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INTAROS Community-Based Monitoring Experience Exchange Workshop

Noor Johnson, Maryann Fidel, Finn Danielsen, Lisbeth Iversen,
Michael Køie Poulsen, Donna Hauser, Peter Pulsifer

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Noor Johnson[1], Maryann Fidel[2], Finn Danielsen[3], Lisbeth Iversen[4], Michael Køie Poulsen[3], Donna Hauser[5], Peter Pulsifer[1]

[1] Exchange for Local Observations and Knowledge of the Arctic, National Snow and Ice Data Center, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

[2] Yukon River Inter-Tribal Watershed Council, Indigenous Observation Network

[3] NORDECO Nordic Foundation for Development and Ecology

[4] Nansen Environmental and Remote Sensing Center

[5] University of Alaska Fairbanks, International Arctic Research Center

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Cover: The Nisga'a fish during eulachon fish harvesting season in Nass Harbour, British Columbia, Canada: Credit: Brodie Guy/Flickr

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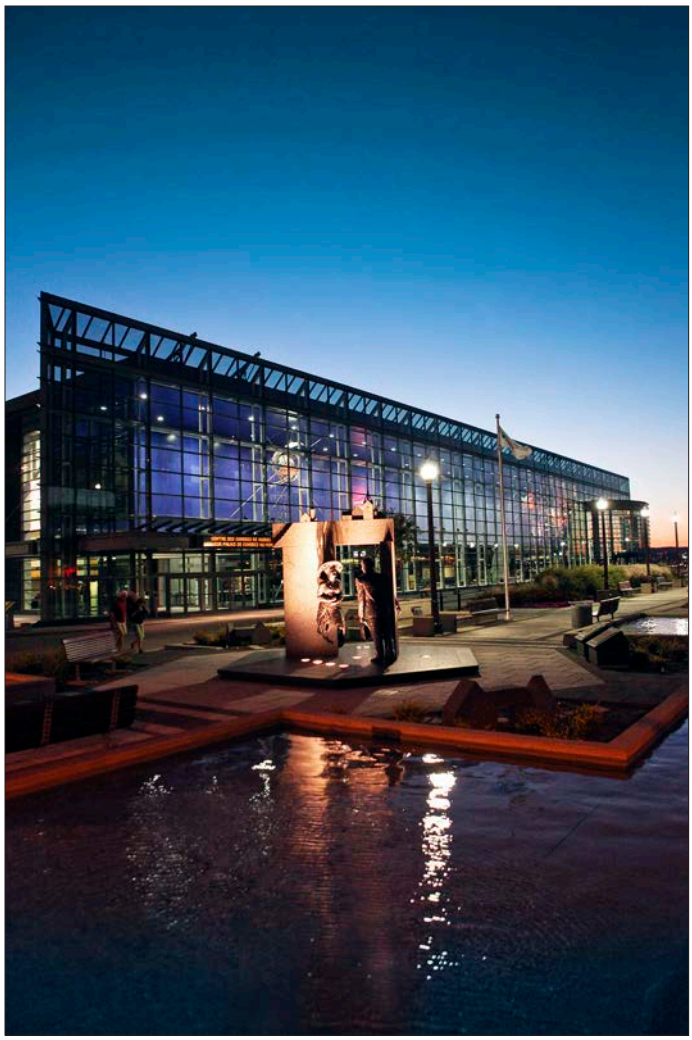
Background

The fourth INTAROS CBM Workshop was held in Québec at the Québec Convention Centre on December 11-12, 2017 concurrently with the Arctic Change 2017 Conference. This workshop offered an opportunity for practitioners of community-based monitoring (CBM) and observing programs from northern Canada to come together to exchange experiences and perspectives. Representatives of ten CBM programs attended; additional participants included representatives of co-management boards, northern research institutions, Inuit organizations, philanthropic organizations, and programs focused on developing or adapting tools for data management and sharing.

The objective of the Quebec workshop was to facilitate exchange of ideas and information among CBM practitioners from Canada. An agenda for the workshop was developed based on input from participants. The agenda included time for brief presentations from CBM programs, breakout and plenary discussion groups, and time for networking over meals and games.

The workshop was funded by the Integrated Arctic Observing System (INTAROS) and organized by a host committee that included representatives of INTAROS, the Exchange for Local Observations and Knowledge of the Arctic (ELOKA), the Yukon River Inter-Tribal Watershed Council (YRITWC), and the International Arctic Research Center (IARC) at University of Alaska Fairbanks (UAF). The earlier INTAROS CBM workshops were held in Fairbanks, Alaska (May 11, 2017) and in the Russian communities of Komi and Zhigansk (September 2017). An additional CBM workshop will be organized in northern Europe in 2018-2019.

INTAROS involves 49 participants from 20 countries, and is the largest single research investment of the EU in the Arctic. INTAROS aims to support the development of a well-functioning Arctic observing system to offer a more holistic understanding of Arctic change and to inform decision making. The INTAROS objective is to extend, improve, and unify observing systems, with CBM understood as one system within the larger network of systems. The CBM work package of INTAROS



The Quebec Convention Center is illuminated at night.. Credit: gotravelaz.com

Noor Johnson (ELOKA), Amos Hayes (GCRC), and Maryann Fidel (Yukon Inter-Tribal Watershed Council) enter the Quebec convection center (right). Credit: Michael Køie Poulsen

includes experience exchange workshops, identifying good practices, and compiling a library of CBM tools. It also includes field components in Greenland and Svalbard to pilot new tools to support decision-making, risk management, and development.

The workshop opened with a brief introduction to workshop goals and objectives and short presentations on INTAROS by Finn Danielsen and Lisbeth Iversen, and on the PISUNA (Opening Doors to Native Knowledge) CBM program in Greenland by Finn Danielsen. PISUNA focuses on monitoring and management of natural resources by fishermen and hunters. The project began in 2009 and is a collaboration between the Government of Greenland and communities in Disko Bay and NW Greenland. Fishermen and hunters decide what to study, collect and use the data locally, and develop recommendations for natural resource management, which are forwarded to regional and national authorities.

Over the one-and-a-half-day workshop, discussions across the themes summarized below allowed participants to build connections and gain insights about what is working well and what is not working or could be improved.

A note on terminology: We use the term "traditional knowledge" or "TK" throughout the document, as this was the term used by the majority of workshop participants to refer to knowledge transmitted across generations by Indigenous Arctic residents. We use other terms, including Inuit knowledge, *Inuit Qaujimajatuqangit,* and traditional knowledge as they arose in presentations by particular CBM programs.

Opposite: Two mountains cradle a glacier on Baffin Island, Nunavut, Canada. Credit: Noor Johnson

Lisbeth Iversen (Nansen Environmental & Remote Sensing Center) and Finn Danielsen (NORDECO) introduce the INTAROS project to workshop participants. Credit: Michael Køie Poulsen

Theme 1

Taking Stock: what, where, why, how, for whom?

The first thematic session was designed to capture the overall picture and current status of the operations of the CBM programs participating in the workshop. The session began with five minute presentations from four CBM programs: Inuvialuit Settlement Region Community-Based Monitoring Program (ISR-CBMP), the Nunavut Wildlife Management Board's Community-Based Monitoring Network (CBMN), the Tłı̨chǫ Government's Marian Watershed Stewardship Program, and the AVATIVUT/IMALARIJIIT programs from Nunavik.

Inuvialuit Settlement Region Community-Based Monitoring Program (ISR-CBMP) (Inuvialuit Settlement Region), presented by Chloe Brogan (remote presentation via Zoom)

The Inuvialuit Harvest Study contributes to a long-term database of Inuvialuit harvest information of birds, mammals, and fish. The project encompasses the six communities of the Inuvialuit Settlement Region (ISR) (half inland and half coastal). The goal is to inform and support decision making by Inuvialuit organizations and co-management boards. For instance, harvest data has contributed to the Porcupine Caribou Harvest Management Plan. Information is collected by nine trained community resource technicians and is enabled by strong partnerships with local Hunter and Trappers Committees (HTCs) using iPads and the ISR Platform (there is also a paper version). It is verified using a four-step process that incorporates Inuit knowledge. The information is being collected for: beneficiaries of the Inuvialuit Final Agreement, HTC, Inuvialuit Game Council, Inuvialuit Joint Secretariat and co-management boards, Inuvialuit Regional Corporation. Other land, wildlife and environmental organizations may request the information.

Community-Based Monitoring Network (CBMN) (Nunavut), presented by Sarah Spencer

The CBMN is run by the Nunavut Wildlife Management Board, the main instrument of wildlife management in the Nunavut Settlement Area. NWMB facilitates wildlife research, informs total allowable harvest, establishes/adjusts the basic harvest needs for communities, and conducts the Nunavut Wildlife Harvest Study. NWMB also approves designations of species at risk and approves plans for management and protection of wildlife and habitat. CBMN is operated in coordination with Hunter and Trappers Organizations (HTOs), collecting data activities through handheld computers issued to hunters, who bring them into the field to document observations and travel routes. The

data is managed by a community clerk, who uploads data files onto secure, online databases. The CBMN uses Juniper Systems technology for an on-line data platform. The information documented through the program includes Inuit Knowledge, struck and lost rates, and bycatch and hunter effort. It contributes to understanding species range expansion, spatial and temporal patterns of harvesting, and identification of habitat and traditional hunting areas, important travel routes, and early detection of disease. Information is collected to inform the Nunavut Wildlife Management Board and to benefit community members (to support positions in co-management), land use planners, researchers, and government. The information is used in co-management decisions and environmental impact assessment.

Marian Watershed Stewardship Program, Tłı̨chǫ Government (Northwest Territories), presented by Michael Birlea and Leslie Lamouelle

The Marian Watershed Stewardship Program, now in its fifth year, is building community capacity and collecting baseline data on Tłı̨chǫ lands. Its objectives are: 1) to conduct community-based aquatic monitoring for water, sediment, and fish quality; 2) to build community capacity for monitoring; 3) to collect baseline scientific data in the Marian watershed; and 4) to build a program that communities can trust. Results are shared with the communities every year by community monitors. The program uses both standards for industry data collection and TK. The data is used by the government to protect clean water for the well-being of Tłı̨chǫ people. There are plans to expand the program each year to monitor more places in the watershed, and to involve academic partners as collaborators.

AVATIVUT/IMALIRIJIIT (Nunavik), presented by José Gérin-Lajoie

AVATIVUT (which means "our environment" in Inuktitut) is an educational program that works with elders and school age youth (secondary level) to learn about science and traditional knowledge through hands-on, land-based activities. The program (currently on hold) collected data on berry productivity, ice processes and permafrost dynamics in several communities in Nunavik. IMALIRIJIIT (means water quality researchers in Inuktitut) is a new project, now in its second year, based in George River, Nunavik. It is driven by the desire to build capacity within communities and community concerns about rare earth mining in the George River Watershed. Project activities involve students, scientists, and traditional knowledge holders and other community members and include land based scientific camps. Water quality, biofilm, benthos, sediments, lichen and contaminants in country food are being monitored with sample kits and documented in an interactive map.

Local guides help filter water samples to analyze the George River water quality during the 2017 Science Land Camp, part of Imalirijiit community-based environmental monitoring program in Nunavik. Credit: Gwyneth Anne MacMillan

It has evolved into a community-based environmental monitoring program where scientists and the community collaborate closely, both providing human, material and financial resources. Data is collected with a goal of supporting decision-making on resource development in Nunavik and community empowerment.

Sonja Ostertag (Western Arctic Beluga Health Monitoring) participates in stock-taking activity as Daniel Gillis (eNuk) looks on. Credit: Michael Køie Poulsen

Group stock-taking exercise

Following the individual program presentations, workshop participants were asked to break into small groups to conduct a "stock taking" of their programs, focusing on five questions (see below). Responses were recorded on flip charts and shared back with the group; when more than one group recorded the same response, this was indicated with a check (as captured below—note that checks do NOT indicate priority or perceived importance).

1. What are the information needs that your program is addressing?

Sea ice	✓✓✓✓✓
Contaminants	✓✓✓✓
Harvest levels	✓✓✓
Traditional knowledge	✓✓✓
Human health impacts (longitudinal surveys)	✓✓
Wildfire abundance	✓✓
Migration routes	✓✓
Disease & parasite levels (wildlife health)	✓✓
Weather/storms	✓✓
Water quality	✓✓
Cumulative impacts	✓✓
Berries	✓
Species distribution	
Tides	

Coastal information/baseline data	
Fisheries	
Salinity/temperature/current (oceans)	
Data knowledge/management	
Access to information	
Economic information (re: harvests)	

2. What is the motivation for the participants?

Sharing knowledge	✓✓✓✓✓✓✓
Addressing the needs of communities	✓✓✓✓✓✓
Integrating scientific and local knowledge	✓✓✓✓✓
Integrate ILK in decision-making	✓✓✓✓
Education	✓✓✓
Baseline information	✓✓✓
To see the potential increase and benefits of a resource	✓✓
Financial motivation/compensation	✓✓
Influencing development (mining)	✓✓
Love of the work	
Learn about science	
Local data/contribution	
Provide samples	
Animal health	
Data sovereignty	
Return info to communities	
Human dimensions of data	
Safety/communication	

3. Who is using the data/information?

Hunters, youth, individuals	✓✓✓✓✓
HTO/HTA/hunter support	✓✓✓✓✓
Federal organizations	✓✓✓✓✓
Academics	✓✓✓✓✓
Provinces/territories	✓✓✓✓
Municipalities	✓✓✓
NGOs	✓✓✓
Parks	✓✓
Regional wildlife environmental management	✓✓

Finn Danielsen (NORDECO) and Denis Ndeloh (Nunavut Wildlife Management Board) exchange ideas. Credit: Michael Køie Poulsen

Taha Tabish (Qaujigiartiit) listens to a workshop presentation. Credit: Michael Køie Poulsen

3. Who is using the data/information?

Industry	✓✓
Search and rescue	✓✓
International organizations	✓✓
Cultural organizations	✓
Wildlife management board/fisheries co-management board	✓

4. What data/information is needed that isn't being collected?

Economics of harvest	✓
TK use in planning harvest not captured by CBM	✓
Human health implications of biological and environmental data	✓
Local weather	✓
Detailed environmental data linked to climate change	✓
Some (all) Inuit and TK knowledge indicators	✓
Spatiotemporal gaps/resolution in all data types	
Historical lack of data (e.g. caribou number)	
Cumulative impacts—larger scale/area	
Youth perspective (not only elders)	
Indigenous languages	
How CBM data is used at the community level	

5. What is working well, and what are the challenges?

Working well

Well supported by community	✓✓✓✓✓✓
Capacity building opportunities	✓✓✓✓
Linking TK and scientific knowledge	✓✓✓
Trust and relationship between communities and scientists	✓
Data recording of traditional knowledge	✓
Funding secure	
Can get short term funding	

Challenges

Funding and long term sustainability	✓✓✓✓✓✓
Aligning/reconciling scientific vs. community priorities	✓✓✓
Linking qualitative vs. quantitative	✓✓
How to disseminate information in a meaningful way	✓✓
Perceptions of data (how data can be used vs. expectations)	✓
Gaps in data collection over time	✓

Challenges continued

- Timeliness to data access
- Burnout by communities
- How to grow program—building new research horizons
- Needing more technical support
- Needing workspace and internet in communities—building infrastructure in community
- Moving data/science to influence change back into communities

Discussion of stock-taking

During a group debrief, participants shared additional information about how CBM programs are already working to address some of the gaps. For example, the Yup'ik Environmental Knowledge Project (not present at the workshop) is now developing a curriculum within schools to engage youth. The Arctic Eider Society is working on addressing cumulative impacts by coordinating and sharing data across five communities. SmartIce is working with partners to develop a predictive element, which would allow it to provide information to more communities.

Participants also discussed priority needs for CBM programs, including the importance of evaluating the way that CBM information is generated and used at the community level (i.e. the "social learning" happening around the CBM project). We also talked about the importance of addressing community priorities beyond monitoring of environmental variables, for example by focusing more effort on issues such as Indigenous languages and community economic development. The discussion emphasized the need to "move beyond doing the same thing in the same way" and to ensure that communities obtain a stronger role in stewardship through innovation and coordination.

Aislin Livingstone (Gordon Foundation), Leslie Lamouelle (Marian Watershed Stewardship Program) and Inez Shiwak (eNuk) participate in a breakout group. Credit: Michael Køie Poulsen

Theme 2

Sustaining CBM programs

Western Arctic Beluga Health Monitoring (Inuvialuit Settlement Region), presented by Lisa Loseto, Sonja Ostertag, and Verna Pokiak

This program has been conducting beluga whale harvest monitoring for nearly 40 years, and has developed one of the most robust long-term marine mammal datasets in the Arctic. Based in six communities in the Inuvialuit Settlement Region, it was first developed when communities had questions about the impact of the oil and gas industry. Sampling happens in beluga harvest camps and is based on TK and community input. The program employs community monitors, who are the cornerstone of the program. Many youth monitors have been involved. Around 100 belugas are harvested annually in the ISR, making the beluga an important food source, an "almost every day meal" for some residents. The length of time working together and a teamwork approach has been essential to sustainability of the program. The program draws on multiple funding sources and has many partners working on communication and capacity building. Communication between scientists and hunters is very important; this occurs informally and formally at the camps, as well as through quarterly newsletters, workshops, and on the internet. The information generated through the program informs the co-management of beluga in the ISR.

Discussion of sustaining CBM programs

The group discussed reasons why some CBM programs have ended, while others are able to continue over time. Some programs stop collecting data because they are unable to secure long-term funding, or because the federal or territorial mandate (and related funding stream) comes to an end. Some programs end because they are focused more on baseline data and do not need to continue to collect observations; some are discontinuous, such as those that take a "snapshot" every five years. Another factor is capacity and ability to retain community monitors over time.

Programs that are sustained have good coordination that continues over time, are forward thinking and able to "sell" the program or translate its value even when policies and political leaders change. One element of success is understanding the different goals of community, academic, and government partners and ensuring the program is able to contribute to all of these (often differing) goals. Programs that are successful often reflect community values, which are not always the same as the values of scientific researchers or policy makers. One suggestion for enhancing financial sustainability is to develop shared infrastructure that can be used by projects with similar goals.

Community members haul in beluga whales at East Whitefish, a whaling camp for Inuvik in the Northwest Territories, Canada. Credit: Lisa Loseto

Community members and scientists take samples of beluga whales harvested at Hendrickson Island, Northwest Territories. Credit: Émilie Couture

Programs have a greater chance of sustainability at the community level when their focus is on something that has cultural and/or local economic value. An example is the beluga monitoring program, where beluga is an important food source, has strong cultural value, and is an important part of the sharing economy for Inuvialuit residents. The beluga monitoring program supports a land camp, which contributes to TK transmission and thus engages cultural values beyond the project. The community and researchers are able to leverage funding for this program, allowing them to work together on a common goal. The project has been sustained because community members see value in different components – the program creates jobs and trains residents to collect samples. The scientists return to the community to share information on a regular basis, visiting harvesters in their homes. The Guardian program (not present at the workshop) was mentioned as an example of a holistic monitoring program that also has been sustainable.

We also discussed the role of partnerships in program sustainability. There is a growing interest among NGOs and industry in supporting CBM programs. For example, Oceans North (an environmental NGO) has supported the ISR-CBMP and other CBM programs. SmartIce is working to become a social enterprise, and is engaging different sectors that are usually not part of CBM programs. They recently hired a business development coordinator to help build partnerships with the private sector. As with other partnerships, it is important in community-industry partnerships to be realistic about expectations and priorities and to be aware of where values may differ. The group also discussed the role of funders in supporting successful partnership models; it would be helpful if funders prioritized or incentivized collaboration in their funding models and awarded funding to CBM programs that support decision-making.

Quotes from participants

"Some communities are researcher fatigued, not research fatigued per se. Communities can and do partner with researchers who 'get it'. This is based on trust."

"When you are doing research in our communities, it needs to be relevant. This means making sure all research is done for the community and it's something they want to see. That will make a difference down the road if the money for the monitoring goes away."

Opposite: SmartICE operator Jonah Keyookta from Qikiqtarjuaq, Nunavut is operating the SmartQAMUTIK, which is an ice-sled mounted sensor, towed by a snowmobile, that measures sea-ice thickness in real time and maps color-coded ice thicknesses along community trails. Credit: Trevor Bell, SmartICE

Theme 3

Using data and information for decision-making

Nunavut Coastal Resource Inventory (Nunavut), presented by Teresa Tufts

This program is run by the Government of Nunavut's Department of Environment and involves documenting Inuit knowledge of coastal species (fish, marine mammals, birds, aquatic plants, invertebrates). The methods involve participatory mapping and Inuit knowledge interviews with Elders, hunters and fishers, which have been conducted in 23 Nunavut communities so far. Paper reports go back to the communities and they developed an online atlas in collaboration with Carleton's Geomatics and Cartographic Research Center. The online atlas allows communities to access the database and to enter new observations as and when they see fit. Within the Department of Environment, the data has been used as a baseline to direct research and fisheries development priorities. The information has also been used for municipal planning and by academic researchers to fill information gaps.

Community-Based Fishery Monitoring Programme (Nunavut), presented by Zoya Martin

This program is run by the Department of Fisheries and Oceans Canada (DFO) in partnership with the Pangnirtung Hunters and Trappers Organization (HTO), the Community of Pangnirtung, the Government of Nunavut, and the Nunavut General Monitoring Program. Program implementation was motivated by the need to build relationships with Pangnirtung, to better understand community research interests, to focus research to meet community and DFO needs, and to provide training. The information is collected in science reports that formally document and incorporate *Inuit Qaujimajatuqangit* (Inuit knowledge) into Stock Assessments, allowing resource managers to use this information. The community has a voice in every step of research from project design, data collection, analysis, and then review of science advice to managers for decision. Some of the things that worked well included building relationships over time, training and retaining project personnel, community hires, and the ability to adjust research collection to match community interest. Handing over complete responsibility of the project to the community did not work, as it was not what the community wanted. Some of the factors that have kept this program alive include invested time, energy, building good relationships, trust and communication,

dedicated people and continued financial funding (funded by DFO 2016 and 2017).

Discussion of using data for decision making

Breakout group discussions focused on how information and data are shared at different scales of decision making. One discussion thread focused on the role of institutions at the community level in sharing information and getting accurate data, and the relationships between community members and outside researchers. As one northern resident summarized: "We [community members] can tell you what is happening, but you [scientists] tell me why."

In Canada, hunters and trappers' organizations (HTOs), which are made up of elected community representatives, play a key role in representing communities in territorial decision-making. HTOs share feedback and information with the co-management board and the community and allocate harvest quotas within the community once they are set by the board.

Elders play a very important role in many CBM programs. In the Tłı̨chǫ Government programs, elders make decisions about when to go on the land and where to conduct monitoring activities. In some cases, the same elders are asked over and over to share knowledge, which creates challenges in terms of one-sided information sharing and data validation. In some cases, elders are engaged as representatives who do not have the support of the community. It is important to avoid overreliance on particular individuals, to make sure that those involved have the trust of the community, and to bring younger perspectives to get a broader picture.

Leslie Lamouelle (Marian Watershed Stewardship Program) listens to presenters. Credit: Michael Køie Poulsen

Gaining and reinforcing trust at the community level was another important theme discussed. It is critical that data comes back to the community—it should not just sit in a spreadsheet. Community radio and Facebook play a large role in sharing information about hunting and wildlife within communities and could be better utilized to share CBM data and information.

Quotes from participants

"[In Nunavut] the go-to for wildlife management has always been the HTO. They're trusted. People still trust the HTOs to make the best decisions."

"Getting information up the chain to decision-makers is difficult. Bureaucracy gets in the way. They [communities] are not seeing where the data is creating a change or being used to inform decisions. The Nunavut Land Claim Agreement (with co-management) is supposed to trump other agreements, but in practice, that doesn't always happen. Science is taken before TK for the most part."

Communities are concerned that their perspectives are not being taken into account in decision-making. The recent example where the Clyde River Inuit argued that they were not properly consulted about the disruptive seismic testing in Clyde River (an opinion that was supported by the Supreme Court) will have a great impact

Opposite: A boat disturbs the waters as it leaves Sam Ford Fjord in Baffin Island, Nunavut, Canada. Credit: ashokboghani/Flickr

Crowberry plants ripen on the summer tundra on Baffin Island, Nunavut. Credit: Noor Johnson

on other programs and how people behave when it comes to knowledge local people have. Another example shared was of a landslide in Svalbard, Norway, that killed several residents and destroyed houses. Surviving residents felt they were not properly informed of the danger by government, and that their concerns about persistent risks were not taken into account.

The ways that data are collected must reflect the value system of knowledge holders. Similarly, as data are shared with decision-makers, it is important to consider who is going to interpret data and how interpretation will be done. Scientists may view TK as a "data point," while an elder would put it in a broader context. There are also some sensitivities and challenges that need to be considered about privacy of data, such as health data, when shared with decision-makers.

Participants noted that CBM is not just a "fancy monitoring program" – it needs to be meaningful to communities. Part of this is demonstrating that the information is feeding into decision-making. For example, the Nunavut Wildlife Management Board uses CBM data in its population assessments of wildlife for setting harvest levels.

Arctic cotton blooms. Inuit traditionally used the seed heads as wicks in seal oil lamps. Credit: Noor Johnson

Opposite: This satellite image shows a portion of Canada's Mackenzie River Delta and the town of Inuvik, home to more than 3,000 people. White, snow-and-ice covered waterways stand out amid green, pine-covered land. Credit: NASA

Theme 4

Data management and sharing infrastructure

Nunaliit Network (platform used by various CBM programs), presented by Amos Hayes

Nunaliit is a knowledge management framework that can be used to visualize a variety of information, both quantitative and qualitative. It has been developed by researchers at the Geomatics and Cartographic Research Centre (GCRC) at Carleton University working in partnership with Arctic communities and researchers through a distributed data management network for local and traditional knowledge. Products developed with Nunaliit include atlases of maps and data visualizations that incorporate images, video and audio recordings. Nunaliit can be integrated with other systems and devices used to log observations. Information can be connected, filtered, searched, and represented in multiple ways. Integral replication and synchronization technology enables distributed data stewardship. In addition to technology and process co-development, GCRC works with partners on knowledge stewardship, visualization, and storytelling.

Mackenzie DataStream (platform used by various CBM programs), presented by Lindsay Day

Mackenzie DataStream is an open-access, data-sharing and management infrastructure for shared water stewardship aimed at community use. It was launched in 2016 through a collaboration between The Gordon Foundation and the Government of the Northwest Territories and 23 communities are currently using it. Functionalities include uploading, graphically representing and downloading water quality data.

The Arctic Eider Society's SIKU platform is a platform designed by and for Inuit towards self-determination in research and is being used by several community-driven research programs and the Hudson Bay Consortium network. Joel Heath presented.

SIKU is a collaborative Inuit Knowledge Wiki and Social Mapping Platform that provides a wide variety of tools and services to benefit Inuit and brings spatial and temporal components together. It includes many essential services one would need to go out hunting (e.g. high resolution sea ice imagery including radar, forecasts, tidal information) that can be directly linked to posts for historical reference. Community researchers and hunters can use SIKU and the SIKU mobile app to document observations and record stories narrated by community members, including the ability to tag photos and posts with

Workshop participants enjoy a moment of humor. Credit: Michael Køie Poulsen

Inuktitut sea ice terminology, wildlife species and other entities linked to wikis and profiles such as organizations, projects, regions, communities, and tools. It hosts information from community-driven research networks across the Canadian Arctic and has capabilities for a wide variety of information types including participatory mapping, hunting stories, oceanographic, sea ice and biological data. A wide variety of educational tools are also integrated and linked to school curriculum including interactive media like Google street view of remote sea ice. It is a project-independent platform that puts Inuit first and foremost in the design and structure for the interface, database and intellectual property management. It allows communities spread over vast distances to share observations and collaborate and lead their own networked research programs.

Discussion of data management and sharing infrastructure

One theme discussed was how to facilitate community control over data, particularly in relation to emergence of different digital platforms for storing and sharing data. Data accessibility is a critical issue for CBM programs to address. Communities are deeply concerned about maintaining control over data, based on a legacy of misuse of information outside the community and a longstanding issue of researchers not sharing data or research results with communities. Frustration is compounded when multiple outside groups collect the same information yet do not make it accessible. Even in collaborative projects where communities have a say, issues can arise, for example when partners want to use data for purposes that were not initially discussed with or authorized by the community.

Successful data management requires having people in the community with the skills needed to be data stewards. "For any information management to contribute to success, you need people in the community making sure it's being used in the right way." Consultation with community members about how they would like the data to be shared is one way to ensure this. SmartIce hires community research coordinators who use a range of community

Children jig for fish on the boat landing at Kangitugaapik, Nunavut. Community-based monitoring programs that engage youth can also support transmission of Traditional Knowledge by teaching land skills and encouraging interaction with knowledgable hunters and elders. Credit: Noor Johnson

forums to consult about data products and data sharing to ensure that products are relevant. "This gives them a sense of management, control and trust." They also request that if community members want to share the information with people from outside the community, they need to consult with individuals involved with the project so that it can be shared correctly. Communities also want to make sure that information and data are properly verified from within the community; data uploaded into databases needs to come from a reliable source, such as community observers who are preapproved. This is critical when it comes to sea ice, for example, to ensure safe travel.

Co-collection of data and licensing agreements that include data policies were discussed as important components of CBM data management. Some projects adopt a data policy that specifies that data producers remain the owners of the data. A data policy can identify which datasets are particularly sensitive (such as health data), and can restrict access to certain user groups. For some datasets, such as water quality, there may be a greater impetus to share across jurisdictions. It is important to always verify accuracy of data with the community to allow community members to decide what data should and shouldn't be made public.

Some data (for example wildlife samples) must leave the community for lab-based processing. Data sharing agreements can help ensure that communities maintain a long-term ownership role. When data is made publicly available, it can be tracked by using data object identifiers (DOI)—this can offer information about who is using data generated by CBM programs.

Another major discussion theme was how to better coordinate across diverse data platforms. Notably, four programs participating in the workshop had developed or were developing platforms that were designed to facilitate collection and sharing of data beyond the scope of one single program, including SIKU, SmartIce, eNuk, and the Mackenzie Data Stream. Two additional initiatives, the Geomatic and Cartographic Research and Information Centre (GCRC) based at Carleton University, and the Exchange for Local Observations and Knowledge of the Arctic, based at

the University of Colorado Boulder, adapt open source software to meet the specific data and information management needs of community project partners.

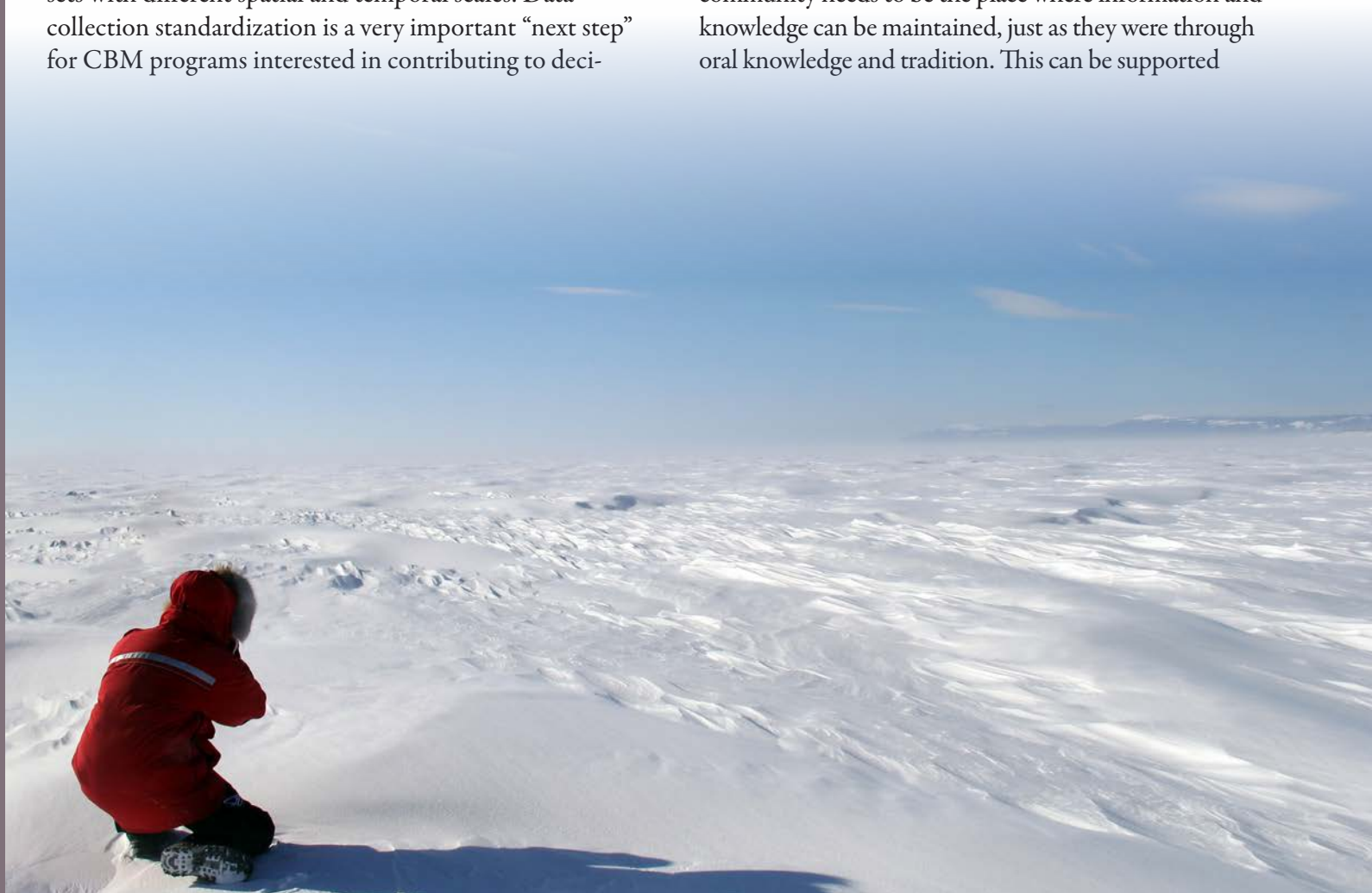
Participants noted that although the focus is now on getting their own systems up and running ("I'm just worried about operability at this point, not interoperability!"), the large-scale ambitions of the different infrastructures suggested a need for greater coordination and communication. As one participant noted, "Everything is starting to converge—maybe one day a lot of these projects will be redundant."

Participants noted that systems should be designed in a way that will allow them to connect to share information with other systems later. For example, apps should be developed with an API (application programming interface). This allows an app to communicate and share data with another app while restricting the second app's ability to modify data without permission. This allows data sharing while still retaining control of the data.

From the perspective of decision-making, the data is much more useful if you can use it to show overarching patterns. This often requires drawing on different data sets with different spatial and temporal scales. Data collection standardization is a very important "next step" for CBM programs interested in contributing to decision-making, yet it is a huge challenge when data needs of communities are different. For example, how to find points of overlap between two programs focused on sea ice – one that is concerned about safety for communities, and the other about ecological analysis. Can these programs agree to collect some data in common, using the same format, and can they also use platforms that are interoperable? Platforms will need to be synchronized to allow information to move between them. For example, could SmartIce share freshwater data with Datastream?

Infrastructure challenges in northern communities were also noted. There is a wide variation in internet bandwidth in different parts of the North American Arctic. In Alaska, a fiber optic cable service is about to be activated in the North Slope communities. In northern Canada, bandwidth speeds range, but are "getting better all the time."

Participants also discussed the proper location for data repositories. One participant noted that researchers are still asking the same questions in his community that they asked 40 years ago. This prompted reflection on the need for information to persist within the community: "The memory of what was done and why, has to survive" since "everything comes and goes except the community." The community needs to be the place where information and knowledge can be maintained, just as they were through oral knowledge and tradition. This can be supported



Inez Shiwak (eNuk) makes a point while Dan Gillis (eNuk) listens. Credit: Michael Køie Poulsen

through developing data repositories, a kind of "community knowledge bank," within communities that can host information and translate it into relevant products. This needs to hold raw data (not just a summary provided by the researcher), since the community may want to use that data at a later time. Researchers can sometimes refuse to share data, citing intellectual property rights protection. For example, when an Elder passes away, residents and relatives may want to access interviews, but researchers may decline because they did not secure the Elder's permission to share the transcript. These issues can and should be addressed from the outset, so that researchers get permission to archive copies of raw transcripts in a community repository.

Clyde River's new knowledge atlas project was mentioned as an example of a community-based data repository and data sharing infrastructure. When communities do not have the infrastructure to coordinate access to a repository, a central repository could help meet this need. For example, Inuit Qaujisarvingat could host a central (potentially cloud-based) database. Different interfaces could be set up to respond to community information needs and to allow communities to manage the data.

Participants noted that politics is the largest challenge to data management, because individuals, communities, regional organizations, and governments all want to be involved in decisions about data, and there are unresolved jurisdictional issues that complicate the discussions. For example, the eNuk program will gather data about mental health distress, and is working to design mechanisms in the eNuk app that will protect sensitive health information, but will alert the appropriate entity when community data indicates a high level of mental health distress. One challenge is that there is shared jurisdiction over health services between the province and the land claim government, leading to concerns around data sharing, data ownership, data privacy, and who should be alerted about potential health risks.

Participants agreed that given the pace of development of technology and the diversity of platforms emerging to support data management and sharing, it will be important to maintain an active conversation about data sharing among CBM programs. More opportunities for networking will help raise awareness of other (similar) work happening. This may allow programs to avoid some redundancies in infrastructure development.

Quotes from participants

"We are all struggling with data management and all at different places."

"Data management is not a technological challenge, it's a social and political challenge."

"I live and work in my community, and in the past, researchers would come from the South in spring and summertime. They would hire people as cooks, guards, and polar bear monitors, rather than being part of the research, itself. Once they had finished collecting data, they would hardly give any feedback to the community. They would bring the results to their schools and universities. We need information to stay in the community so it's available for the community, itself."

Opposite: A researcher tests the cold-hardiness of iPod technologies for on-the-land monitoring outside of Rigolet, Nunatsiavut. Credit: Ashlee Cunsolo

Theme 5

Co-producing observations based on TK and conventional scientific monitoring

eNuk (Nunatsiavut), presented by Ashlee Cunsolo, Dan Gillis, and Inez Shiwak

eNuk is an Inuit-led and Inuit-designed environment and health monitoring program in Rigolet, Nunatsiavut. The goal of the eNuk program is to "develop a community-based monitoring system, based on Inuit-knowledge and priorities, to track, analyze, and respond to health impacts of climatic and environmental change and resulting socio-cultural and socio-economic shifts." Previous research led by the community from 2006 onward has documented information on climate change impacts on physical and mental health, food and water security, cultural continuity, and resilience. In order to move from documentation to response, the community identified the need to streamline all the research, and put all environment and health information in one place. Responding to this need, the eNuk program is creating an app to track environment and health indicators identified by the community. The program draws on TK and conventional scientific approaches to collaboratively identify monitoring indicators. The app allows Inuit in the community to upload pictures of videos, add text, use emoticons, and track and map key places. Additional information will be gathered through short surveys and 'gamification' strategies. The eNuk app is also collaborating with RightMesh, a company that utilizes mesh technology to link mobile devices together in the community, allowing for instant sharing of observational data through the app.

Discussion of co-producing observations

The most important factor in successful co-production for research is respect, which goes both ways (scientists and community members/TK holders). As one participant put it, TK and science have different "atmospheres." Communities and scientists can be worlds apart. One indicator of respect is an emphasis on listening. Recognizing that scientists and TK holders come from different cultures can help develop respect and encourage respectful listening. When co-production doesn't work, it is often based on a lack of understanding, education and/or respect.

The group discussed benefits to TK holders and scientists from knowledge co-production. What counts as a

Michael Birlea (Marian Watershed Stewardship Program) and Brenda Parlee (Tracking Change) engage in a discussion about sustaining CBM programs. Credit: Michael Køie Poulsen

different qualities which they also need. When managers slowed down to listen to what community members were saying, they were able to adjust the quotas to meet community needs. Connecting and linking TK with scientific knowledge is a skill and should be recognized; projects may benefit from hiring (and paying) individuals who are skilled at building these connections.

Although most felt that the growing interest in co-production is positive, participants also emphasized the importance of considering the relationship between CBM on governance and Indigenous rights. In some parts of northern Canada, there has been a breakdown of relationships between polar bear scientists and communities. There is some concern about the potential for monitoring to serve as a form of surveillance of community harvesting activities. It is important to ask: What is the benefit of tracking harvests and who is benefiting? There is also an increase in community interest in meaningful consultation and the right to veto

Quotes from participants

"It's important for research to be able to adjust. If you have a set idea of what you want to research, but the community has a totally different idea, you need to adjust your idea. We have had projects started where the community has different idea... you can't go in with a set mindset. You need to be able to think on the fly and come up with a new idea."

benefit varies depending on who is in the room. It is important to make sure TK holders are part of developing the project and identifying how resulting data will be used. Examples of questions that are relevant to TK holders that can be addressed through CBM were shared throughout the workshop: Is our food safe to eat? Is our water safe to drink? Is it safe to travel?

Community monitoring often includes more attributes than scientific monitoring and may show where to target scientific monitoring. Although it would be great if they always aligned, this often is not the case. One example shared was from caribou management on Baffin Island: Scientists recommend harvesting males only, but communities know that females have a research or monitoring project that does not fit with community priorities.

Greg Jacque takes pictures of ice conditions near Postville, Nunatsiavut. Credit: Ashlee Cunsolo

Opposite: A zodiac boat wades into a fjord off of Baffin Island, Nunavut, Canada. Credit: ashokboghani/Flickr

Theme 6

Network building

Community Ecological Monitoring Program (Yukon Territory), presented by Todd Powell (remote presentation via Zoom)

This long-term monitoring program is run by the Government of Yukon and includes community and academic partners. Its goal is to track populations that are important to ecosystem function: small mammals, snowshoe hares, predators, white spruce, berries, and mushrooms. Monitoring happens at fixed sites throughout the Yukon Territory. Following specific protocols, this data is collected by field teams who regularly visit permanent sample plots and permanent transects throughout Yukon Territory. By developing a network of sites and involving community members in data collection, often under contract by the Government of Yukon, community members find the information more credible. The project has produced journal articles and science reports that contribute to our understanding of ecosystem dynamics and health.

SmartICE (establishing operations for 2018 in Nain and North West River, Nunatsiavut; Arctic Bay, Pond Inlet, Qikiqtarjuaq, Iqaluit, Arviat, Resolute Bay, and Cambridge Bay, Nunavut), presented by Trevor Bell and Andrew Arreak

SmartICE is an ice monitoring and information service for communities and industry. It uses a combination of satellite imagery and stationary (SmartBUOYs) and mobile (SmartQAMUTIKs) instruments that are deployed along locally important routes to measure sea ice thickness. Maps are created from this information and interpreted as 'go', 'no go', or 'slow go' to inform travel decisions of northern residents and industry. SmartICE currently operates in three regions of Canada, and is developing a platform that can be used throughout the Arctic, facilitating network building and exchange of sea ice safety information. SmartICE is a social enterprise that creates a social return on investment while applying an entrepreneurial approach to the delivery of novel sea-ice information services for the public and private sectors. SmartICE is developing a freshwater ice monitoring service to empower Indigenous communities across subarctic Canada to monitor their winter resupply trails (approx. 10,000 km in

Workshop participants take a break to play a dice game in the hallway of the convention center. Credit: Michael Køie Poulsen

length). Through technological innovation and science, SmartICE strives to integrate and augment (not replace) Indigenous knowledge about local sea-ice conditions while involving communities in all aspects of its operation and decision-making.

Tracking Change (Northwest Territories), presented by Brenda Parlee

Tracking Change is a six-year project documenting and sharing local and traditional knowledge (LTK) in the Mackenzie River Basin with partners in the lower Amazon, Brazil and Mekong, Thailand. The goal is to determine and demonstrate the importance of LTK to our understanding of social and ecological change in the Mackenzie River Basin and contribute to regional, territorial/provincial and federal decisions about its continued sustainability. Partner communities made a list of indicators that they wanted to focus on, using both qualitative and quantitative measures. Communities decided that all projects need to happen out on the land and must involve youth. Partners participate in workshops and canoe trips, which support network building and exchange among the different communities. Tracking Change has created a research funding system where communities apply for money to support their projects. The project documents place-based knowledge of changes in the Mackenzie Basin, yielding insights into common approaches to monitoring change, the value of network-building, and social learning and engagement of youth as knowledge holders.

Discussion of networks

The group discussed different possible network models, including community-to-community networks, regionally or territorially focused networks, and networks linking CBM programs at the national and international levels. They weighed benefits and drawbacks of network-building, and talked about what networking could do for CBM programs.

In terms of the benefits of networks/networking for CBM programs, participants mentioned the opportunity to build relationships and share innovations to avoid "reinventing the wheel." Networks could help researchers interested in local monitoring understand existing programs and points of overlap and identify gaps that they could help fill. Networks could also help sustain employment of community members, for example by pooling resources to employ a community-member full-time who could contribute to managing several CBM programs.

Networks can facilitate sharing information, innovation, and best practices from successful CBM programs "no matter where they are." Many communities are eager to learn about what is happening "upstream or downstream" (in both literal and metaphoric senses). Networks can facilitate learning and exchanging information in a variety of formats, including exchange of narratives or stories, as well as standardized data about shared areas of concern.

Opposite: The curving tongue of the Kaskawulsh Glacier is here in the Yukon Territory, Canada. Credit: M.E. Sanseverino/Flickr

Arctic poppies bloom. Credit: Noor Johnson

For example, a network might agree to collect standardized data on sea ice and to gain a better understanding of how sea ice is changing regionally and at a circumpolar scale. Networks can also be avenues for sharing challenges or failures—what doesn't work and why. They could contribute to documentation of the social learning that happens around CBM at the community level, such as who is using the data and information generated. Networks could support development and implementation of monitoring and evaluation of CBM programs.

Networks facilitate connection to other networks, thus leveraging the power of connection. A network of CBM programs may have greater potential to impact a governance system by leveraging different kinds of data and observation, more data points, and by engaging more communities and community members with a vested interest. Networks could also support implementation of community data repositories and develop best practices for ensuring that communities maintain control of data.

Networks can enhance capacity in various ways. For example, communities interested in building direct links and connections to other communities can find it difficult to get funding for these activities. A network could offer training (i.e. proposal writing, project leadership) and even small grants for communities interested in sending someone to another community to learn about their CBM programs. A network could assist with lobbying to modify funding structures in a way that would facilitate community-to-community networking. Networks could also inform advocates working at the national and international levels of community priorities "so we can push the right questions, things to be monitored, and the right indicators." Networks can also work to keep the focus on the community level in other ways, for example by sharing strategies for using monitoring to advance local goals.

The group also discussed challenges to network building, noting that every community has its own priorities, and the same approach won't work everywhere. Networking or linking programs would need to be done in a way that used a flexible structure, did not try to promote a single tool (i.e. "THE app"), and was not perceived as too top-down. Issues related to intellectual property vary by community; although most communities do want to share some of their data, local autonomy and control is important to sustaining engagement and interest. A network would have to support local autonomy and not be perceived as a threat to autonomy.

Some participants questioned the value of a circumpolar network, wondering whether it was really possible to link all monitoring across such a broad geographic region. Even at a sub-national (or as this is called in Canada, "regional") level, data collection may be difficult to implement in a way that is relevant to all communities. The Tracking Change program, which engages a network of communities across the Mackenzie Delta, mentioned that some indicators are cross-cutting at different scales, and that there is an ongoing challenge to align these.

Participants were interested in pursuing network activities, with several stating that they were most interested in starting locally ("we should do it one community at a time") or sub-nationally ("starting in Nunavut") and expanding from there, scaling in the "right way" (and noting that "not everything needs to be scaled"). It is important to avoid "network fatigue" by engaging communities in the process of designing CBM networks and identifying incentives to stay involved, recognizing that participation may ebb and flow over time. As one participant noted, networks

do not need to be dense to be effective—it only takes one connection between one point and another to make a large network. "Successful networks are built on loose ties."

One participant felt that "it would be good to have an interactive map of all CBM as every community is different." Information was then shared about an existing resource, The Atlas of CBM and IK in the Arctic (http://www.arcticcbm.org/index.html), which offers an inventory of CBM and TK projects relevant to observing based on collected metadata about each project. The atlas aims to make it easier for communities, researchers, and governments to find CBM programs based on geography or observation type. It demonstrates the variety of CBM programs in the Arctic and can support network-building among programs collecting similar types of observations. It could also be used to facilitate networking with a goal of using observations for larger scale analysis and assessment.

Similarly, ELOKA is working to support network building. ELOKA provides data management services and technical support, as well as facilitating knowledge exchange between communities, individual researchers, and IK holders.

Participants highlighted the importance of working together for CBM to succeed in the long term. This success will require awareness of changes in the broader context of Arctic observing, such as new platforms and new actors. For example, at Arctic Change 2017 Google Earth presented on Google Earth Engine and the Arctic. Google Earth is a geospatial data processing and analysis platform that stores and analyzes global scale satellite imagery and makes it freely available to researchers. It also provides tools to assist researchers with analysis of data. New platforms such as this one can disrupt the value of older platforms, even those developed carefully over time with significant community involvement.

Quotes from participants

"One of the beauties of this meeting is that we are learning from each other. I had little knowledge of CBM before this workshop. That may reflect that Nunatsiavut is the newest land claim. We don't have hunters and trappers support programs in our village. Instead, we tend to get information from conservation officers. Now I can see the role and value of CBM, of having that in Nunatsiavut, and I hope our government will adopt CBM programs."

"CBM programs come from governments, communities, and NGOs, and we can only succeed at networking if we can share, try to trust each other. CBM is just going to expand. For it to succeed in the long term, we have to be willing to work with one another. Those of us who are at forefront of implementing programs need to make sure we are clear about value of sharing knowledge and data."

"How can you bring the model of beluga monitoring to other communities? Others depend on the mattaq too. We should send instructions on exactly how to take the sample to all communities that harvest the whale. With DFO research on whales we ask: why is this not happening all over? ISR needs the information, but so might others."

"If you are networked, people will see the [environmental change] coming. In Cumberland Sound, we have capelin present. With temperatures increasing, that will expand and go from community to community. Southern communities may have already found ways to reap benefits in their environment. Changes are coming, and if we are networked, we can prepare and adapt more easily."

Conclusions

Taking stock

The motivations for implementing CBM programs differ but included: influencing decisions about industrial development and regulations in fishing and hunting; gaining a better understanding of the challenges and opportunities of climate change and social and human health conditions, as well as education and capacity building.

Similarly, the motivation for individuals to be involved in CBM varied but included addressing the practical needs of communities. Other sources of motivation for individuals included developing a better understanding the environment, and sharing knowledge and learning from each other.

There were a variety of attributes being monitored by the CBM programs in attendance, although there were still many information needs and gaps identified.

A variety of people and organizations are using CBM generated information including: individuals, hunter trapper organizations, civil society organisations, industry, and government organizations at all levels, especially wildlife management agencies.

Good practices are considered practices that have proven to work well for CBM programs. These included CBM practices that are supported by the community, provide capacity building opportunities, link TK and science, and document TK. Trust among community members and scientists is also important.

Challenges that CBM program representatives have faced included the ability to secure long term funding leading to gaps in data records over time. Other challenges included reconciling science and community priorities, linking quantitative with qualitative approaches, and meaningful dissemination of information. There were also challenges related to avoiding misconceptions of how the data can be used, timeliness of producing accessible data, community burnout, and difficulties of growing a program. Other challenges included a lack of technical support, limitations in community infrastructure and connectivity, and difficulties in influencing change.

There was also a general agreement that CBM programs need to evolve, building on what we have learned rather than doing things the way they have always been done.

Sustainability of CBM

CBM sustainability can be enhanced through partnerships and working together. This could lead to shared data platforms and better coordinated efforts to reduce redundancy. CBM programs that are able to be relevant and address the needs of communities, scientists and decision makers are more likely to be sustained.

Decision making

It is important for CBM information to be included in decisions about industrial development.

Decision makers often need to understand large scale processes. For CBM data to contribute, it needs to be interoperable (able to be analyzed across different programs). This is sometimes difficult since CBM programs and community priorities vary.

Data

Methods of data collection must be culturally appropriate.

Community consultation to create data sharing agreements should happen before a project is implemented. All parties need to be clear on what happens to data after it is collected. The community should have the opportunity to verify the data and decide what to make publicly available.

CBM organizers need to take into account the connectivity and infrastructure of rural communities.

Data and information needs to be returned to communities, not just in summary form, but also the raw data. A repository of data should be available to community members to meet current and future information needs.

The technical challenges to data sharing are not as great as the jurisdictional and political challenges to data sharing.

Co-producing Observations

Successful CBM programs build on mutual respect and understanding, which comes from listening and educating oneself.

Certain people are talented at building bridges between science and Arctic communities. CBM programs ought to hire and support these individuals.

A mountain on Baffin Island, Nunavut, Canada is cleaved in half. Credit: junaidrao/Flickr

It is important to consider the implications of the CBM program on Indigenous rights.

Networks

Participants recognized that working together will improve long term success of CBM. Benefits of a network could include many aspects. It could help researchers from outside the community understand where the gaps are in what is being monitored and avoid duplication of efforts. A network could contribute to better employment and training and capacity building opportunities (e.g. could potentially provide small grants to facilitate skill building and knowledge exchange of CBM programs). It could facilitate exchange of information to learn from the mistakes and successes of others, in addition to better understanding how other communities have successfully dealt with change. A network could advocate for CBM to be valued in decision making, risk management, and economic development, and for changes to funding structures.

A CBM network would need to be flexible, as communities are diverse. It is important to provide benefits to network participants, and recognize that participation may vary over time.

Opposite: A herd of caribou wander on Fogo Island, Newfoundland, Canada. Credit: Paul Asman and Jill Lenoble/Flickr

Good practices and needs

CBM programs are improved when they:

Connect with decision making needs

Build community capacity (e.g. training, employment) and provide opportunities to learn

Are supported by the community

Build trust among community members and researchers

Utilize culturally appropriate data collection methods

Include data sharing agreements developed and understood by all partners

Consider connectivity issues and utilize creative ways of communicating effectively

Return data to communities (including the raw data, not just summaries) and build capacity to host data and information products within communities

Engage individuals who can build bridges between communities and scientists

Consider the political context that the CBM program operates in and recognize rights of Arctic residents to address issues of concern in their communities

CBM programs often find it challenging to:

Secure long-term funding

Reconcile science and community priorities

Plan for long-term data management

Meaningfully disseminate information (exacerbated by limited connectivity in many rural communities)

Prevent community burnout

Access technical support

To influence change, especially in the context of industrial development

Facilitate data interoperability, since CBM programs reflect the diversity of northern communities

Workshop participants take a break to play a dice game in the hallway of the convention center. Credit: Michael Køie Poulsen

Participant List

First name	Last name	Organization	Program
Lucassie	Arragutainaq	Arctic Eider Society	SIKU
Andrew	Arreak		SmartICE
Trevor	Bell	Memorial University	SmartICE
Michael	Birlea	Tlicho Government	Marian Watershed Stewardship Program
Ashlee	Cunsolo	Labrador Institute of Memorial University	eNuk
Finn	Danielsen	Nordic Foundation for Development and Ecology (NORDECO)	INTAROS
Lindsay	Day	Gordon Foundation	Data Stream
Maryann	Fidel	Yukon Inter-Tribal Watershed Council	Yukon Inter-Tribal Watershed Council
José	Gérin-Lajoie	Centre d'Études Nordiques	AVATIVUT/IMALARIJIIT
Daniel	Gillis	University of Guelph	eNuk
Donna	Hauser	International Arctic Research Center, University of Alaska Fairbanks	Alaska Arctic Observatory and Knowledge Hub
Amos	Hayes	Carleton University	Geomatic and Cartegraphic Research Centre
Joel	Heath	Arctic Eider Society	SIKU
Gerald	Inglongasuk	Fisheries Joint Management Committee	
Lisbeth	Iversen	NANSEN Environmental and Remote Sensing Center	INTAROS
Noor	Johnson	National Snow and Ice Data Center	Exchange for Local Knowledge and Observations of the Arctic
Leslie	Lamouelle		Marian Watershed Stewardship Program
Aislin	Livingstone	Gordon Foundation	Data Stream
Lisa	Loseto	Department of Fisheries and Oceans Canada	Western Arctic Beluga Health Monitoring
Zoya	Martin	Fisheries and Oceans Canada	Community-Based Fishery Monitoring Programme and Stock Assessment Framework for Arctic Char
Denis	Ndeloh	Nunavut Wildlife Management Board	Community-based Monitoring Network (CBMN), Nunavut Wildlife Management Board
Scot	Nickels	Inuit Tapiriit Kanatami	Inuit Qaujisarvingat: Inuit Knowledge Centre
Sonja	Ostertag	Department of Fisheries and Oceans Canada	Western Arctic Beluga Health Monitoring

Brenda	Parlee	University of Alberta	Tracking Change: Local and Traditional Knowledge in Watershed Governance
Verna	Pokiak		Western Arctic Beluga Health Monitoring
Derrick	Pottle		eNuk
Michael	Poulsen	Nordic Foundation for Development and Ecology (NORDECO)	
Peter	Pulsifer	National Snow and Ice Data Center	Exchange for Local Knowledge and Observations of the Arctic
Inez	Shiwak	Rigolet Heritage Society	eNuk
Sarah	Spencer	Nunavut Wildlife Management Board	Community-based Monitoring Network (CBMN), Nunavut Wildlife Management Board
Taha	Tabish	Qaujigiartiit Health Research Centre	
Teresa	Tufts	GN Department of Environment	Nunavut Coastal Resource Inventory

Remote participants

Chloe	Brogan	Joint Secretariat	Inuvialuit Settlement Region Community-Based Monitoring Program (ISR-CBMP)
Todd	Powell	Government of Yukon	Community Ecological Monitoring Program