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CAFF Designated Agencies:

- Norwegian Environment Agency, Trondheim, Norway
- Environment and Climate Change Canada, Ottawa, Canada
- Faroese Museum of Natural History, Tórshavn, Faroe Islands (Kingdom of Denmark)
- Finnish Ministry of the Environment, Helsinki, Finland
- Icelandic Institute of Natural History, Reykjavik, Iceland
- Ministry of Foreign Affairs, Greenland
- Russian Federation Ministry of Natural Resources, Moscow, Russia
- Swedish Environmental Protection Agency, Stockholm, Sweden
- United States Department of the Interior, Fish and Wildlife Service, Anchorage, Alaska

CAFF Permanent Participant Organizations:

- Aleut International Association (AIA)
- Arctic Athabaskan Council (AAC)
- Gwich’in Council International (GCI)
- Inuit Circumpolar Council (ICC)
- Russian Indigenous Peoples of the North (RAIPON)
- Saami Council


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ACKNOWLEDGEMENTS

This coastal workshop was hosted by Polar Knowledge Canada at the Lord Elgin Hotel in Ottawa, Canada between February 29 and March 3, 2016. Workshop organizers would like to thank the following organizations who contributed to travel for Inuit TK experts and other workshop related expenses – Makivik Corporation, Nunavut Department of Fisheries and Sealing, Oceans North, and the U.S. Geological Survey.

KEY TERMS

Biodiversity is defined by the United Nations Convention on Biological Diversity as “the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems, as well as the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems”. Under this definition, biodiversity refers to the broad range of species in the coastal ecosystem, from microbiota to plants, mammals, fish, and birds. Changes to the physical environment as well as human activities can affect the biodiversity of ecosystems and the Arctic may well see an increase in biodiversity as new species move north.

Focal Ecosystem Components (FECs) are key ecosystem elements that are, or will become, the targets of the monitoring effort, as well as their related attributes. As an example, shorebirds may be selected as FECs, and shorebird attributes (the components of shorebirds on which we want to report) that may be monitored could include shorebird composition, and demographics, with shorebird parameters (the actual measures we use) being shorebird species richness or other population measures.

Conceptual ecosystem models (essentially combining the key elements of ecosystems and the relationships between them) were used throughout the meeting and served as a useful approach for identifying key species in an ecosystem (e.g. a tidal lagoon) and the relationship of these species with each other, the physical environment, human needs and activities, and climate change.

Traditional Knowledge is a systematic way of thinking and knowing that is elaborated and applied to phenomena across biological, physical, cultural and linguistic systems. Traditional Knowledge is owned by the holders of that knowledge, often collectively, and is uniquely expressed and transmitted through indigenous languages. It is a body of knowledge generated through cultural practices, lived experiences including extensive and multigenerational observations, lessons and skills. It has been developed and confirmed over millennia and is still developing in a living process, including knowledge acquired today and in the future, and it is passed on from generation to generation.

GLOSSARY OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AMAP</td>
<td>Arctic Monitoring Assessment Program</td>
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<tr>
<td>CACCON</td>
<td>Circum-Arctic Coastal Communities Knowledge Network</td>
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<tr>
<td>CAFF</td>
<td>Conservation of Arctic Flora and Fauna</td>
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<tr>
<td>CBMP</td>
<td>Circumpolar Biodiversity Monitoring Program</td>
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<tr>
<td>CEMG</td>
<td>Coastal Expert Monitoring Group</td>
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<tr>
<td>DFO</td>
<td>Department of Fisheries and Oceans - Canada</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FEC</td>
<td>Focal Ecosystem Component</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>IPY</td>
<td>International Polar Year</td>
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<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
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<tr>
<td>PDC</td>
<td>Polar Data Catalogue</td>
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<tr>
<td>POLAR</td>
<td>Polar Knowledge Canada</td>
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<td>TK</td>
<td>Traditional Knowledge</td>
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<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
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WORKSHOP PARTICIPANTS

Traditional Knowledge, northern community representatives, and Permanent Participants

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Henry Alayco – Nunavik Marine Region PC
Roy Ashenfelter – Bering Straits Native Corp.
Carolina Behe* – Inuit Circumpolar Council
John Cheechoo – Inuit Tapiriit Kanatami
Patrick Gruben – Joint Secretariat, Inuvialuit
Qaiyaan Harcharek – IK holder, Hunter, Anthropologist
Cyrus Harris – IK holder, Hunter
Jimmy Johannes – RNUK/NHFTA/Nunavik Hunters, Fishermen and Trappers Association
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Baba Pedersen – Canadian Rangers & INAC

Representatives from academia, national governments and government agencies

Canada

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Nicole Couture – Geological Survey of Canada
Donald Forbes – CACCON/ Future Earth Coasts
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Jonathan Pierce – Environmental IRB - Inuvialuit
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Katherine Wilson – Canadian Ice Service
Angela Young – Government of Nunavut

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IRB = Impact review board
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Becci Anderson* – U.S. Geological Survey
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Stacey Fritz* – Bureau of Land Management
Tahzay Jones – National Park Service
Vanessa von Biela – U.S. Geological Survey

CAFF Secretariat

Courtney Price – Conservation of Arctic Flora and Fauna
INTRODUCTION
The Coastal Expert Workshop, which took place in Ottawa, Canada from March 1 to 3, 2016, initiated the development of the Arctic Coastal Biodiversity Monitoring Plan (Coastal Plan). Meeting participants, including northern residents, representatives from industry, non-governmental organisations (NGOs), academia, and government regulators and agencies from across the circumpolar Arctic, discussed current biodiversity monitoring efforts, key issues facing biodiversity in Arctic coastal areas, and collectively identified monitoring indicators, or Focal Ecosystem Components (FECs). On February 29, the day before the workshop, a full day was allocated to Traditional Knowledge (TK) holders to meet and elucidate how this important knowledge can be included in the process of building the Coastal Plan and monitoring biodiversity in Arctic coastal areas, along with scientific data and variables.

This document provides 1) background information about the Circumpolar Biodiversity Monitoring Programme and the Coastal Expert Monitoring Group, 2) overviews on workshop presentations and breakout sessions, and 3) details regarding outcomes of the workshop that will inform the drafting of the Coastal Plan.

BACKGROUND
The Coastal Expert Monitoring Group (CEMG) is organized within the Circumpolar Biodiversity Monitoring Program (CBMP), an international network of scientists, governments, Indigenous organizations and conservation groups. The CBMP works to harmonize and integrate efforts to monitor the Arctic's living resources under the Conservation of Arctic Flora and Fauna (CAFF) Working Group of the Arctic Council.

CBMP aims to develop four coordinated and integrated Arctic Biodiversity Monitoring Plans to help guide circumpolar monitoring efforts. These plans represent the Arctic's major ecosystems:

- Marine
- Freshwater
- Terrestrial
- Coastal

The Coastal Expert Monitoring Group is charged with developing a biodiversity monitoring program for coastal ecosystems across the circumpolar Arctic.

For more information visit http://www.caff.is/monitoring
WORKSHOP OBJECTIVES
There were five primary objectives of the workshop:

1. Continue to develop an inventory of ongoing Arctic coastal biodiversity monitoring across circumpolar countries.
2. From a range of Northern perspectives, develop a comprehensive understanding of the major questions and issues facing Arctic coastal biodiversity and questions that need to be addressed to meet the needs of Coastal Plan developers and users.
3. Develop a list of Focal Ecosystem Components that prioritize important coastal biodiversity and ecosystem components for monitoring.
4. Develop and utilize a series of conceptual social-ecological models that link FECs to the drivers and stressors that currently, or may in the future, impact Arctic coastal biodiversity.
5. Develop a process for inclusion of Traditional Knowledge of Arctic coastal ecosystems in the design and delivery of the Coastal Plan.

OVERVIEW OF INFORMATION GATHERING PROCESS
Gathering information for the Coastal Plan, including a list of Focal Ecosystem Components, was one of the major goals of the CEMG workshop. The following initiatives and activities took place prior to and during the workshop to stimulate discussion and elicit input from a variety of coastal experts. These activities will be covered in detail in this workshop report:

1. A CEMG Questionnaire was distributed to stakeholders in the coastal ecosystem community inviting them to comment on the most pressing issues affecting Arctic coastal biodiversity, including recommending coastal ecosystem components to be considered as FECs for the Coastal Plan. It was distributed to northern residents, Traditional Knowledge holders, government scientists, university researchers, NGOs, and industry.
   [https://form.jotform.com/60272016921952](https://form.jotform.com/60272016921952)
2. Key monitoring questions were identified by participants during a breakout session on the first day of the workshop. These were structured under a number of themes such as climate change, food security, pollution, infrastructure, and development and shipping.
3. Conceptual models of coastal ecosystem sub-systems (e.g. deltas, barrier islands, tundra cliff and sandy shores, rocky shore ecosystems) posted on the walls throughout the CEMG meeting venue as large poster diagrams, and participants were encouraged to annotate these posters with specific issues or suggestions of FECs relevant to those sub-systems.
4. Small breakout groups on FEC development were carried out on the second day of the meeting to facilitate identification of FECs. This was done in the context of specific coastal sub-systems (rocky-shore, soft-shore, and coastal wetlands and freshwater sub-systems), as well as FECs of concern under the broader food security lens and those identified by the industry and NGO communities.
Prior to the workshop, a questionnaire was circulated to solicit input from those with extensive knowledge of Arctic coastal environments, specifically, those people who would benefit from a comprehensive Coastal Plan. Respondents included community members, coastal scientists, Traditional Knowledge holders, and knowledge users. The questionnaire asked respondents to consider the following questions:

- What are the most pressing issues facing Arctic coastal biodiversity at this time?
- What specific Arctic coastal species should be monitored? Why these species?
- Which specific Arctic coastal locations need to be monitored? Why these places?
- What are the key gaps in Arctic coastal monitoring at this time?
- The CEMG is dedicated to including the Traditional Knowledge of Indigenous Knowledge holders. What suggestions do you have to include TK in developing and maintaining the Coastal Plan?
- We would like to make the Coastal Plan as useful as possible. What do we need to consider to make the Coastal Plan useful from your perspective and for your management needs or reporting requirements?

The figure below summarizes the overlap between FECs recommended from the perspectives of Traditional Knowledge and science.

Figure 1. Summary of FEC submissions to the CEMG questionnaire
There are many questions that Traditional Knowledge holders must address and many decisions that coastal communities face. When working with scientists and international programs, some of the questions and decisions include how to share TK information, how information from TK holders should be used with science, how to safeguard information documented from TK holders, and how to ensure that TK holders are involved in analysis and interpretation of their information.

This one-day meeting allowed for TK holders and Arctic Council Permanent Participant representatives to become familiar with the CEMG and to openly discuss the use of TK within the CEMG.

The meeting objectives were to:

1. obtain a general understanding of CEMG intentions and goals,
2. discuss challenges and opportunities for the inclusion of TK within the Coastal Plan,
3. discuss the processes needed to establish a platform for the co-production of knowledge platform within the Coastal Plan, and
4. discuss how information from TK holders can be documented, recorded, archived, and made available for the assessment of coastal biodiversity.

A full meeting report on this meeting can be found in the attached companion report, Coastal Monitoring Indigenous Knowledge Holders Meeting Report, an independent report prepared by ICC and sponsored by Polar Knowledge Canada.

(Please note: The Arctic Council uses the term Traditional Knowledge. ICC and the Indigenous Peoples attending this workshop prefer the term Indigenous Knowledge. The companion report therefore uses the term Indigenous Knowledge.)
WORKSHOP DAY 1: TUESDAY MARCH 1, 2016

The first day of the workshop focused on setting the stage with background material, including Introductory presentations, national monitoring inventory reports given by the participating countries, and an interactive breakout session.

DAY 1 PRESENTATIONS

CBMP TRACKING CHANGE IN ARCTIC ECOSYSTEMS (TOM CHRISTENSEN)

This opening presentation introduced the working structure of the CEMG within the Arctic Council, CAFF, and CBMP. It also covered the overall goal for this working group, which is to develop the CBMP Arctic Coastal Biodiversity Monitoring Plan, similar to those developed for marine, freshwater, and terrestrial Arctic ecosystems. CBMP monitoring plans are a means of acting upon the recommendations of the Arctic Biodiversity Assessment (www.arcticbiodiversity.is). Key objectives of CBMP monitoring plans include the identification of:

- key user needs for biodiversity information
- biological focal ecosystem components, attributes, and parameters
- key abiotic drivers, which should be integrated
- existing scientific and TK monitoring capacity and data
- ways to coordinate and standardize sampling methods
- ways to harmonize and manage collected data
- key monitoring methodologies with inclusion of TK expertise
- priority gaps

CEMG – ARCTIC COASTAL BIODIVERSITY MONITORING PLAN OVERVIEW (DONALD MCLENNAN & BECCI ANDERSON)

The planned approach for the CEMG workshop was outlined, including discussion on how coastal regions are defined, incorporation of existing monitoring activities, the integration of Traditional Knowledge, the inclusion of community-based monitoring initiatives, and how to identify and fill gaps in current monitoring programs. Generally, coastal regions have been defined as those areas incorporating coastal wetlands, dunes, the intertidal zone, deltas, lagoons, estuaries and marine ecosystems to 30 m depth (see Appendix 1 for a more detailed example of how coastal boundaries have been defined).

NATIONAL REPORTS ON COASTAL MONITORING (NATIONAL REPRESENTATIVES)

National reports summarizing monitoring initiatives were reported for Canada (Jennie Knopp), The Kingdom of Denmark/Greenland (Ole Geertz-Hansen), Norway (Paul Renaud), Russia (Liudmila Sergienko), and the United States (Stacey Fritz). Iceland was not able to attend. Because Sweden and Finland do not have Arctic coastlines, they do not participate in this group, although they are supportive through the other CBMP groups.

The table in Appendix 3 summarizes selected examples of ongoing monitoring activities of five of the Arctic Council nations. A common theme between all nations was that monitoring programs are consistently required to seek out funding to maintain monitoring, and this will be the major challenge for the Coastal Plan. A common opportunity noted by all nations was the potential strength that could be gained from collaborative monitoring initiatives that are developed and managed with the cooperation of Arctic coastal communities. Although the national summaries are only a sample of all the activities taking place within government, industry, academic, and community-based monitoring initiatives for each nation, it is a robust start to understanding the opportunities for monitoring biodiversity in Arctic coastal areas.
INTRODUCTION TO TRADITIONAL KNOWLEDGE, CO-PRODUCTION OF KNOWLEDGE, CHALLENGES AND OPPORTUNITIES (CAROLINA BEHE, PITSEOLALAQ MOSS-DAVIES)

This presentation introduced the position and important role of the Permanent Participants in the Arctic Council, the historical nature of TK as it relates to environmental monitoring, and summarized the questionnaire responses from Indigenous Peoples. Key concerns raised in the questionnaire by Indigenous Peoples include:

• Localized Traditional Knowledge is seldom included
• Lack of communication
• Need for permanent monitoring
• Language – need for translated material
• Need funding for Indigenous organizations to do research
• Change in hydrodynamics due to loss of permafrost
• Lagoon systems importance to primary production
• Understanding the importance of winter food chains

This presentation was followed by plenary conversation and provided the opportunity for northern residents and TK holders to share experiences of observed changes in their local coastal ecosystems, and also their experiences, both positive and negative, with scientific collaborators. The concern for how to engage youth in environmental stewardship and monitoring activities was also expressed and discussed among the group.

Carolina Behe presented the Ottawa Traditional Knowledge Principles document as a helpful guideline for engaging TK in an effective and respectful manner:

A MARINE MONITORING PLAN FOR THE SOUTHERN CANADIAN ARCTIC ARCHIPELAGO (BILL WILLIAMS)

An overview of coastal-marine studies taking place in the vicinity of Cambridge Bay and Bathurst Inlet provided an example of a scientific approach to understanding coastal ecosystems and biodiversity. The presentation focused on estuarine circulation, the processes driving the mixing of waters in this region, and how nutrients are brought up from deeper waters. It was specifically noted that Pacific Ocean inflow waters have a higher concentration of nutrients, whereas river inflow is lower in many nutrients. These processes are beginning to be monitored in further detail through a partnership between Polar Knowledge Canada and the Department of Fisheries and Oceans (DFO) Canada using both ice and ship-based instruments to understand nutrient cycling and the redistribution of warmer waters.

BAFFINLAND IRON MINES MARINE BIODIVERSITY MONITORING (JENNIFER ST. PAUL BUTLER)

This presentation introduced the Mary River Project’s intended plans for coastal-marine shipping of iron ore and the monitoring projects undertaken by the company to assess the potential impact of shipping activities on the coastal-marine ecosystem near the community of Pond Inlet, Canada. Specific monitoring activities have included surveys of whale activity (Bruce Head monitoring program and acoustic monitoring), marine benthic monitoring, and aerial surveys, and partnerships with Environment Canada and local communities (e.g., the Workshop on Shipping Through Ice in Pond Inlet).

CONCEPTUAL ECOSYSTEM MODELS (DONALD MCLENNAN)

Ecosystem models were presented as a way for the group to visualize coastal ecosystems and to help develop key questions for determining FECs. This method allows for different social and cultural perspectives to find common ground and highlights the relationships and linkages between coastal
biodiversity and abiotic drivers, processes, and threats. This presentation introduced the first activity for the breakout session later in the day.

**SUMMARY OF KEY COASTAL ISSUES IDENTIFIED FROM THE CEMG QUESTIONNAIRE (BECCI ANDERSON)**

An primary concerns from the questionnaire were presented. They included climate change, bad decision-making, invasive species, food security, infrastructure/development, and associated pollution. This presentation motivated the second part of the breakout session later in the day, in which participants listed key issues associated with specific themes related to coastal ecosystems.

**DAY 1 BREAKOUT SESSION**

**IDENTIFYING KEY QUESTIONS AND REVIEWING CONCEPTUAL ECOSYSTEM MODELS (ALL PARTICIPANTS)**

Appendix 4 contains a full listing of information produced from these activities.

*Identifying key questions*

During this session of the workshop, participants were encouraged to work with moderators at large poster boards to identify key questions related to four topics: food security; climate change; pollution; and infrastructure, development, and shipping. An additional large poster board was available for ideas that did not fit into these categories. This activity, along with the CEMG questionnaire, enabled members of the CEMG to recognize key issues to help build the environmental, cultural, and socio-economic context for the eventual selection of FECs. The key issues identified under specific themes include:

**Climate change**
- ocean acidification and sea-level change (emergence and submergence)
- changing storm-surge climatology and wave regime (with more open water)
- permafrost degradation: increasing depth of thaw (degrading permafrost, coastal erosion)
- pathogen effects in a warming climate
- changes to the timing and duration of sea ice; changes in ice cover, thickness, and extent
- changing weather and oceanic conditions and their influence on number, movement, and behavior of marine species

**Decision-making process**
- knowledge gaps (including decision trees and accessibility of pertinent and sufficient knowledge for decision-making)/poor knowledge and information for decision-making
- lack of TK applications within current planning framework
- lack of ecosystem based planning
- lack of common management goals
- lack of physical knowledge

**Invasive and expanding species**
- early identification of aquatic and marine invasive species, and transport vectors
- invasive species effects on indigenous species
- northward spread of non-native species
- native species range changes
- Canada goose population growth
Animal population changes
- shifts in upper trophic level species distributions, size, mortality, natality
- changes in spawning grounds
- changes in the number, make-up, and behavior of resident and migratory species
- effects of climate change and erosion on wildlife presence, abundance, and activities

Development/military presence
- effects of development on resident and migratory species
- militarization of an important coastal area, Wrangel Island Infrastructure issues
- untreated sewage from expanding communities; unseparated landfill waste
- ageing community infrastructure
- electricity produced solely through diesel generators

Cross-cutting issues
- Food security (spanning all themes)
- Noise
- Pollution
- Shipping
- lack of funding outside of industry dollars
- Preparedness (lack of response infrastructure for oil spills/major pollution events)
- Freshwater quality and quantity
- Changing nature of fresh water input in the coastal marine environment

Conceptual ecosystem models
During the breakout session, and throughout the rest of the meeting, participants were encouraged to review conceptual ecosystem models printed on large, poster-sized paper and placed on the walls of the conference room. Participants had the opportunity to annotate conceptual models illustrating the physical setting of several coastal ecosystem sub-systems (e.g. delta, barrier island, tundra cliff and sandy shores, and rocky shore ecosystems) and also conceptual maps centered on sea ice and walrus from the Inuit Circumpolar Council-Alaska Alaskan Inuit Food Security Conceptual Framework: How to Assess the Arctic from an Inuit Perspective (http://iccalaska.org/wp-icc/wp-content/uploads/2016/05/Food-Security-Full-Technical-Report.pdf).

The graphics below in Figure 2 summarize the comments made on the conceptual ecosystem posters, and highlight potential knowledge gaps in our understanding of these coastal ecosystem sub-systems.
Note the human use of fish including Arctic char, whitefish, cisco complex, sheefish, pike, burbot; and ducks and geese.

Monitor shallow lakes as fish nurseries and habitats for ducks.

Subsidence changes with variation in flooding, runoff, and timing of the freshet, with impacts for water levels and associated biology.

Monitor changes in phenology (i.e. timing) of flooding.

Near estuaries, what are the impacts of differences in flow input on the connectivity of river/delta systems?

Saltwater inflow in winter correlates with arrival of specific fish.

Note that fish assemblage changes both seasonally and yearly.

Seasonal variability in freshwater outflows, currents, and the input of terrestrial organic carbon.

Impacts of acidification on planktonic communities.

Liverpool Bay and Tuktoyaktuk peninsula, Canada
NASA Earth Observatory
Woodfjorden, Svalbard
NASA Earth Observatory

Tundra Cliff and Sandy Shores

Seasonal changes in land-fast sea-ice? Potential loss of coastal heritage resources?

How will less sea ice change salinity and impact access for people and polar bears?

For settlements, what erosion control measures work and are they a long-term solution?

How are benthic species in the intertidal and sub-tidal zones changing as a result of shoreline changes? (e.g. nutrient/sediment inputs, snow, currents)

Rocky Shore Ecosystems

Recommend study of key intertidal organisms and their relationships with substrates.

Urchins, starfish, sculpins, tunicates, anemone, seagrasses, algae, intertidal SPP as potential FECs. Which ones are harvested resources?

Zooplankton/phytoplankton; benthic-pelagic coupling; role of kelp in primary production.

What are the potential positive feedback effects regarding water temperature and quality (suspended sediments and dissolved chemistry)?

What about benthic communities on other substrates? How does benthic diversity vary with shoreline morphology? (depth, ice scour zone, etc.)

How will changes in the seasonal cycle impact the social-infrastructure?

Figure 2. Comments added to the conceptual ecosystem model
WORKSHOP DAY 2: WEDNESDAY MARCH 2, 2016

The second day of the workshop focused on the development of Focal Ecosystem Components, including a breakout session by coastal habitat areas and themes. Additionally, informational presentations were given throughout the day.

DAY 2 PRESENTATIONS

SELECTING ARCTIC COASTAL FECS THAT MEET CLIENT NEEDS (TOM CHRISTENSEN)

Tom Christensen started the day by introducing a question-driven approach to determining FECs – questions that reflect the needs of Arctic communities, governments, scientists, and industry. Conceptual ecosystem models were demonstrated as a means of identifying key indicators within an ecosystem. This approach can aid in determining:

- ecological importance in conceptual models,
- relevance to ecosystem services,
- importance to Arctic communities,
- importance for management, and
- legislated needs.

This presentation was followed by an extensive plenary discussion concerning defining FECs and how to manage species that cross between the coastal/terrestrial/marine borders. Group comments included:

- How does habitat fall into this monitoring scheme, and can habitat be considered a FEC? Discussion followed that habitat, or specific aspects of it, could itself be an FEC, or considered a stressor.

- What is a coastal FEC? For example the beluga whale is a traveler; it travels across marine, coastal and freshwater habitats. Are they considered coastal?

- Migratory species, such as the Canada goose, are sensitive to habitat change inside and outside the Arctic – this plan focuses on change in Arctic habitats.

- Building on the last example, many coastal species cross boundaries. If habitat is going to be considered in FEC monitoring, we need to consider that some habitat’s components will fall outside the “coastal” or even “Arctic” definitions.

RECOMMENDED FECS FROM THE CEMG QUESTIONNAIRE RESULTS (DONALD MCLENNAN)

Posters compiling the list of FECs suggested from the questionnaire were provided, and the group was invited to add to the list.

MONITORING INTRODUCED AND NATIVE BIODIVERSITY OF COASTAL INVERTEBRATES IN THE CANADIAN ARCTIC (KIMBERLY HOWLAND)

This talk provided an overview of invasive species and the potential means of their introduction into northern waters (e.g., ship hulls, ballast water, change in migration patterns). Strategies for prevention and mitigation were presented, including methods for management, early detection, and the development of a community-based monitoring network.

A particularly valuable concept presented was the “invasion curve”, which illustrates the relationship between the spatial extent of an invasive species and the possibility for species eradication. It illustrates that the earlier an invasion is detected and acknowledged, the more likely the invasive species will be eradicated.
ARCTIC CHAR MONITORING ACTIVITIES AND OTHER INITIATIVES IN THE CENTRAL CANADIAN ARCTIC (LES HARRIS)

An overview of Arctic char monitoring projects in the area of Cambridge Bay, Paulatuk, and Darnley Bay (Canada) was presented by DFO fish scientist Les Harris. These studies focus on the migration patterns and health parameters of the Arctic char community (e.g., length, age, harvest statistics). A common theme between these monitoring projects is a significant emphasis on the following:

- community-based monitoring
- community awareness, training/capacity building
- consistency in community monitors through time
- consistency with the researchers present through the course of the project (building trust)

The ocean-tracking network follows migrations of 330 tagged Arctic char and seven lake trout with over 60 receivers in marine and freshwater environments.

DAY 2 BREAKOUT SESSION
FOCAL ECOSYSTEM COMPONENT DISCUSSION (ALL PARTICIPANTS)

To stimulate further ideas and input on generating lists of FECs, breakout groups formed and focused on a holistic view or specific aspects of the coastal ecosystem subsystems (e.g., rocky coastal shores, soft coastal shores, coastal wetlands and freshwater systems), community-led and focused monitoring, and the roles of industry and NGOs.

At the end of the session, all groups reconvened together and each breakout group summarized their process and their list of potential FECs. These are described in detail in Appendix 5. In some cases, groups used key questions developed during the breakout session of the first day to develop a list of FECs. Other groups integrated the structure provided by other monitoring programs, such as the CBMP Marine Steering Group.
WORKSHOP DAY 3: THURSDAY MARCH 3, 2016

The final day was focused on data management and included a final breakout session for participants to work together on FEC lists.

DAY 3 PRESENTATIONS

ARCTIC BIODIVERSITY DATA SERVICE (COURTNEY PRICE)
This presentation illustrated how CAFF manages scientific data, with particular focus on the promotion of free and open access to data whenever possible. The Arctic Biodiversity Data Service (ABDS) GeoNetwork hosts data and metadata (i.e., context for the data) and enables people to both submit their own data and access other datasets. ABDS also facilitates links to other data portals, such as the Global Biodiversity Information Facility (GBIF). It is important to note that ABDS is active, but also in continual development. Current activities include uploading existing data holdings to the GeoNetwork, streamlining data flow into the CAFF office (CBMP marine, freshwater, terrestrial reports), and linking with existing systems to increase the access to information (e.g., Polar Data Catalogue, (PDC) Ocean Biogeographic Information System (OBIS)).

Further information about ABDS can be found at www.abds.is

MANAGEMENT OF TRADITIONAL KNOWLEDGE INFORMATION AND THE COASTAL PLAN (CAROLINE BEHE)
Carolina Behe lead a discussion about the use and treatment of TK, particularly as it travels further from the community, and the critical need for context to be provided about the information.

Specifically noted was the need to involve TK holders in the analysis of information from TK. Additionally, it is important to return TK records to the community and show explicitly how TK has been used for evidence in the realms of science and policymaking – these actions show respect and build trust.

CIRCUMPOLAR ARCTIC COASTAL COMMUNITIES KNOWLEDGE NETWORK (DONALD FORBES)
Donald Forbes provided an introduction to the Circumpolar Arctic Coastal Communities Knowledge Network, or CACCON (“Catch On”) – a pan-Arctic network of community-engaged and integrated coastal observatories, with local and regional knowledge hubs. Projects in CACCON are co-designed and co-produced with community members and aim to create adaptable and resilient communities.

CACCON enables connections between Arctic communities to build collaborations on projects that address issues that are common between communities (e.g., land-fast sea ice monitoring).

To learn more about CACCON visit caccon.org
The SmartKOMATIK is a survey tool used by SmartICE to monitor community sea-ice conditions. It is an adapted ground conductivity meter deployed on a snowmobile-drawn ice sled (komatik [Labrador] or qamutik [Nunavut]) to map landfast ice thickness in areas of community use, and particularly conflicting use with winter shipping. In late March 2016, Joey Angnatok and Rodd Laing from Nain (Nunatsiavut) surveyed ice thickness with the SmartKOMATIK to inform navigation of the MV Arctic through the landfast ice en route to Voisey’s Bay mine site.

SmartICE is a community-university-government-industry research and monitoring partnership that addresses local priority issues around safe sea-ice travel and shipping-community sea-ice interactions. The overall goal of SmartICE is to develop an integrated, near real-time monitoring and dissemination system that informs decisions about coastal sea-ice travel and shipping, thereby improving safety. SmartICE technologies and operations are being piloted in Nunatsiavut (Nain) and Nunavut (Pond Inlet). Although primarily designed to support ice-travel safety, SmartICE observations may also inform winter fishery and harvesting programs, search-and-rescue operations, climate change adaptation planning, ecosystem monitoring, and sea-ice technology validation. SmartICE directly involves Inuit in all aspects of its operation and most importantly strives to integrate Inuit Qaujimajatuqangit about sea-ice conditions.

DAY 3 BREAKOUT SESSION
SMALL GROUP REVIEW OF FOCAL ECOSYSTEM COMPONENTS (ALL PARTICIPANTS)
In the final breakout session of the workshop, participants spent time discussing FECs in small, mixed groups. The focus of this activity was to intentionally mix groups, fostering communication between TK holders, scientists, and NGO and industry participants. Participants reviewed the FEC lists that were produced in the Day 2 breakout session and discussed which were most applicable from their unique perspectives.
MEETING OUTCOMES

This workshop was the first step to developing a useful and useable plan for monitoring coastal biodiversity across the Arctic – this is key to a sustainable program and is fundamental for fostering long-term relationships among the communities of coastal experts.

The Arctic Coastal Biodiversity Monitoring Plan, once implemented, will provide timely information about ongoing and anticipated changes in coastal biodiversity that can inform proactive decision-making in communities, governments, and industry. To this end, participants are encouraged to continue contributing and communicating with the Coastal Expert Monitoring Group, including feedback on summaries and reports, in the coming months and years. Although the implementation of Arctic coastal biodiversity may be different among countries, the overall goals will be the same.

The principal CEMG meeting outcomes that directly relate to the outlined meeting objectives include:

1. Inventories of ongoing coastal biodiversity monitoring were presented from each of the nations attending the workshop (Canada, Denmark & Greenland, Norway, Russia, and the United States). A summary of these inventories is available in Appendix 3.

2. A comprehensive list of the major questions and issues was developed from breakout sessions and discussions during the meeting, and from a Coastal Expert Monitoring Group (CEMG) online questionnaire [https://form.jotform.com/60272016921952](https://form.jotform.com/60272016921952). These are presented in Appendix 2 and ongoing solicitations are welcome over the course of the plan development.

3. A list of key Focal Ecosystem Components (FECs) was developed based on feedback from workshop breakout sessions and the CEMG questionnaire. A summary of all suggested FECs is available on the following two pages. Appendix 5 contains FECs developed during the breakout session.

4. Meaningful discussions throughout the meeting indicate a collective will and intent to work towards a system that builds trust through equitable engagement incorporating Traditional Knowledge and science in knowledge co-production processes.

Two additional points were raised numerous times throughout the CEMG meeting. First, the need to incorporate knowledge of the physical environment will require clear communication and collaboration with the Arctic Council’s Arctic Monitoring and Assessment Programme (AMAP) Working Group research community to ensure that the abiotic data relevant to Arctic coastal ecosystems is being collected, recorded, and reported. Specific AMAP documents that can contribute to the understanding of the coastal environment include:

- Snow, Water, Ice and Permafrost in the Arctic (SWIPA) [http://www.amap.no/swipa](http://www.amap.no/swipa)
- Similarly, current research into the physical changes to the Arctic coastline is being investigated by the Coastal Dynamics group of the International Permafrost Association: [http://ipa.arcticportal.org/about-the-ipa/working-parties/arctic-coastal-dynamics-acd](http://ipa.arcticportal.org/about-the-ipa/working-parties/arctic-coastal-dynamics-acd)

Second, collaboration with the marine, terrestrial, and freshwater CBMP groups will be necessary to ensure that key knowledge gaps are being addressed, relevant data are collected and shared, and that CBMP monitoring efforts are not redundant. The CBMP monitoring plans for these can be found...
at:

- Arctic Freshwater Biodiversity Monitoring Plan (The Freshwater Plan): http://www.caff.is/freshwater/freshwater-monitoring-plan
### SUMMARY OF ALL SUGGESTED ARCTIC COASTAL FECS

The following two pages compile all FECs suggested to date through the workshop process and from the CEMG questionnaire.

#### Fish
- Arctic char
- Arctic and least cisco
- broad and lake whitefish
- burbot
- capelin
- flatfish
- herring (Pacific)
- lumpsucker
- pike
- rainbow Smelt
- saffron and Arctic cod
- salmon (Pacific, Pink)
- sculpins
- sheefish
- smelt
- lagoon species

#### Mammals
- Seals: ice, bearded (ugruk), ringed (natchiq), ribbon (qaigulik), harbour, spotted
- whales (beluga, bowhead, grey, humpback, orca, narwhal)
- walrus
- polar bear
- reindeer/caribou
- muskox
- mice and lemmings
- fox
- grizzly bear
- sea otters

#### Birds
- seabirds
- shorebirds
- lagoon species
- Spectacled and Steller’s eiders
- Canada goose
- snow geese
- ducks
- Golden crowned sparrow
- murre
- purple sandpiper
- loons

#### Related issues/concerns
- protection of breeding grounds (food security)
- impacts of changing sea ice thickness and extent
- importance of identifying and focusing on harvested species
- risk of disease in warming climate
- occurrence of “mismatch” due to climate change
- impact of ice-breaking on seal, walrus, and bear activities
- changes in the number, make-up, and behaviour of resident and migratory species
- impacts of climate change on migration patterns, feeding areas, and breeding areas
- species dietary needs and diversity
- note that water birds also play an important feedback in nutrient cycling in lagoons and marshes
### Invertebrates
- shellfish and bivalves generally
- king crab
- brittle stars
- blue mussels
- clams
- shrimps
- copepods
- euphasids
- urchins
- starfish
- anemone
- tunicates
- benthic inverts
- zoo/phytoplankton
- microbes (generally)
- gypsy moth
- ungulate ticks
- mysids

### Plants
- benthos
- *Fucus* spp
- (bull) kelp (and kelp forests)
- other primary producers
- invasive sea weeds and plants
- algal blooms and mats
- sea/eel grass
- sea ice biota

### Related issues/concerns
- the role of soil/seabed substrates and potential risks of pollution (e.g. sewage)
- impacts of erosion on vegetation, including changing turbidity and deposition of eroded sediments
- identification and sensitivity of harvested resources
- impacts of potential oil spills on species in the intertidal zone
- consequences of flooding and salt-water inundation of low-lying areas (e.g. marshes)
- relative roles of species in primarily production

### Cross-cutting issues/concerns
- changing range, migration and phenology patterns
- early detection and identification of invasive species
- need for year-round monitoring of species to understand behaviour through the seasons
- potential risk of increased pathogens and diseases with warming climate
- food security
- response planning for potential environmental disasters
- impacts of changing sea ice on species’ behaviour, shoreline stability, and resulting impacts on habitat
- impacts of human activity (shipping, tourism, infrastructure development, monitoring practices) on coastal species
- consequences changing ocean and nutrient circulation

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*Figure 3. Summary of all suggested Arctic coastal FECs*
“I would like to present to you a very old traditional knowledge from our culture about the beluga. We will start with when the beluga is at the wintering site. If we/ since we don’t have a map with us about the area, I will say in my area the beluga will be in the Hudson Strait. The beluga will winter in this area where the ice will not move, since it’s not moving the beluga will winter in that area. Once the season begins it changes towards springtime, and when the ice begins to move, so does the beluga begin to move, to migrate. The beluga will replenish itself, it will accumulate fat as it prepares itself to give birth in the month of July. The beluga will not necessarily migrate to the immediate shoreline, it is not dumb, it will avoid crushing ice so it will move offshore. When you live in an area with rocky shore and steep cliffs the land-fast ice will accumulate and stick to the cliffs; the beluga will avoid this area. Once the ice starts to fall off the cliffs, the beluga will then move close to the shoreline, when it’s that time the beluga will migrate. It migrates from our area a long distance following the shoreline, up past James Bay to the western side of Ontario and go moult its skin in the Churchill area of Manitoba. As the season progresses towards the fall it is the big male beluga that begin its migration as the first group to leave. Its health is very lean; it is not fat when it begins its journey. Thus on its return migration as it did in the springtime, it will return by the same route back to where it spent the winter. I must add that Inuit might not necessarily be scientists, but through this time this is the lessons they learn through this passage, and this is also what is in a knowledge holder. We also hear of beluga and narwhal that become entrapped because of the ice conditions. It happens in our area and in the Nunavut area. This is a part of Inuit knowledge since time immemorial.”

- Quitsak Tarriasuk, Kuujjuaq, Nunavut, As part of discussions concerning the selection of FECs
The next steps toward developing the Coastal Plan include:

1. Completion and distribution of the Workshop Report (this document)
2. Development of the Coastal Plan through several writing meetings
3. Approval and implementation of the Coastal Plan

Ongoing engagement is key! There are a number of ways participants can remain involved. First, additional questionnaire responses are encouraged. The questionnaire can be accessed at:

Questionnaire: [https://form.jotform.com/60272016921952](https://form.jotform.com/60272016921952)

Also, to stay up-to-date with CAFF and CBMP activities, please visit:

- CAFF website: [http://www.caff.is/monitoring](http://www.caff.is/monitoring)
- Coastal monitoring page: [http://www.caff.is/coastal](http://www.caff.is/coastal)
- Twitter: [@CAFFSecretariat](http://www.caff.is/coastal)
- Instagram: [caff_arctic_biodiversity](http://www.caff.is/coastal)
- Facebook: [www.facebook.com/CAFFS](http://www.facebook.com/CAFFS)
- Email: [caff@caff.is](mailto:caff@caff.is)

The Coastal Expert Monitoring Group would like to thank the attendees for taking the time to participate in the meeting and for everyone’s contributions during the presentations, discussions, and breakout sessions. Working together, we will build an integrative coastal monitoring plan that will help the detection, assessment, and adaptation to changes in our coastal regions and communities.

“We have to work together, the Arctic is harsh, we have no choice but to work together; you have to accept our invitation to work together.”

- Quitsak Tarriasuk, Kuujjuaq, Nunavut

Koana! Tak! Qujannamiik! Спасибо! Quyanainni! þakka þér! Quyana!
APPENDICES

APPENDIX 1: COASTAL BOUNDARIES

This table summarizes the potential boundaries that can be used to define the coastal area.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Referenced Plan</th>
<th>Boundary Definition for Coastal Plan</th>
<th>Caveats/Additions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal-Marine</td>
<td>Arctic Marine Biodiversity Monitoring Plan</td>
<td>Intertidal and sub-tidal areas outwards to approximately 30 km from the coast and to 30 m depth</td>
<td>Except where biota/habitats controlled by coastal processes go deeper than 30m, or where a country has already defined 'coastal' for national programs, and prefers to stay with that definition</td>
</tr>
<tr>
<td>Coastal-Terrestrial</td>
<td>Arctic Terrestrial Biodiversity Monitoring Plan</td>
<td>Limited by the HAT, only including coastal ecosystems directly affected by marine inundation</td>
<td>Also includes areas affected by recent or historic storm surges or new land recently inundated by ocean water with normally negative effects on non-adapted ecosystem types and actively eroding shoreline zones</td>
</tr>
<tr>
<td>Coastal-Freshwater</td>
<td>Arctic Freshwater Biodiversity Monitoring Plan</td>
<td>Defined as water having a salinity of 5 psu</td>
<td>Species migrating between the different salinity regimes (e.g., salmon) may be subject to cooperation between the monitoring groups or allocated to one of the groups after being discussion and agreement.</td>
</tr>
</tbody>
</table>
## APPENDIX 2: FOCAL ECOSYSTEM COMPONENTS IDENTIFIED IN THE CEMG QUESTIONNAIRE RESULTS

<table>
<thead>
<tr>
<th>Fish</th>
<th>Marine Mammals</th>
<th>Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Arctic char</td>
<td>Seals</td>
<td>- Canada goose</td>
</tr>
<tr>
<td>- anadromous fish</td>
<td>- ice seals</td>
<td>- Spectacled and Steller’s eiders</td>
</tr>
<tr>
<td>- sheefish</td>
<td>- bearded seal</td>
<td>- seabirds and their diets</td>
</tr>
<tr>
<td>- Arctic and least cisco</td>
<td>- ringed seal</td>
<td>- marine and migratory birds</td>
</tr>
<tr>
<td>- herring (Pacific)</td>
<td>- spotted seal</td>
<td>- snow geese</td>
</tr>
<tr>
<td>- broad and lake whitefish</td>
<td>- Ugruk</td>
<td>- Golden crowned sparrow</td>
</tr>
<tr>
<td>- rainbow Smelt</td>
<td>- Natchaq</td>
<td>- murre</td>
</tr>
<tr>
<td>- saffron and Arctic cod</td>
<td></td>
<td></td>
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<tr>
<td>- flatfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- salmon (Pacific, Pink)</td>
<td></td>
<td></td>
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<tr>
<td>- sculpins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- capelin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- smelt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- salmon spawning areas</td>
<td>Walrus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polar Bear</td>
<td></td>
</tr>
</tbody>
</table>

### Plants

- Fucus SPP
- (bull) kelp (and kelp forests)
- benthic algae
- benthos
- primary producers
- macroalgae
- invasive sea weeds and plants
- algal blooms
- eel grass

### Invertebrates

- king crab
- brittle stars
- blue mussels
- marine invasives
- biofouling
- marine invertebrates as food
- copepods
- euphausids
- benthic inverts
- zoo/phytoplankton
- marine invasives
- clams
- gypsy moth, ungulate ticks

### Other

- species range change
- coastal geomorphological processes
- permafrost degradation
- coastal bacteria species with potential harmful effects
- life in the polar night
- acidification
- freshwater inputs
- sea level change, storm surge, climatology and wave regimes, permafrost
- food security
- all harvested species
- coastal ecosystems
- sea ice, coastal weather, development, erosion, entire food chain, caribou
- coastal ecosystems

*Note that questionnaire participants identified many FECs more than once*
### APPENDIX 3: NATIONAL REPORTS ON COUNTRY MONITORING

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>PHYSICAL SETTING</th>
<th>EXAMPLES OF MONITORING ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canada</strong>&lt;br&gt;Jennie Knopp</td>
<td>• &gt;150,000 km of coastline covers 50% of Canada's coastline &lt;br&gt;• Approx. 43,000 Inuit in 53 communities &lt;br&gt;• Coastline settings are variable and range from erodible soft-shore with delta and lagoons along the western mainland coast, to steep rocky shores at higher latitudes in the Arctic archipelago</td>
<td>Monitoring at international, federal, territorial, industrial, and community levels. For example:  &lt;br&gt;• Circumpolar seabird population, in collaboration with Norwegian SEAPOPS group (international)  &lt;br&gt;• Beaufort Regional Environmental Assessment (multi-stakeholder: industry, government &amp; communities)  &lt;br&gt;• Nunavut Coastal Resource Inventory – initiated in 2007, gathering information of coastal resources and activities from interviews with local hunters (territorial); the initiative has created inventories for 17 coastal communities  &lt;br&gt;• NRCan – CanCoast: Geospatial (mapping) database that compiles coastal features to assess coastal vulnerability to climate change and to assist in adaptation and planning in coastal zones (federal)  &lt;br&gt;• Baffinland Iron Mines Corp. Mary River Project Environmental assessment and Marine Biodiversity Monitoring activities (industry)</td>
</tr>
<tr>
<td><strong>Denmark &amp; Greenland</strong>&lt;br&gt;Ole Geertz-Hansen</td>
<td>• Greenland: &gt;40,000 km of coastline &lt;br&gt;• 56,000 inhabitants in 16 cities and 60 settlements (all coastal) &lt;br&gt;• Coastal setting is primarily rocky-shore with many fjords and archipelagos</td>
<td>Monitoring (primarily federal and university) includes:  &lt;br&gt;• Zackenberg Ecological Research Operations (ZERO) hosts research projects into ecosystem structure, processes, and responses; hosts baseline studies, both biotic and abiotic, that have continued since 2003  &lt;br&gt;• Nuuk Ecological Research Operations (NERO) – ecological monitoring approach similar to ZERO, initiated in 2007  &lt;br&gt;• Other research stations based in Disko and Niaqornat  &lt;br&gt;• Oil spill sensitivity atlas, which assess the offshore sensitivity of the Greenland coast to potential oil spills during each of the four seasons  &lt;br&gt;• Compilation of the Strategic Environmental Impact Assessments for Eastern Baffin Bay, Disko West, Davis Strait, South Greenland, and the Western Greenland Sea (Aarhus University)</td>
</tr>
<tr>
<td><strong>Norway</strong></td>
<td>Monitoring activities include federal and university</td>
<td></td>
</tr>
<tr>
<td>COUNTRY</td>
<td>PHYSICAL SETTING</td>
<td>EXAMPLES OF MONITORING ACTIVITIES</td>
</tr>
<tr>
<td>------------</td>
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</tbody>
</table>
| **Paul Renaud** | • Northern Norway coastline is ~12,000 km; Coast of Svalbard archipelago is 6,000 km  
• 460,000 inhabitants on northern mainland; 2,600 inhabitants on Svalbard  
• Coastal setting is primarily rocky-shore with many fjords and archipelagos | based activities such as:  
• Oceanographic mooring network  
• Hard-bottom fauna (underwater photography)  
• Intertidal surveys  
• Soft-sediment fauna  
• Epibenthos surveys (trawling studies)  
• Zooplankton/CTD transects  
• Regional biodiversity records  
• Seabird migration  
• Coastal ecosystem (ØkoKyst) assessment  
These studies primarily take place on Svalbard in the region of Longyearbyen, Ny-Ålesund and sites near the northern and southernmost coasts, and on the northern Norwegian mainland in the area of Alta. |
| **Russia**   | • Russian Arctic coastline is 26,000 km in length  
• Over 258,000 indigenous peoples in northern communities  
• Coastal setting is primarily soft-shore, with physical morphology being defined by estuaries, deltas, and muddy soft-shores | Monitoring programs (district, university, research institutions, industry and NGOs) include:  
• Mechanisms of the sustainable function of the coastal biota of the tidal Arctic Seas (Petrozavodsk St. Univ.)  
• The state of the phototrophic component of the coastal wetlands (Petrozavodsk State Univ.)  
• Variation and factors controlling the plant cover of the far North in time and space  
• Strategy for the conservation of migratory waterbirds and wetlands in the Nenets Autonomous district  
• Oil spill response sensitivities of Arctic wetlands: An ecosystem approach to oil spill response planning  
• Russian Academy of Sciences northern projects include the following:  
  - biology and ecology of benthos, plankton, marine fish, birds and mammals of Northern seas  
  - physiology and biochemistry of aquatic organisms, the processes of adaptation to Arctic conditions, cellular and molecular mechanisms  
  - determining the levels and dynamics of chemical and radiation pollution in marine ecosystems  
• WWF project: study of marine mammals in the South-Eastern part of the Barents Sea |
<p>| <strong>USA</strong>      | • &gt;35,000 km of Arctic coastline in Alaska | Monitoring programs (district, university, research institutions, industry and NGOs) include: |</p>
<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>PHYSICAL SETTING</th>
<th>EXAMPLES OF MONITORING ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23,000 inhabitants in a few cities and numerous settlements (primarily coastal) Coastal setting includes both rocky-shore (e.g. through the Aleutian Islands) and soft shore (along the North Slope)</td>
<td>• Beaufort Sea Fish Surveys: Baseline fish &amp; invertebrate presence, abundance, distribution &amp; biomass • Arctic Coastal Ecosystem Survey (ACES): Nearshore fish ecology (lagoons) as ice retreats • Aerial Surveys of Marine Mammals: migration etc. of bowheads, ice seals, walruses, &amp; polar bears • Coastal Observation and Seabird Survey Team (COASST): Beach Wildlife and Oil – trains coastal residents in their communities to conduct monthly surveys • Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA - Arctic Nearshore Impact Monitoring in Development Area) – contaminants in sediments and biota • Arctic Marine Biodiversity Observatory Network: Build an operational marine biodiversity observing network from microbes to whales • Alaska ShoreZone Program: Aerial coastal habitat mapping of Alaska’s Coastline Biophysical attributes • Coastal oceanography measurements of temperature and salinity by community members (Beaufort and Bering Seas) • Coastal Erosion Monitoring by National Park Service • Monitoring, Surveys, and Technical Reports on Human Use, Subsistence Harvest, Recreational Use, Human Presence/Use, Trails. Include, on a project specific basis, the documentation of traditional ecological knowledge on key species and the marine and terrestrial environment. Local observations of change and impacts to subsistence are also collected.</td>
</tr>
</tbody>
</table>
APPENDIX 4: KEY QUESTIONS IDENTIFIED THROUGH THE DAY 1 BREAKOUT SESSION

CLIMATE CHANGE
• How will acidification affect the trophic web?
• How will species ranges change? Which are/will become invasive? (Consider trophic cascades and ecosystem changes)
• How will climate change affect diseases in species (vector borne)? Birds, mammals, etc., and people could be impacted.
• How can you detect sub-optimal conditions decreasing ranges? How to “translate” to impacts on biodiversity?
• How do increases in temperature affect migration patterns, feeding areas, breeding areas?
• What can biodiversity monitoring tell us about cascading effects of climate change?
• How does industry on a project-by-project basis monitor and delineate the effects of the development from effects of climate change?
• How will climate change affect shipping pathways? How does this affect species?
• How will increased/decreased precipitation, ice, and runoff affect salinity and biodiversity?
• How will changes in productivity cause cascading affects in trophic levels?
• How will a longer open water season affect time at sea by anadromous species (e.g. feeding opportunities)
• How will climate change affect polynyas/upwelling and biological hotspots?
• What can old place names tell us about climate change?
• Are there any incidences of “mismatch” that can be attributable (in part) to climate change in the coastal zone?
• Where are areas of resilience that can support biodiversity? (and inform priorities)
• How is resilience captured/included in adaptive management schemes (which need to reflect rapid changes) and monitoring programs (which need to build in flexibility)?
• How will climate change facilitate introductions of new/alien species via shipping? (Increased shipping and potential species introduced, better conditions for non-Arctic species to establish)
• How do we identify which species (alien/invasive) to be concerned about?
• What will be the impact of increase glacier melt (i.e. more freshwater + sediment input to the sea) on fjord and coastal ecosystems?
• What is the carbon contribution of melting permafrost? (also on coastal erosion and biological communities?)
• What does a longer open water season mean for coastal communities (regarding storms and weather)?
• How long does it take for physical changes to be transmitted up food chains to fish and marine mammals?

INFRASTRUCTURE, DEVELOPMENT, & SHIPPING
• How does/will ballast water with invasive species affect marine mammals and other species?
  o How does this affect communities? Are ballast regulations effective?
  o Will ballast water treatments be effective in the Arctic?
  o Do domestic ships pose risks related to invasive species through ballast water and should domestic ships be regulated?
  o How can a plan like this get industry buy-in without additional regulation?
  o Should emergency ballast water exchange zones in the Canadian Arctic be revised?
• How will oil spills affect food security and community health and environmental health?
• Do we need oil spill sensitivity maps for pan-arctic?
• Where are the areas most sensitive/at risk to infrastructure/development/shipping?
• How many tourist ships can the ecosystem handle?
• What controls are there/should there be on foreign visitors and vessels?
• What are the risks of non-native hull organisms on ships on ecosystems in the Arctic?
• How can potential development influence migratory pathways?
• What invasive species should be monitored in shipping, infrastructure, and development?
And how do we respond to, or discover, emergent invasive species (note that exotic /= invasive)?
• Where are areas of high overlap between shipping and key ecological areas? How do cumulative impacts effect ecology and food security?
• What species are facilitated by shipping?
• How does human-generated noise/sound affect ecosystems (mammals, fish, etc.)?
• How will shipping/cruises affect communities and ecosystems in emergency situations? Who will respond?
• How might shipping/cruises disrupt subsistence activities?
• How might ice breaking affect ice conditions and travel for hunting?
• Will ships (i.e. their wake) swamp coastal low-lying areas and bird nests?
• What are the impacts of winter shipping on ice stability and ice ecosystems?
• What are the impact of port developments?

POLLUTION
• How do fuel spills from coastal ships effect coastal fish and benthos?
• What is the amount and impact of marine debris plastics and micro-plastics nets, etc.?
• How present and what are the threats of heavy metals (e.g. mercury, cadmium, etc.) and other toxins (e.g. BFAs)?
• How will coastal erosion influence the flux of terrestrial pollutants into the nearshore?

FOOD SECURITY
• Regarding the quota system, how can harvesting in times of scarcity be managed without making residents criminals? (i.e. is food security not a basic human right?)
• What kind of term can we use for circumpolar indigenous peoples’ niqipiaq/country food/traditional food security that conveys the specific meaning of ‘food security’ in this context (since ‘food security’ does not mean <the right to hunt & fish> ample niqipiaq/country food for the rest of the world)?
• How to communicate to non-indigenous organizations or policy makers that the majority of these traditional species are actually food? (That it is spiritual and has a serious nutritional component i.e. for body and spirit)
• How can we convey that food security includes not just availability but quality (i.e. that it is not too contaminated)?
• How can communities gain control (labs?) over ensuring quality of subsistence foods?
• How can we facilitate (legalize) effective sharing and barter between communities of country food?
• How can we establish local country food processing and preservation facilities (vacuum packing or canning)?
• How can we strengthen/better monitor for including newly arrived subsistence species to improve the quota system?
• How can we persuade North Slope Inupiat that muskox are yummy?
• How can communities adapt to changes in traditional species timing (phenology) availability due to climate change? Is there a good way that they can learn from other communities about how they are adapting? And, what kind of information do they need to adapt to these changes?
• What species should we monitor for bioaccumulation of contaminants and biotoxins (i.e. saxitoxins)?
  o How can information on contaminants and toxins be communicated in ways that do not result in too much fear of eating traditional food?
• How can we help explain that indigenous ‘food security’ includes culture, education language, etc. availability, accessibility, well-being and health, decision making and stability throughout the entire food web-food system.
• How can CAFF help demonstrate that conservation through use supports biodiversity?
• What type of information needs to be gathered through monitoring to support food security?

OTHER
• How will different types of drivers affect biological processes in coastal ecosystems?
• How can cumulative effects impact coastal ecosystems?
• How will changes in coastal biodiversity affect other systems?
• How do we involve young Inuit in community monitoring & research? And, how will it be funded?
• How do we translate/communicate scientific terms into plain language?
• Will increased amount of nitrogen compounds in the atmosphere/precipitation affect coastal ecosystems?
• How to ensure comprehensive data input from monitoring programs (including CBM, TK, Science etc.)?
• How do we identify ecological and cultural important and sensitive areas?
• How can early warning related emerging issues in the coastal Arctic ecosystems be established through CBMP?
• Will the high Arctic coast be the last Arctic fauna refuge?
• Can CBMP help to harmonize coastal monitoring among coastal states?
• Can CBMP be used to establish a baseline (pan Arctic) map of coastal zone habitat, to ensure protection and monitoring of representative habitats on a circumpolar scale?
**APPENDIX 5: FOCAL ECOSYSTEM COMPONENT DAY 2 BREAKOUT SESSION NOTES**

<table>
<thead>
<tr>
<th>Ecosystem sub-system / Theme</th>
<th>Suggested FECs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky shores</td>
<td>This breakout group based the structure of its FEC suggestions around the CBMP Marine working group’s plan:</td>
</tr>
<tr>
<td></td>
<td><strong>Plankton</strong></td>
</tr>
<tr>
<td></td>
<td>• Included considering fjord issues and coastal areas with upwelling (as an example)</td>
</tr>
<tr>
<td></td>
<td>• Species include: phytoplankton, zooplankton (all size groups), and microbes</td>
</tr>
<tr>
<td></td>
<td>• To be coordinated with the marine group</td>
</tr>
<tr>
<td></td>
<td><strong>Sea-ice biota</strong></td>
</tr>
<tr>
<td></td>
<td>• Noted as relevant in few/some coastal areas but that this item is covered well within the marine group; therefore, recommend to simply coordinate for relevant data to be delivered from the marine group</td>
</tr>
<tr>
<td></td>
<td><strong>Benthos</strong> (species found on the sea-bed – e.g. corals and plants)</td>
</tr>
<tr>
<td></td>
<td>• Fauna, macroalgae (e.g. seaweeds), benthic microalgae (e.g. diatoms)</td>
</tr>
<tr>
<td></td>
<td><strong>Fish</strong></td>
</tr>
<tr>
<td></td>
<td>• Pelagic (species connected to the water column)</td>
</tr>
<tr>
<td></td>
<td>• Coastal anadromous fish like Arctic char that migrate between fresh and coastal waters and spend their marine phase in brackish freshwater close to the coast</td>
</tr>
<tr>
<td></td>
<td>• Fish specifically linked to rocky shore and fjord coastal areas: sculpins, lumpsucker, and capelin</td>
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<tr>
<td></td>
<td><strong>Mammals</strong></td>
</tr>
<tr>
<td></td>
<td>• Walrus, polar bear, seal species, northern fur seal; coordinate with marine group</td>
</tr>
<tr>
<td></td>
<td>• Reindeer/caribou, muskox, grizzly bear, fox; coordinate with terrestrial group</td>
</tr>
<tr>
<td></td>
<td><strong>Seabirds</strong></td>
</tr>
<tr>
<td></td>
<td>• Covered well within marine group</td>
</tr>
<tr>
<td></td>
<td>• Purple sandpiper specific to coastal zone (shorebirds?)</td>
</tr>
<tr>
<td></td>
<td><strong>Discussion</strong></td>
</tr>
<tr>
<td></td>
<td>• Traditional knowledge shared by Henry Alayco about the Sedna</td>
</tr>
<tr>
<td></td>
<td>• Recommend to include sea otters in the region of the Aleutian Island</td>
</tr>
<tr>
<td></td>
<td>• Noted that it is sometimes difficult to identify new species as migration patterns and range change, it would be beneficial for communities to have resources to help in the identification of new species</td>
</tr>
<tr>
<td>Soft shores</td>
<td>Overview provided of the physical environment of soft shores, which are subject to significant erosion and subsequent deposition of sediments onto</td>
</tr>
<tr>
<td>Ecosystem sub-system / Theme</td>
<td>Suggested FECs</td>
</tr>
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| the ocean floor. This process impacts turbidity, as well as the amount of organic carbon released. These processes, as well as changes in sea ice coverage, storm frequency, and the inundation of low-lying areas with subsidence and sea level rise are dramatically changing the physical characteristics of Arctic soft shores and impacting coastal biodiversity.  

**Recommended FECs:**
- Primary producers (e.g., plants, phytoplankton, algal matts, benthic algae, eel/sea grasses, zooplankton)
- Bivalves (crabs, clams, etc. as vary with region)
- Sand fleas and shrimps
- Salmonid species
- Birds: shorebirds, ducks, eiders
- Mammals: Beluga, walrus, grey whales, ice-seals, polar bears

**Discussion**
- TK shared concerning significant sea-level lowering observed in the region of Kuujjuak, which has led to the abandonment of boats that are now left on dry shores; while some regions are experiencing sea level rise, others are not
- Response to above notes that the Hudson Bay region of Canada is undergoing some of the most significant uplift (a process that results in the “rebound” of the Earth’s crust following the retreat of the ice sheets during the last glacial maximum)
| Coastal wetlands and freshwater systems | This group chose to primarily focus on lagoon settings and noted the important physical properties impacting the lagoon ecosystem model including water salinity, pH, and temperature. Physical processes such as flooding, inundation, and draining noted as key factors impacting coastal wetlands.  

**Recommended FECs:**
- Phytoplankton, zooplankton
- Shellfish
- Mice/lemmings
- Lagoon Fish (e.g., whitefish, char, cod, salmon)
- Seabirds and waterfowl (loons); noted that these species also have an important feedback of nutrients into the wetland/lagoon ecosystem as well
- Vegetation (noting significant variability between sites, soil type, etc.)

**Discussion**
- Change in the taste of Arctic char noted by two Inuit communities in Canadian Arctic as a result of changing coastal/freshwater conditions; can ‘taste’ be an attribute?
- Many participants note that consideration of physical parameters will be key to understanding the responses of FECs; specific reference given to the AMAP “State of the Arctic Coast” report
<table>
<thead>
<tr>
<th>Ecosystem sub-system / Theme</th>
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| Community-led and focused monitoring | • The relationship between species, processes, environmental changes, community and industry impacts are recognized by both TK and scientists, but the structure and priority of these relationships and the means of identifying these relationships are different  
• Information from monitoring needs to answer community based questions as much as scientific questions, and these results need to be shared and communicated in a way that is relatable and meaningful for northern residents (i.e. appropriate scale, scope, and format – including translated documentation)  
• Monitoring needs to incorporate seasonal monitoring (e.g. changes in animal behaviour during the winter months; migratory timing on the shoulder seasons)  
• Food security is a powerful lens to view what species are key FECs for northern residents and TK holders, it also provides a meaningful and relatable motive for initiating and/or maintaining monitoring efforts  
• Of particular concern is the treatment of TK in decision making processes and that TK is often not seen as equally valid alongside scientific knowledge  
• In similar discussion, it was also noted that Inuit travel much further than researchers do, that communities that span wide areas, and that there is good communication between communities such that the spatial element is a key strength of TK (noted that Nunatsiavut not represented at CEMG meeting) |

| Group discussion/comments | • It was mentioned that Permanent Participants have involvement at every level of the Arctic Council  
• Considering that in the coastal monitoring group coastal communities are particularly impacted it was put forward that possibly this group of experts could work together to make a suggestion document to the CAFF board and to the Arctic Council requesting that representatives from each community/indigenous nation have a voice at such meetings  
• It was expressed that selecting TK holder/indigenous representatives should be done by PPs  
• Followed up with recognition that this type of effort is already in development at the national level in many cases |

| Industry & NGOs | From the perspective of industry, the FECs that are most valuable to northern communities are also their priority because industry depends on stable and sustainable communities. Therefore recommended FECs include:  
• Access (of community members to hunting/fishing areas) and subsistence  
• Jobs (economy)  
• Environmental justice  
• Noise and disturbance  
• Visual resources (information that is relatable and relevant) |

| Discussion | • Industries entering communities are keen to buy into existing monitoring initiatives  
• Can we also monitor the health of local culture and language? |
COASTAL MONITORING INDIGENOUS KNOWLEDGE HOLDERS
MEETING REPORT
Ottawa, Canada, February 29, 2016
Facilitated by the Inuit Circumpolar Council (ICC) with funding provided by Polar Knowledge Canada.

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Workshop organizers would like to thank the following organizations who contributed to travel for Indigenous Knowledge holders and other workshop related expenses – Inuit Circumpolar Council, Makivik Corporation, Nunavut Department of Fisheries and Sealing, Oceans North and Polar Knowledge Canada.
COASTAL MONITORING INDIGENOUS KNOWLEDGE HOLDERS MEETING REPORT
Hosted by Canada and facilitated by the Inuit Circumpolar Council (ICC). Ottawa, Canada, February 29, 2016. This is an independent report prepared by ICC and sponsored by Polar Knowledge Canada. All information within this report is the intellectual property of the Indigenous Knowledge holders attending the meeting. Photographers maintain all rights to the photos within this report. No photos may be duplicated or copied.

Photo by Laura Thomson. Left to right: Eva Krummel, Pitsey Moss-Davies, Stacey Fritz, Baba Pederson, Patrick Gruben, Carolina Behe, John Cheechoo, Qaiyaan Harcharek, Roy Ashenfelter, Quitsak Tarriasuk, Jimmy Johannes, Martha Flaherty, Cyrus Harris, Donald McLennan

“We have been here for thousands of years. We know these animals. Sometimes if they [researchers] just asked us, we would be able to give them the answer. They won’t need to spend so much money and we can get to a more current question.” – IK holder participant

Participants: Roy Ashenfelter, Nome Alaska; Patrick Gruben, Inuvik; Qaiyaan Harcharek, Barrow, Alaska; Cyrus Harris, Kotzebue, Alaska; Jimmy Johannes, Kuujjuaq; Baba Pederson, Kugluktuk; James Simonee, Pond Inlet; Quitsak Tarriasuk, Ivujivik; Scott Nickels and John Cheechoo (Inuit Tapiriit Kanatami); Donald McLennan (Coastal Expert Monitoring Group co-chair); Pitsey Moss Davies and Carolina Behe (Inuit Circumpolar Council and Coastal Expert Monitoring Group); Martha Flaherty (Interpreter); Stacey Fritz and Laura Thomson (Note takers).
Introduction
The Coastal Expert Monitoring Group (CEMG) is organized under a Conservation of Arctic Flora and Fauna's (CAFF) Circcumpolar Based Monitoring Program. The primary goal of the CEMG is to develop a long term, integrated, multi-disciplinary, circumpolar Arctic Coastal Biodiversity Monitoring Plan that relies on science and Indigenous Knowledge, and has direct and relevant application for communities, industry, government decision makers, and other clients of the knowledge generated. Given approval of the Coastal Plan, CEMG will work to develop an implementation plan that will identify a timeline, costs, organizational structure and partners. It is fundamental to the Coastal Plan that implementation partners will include Arctic Indigenous peoples and information/concepts from Indigenous Knowledge.

There are many questions that Indigenous Knowledge holders must address and many decisions that our coastal communities face. In working with scientists and international programs, some of the questions and decisions include how to share our information, how information from IK should be categorized when used with science, how to safeguard information documented from IK holders, and how to ensure that IK holders are involved in analysis and interpretation of their information.

With this understanding Canada hosted a one-day meeting, facilitated by ICC that brought together IK holders to become familiar with CAFF, CBMP and to prepare for the Coastal Expert Group Monitoring workshop. The ICC facilitated the workshop. Though all Permanent Participants were encouraged to attend, they were unable to. Through the one-day workshop, participants held open discussions on the threats to biodiversity within their given regions, changes occurring; ways that IK directs daily monitoring activities; challenges and potential solutions for the inclusion of IK within CEMG; monitoring priorities and IK approaches to monitoring; what programs may be occurring within their respective regions that are based on IK and/or science and the potential benefits to taking part in CEMG.

Below provides a brief discussion of the main points raised during the one-day workshop. Many of these points were further expressed and explored during the full CEMG workshop. The largest point raised continuously throughout the IK holder and the CEMG workshops is the need for trust and respect. We will come back to this discussion toward the end of this report. For now, we begin the discussion with ways of monitoring.

Cambridge Bay, Canada. Photo by Carolina Behe
Indigenous Community Monitoring: Applying a food security lens, applying an Indigenous Knowledge approach to monitoring

Recently, ICC-Alaska completed a food security project and report. The products of the project come from Inuit throughout the four Inuit regions of Alaska and provide descriptions of Indigenous Knowledge assessment processes and point out important Indigenous monitoring philosophies. As the participants of this CEMG workshop shared, Inuit have monitored their environment for thousands of years. Inuit monitoring centers on relationships among components, as opposed to the monitoring of individual components\(^1\). The below conceptual map from the ICC-Alaska food security report demonstrates connections that Inuit monitor. Though scientists may at times also monitor connections as opposed to individual components, often these are different connections. Looking at monitoring questions developed by both scientists and IK holders will aid in gaining a more holistic image of what is occurring within the Arctic.

![Interconnecting drivers surrounding walrus within a given time and space. Conceptual model provided by the ICC-Alaska Food Security Report (ICC-Alaska. 2015)\(^2\)](image)

In developing CEMG utilizing both IK and science, meeting participants pointed out the importance of using methodologies from both knowledge systems. For example, it is likely that IK categorizes information differently than science. In some areas, categorization occurs by seasons as opposed to specific species or trophic levels. How boundaries are defined also differs.


\(^2\)ISDB
For example, participants explained, that beluga is a coastal animal. Beluga must migrate into freshwater areas where there are pebbles in order to moult and to give birth. This example demonstrates the multiple layers that IK is considering when monitoring: the animal uses both salt and fresh water; it is important for beluga to go up particular rivers to shed their skin every year; beluga in other areas may follow salmon upriver to feed; they need freshwater to give birth. These animals, dependent on both salt and freshwater habitats, are considered coastal. IK allows for adjustment of the ‘coastal boundary line’ to include where the animals move. It is possible for CEMG to allow for this shifting boundary line in addition to the hard lines that scientists often require in their work.

**Overall, participants expressed the need to:**

1. Monitor through seasons
2. Recognize changing boundaries
3. Identify parameters and attributes through both
   - IK and science (i.e. taste, smell, weight, etc.)
4. Monitor through a food security lens/approach
   a. look at the base species and what effects them
   (e.g. cod to lemmings)
   b. connecting social, natural and physical pieces
5. Work together - co-production of knowledge
6. Engage youth
7. Communicate – communication between IK
   - holders and scientists; between communities and scientists
8. Ensure that information addresses community driven concerns
9. Fund Inuit involvement
10. Report out (before publishing or making publicly available)
11. Share knowledge
12. Understand the inherent conservation process in IK
13. Collect place names
14. Acknowledge that language and cultural preservation
   - is connected to maintaining biodiversity
15. Encourage more community driven research and community driven monitoring
16. Establish trust and respect
**Questionnaire Discussion**

In preparation for the CEMG workshop, a questionnaire was sent to scientists, IK holders, practitioners, industry and managers to gain information on their perspectives of the state of coastal biodiversity. Of the 48 questionnaires answered, 25 were answered by Indigenous peoples. To the question of what are the most pressing issues facing coastal biodiversity, the following answers were provided. The workshop participants discussed the pressing issues listed and added to them. A large focus of the discussion was on changes occurring in sea ice thickness and coverage, impacts of industrial activity, the need for IK holders and scientists to work collaboratively in order to make effective decisions, and the need for respect.

1. Climate change
2. Pollution
3. Shipping
4. Erosion
5. Change in sea ice
6. Bad decision-making/outside values imposing decisions on what occurs in the Arctic
7. Noise
8. Development
9. Fish farming
10. Lack of inclusion of Indigenous Knowledge in planning, research and decision making

Workshop participants also pointed out that some Arctic communities are producing the pollution that impacts the local environment (e.g., trash is not contained or old batteries are leaking in landfills). Additionally, participants raised concerns about invasive species and the potential risks associated with an increase in shipping. The following section provides a brief summary of some of the main points from this discussion.

“Some of the caribou feed on algae – and they cross the ice to go to islands. Caribou cross some areas when the ocean freeze. Now they are falling through because the ocean is not freezing at the same time” – IK holder participant

“Respect for the ocean and all it provides, you take care of it and it will take care of you. Keep it clean, don’t cause harm to its occupants, don’t waste or kill them for sport” – Carol Oliver (IK holder from Chinik)
**Decision making**

Overcrowding was one issue that was attributed to poor decision-making.

The challenge of where towns are located was discussed, and it was concluded that this was due to the engineers’ lack of knowledge and not including Indigenous Knowledge. The towns were not located in areas where people lived [at the time]. Decisions were not made according to what was appropriate for the community. For example, a US [government] airstrip was placed in a village. The homes are too close only 30 feet apart. It becomes difficult to have space to dry meat, butcher food, etc. During the summer it is okay because people are working outside. But during the winter it is a challenge. Everyone is in the house and the house becomes too crowded. There is also a problem with inadequate sewage tanks. This is common throughout the Arctic. It impacts peoples’ quality of life negatively. -IK holder participants

“Polar bears eat moss before eating seals. The moss helps retain seal oil. So that they do not excrete all of it.” – Quitsak Tarriasuk (Elder IK holder)

Many examples were provided regarding the management of coastal animals. These examples often led into deeper discussions about respect and trust.

In one case, IK suggests that the walrus have not disappeared, but rather that they moved on to a new area with more food. This was not believed by the scientists. In this community, the elders teach younger hunters how to interact with walrus. They are taught to never bother or hunt the walrus when they are on a particular island. This is a time that the walrus has to be left alone. This management practice is based on long term monitoring that has led to knowledge of how the walrus behaves and why it would move. In another example, IK indicated that an increase in snow geese was needed. Federal regulations applied a limit and the population increased to a point that it has impacted other species. - IK holder participants

Through these examples and others, participants stressed the need for IK holders and scientists to work collaboratively to aid in evidence-based decision making that supports biodiversity conversation.
Sea ice, swells, storm surges, sea level rise...

There are unique or certain ways that nature provides protection. For example, ice provides protection from storm surges. Participants described that changes in sea ice thickness and coverage, sea level rise, increase in storm surges, freshening of some water bodies and an increase in salinity of other habitats, change in types and amounts of precipitation, increase in erosion, changes in near shore currents and gyres, timing and level of snow fall, and shifts in wind directions are all connected and are impacting biodiversity. Many of these changes are directly related to shifts in animal migration patterns, shifts in food web dynamics, changes in food gathering practices, loss of hunting camps and homes, changes in water salinity levels, and changes in breeding, nesting, and refuge areas.

Industrial impacts

Participants raised concerns about the impacts of industrial activities on biodiversity. Many of these concerns come back to questioning how impact assessments are conducted and the need to include IK in the process. Below are a few examples that were raised:

1. Hydro dam – the discharges leaves murky water along the shoreline. Because the discharge is made up of freshwater the saltwater is pushed down.. When hunting, seals are not floating on the water, they sink down.
   In another area, a hyrdo dam has resulted in a decrease in the river water level and water flow.
2. Roads – roads built in some areas disrupt migration patterns.

“If there is no ice, but it is snowing heavy in April, water gets high but then a big wall of snow is created. [This] creates a gate and ocean waves are on the other side…slush pile. If there is no sea ice, we are at least praying for snow. How life is protected from storm surges should be monitored. In Alaska, sandbars are a protection from storm surges.” – IK holder participant
Shipping
The current and potential impact of shipping activities on biodiversity are large (ships are impacting life and ice formation). Participants discussed different examples of the impact that shipping is having.

1. Noise – animals are very sensitive to sound. In some areas, people are witnessing a changing in animal behavior and migration in response to the noise.
2. Artificial leads are created – when artificial leads are created, whale migration patterns shift
3. Invasive species – there is a large concern of what the ships and the people on the ships may bring with them
4. Ballast water – concern of pollutants released into the water in addition to invasive species
5. Potential accidents – concerns of impacts that an accident will have throughout the entire food chain

Impacts of seasonal Activities
Participants raised concerned of the impact that some research activities have on animal well being.

1. In some areas, monitoring equipment is set up in areas that animals use as refuge (it is important to the health and wellbeing of animals to ensure that their area of rest are not distributed).
2. In other areas, the number of ships conducting research becomes disruptive to the animals by creating noise and/or light pollution or traveling through their migration path.
3. There is a concern for how animals are tagged and [at times] tranquilized. Concerns are focused on the impact that tagging has on the animal health and well-being and the toxin that may stay in the animal’s body.
4. Airplanes and helicopters coming into the area to bring tourists, reporters, visitors or researchers can at times also be disruptive to animals. In one situation, a reporter trying to get close to a walrus herd caused a stampede. In another example, air craft flying close to cliffs disrupt nesting murres. The birds are startled by the noise and quickly flee the nest, subsequently knocking the eggs from the nest.
Key gaps identified in the questionnaire by Indigenous Peoples were:

1. Localized IK is seldom included
2. Lack of communication
3. Need for permanent monitoring
4. Language – need for translated material
5. Need funding for Indigenous organizations to do research
6. Shrinking of coastal ponds
7. Change in hydrodynamics due to loss of permafrost
8. Lagoon systems and their importance to production
9. Understanding of the importance of winter food chains

“Some of the caribou feed on algae – and they cross the ice to go to islands. Caribou cross some areas when the ocean freeze. Now they are falling through because the ocean is not freezing at the same time” – IK holder participant

Participants discussed and stressed the significance of the following answers –
1. Bad decision making; outside values imposing decisions on what occurs in the arctic
2. Lack of inclusion of IK in planning, research and decision making

***It is recommended that CAFF further investigate these two causes or threats to biodiversity within the Arctic. Following is a brief description of some of the points raised.

Lakes are drying up
Lakes and ponds are drying up. Many communities collect drinking water from lakes and ponds. There is a witnessed shift in some animal migration patterns as this water source is no longer available for them. Vegetation changes with the loss of fresh water. The drying of the lake and ponds are thought to be related to melting of permafrost and at times erosion.

Language and culture connected to biodiversity
Preservation of language and culture is a necessary topic within any Arctic biodiversity monitoring plan. The knowledge and language maintained by Indigenous peoples aids in supporting biodiversity and overall health of the Arctic. It is important to remember that culture is part of the ecosystem. Working to support one aspect of the ecosystem, while neglecting other aspects, will result in a decrease in biodiversity.
**Food web dynamics**

There are many examples of shifts occurring in Arctic food web dynamics. Some shifts are the result of an increase in predators. For example, eider duck eggs are being eaten more frequently by polar bears. As Orcas increase in numbers in the Arctic Ocean they add to the predation role. Additionally, there are changes in the food that some animals rely on. For example, a change in zooplankton will impact the distribution of beluga; shift in benthic species results in a shift in walrus distribution and/or food intake. These examples provide a valuable example of different pieces that are important to monitoring. Inuit monitoring is often focused on food web interconnections. Under the conversation of food webs, there are concerns over increased vulnerability to parasites and bacteria as the Arctic changes.

**Trust and Respect**

Participants pointed out that lack of trust and respect has created a large barrier between scientists and IK holders. The inherent level of trust and respect given to scientific experts and those that have been in their fields for many years is not given to Indigenous Knowledge holders.

“Remember that our elders are not numerous across the Arctic. They are an invaluable resource and they are challenged with ridicule of others passing it off as “old” knowledge. More and more we have people from the south and they have another knowledge and it is hard having someone from the south acting as though they have more knowledge than you. This can make you feel small or even die from the suppression and immensity of this other knowledge” – Quitsak Tarriasuk

Through this discussion, one participant summed up the discussion on trust, respect and validity of knowledge holders.

“Often older scientists teach younger scientists. They teach them how to become good scientists. The young scientists are taught how to build their reputation within the scientific community, by publishing peer-reviewed papers. To become respected and considered knowledgeable in your field. Inuit also have a process. Elders train younger generations. A hunter gains a reputation, the power of a hunter, is in being a provider. For the scientist it is about working toward their scientific knowledge base so they can also make money for their family, to provide for their family. The scientists are doing the same thing through a different path. As the Elder [meeting participant], is talking about walrus we all feel that we receive the knowledge. We [those attending the IK holder meeting] accept it, we trust it. But scientists believe that someone has to come and look up what the elder has said in a book; that they have to see a scientific paper proving that what the hunter is saying is true in order to verify the Indigenous Knowledge by using science. But this is not possible. This is what young scientists are learning today. To us, this is disrespectful to our Elders and to our way.”

IK holds validation and evaluation processes and ways of determining who has the most knowledge (or are considered experts). It is crucial for this to be understood and respected in order for knowledge holders of different systematic ways of thinking to work together. With this understanding, IK holders and scientists will be able to move forward working collaboratively as opposed to attempting to translate one type of knowledge into the other.
Inuit have experienced researchers coming to their communities and acting as if they know more about the land, water, birds, animals, plants or anything in the area than the knowledge holders of that area. This leaves people feeling “shrunk down”, as an elder explained. Once this has occurred, there is a feeling of lack of respect and trust is lost. Because of past experiences of how information from IK holders has been used or Inuit have been treated, many people are becoming increasingly distrusting.

Another participant offered examples of how information was gathered from IK holders regarding polar bears. The IK holders worked with the scientists and felt that they had all worked collaboratively together and had spending a great deal of time analyzing information together. They had begun to build a trusting relationship. When the reports were released the analysis that they had agreed upon was not in the report. They saw their IK separated out and misinterpreted. This left the IK holders feeling hurt and disrespected.

The meeting participants stressed the need for researchers and IK holders to find common ground. Though the two may be asking different questions that require monitoring, it is still possible to find common ground and to use all of the information gathered to have a stronger understanding of the ecosystem.

The CEMG is taking a positive step by developing a platform of trust and respect that will allow for a co-production of knowledge. This step has begun with having a meeting that includes IK holders, working collaboratively with Arctic Council Permanent Participants, and finding ways to include IK holders in all steps of the process. It will be important to continuously come back to the topic of trust and respect and to re-evaluate the process to ensure that the best monitoring processes are providing the information needed to make effective, ecosystem-based decisions.

“…for it to work [monitoring plan] in the long term, you need elders and youth.” – IK holder participant

“…connect with youth groups – plug into modern tech. One idea is to develop animal sounds for the youth to use on their phones. They become familiar with the sound.” – IK holder participant
Focal Ecosystem Components

Focal Ecosystem Components (FEC) are chosen within the beginning of the CEMG process. FECs are the things that will be monitored (or monitoring information gathered about). In discussing focal ecosystem components (FECs), participants stressed the need to also consider culturally rooted FECs, such as feasts, celebrations, language and education. Though the CEMG may not actively monitor these suggested FECs, it will be good to included them and to work collaboratively with the Sustainable Development Working Group when developing reports. *The below list should not be considered exhaustive. The list is the product of a short meeting with a few IK holders. The items are listed in no particular order of importance.

FECs identified

<table>
<thead>
<tr>
<th>Caribou</th>
<th>Berries (salmon, blue, etc.)</th>
<th>Polar bear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beluga</td>
<td>Sea weeds</td>
<td>Fish (all salmon, char, cods and white fish, Sculpin, Flounder, her ring and candle fish)</td>
</tr>
<tr>
<td>Oogruk (Bearded Seal)</td>
<td>Zooplankton</td>
<td>Various plants (sura and Celery)</td>
</tr>
<tr>
<td>Beaver</td>
<td>Wolverine</td>
<td>Migratory and resident birds (Sea gulls, geese, murres /eggs, eider ducks, eellow belly loon)</td>
</tr>
<tr>
<td>Various bird species</td>
<td>Phytoplankton</td>
<td>Sea weed</td>
</tr>
<tr>
<td>Benthic species (clams, muscles, tunicates)</td>
<td>Whales</td>
<td>Sea weed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots</td>
<td>Wolves</td>
<td>Narwhal</td>
</tr>
<tr>
<td>Muskrats</td>
<td>Lemmings</td>
<td>Phytoplankton</td>
</tr>
<tr>
<td>Ice seals</td>
<td>Grey whale</td>
<td>Mosquitos</td>
</tr>
<tr>
<td>Bowhead whale</td>
<td>Sea urchin</td>
<td>Crab</td>
</tr>
<tr>
<td>Killer whale (Orca)</td>
<td>Grizzly</td>
<td>Parasites</td>
</tr>
<tr>
<td>Water flies</td>
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</tbody>
</table>

Gambell, Alaska. Photo by Carolina Behe
Concept Maps
Participants collectively created a concept map to identify key species, habitats and activities during a season (June/July). Two types of concepts maps were developed. One map demonstrated connections and concepts through drawings and a second made connections using terms and lines. The lines could then be weighted through a fuzzy concept map exercise (although workshop participants ran out of time before this process could be fully completed). Below is a description of what participants asked to be included in the two concept maps.

The maps demonstrate activities occurring across the entire North America Arctic coastline. geese, sitting on nests or guarding chicks on coast; oogruk (bearded seal) near the ice, sunbathing on floes – no predators; ducks in the water near the ice; th seagulls come first, then the ducks; murres lay eggs last on giant cliffs; beluga are feeding at the mouth of the river, and come to rub on rocks in freshwater molting; clams and mussels at mouths of river where fresh and salt water is mixed and high/low tides; seaweed below cliff on shoreline; herring spawning; candlefish; cod fish, arctic cod; grey whale; beluga whaling begins; pink, red, chum and king salmon are running; char; drying racks near coast away from bugs and bears; seagulls are becoming a huge nuisance everywhere, resulting in difficulty cutting cutting fish; some polar bears are starting to show up at dumps; sculpin; devilfish everywhere; mosquitoes; flounders sea urchins; fish like to hide where the snow is thickest; fish also hide where ice is thinnest; collect roots (masu) when plants are blooming; sura; eskimo celery; beaver – farther up the river; muskrats; wolverines are gone in their region (northern quebec), there are lots on north slope in alaska; wolf populations are increasing; at edge of the ice, life frozen in the ice begins to fall into the water during the thaw - fish eat the life; rock cod or greenland cod; saffron cod; blue cod are important food source for sea mammals further out at sea; salmon berries – august unless it is a hot summer then earlier; collect berries in late july in swampy areas; walrus – on an ice floe or an on island; crab in july are offshore; sea ice.

Conclusion and lessons learned
The IK holders provided a valuable opportunity for all of the IK holders to become familiar with each other, to learn about CAFF, CBMP and the intention of CEMG. All participants left the meeting feeling more prepared for the CEMG two-day workshop. In moving forward, it will be important to translate all meeting material for participants prior to the meeting. We are grateful to the Canadian government for hosting this meeting and to all of the meeting participants, note takers, translators and the CEMG co-leads. We are also grateful for the funding provided by Polar Knowledge Canada and Oceans North.