording a statistic in the Research Document that states "harvests of approximately 22,599 Dovekie, [comprise] 81% of the total food harvested (Dietz et al. 2018)". 81% refers to the number of dovekies harvested as a percentage of the total animal harvest, not the weight of food consumed. The group decided to retain the number of dovekies harvested in Greenland but remove or contextualize the 81% calculation.

Thick-Billed Murre

A participant had minor issues with the Research Document's estimates of murres using the North Water on the Greenland side, and recommended using only the most recent estimate (362,000 birds; Merkel et al. 2014). Additionally, it is important to highlight that the North Water is the only region in Greenland where their numbers are not decreasing.

A participant recommended mentioning that murres dive to feed on deeper fish, so they may not be exploiting the same trophic level as other birds.

DANISH NORTH WATER REPORT – SEASONALLY IMPORTANT AREAS

Presented by Anders Mosbech and Tom Christensen, Aarhus University

Summary

To initiate discussion of seasonally important areas, the Research Document referenced core areas outlined in Christensen et al. (2019), referred to here as the 'Danish North Water Report'. Participants were presented with an overview of the report. The report outlined core areas of biodiversity, specifically identifying potential sensitive areas within the North Water study area. To do this, the authors developed a tool to visualize and integrate information on the occurrence of species. 24 species and 57 seasonal maps were used to create the final maps. Maps also included chlorophyll and ice edge as ecologically important features. Maps were primarily based on regions of biological significance to seabirds and marine mammals (walrus, Beluga, and Narwhal) and largely excluded seals, fishes, and other important physical features and oceanographic or sea ice processes within the polynya.

Each species was assigned an importance value of 1–4 based on EBSA criteria, and a value of 1–4 based on the importance of its role in the North Water (giving a maximum value of 16). For example, walrus was given a value of 16 because they rely heavily on the North Water and are globally important. Species maps were compiled during expert workshops, converted to raster format and overlaid to assign an importance value to each pixel. Importance was spread evenly in areas where no knowledge existed. Density distributions for seabirds were made using foraging distance to estimate a rate of decline away from colonies. This process was repeated for specific time periods for each layer, allowing the authors to sum all layers for any day of the year. The tool was intended to illustrate spatial linkages to assist in planning protection.

Discussion

The group discussed additional information that could be used in identifying important areas. This included additional ice data, and spatial data on fishes and zooplankton. In terms of ice data, only the ice edge was used (monthly averages), but ice type would be a useful edition. It was agreed that some data (like spatial data on fishes) would be useful but are generally lacking. Participants recommended highlighting which elements are missing and clarifying exactly what each map shows. Some of this information could be incorporated into map legends and figure captions.

A participant asked if weighting was applied to certain species. It was explained that each species was given a weight relative to all other species. The weighting system was transparent

and outlined in the original report. Since this is a tool that is meant to be used, the weighting system can be discussed and modified as needed.

The group discussed the possible uses for the maps, and the conclusions that could be drawn from them. For example, they may be useful in thinking about mitigation of stressors and human activity. Currently they do not show specific sensitivities but can be used to infer times of sensitivity to certain stressors. For example, noise would be an important stressor during times when belugas are contributing to important areas, while the impact of oil spills would highest when eiders are moulting. One participant pointed out that this is a tool under development and may not be definitive insight as part of the Research Document. Other participants responded that these maps merely compiled important elements in the area from a biological perspective, and they do expand our understanding of the North Water. From a decision-making perspective these types of analyses can be very useful.

The group recommended including a narrative throughout the report relating to these maps, so they are not presented as a stand-alone section. The section was taken from the Danish North Water Report but was not completely consistent with what is presented in the rest of the Research Document. Consistency would allow the maps to have a meaningful bullet in the SAR.

Participants recommended highlighting that the polynya is a seasonal feature; during part of the year it is really special, but by mid-summer it is similar to neighbouring areas. This is included in the text but should be pulled out and incorporated into the maps if possible.

MAPPING STUDY – HUNTERS IN QAANAAQ

Presented by Anders Mosbech, Aarhus University

Summary

Participants were presented with a mapping study conducted with hunters in Qaanaaq. The study is now published and provides new information which could be referenced in the Research Document. The study was a collaborative effort with hunters in Qaanaaq and Savissivik where hunters were provided with a GPS and reported on transportation means, species harvested, and other observations. 15 hunters from Qaanaaq and 2 hunters from Savissivik contributed to the program. In total about 20,000 km of hunting tracks were summarized for the area. Final products included a map of the ‘hotspots’ (where hunters get the most biomass) and results were presented in Nuuk in 2017.

ENVIRONMENTAL STRESSORS

Presented by Claire Hornby, Fisheries and Oceans Canada

Summary

Climate change is likely the most significant impact to the North Water ecosystem. Many marine mammals using the area have been designated as sensitive to changing habitat and climate change (Laidre et al. 2008), specifically Polar bears and seals. There is a projected freshening and warming of the Baffin Bay surface layer under the high emission scenarios (Hamilton and Wu 2013, Zweng and Munchow 2006). The Research Document summarized a selection of known, observed and potential climate induced stressors, but it was not an exhaustive list.

Much of our understanding of gas fluxes and carbon dynamics in the North Water comes from the International North Water Polynya Study (Barber et al. 2001). Our current knowledge is largely based on observations throughout the open water season and assumptions of wintertime processes. Descriptions of CO2 exchange are based on knowledge from other regions and

areas. As such, there is a need to gain a better understanding of gas fluxes in the North Water polynya (and how this relates to source and sinks), as well as the role of the North Water in overall ocean acidification.

In terms of the carbon cycle, specific knowledge gaps include: the amount of CO_2 in the surface waters throughout the winter season; the impact of changes to glacier meltwater inflow; the relative contributions of biological activity and water mass circulation to oceanic CO_2 decreases during the summer.

The POPs and metal contaminants present in the North Water polynya are transported (via surface water, atmospheric, glaciers, sea ice, etc.) from their source regions in mid and low latitudes. After entering the marine system, many contaminants go through biomagnification (a process by which toxins enrich in animals at high trophic levels of the food chain). Zooplankton and invertebrates may be important contributors to contaminant cycling in Arctic food webs. There have been numerous studies contributing to our knowledge of mercury and contaminants in Polar bears, Ringed seals, Bowhead whales, Ivory gulls, and other seabirds. Ivory gulls, for example, have high levels of organic pollutants, including organochlorides and PCBs.

Current or future stressors in the North Water include those caused by industrial activity, shipping, ecotourism, pollution, many of which may increase due to climate induced changes. Most of these stressors are low in the North Water compared to other regions (e.g., S. Baffin Bay), but have potential to increase and would have a large impact. Microplastics are another concern, posing a potential threat to fish and birds. Levels of microplastics in Arctic marine fish are currently low compared to Arctic seabirds, but contamination of a key trophic link such as Arctic Cod is possible and warrants additional monitoring.

Discussion

Climate Change

A participant recommended referencing Steiner et al. (2015). The paper outlines expected outcomes in the peripheral seas (including Baffin Bay) and is a good general overview of what could happen.

A participant reiterated that a key element of polynya formation is wind forcing and recommended adding projected climate driven changes in wind patterns.

The group cautioned that climate change issues are looked at on large scales and there is tendency for people to take what is happening across the Arctic and apply it to sub-areas; this is not always valid. For instance, conditions in Baffin Bay are very different than the Central Arctic. Efforts should be made to specify aspects of climate change that are unique to the North Water and avoid general statements when creating a series of bullets. The group discussed using high resolution climate models that could be used to identify local changes; however, it was argued that the Research Document needs to draw on conclusions already made and should not embark on a new modelling exercise. The group decided the document could note weaknesses in current models and identify knowledge gaps and opportunities for future research. One participant offered to write a small section on results recently presented at ArcticNet in 2019. The group agreed.

The group suggested adding a paragraph on the interaction among stressors and the cumulative impact. In most cases the full range of impacts are unknown, but this can be highlighted as a knowledge gap.

Participants noted that the language in this section is very speculative, which will be difficult to capture in the SAR. The key point is there is uncertainty about the future of the climate in this

region especially as it relates to stressors. This message can get lost in long lists of bullets. The group recommended moving discussion on climate change to the climate section. This stimulated a discussion about the stressors section in general. The group recommended adding a summary to the end of each section and using this to highlight the stressors and knowledge gaps within their respective sections. The most important points should be synthesized in a narrative style at the end of the Research Document and would be packaged together in the SAR.

Gas Fluxes and Carbon Cycle

A participant noted that gas fluxes are not stressors (acidification is the stressor), and so the section should be moved closer to the front. The group agreed.

A participant stated that the section needs major restructuring and listed a number of issues and suggestions, including:

- the section is written with redundancy;
- the section is missing information on organic carbon;
- the title should reference climatically active gas (gases that affect the climate);
- recent studies should be referenced that support the notion that the North Water is a CO_2 sink;
- variability should be highlighted, including the response to changes in biophysical system;
- the relationship between seawater CO_2 and sea-ice concentration needs to be better established;
- it should be highlighted that information is based on snapshot of processes in summer and fall, there is a knowledge gap for winter data;
- it should be highlighted that measurements are from south of the North Water;
- a short paragraph should be written on the decreasing trends of acidification (Steiner et al. 2014);
- papers referencing dimethyl sulfide, methane a N_2O should be cited; and
- a group from Laval should be added to the reference list.

The participant offered to restructure and revise the section according to the above suggestions. The group agreed. The group decided that ocean acidification (current trends) would be covered with the carbon cycle. Impacts of ocean acidification would be highlighted as a stressor and covered with other stressors and knowledge gaps.

Contaminants

The group recommended that the section be condensed to central pieces of information relevant to the North Water, and updated information on trends in adjacent areas should be brought in. A recent AMAP (2018) assessment on biological effects of contaminants should also be referenced.

A participant asked about environment impacts from residual hydrazine fuel contained in Russian rocket stages that regularly splash down in Baffin Bay and the North Water. Another participant explained that a colleague was asked to investigate this two years ago. The colleague was not concerned about the risk because hydrazine is highly volatile, however no study has looked at the volatility in cold water. The group decided it should be listed as a concern and a knowledge gap.

Other Anthropogenic Stressors

The group recommended the entire section be retitled anthropogenic stressors since all stressors discussed so far are anthropogenic. The knowledge gaps section would follow. The carbon cycle and acidification sections would be moved earlier in the paper as previously discussed.

The group remarked that there is an imbalance in the amount of information presented; some topics were given full explanations (e.g., microplastics), while others were merely listed (e.g., shipping). The group recommended retaining the paragraphs on plastics, and including additional paragraphs on commercial shipping, marine tourism, industrial activity, and cumulative effects. Invasive species could also be given a small section. The type of stress should be delineated within each topic (e.g., noise, ice breaking, and fuel spills within the shipping subsection).

A participant suggested including information on sustainable vs. non-sustainable targets for hunting and fishing. The group decided this information should captured in the species subsections. Another participant requested adding details explaining the difference between local subsistence and commercial fisheries.

BREAKOUT GROUPS

In previous discussions, the group decided to organize key findings and knowledge gaps into each section within the Research Document, rather than large lists at the end. These bullets would form foundation of SAR. To determine and reflect on three or four key findings and knowledge gaps the group split into breakout groups for 45 minutes to discuss. The groups were divided according to 5 main themes within the Research Document: Inuit Qaujimajatuqangit and the Human Perspective; Ocean, Ice and Atmosphere; Productivity and Biochemistry; Benthos, Zooplankton and Fishes; Marine Mammals, Polar bears and Birds. Cross-cutting issues would be presented as a synthesis at the end of the document.

INUIT QAUJIMAJATUQANGIT AND THE HUMAN PERSPECTIVE

The Inuit Qaujimajatuqangit and the Human Perspective breakout group presented key messages that they felt needed to be considered for the SAR and/or Research Document.

Key Messages

- It is important to recognize that humans have been a part of this area for at least 4,000 years and are part of the ecosystem.
- The CAFF food web figure that shows hunters as part of the food web should be included.
- Harvesting of living resources is and has been part of the area long before the site was described in Western science. Harvesting is already managed, harvesting is done in addition to scientific advice in (e.g., Greenland, though not in the area itself).
- Local, rights-based hunting/harvesting should not be considered a “stressor”; local harvests are well regulated at the local level and through bilateral cooperation on both sides (e.g., bilateral arrangements on Polar bears, Narwhal and Beluga)
- If included as a stressor it must be with the context that it could be a potential stressor only if it is unmanaged or unregulated.
- Commercial fishing/harvesting is a potential stressor, and the effects of commercial harvests on local or community based harvests are knowledge gaps.

- The term for local fishing (including commercial or for economic gain) is small scale or artisanal – this should not be considered a stressor when referencing commercial fishing.
- Knowledge gaps can be filled with IQ.
- Locals are in the area, have a great knowledge of the area and can handle the collection of knowledge in many forms. In particular locals can address the need for year-round, sustained monitoring. This will ensure continuity, flexibility and local involvement in any event.
- There is a need to be innovative because an Inuit led management approach will be the basis for future management of the area.
- Possible actions like this are already described in the PAME MPA Workshop report (PAME 2019) as well as the QIA conservation economy prospectus for Tallurutiup Imanga.
- The difference of co-generation of knowledge vs. co-development should be referenced (e.g., NISR).
- Possible development of fisheries must distinguish between coastal and offshore fisheries, as is already in the Greenland legislation.
- There is a need to recognize that, though there are currently some gathering of data to support harvesting decisions, there is a need for more, and a need for a deeper understanding of system changes.
- There is a need to include the idea of the conservation economy that supports hunting culture.
- There is need for a separate IQ process as another pillar of knowledge.
- The connectivity of the High Arctic Basin, Tallurutiup Imanga and Pikialasorsuaq should be highlighted.

Discussion

The group agreed that many of these points should be added to the beginning of the Research Document. Key messages about connectivity and the contribution of IQ to the knowledge base should be included in the SAR. The breakout group suggested some ideas could be captured in the overview at the beginning of the SAR.

The group discussed ways to include the ecosystem model in the research document, possibly as a map. A participant suggested adding a map that shows other managed water systems that are a part of Pikialasorsuaq. Another participant added that it is good practice to show communities on maps wherever possible.

A participant recommended making stronger linkages between anticipated ecosystem changes and information needed to manage harvests. It should be clear that more information is needed on how to manage stocks in face of uncertainty.

OCEAN, ICE, ATMOSPHERE

The Ocean, Ice and Atmosphere breakout group presented key messages and knowledge gaps, these were revised to the following and agreed upon by the other participants (with minor revisions to be made after the meeting):

Key Messages

- The North Water is a distinctive oceanographic feature in Northern Baffin Bay characterized by a sea ice presence and thickness less than surrounding areas.
- Its existence and biological importance are attributed to:
    - pattern of atmospheric circulation produces a dominant wind from the North that is accelerated through Nares Strait pushes ice south through Baffin Bay;
    - geography that promotes the formation of ice bridges in Nares Strait preventing southward flow of sea ice leading to reduce ice cover in northern Smith Sound;
    - supplies of nutrients flowing down from the north, which originate in the Bering Sea, and flowing up from the south, which originate in the North Atlantic;
    - stratification of the water column determined by the low salinity of the Arctic inflow and freshwater input from glacial meltwater; and
    - oceanographic circulation that allows upwelling of nutrients imported at depth along Greenland coast and redistributed across Smith Sound.

Knowledge Gaps

- year-round monitoring (in-situ) of ocean, sea-ice and atmosphere properties is essential to the understanding of the physical science and its variability and change in the North Water;
- coastal processes (marine and terrestrial) are relatively unknown and understudied specifically with meltwater discharge from the adjacent glaciers at surface and depth, mixing of water masses in fiords and processes that play a key role in primary production/biogeochemistry coupling;
- interannual variation and ability to accurately model the local to regional scale processes and their interactions between the ocean, sea ice and atmosphere to provide future predictability;
- linking the hemispheric changes in atmospheric circulation and water movement to the variability of the north water – global change and influence of local weather on the polynya;
- how the increase of the runoff from the Greenland and Canadian ice sheet will change the biological productivity by suppressing ocean mixing;
- there is a conceptual understanding of the formation and break-up of the ice bridge but there is no effective way to simulate and predict the formation and break-up; and
- lack of precipitation data (e.g., what is falling, accumulated snowfall on ice caps, ice regime through evaporation, runoff).

PRODUCTIVITY AND BIOCHEMISTRY

The Productivity and Biochemistry breakout group presented key messages and knowledge gaps, these were revised to the following and agreed upon by the other participants (with minor revisions to be made after the meeting):

Key Messages

- North Water is one the most biologically productive areas in the Arctic with the magnitude and timing of productivity dependent on complex physical and biogeochemical controls.
- There are several indications that the surface water productivity has declined from 1998 to 2015 and its extent is moving northwards.

- Regionally, east-west, and north-south, the polynya productivity is subject to substantially different moderating controls such as nutrient supply, circulation patterns, and strength of stratification.
- The North Water remains a sink for anthropogenic CO_2; observations show the CO_2 footprint is strongly impacted by regional forcing including composition of sea water, biological processes, water temperature, sea ice, and water mass mixing.
- The indices of acidification have been observed in the region, but the effects on the ecosystem remain unknown.
- The group also noted that the high biodiversity of the region was important and should receive its own bullet.

Knowledge Gaps

- It remains unknown if the recent decline in surface productivity and its northward shift is a long-term trend or a transient phenomenon, and what controls it (variable ice bridge dynamics).
- Better spatial and temporal coverage for system observations is needed in order to establish long-term trends, and define spatial variability and controls.
- Better understanding of spatial and temporal changes of the drivers in OA and OA impacts on the ecosystem is necessary.
- Species diversity is relatively unexplored.

Comments

A participant noted that the term ‘biological processes’ is huge and requested the language be more precise. The participant also requested the term freshwater be clarified. The breakout group agreed to work on the wording.

A participant was concerned that the second key message is an over interpretation; measurements of primary productivity were only made in two years so the ‘decline’ in productivity may be due to variability. A participant from the breakout group defended the bullet, stating that comments in the Research Document are not complete; the measurements and satellite record are convincing (with some caveats added). The Research Document would be revised to reflect this.

BENTHOS, ZOOPLANKTON AND FISHES

The Benthos, Zooplankton, and Fishes breakout group presented key messages and knowledge gaps, these were revised to the following and agreed upon by the other participants (with minor revisions to be made after the meeting):

Key Messages

- Changes in oceanographic conditions could result in a shift towards smaller zooplankton species that are less rich in lipids than the high Arctic species. Such shifts are observed in other seasonally ice-covered areas (i.e., Labrador Sea and Disko Bay) and could have cascading effects on the energetics of higher trophic levels.
- Macroalgae serve as food for higher trophic levels and create habitat sheltered from predators, waves and currents but information on their spatial distribution is limited.

- Zooplankton standing stock in the North Water is similar to the Southern Beaufort Sea and higher than the rest of the Canadian Arctic.
- The benthic community species diversity in the western North Water is higher than in the southern part of the Labrador Sea and the Gulf of St. Lawrence, and is considered a hotspot of biodiversity.
- Functional diversity of benthic community in the North Water is similar to Cape Bathurst and higher than the rest of the Canadian Arctic.
- Benthic species unknown to science have been discovered and described in the North Water.
- There is an increase (temporal) in the pelagic-benthic coupling (i.e., transfer of energy through the food web) due to local changes in biophysical conditions, such as sea-ice dynamics and the timing of the algal bloom.
- Arctic cod (*Boreogadus saida*) is a key species for the entire food web and potential changes in its abundance or distribution would result in cascading effects on the energetics of higher trophic levels.
- Arctic char is a valuable subsistence species for local communities. Its relative abundance in the North Water is unknown.
- Northwards expansion of commercial fisheries for Greenland halibut in the North Water represent both an opportunity for northern communities and a potential threat to the ecosystem. Before expanding this fishery more knowledge on stock connectivity is recommended.

Knowledge Gaps

- Unknown coastal distribution and abundance of macrophytes, benthos, fish and zooplankton in the North Water.
- Lack of information on life history of benthos, zooplankton and fish over the annual cycle in the North Water and the Arctic.
- Limited knowledge on assemblage, seasonal vertical and horizontal migrations of zooplankton and fish in the North Water and the Arctic.
- Limited information on spatial migrations and connectivity between coastal and offshore populations of Greenland halibut in Canada and Greenland.
- Quantify the cascading impact of changes in biophysical conditions on lower trophic levels up to higher trophic levels.
- Identify the causes and degree of change in pelagic-benthic coupling and resulting impacts on the North Water ecosystem.
- Very limited information on the ecology and distribution of Northern Shrimp (*Pandalus borealis*) in the North Water preventing science-based management of future fisheries in the area.

Comments

The breakout group noted that shrimp needs to be included in the Research Document.

The group discussed the use of the term ‘commercial fisheries’ in the last key messages bullet. Some participants expressed the need for differentiation between small- and large-scale fisheries. It was suggested to expand upon by including local, small-scale, large-scale in parentheses. Other participants reminded the group to be mindful when discussing the risks of commercial fishing. Statements should be specific to species and only where evidence is available. Immodest statements of risk that implicate entire industries should be avoided as they may be inconsistent with Inuit rights to sustainable economic activity within a conservation economy. Furthermore, it is not the role of the science report to prohibit or control commercial fishing, only to identify specific harm that might occur. There is a need for science-based information on sustainable harvest no matter the size of the fishery. The group agreed there is abundant evidence that the destruction of habitats from bottom trawling, and the high bycatch rate of Greenland Shark when long lining are important stressors, and these should be captured in the Research Document and the SAR.

A participant noted that some key points lack specificity (e.g., those referring to oceanographic conditions, sea ice dynamics, etc.). The group decided to address the concern by adding examples to clarify. These would be added after the meeting.

MARINE MAMMALS, POLAR BEARS AND BIRDS

The Marine Mammals, Polar bears and Birds breakout group presented key messages, and these were revised to the following and agreed upon by the other participants (with minor revisions and rewording to be made after the meeting):

Key Messages

- The North Water is important habitat for seabirds and marine mammals because of the foraging opportunities. It is seasonally important for a number of seabird and marine mammal species that range throughout the broader region. Many of these species are culturally and economically important throughout the area.
- It is important overwintering habitat for marine mammals (belugas, narwhals, walrus, Ringed seals) in particular because the polynya provides open water and access to foraging.
- Adjacent coasts and fiords are important for Narwhal and walrus, and Polar bears in summer. Seabirds occur in large numbers throughout the area during summer months, and have large nesting colonies in coastal regions.
- There is a limited knowledge in the population structure, distribution, numbers, and ecology of a number of seabird and marine mammal species that occur in the North Water. Information is required to support conservation and sustainable use of the species/ecosystem.
- Birds and marine mammals are indicators of ecosystem change; they congregate at areas of increased productivity and so can be used to identify hotspots.

Comments

The breakout group emphasized that these points are not restricted to the polynya, they also include adjacent fiords and inlets. A participant commented that fiords are important winter habitat for Ringed seals and, therefore, are also important for Polar bears. The breakout group agreed to add a point on this.

Participants debated the level of specificity that should be given when describing knowledge gaps in the SAR. It was decided that being too specific would generate many repetitive points, but some key species, like the Ivory Gull and Dovekie should be highlighted.

The group discussed the need for regular monitoring. A participant pointed out that the need for continuous long-term monitoring is a common thread among all topics and there is a need for coordination in monitoring methods between Canada and Greenland. The group agreed to add a bullet on the need for monitoring information and coordination of efforts.

The group agreed to add a bullet on stressors.

A participant commented that residents of Grise Fiord have witnessed an explosion of the raven population. These birds have been known to attack ptarmigans and Gyre falcons, and can have a major impact on sea bird colonies. This population increase is likely due to a combination of natural and anthropogenic influences. The participant requested that ornithologists investigate this.

FINAL COMMENTS

A participant pointed out that connections between the terrestrial and marine environments were not covered in the Research Document (e.g., anadromous fishes, snowfall on foraging caribou, etc.). Similarly, economic potential of the ecosystem (contribution to the economies of Greenland and Nunavut) was not discussed. The group decided that a small paragraph would be included to identify these points as things that were not discussed.

This was a unique CSAS process because the study area spans two countries. As such, it was agreed that a follow-up meeting would occur to finalize the SAR and integrate comments from the Greenland side. The follow-up meeting will not generate new content, it will only ensure content is brought together in a coherent way.

To conclude, a participant shared a satellite image of the North Water and ice bridge in Smith Sound from January 24, 2020 (the final day of the meeting; Figure 2). The participant pointed out that open water and thin ice areas are clustered along the North East shore of Baffin Bay and not in Smith Sound. The image shows an ice bridge across Smith Sound, but no open water. This demonstrates that at the time, the ice bridge in Smith Sound was not playing a role in clearing the sea surface of ice, although it does do so in other weather situations. The fraction of the surface of the North Water region that is bright yellow is quite small; the intermediate colours are indicative the presence of young and thin ice forms. Ice bridges and narrow open leads can be seen at other locations, including: Hell Gate, Lady Ann Strait, Lancaster Sound, and Wellington Channel.

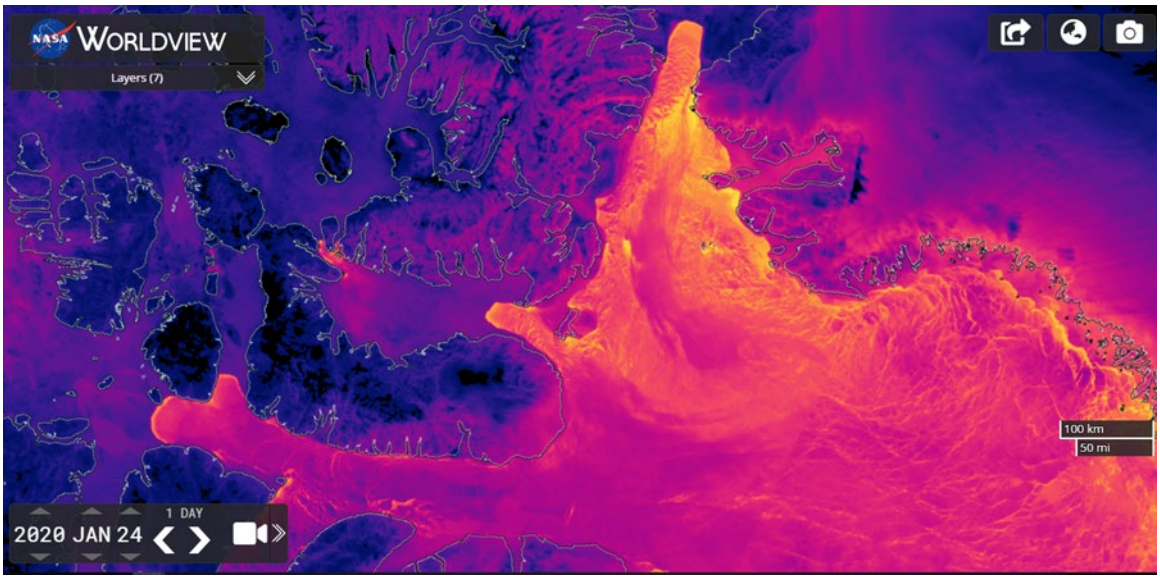

Figure 2. MODIS thermal band image displaying surface temperatures between ~ -2°C (light) and -30°C (dark) on Jan 24, 2020. Open water and thin ice areas are those in the brightest yellow.

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APPENDIX 1. TERMS OF REFERENCE

Biophysical and Ecological Overview of the North Water Polynya and Adjacent Areas

Regional Peer Review – Central and Arctic Region

January 22-24, 2020
Winnipeg, MB

Co-Chairs: Jason Stow and Tom Christensen

Context

The North Water Polynya (Pikialasorsuq) lies between Canada and Greenland and is formed by currents and wind conditions (see map). Pikialasorsuaq means “great upwelling”, and is the Kalaallisut (West Greenlandic) name for the North Water. This region has the largest per unit biological production of any waters in the Northern Hemisphere and the highest primary production in the Arctic Ocean. Considered to be one of the largest polynyas within the Arctic, an estimated more than 60 million birds inhabit the region, including the largest single species aggregation on earth of Dovekies/ Little Auks. The polynya is critical habitat for many marine mammal species such as Atlantic Walrus (*Odobenus rosmarus*), Beluga (*Delphinapterus leucas*), Narwhal (*Monodon Monoceros*), Bowhead (*Balaena mysticetus*), Ringed Seal (*Pusa hispida*), Bearded Seal (*Erignathus barbatus*) and Polar Bear (*Ursus maritimus*).

Due to its biological, social-economical, and cultural importance, this area has been evaluated as unique through several international processes. The North Water Polynya was identified as an Ecologically and Biologically Significant Area (EBSA) by Fisheries and Oceans Canada in 2011 (DFO 2011). In another process in 2011, made by Aarhus University and the Greenland Institute of Natural Resources, the area was ranked highest of all Greenlandic Marine Areas, by using the IMO Particular Sensitive Sea Areas Crtieria. In 2017, the International Union for Conservation of Nature and Natural Resources (IUCN) and the UNESCO’s World Heritage Centre identified the North Water Polynya and Adjacent Areas as one of seven potential candidate areas in the Arctic for Outstanding Universal Value (OUV). Further, from 2016 to 2018, the Inuit Circumpolar Council (ICC) established the Pikialasorsuaq Commission to gather information from communities surrounding the North Water Polynya, and support Inuit in providing future recommendations for the region (e.g., Kyhn and Mosbech 2019).

The Canadian Science Advisory Secretariat (CSAS) will be hosting an international meeting to review the state of knowledge for the North Water Polynya. A current literature review of the North Water will be assembled from published scientific documents, reports and peer reviewed journals, as well as any documented Inuit Qaujimajatuqangit[1] (IQ) and hunter/user knowledge for the region. This information has been requested to help inform future collaborations related to the North Water, and will attempt to identify areas for which both scientific, Indigenous and hunter/ local knowledge may be lacking, and where more work is needed to understand this sensitive ecosystem. Further, Aarhus University and the Greenland Institute of Natural Resources have provided a background document summarizing published descriptions and spatial information on the most important biological areas in the North Water Polynya (Christensen et al. 2017). This meeting will be attended by international researchers and knowledge holders, and local subject matter experts.

[1] Defined as Inuit ways of doing things, including the past, present and future knowledge, experience and values of Inuit society.

Objectives

The intent of the meeting is to conduct a peer-review of an Ecosystem Overview Report on the North Water Polynya, which will be based on the most relevant available information and scientific research for the area. Background material in the form of scientific overview documents provided by proposed partners and contributors will be included, and will provide the basis for discussion and scientific advice on the specific objectives outlined below:

1. Describe and map, where possible, key ecological and biological features, representative coastal and marine ecosystems, and other key physical oceanographic and habitat features within the North Water Polynya and adjacent areas;
2. Identify key uncertainties and knowledge gaps within the North Water Polynya,
3. Identify activities and likely/known stressors that may affect the key ecological and biological features in the North Water Polynya.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document(s)

Expected Participation:

Participants will be invited from a variety of organizations with expertise in relevant disciplines,

in order to capture the full diversity of scientific schools of thought and opinion. Participants are expected to contribute their knowledge and expertise to the meeting independent of any organizational mandates or agendas

- Government organizations (e.g., Fisheries and Oceans Canada, Parks Canada, relevant Ministries from the Government of Greenland)
- Local experts from Canadian and Greenlandic communities (e.g., Grise Fiord, Qaanaaq)
- Inuit Organizations, Hunters and Trappers Organizations (e.g., Inuit Circumpolar Council Canada, Kalaallit Nunaanni Aalisartut Piniartullu Kattufiat [KNAPK])
- Academic Institutions (e.g., University of Manitoba, Aarhus University, Greenland Institute of Natural Resources & Greenland Climate Research Centre)
- Non-Governmental Organizations (e.g., World Wildlife Fund, Oceans North)

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APPENDIX 2. LIST OF MEETING PARTICIPANTS

Name	Organization/Affiliation
Jason Stow (Co-Chair)	DFO – Science, Ontario and Prairie Region
Tom Christensen (Co-Chair)	Aarhus University, Denmark
Claire Hornby (Science lead)	DFO – Science, Ontario and Prairie Region
Kevin Scharffenberg (Rapporteur)	DFO – Science, Ontario and Prairie Region
Elizabeth Worden (Rapporteur)	University of Manitoba, Canada
Bethany Schroeder	DFO - Marine Planning and Conservation, Arctic Region
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Steve Ferguson	DFO – Science, Ontario and Prairie Region
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Andrew Randall	Qikiqtani Inuit Association, Canada
Andrew Bresnahan	Qikatani Inuit Association, Canada

APPENDIX 3. AGENDA

DAY 1 – Wednesday, January 22, 2020

9:00 am Welcome and Meeting Introduction (Chairs)

- Participant Introduction (Please be prepared with a few sentences about your background, knowledge and expertise for this meeting)

9:30 am Overview of the CSAS Peer Review Process (Joclyn Paulic)

- Review Terms of Reference
- Review Meeting Agenda

10:15 a.m. Health Break (refreshments provided)

10:30 am Fisheries and Oceans Canada (DFO) Context and Applicability (B. Shroeder)

10:45 am Greenland/Denmark Context and Similar Processes (TBD)

11:00 am Working Paper Presentation – Methods and Process (C. Hornby)

11:45 am Lunch (not provided)

12:45 pm Working Paper Presentation and Discussion – Sea Ice, Bathymetry, Oceanographic and Climate themes (C. Hornby)

2:00 pm Working Paper Presentation and Discussion – Nutrients and Lower trophic level themes (Microbial, Productivity, Zooplankton, algae and benthos) (C. Hornby)

2:30 pm Health Break

2:45 pm Continued Discussion

3:30 pm Working Paper Presentation and Discussion – Marine fishes theme (C. Hornby)

4:25 pm Summary of Day 1 and review Day 2 agenda

4:30 pm Day 1 Adjourns

DAY 2 – Thursday, January 23, 2020

9:00 am Summarize Day 1 and review Day 2 agenda (Chairs)

9:10 am Working Paper Presentation and Discussion – Marine Mammals and Birds themes (C. Hornby)

10:30 am Health Break (refreshments provided)

10:45 am Continued Discussion

11:30 am Working Paper Presentation and Discussion – Danish North Water Report Seasonally Important Areas (A. Mosbech/ T. Christensen)

12:00 pm Lunch (not provided)

1:00 pm Working Paper Presentation and Discussion – Ecologically Significant features and seasonally important areas (C. Hornby)

2:30 pm	**Health Break**
2:45 pm	Working Paper Presentation and Discussion –Anthropogenic activities, environmental stressors and knowledge gaps (C. Hornby)
3:35 pm	Acceptance of Working Paper
4:00 pm	Presentation and Discussion of Draft Science Advisory Report (Chairs)
4:25 pm	Summary of Day 2 and review Day 3 agenda
4:30 pm	Day 2 Adjourns

DAY 3 – Friday, January 24, 2020

9:00 am	Summarize Day 2 and review Day 3 agenda (Chairs)
9:10 am	Continue drafting Science Advisory Report (Chairs)
10:15 am	**Health Break (refreshments provided)**
10:30 am	Finalize Summary Bullets (Chairs)
12:00 pm	**Lunch (not provided)**
1:00 pm	If needed-continue finalizing Science Advisory Report (Chairs)
1:45 pm	Summary of Meeting and Outcomes/Next Steps (Chairs)
2:00 pm	Meeting Complete – THANK YOU!