OCS Study
BOEM 2017-080

U.S.-Canada Northern Oil and Gas Research Forum
Final Report

US Department of the Interior
Bureau of Ocean and Energy Management
Alaska OCS Region

BOEM
Bureau of Ocean Energy Management

OCS Study
BOEM 2017-080

U.S.-Canada Northern Oil and Gas Research Forum Final Report

January 2018

Author:

Sierra Fletcher, Principal Investigator

Prepared under BOEM Contract Number M17PX00020
by
Nuka Research and Planning Group, LLC
PO Box 175
Seldovia, AK 99663

US Department of the Interior
Bureau of Ocean and Energy Management
Alaska OCS Region

BOEM
Bureau of Ocean Energy Management

DISCLAIMER

Study concept, oversight, and funding were provided by the U.S. Department of Interior, Bureau of Ocean Energy Management, under Contract Number M17PX00020. This report has been technically reviewed by BOEM and it has been approved for publication. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government, nor does mention of the trade names or commercial products constitute endorsement or recommendation for use.

REPORT AVAILABILITY

To download a PDF version of this document, go to the BOEM Data and Information Specifications webpage (https://www.boem.gov/ESP-Data-and-Information-Specifications/).

CITATION

Nuka Research and Planning Group, LLC. 2018. 2017 US-Canada Northern Oil and Gas Research Forum, Final Report. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region. OCS Study BOEM 2017-080. Provided to BOEM by Nuka Research and Planning Group, LLC, 46 pp, plus Appendices.

ABOUT THE COVER

Cover graphic by Kathleen George.

ACKNOWLEDGEMENTS

The following BOEM offices contributed to this document: Alaska OCS Region Directors Office and the Alaska Environmental Studies Management Section. We thank Dennis Thurston, BOEM, and Filip Petrovic, INAC, for co-chairing the Forum organizing committee. Rick Raymond and Jeffrey Brooks provided comments on drafts of this report.

Contents

List of Abbreviations and Acronyms

AK LNG	Alaska Liquid Natural Gas project
AMBON	Arctic Marine Biodiversity Observing Network
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environment
CAMx	Comprehensive Air Quality Model with Extensions
CAFF	Conservation of Arctic Flora and Fauna (Arctic Council working group)
DBO	Distributed Biological Observatory
DOI	Department of Interior
EBM	Ecosystem-based Management
EPPR	Emergency Prevention, Preparedness, and Response (Arctic Council working group)
ERMA	Environmental Response Management Application
iBO	integrated Beaufort Observatory
INAC	Indigenous and Northern Affairs Canada
ISO	International Standards Organization
ICC	Inuit Circumpolar Council
LEO	Local Environmental Observer
LCC	Landscape Conservation Cooperative
MARES	Marine Arctic Ecosystem Study
MMIF	Mesoscale Model Interface
MPA	Marine Protected Area
NIRB	Nunavut Impact Review Board
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCan	Natural Resources Canada
NSSI	North Slope Science Initiative
NWT	Northwest Territories
Ohmsett	Oil and Hazardous Materials Simulated Environmental Test Tank
OPP	Oceans Protection Plan
OSCIA	Oil Spills in Ice-Covered Arctic
OCS	Outer Continental Shelf
PAME	Protection of the Arctic Marine Environment (Arctic Council working group)
PGM	photochemical grid model
QIA	Qikiqtani Inuit Association
USGS	U.S. Geological Survey
WRF	Weather Research Forecast

1 Introduction

The fifth Northern Oil and Gas Research Forum (the Forum) convened at the Dena'ina Center in Anchorage, Alaska on October 11-13, 2017. Organized by a binational committee from the U.S. and Canada, the event included 67 presenters, 4 posters, and 181 total attendees. The Forum was originally conceived by Canadian and U.S. colleagues working on an Arctic Council assessment, with the first event held in 2008 in Anchorage, AK. Since then, the event has been held in Calgary, AB (2010), Anchorage, AK (2012), and Yellowknife, NWT (2014). The U.S. and Canada share a history of oil and gas exploration and development in the Beaufort Sea and adjoining coastal areas, including significant research in support of their respective environmental assessment and regulatory processes. As noted following the first Forum, "This research is important as it enables both governments and industry to fulfill their responsibilities to minimize environmental and social impacts while pursuing economic development and energy production" (BSES, Inc., 2009).

The 2017 Forum incorporated a wide range of topics related to environmental issues, research methods and results, scenario planning, oil spill prevention and response, and community engagement as related to actual or potential future oil and gas operations in Alaska and the Canadian North. Participants represented federal, state, and local government, indigenous groups, consultant scientists, non-profit organizations, industry, and both academic and government researchers.

This final report summarizes the panel presentations, technical sessions, and posters that comprised the conference, including recommendations and observations shared in a final discussion at the conclusion of the three-day event. The report was developed based on author-provided abstracts, PowerPoint presentations, and notes taken during the event. No additional research was conducted to validate the content presented.

The Forum agenda is provided in Appendix A. Presentations are available at: www.boem.gov/uscanada2017.

2 Opening Remarks

Mark Hopkins, Director General of Natural Resources and Environment for Indigenous and Northern Affairs Canada (INAC), and Walter Cruikshank, Acting Director of the U.S. Bureau of Ocean Energy Management (BOEM), opened the event with greetings from both the Canadian and U.S. Federal Governments. Both speakers expressed appreciation for the efforts of the Organizing Committee in planning the event and in the time spent by participants to travel to and attend the Forum.

Mark Hopkins, Director General
Natural Resources and Environment
Indigenous and Northern Affairs Canada
Mr. Hopkins noted that the Canadian Western Arctic/Beaufort Sea region climate is changing faster than models had predicted 5-10 years ago. Climate change alters the operating environment for industry; local livelihoods; and transportation corridors for people, vessels and wildlife. These changes can raise concerns about the potential impacts of new activities on people and the environment, as well as potential conflicts of use. This context necessitates inter-disciplinary work across scientific fields and among both natural and social scientists. These must also be integrated with indigenous knowledge. New networks for

understanding among these different sectors or groups is critical to making sound decisions in the face of inherent uncertainty.

Prime Minister Trudeau and former President Obama issued a Joint Arctic Leaders statement in 2016. While the U.S. administration has changed, this document remains a clear statement of Canadian domestic policy towards the Arctic.

The Government of Canada is currently focused on growing jobs for the middle class, addressing climate change, and reconciling with indigenous peoples in Canada. Smart natural resource development with a robust regulatory framework can support these goals. Currently, there is a moratorium on offshore oil and gas licenses in Canada's Arctic waters. This policy will be reviewed on a 5-year cycle. INAC is currently conducting two Strategic Environmental Assessments in partnership with regional governments and organizations. The agency is also developing a new program of community-based monitoring that includes funding to indigenous communities and will form a network across the Canadian Arctic.

Walter Cruikshank, Acting Director
U.S. Bureau of Ocean Energy Management
Mr. Cruikshank described the importance of energy production from U.S. federal lands to President Trump's energy development priorities. Within the U.S., Alaska is vital to achieving the administration's goals, with a prominent role for the Department of Interior (DOI). Within the Department, the Bureau of Land Management (BLM) manages onshore federal lands, BOEM is responsible for offshore resources, and the Bureau of Safety and Environment (BSEE) serves as a sister agency to BOEM, also focused on regulating the offshore areas. In April 2017, the President issued an executive order to expand energy production from the Outer Continental Shelf (OCS), along with ensuring that any such activity is safe and environmentally responsible. A new leasing program will be issued by the end of 2019 that considers Alaska's one billion acres of the OCS (including the Chukchi, Beaufort, and Cook Inlet).

Planning for leasing and other activities requires critical information regarding the Alaska OCS Region. The U.S. and Canada have a common history of activities in northern regions, and a long history of cooperation on research. BOEM's Environmental Studies Program has funded $1.1 billion in research over the past 40 years, with $500 million in research funding on the Arctic in the last 10 years resulting in 1000 peer-reviewed publications. Mr. Cruikshank highlighted the Marine Arctic Ecosystem Study (MARES), which enjoys the participation of the U.S. and Canadian governments, the State of Alaska, Tribes, universities, and private partners.

Scientists should understand the type of information needed by resource managers and decision-makers, and how it will be used. Meetings and gatherings such as the 2017 Forum provide valuable opportunities for managers and researchers to interact. Traditional knowledge must also be incorporated, and is considered critical to BOEM's work.

Questions & Discussion

Forum participants posed the following questions and comments to the speakers:

- When will the next review of Canada's moratorium on offshore oil and gas operations be? How is the review process structured?

  Mr. Hopkins: The next review in the 5-year cycle will be in December 2021. At that point, a decision will be made to continue the moratorium on offshore exploration or allow it with conditions. The review process includes a regional assessment with intensive community consultation. It will also consider climate change.

- What are the Government of Canada's overarching means of consultation with indigenous peoples regarding resource development in the north?

  Mr. Hopkins: The highly consultative regional strategic environmental assessments mentioned previously are just one part of the approach. In the three northern territories, there are also land claims agreements, land use planning boards, environmental assessment boards, and water boards. Those institutions are critical to the effort to institutionalize indigenous control and consultation to decision-making processes.

- What is the status of the U.S. moratorium on offshore oil and gas activity in the Beaufort Sea announced in December 2016 (under the previous administration)?

  Mr. Cruikshank: When the President announced the change in policy regarding offshore oil and gas leases, he left in place the existing marine sanctuaries. However, while there is a current challenge in the courts over the change to the previously announced moratorium for the Beaufort Sea, there have been no legal decisions that prevent BOEM from proceeding with the lease plan as discussed.

- What is the best way to encourage the inter-disciplinary research collaboration? One participant observed that in Canada research funding is structured so individual researchers receive smaller amounts of money than in the U.S., necessitating more partnerships and collaboration.

  Mr. Hopkins noted that this may be an unintended consequence of Canada generally having less research funding available than the U.S. The overall trend in scientific funding today is to encourage partnerships across disciplines.

3 Opening Panel: Science and Informed Decision-making

Mark Fesmire, Alaska Regional Director of BSEE, chaired this panel. Panelists included:

- James Kendall, Regional Director, BOEM
- Karen Mouritsen, Alaska State Director, BLM
- Donna Kirkwood, Chief Scientist, Natural Resources Canada (NRCan)
- Scott Gedak, Northwest Territories (NWT) Environmental Studies Management Board

James Kendall, Alaska Regional Director
Bureaus of Ocean Energy Management
Mr. Kendall began by referring to BOEM's mission statement, "to manage development of U.S. OCS energy and mineral resources in an environmentally and economically responsible way." The bureau considers people to be a key part of the environment as referenced in the mission statement. BOEM has funded almost $500 million in studies in Alaska. From his experience, collaboration among researchers is critical when doing inter-disciplinary work, and people in Alaska tend to know each other and forge strong working relationships.

Traditional or indigenous knowledge is also important to BOEM, and is included in BOEM's Environmental Studies Program. BOEM's study process has built-in feedback loops to incorporate new information. An example of integrating western science with traditional/indigenous knowledge, the Cross Island Subsistence Bowhead Whale Hunt mapping project included information from hunters, many of

whom agreed to use Geographic Positioning Systems for 10 years to contribute to the study. In another example, scientists and traditional knowledge holders designed an Arctic cisco fishery research project together using a workshop format. Traditional/indigenous knowledge is also incorporated into BOEM's Environmental Impact Assessments for both the Liberty and North Star projects in the Alaskan Arctic.

Mr. Kendall made the point that it is often perceived as difficult to integrate traditional knowledge with western science, but ultimately it is necessary to treat the two as comparable knowledge systems in the decision-making process.

Karen Mouritsen, Alaska State Director
Bureau of Land Management
Ms. Mouritsen discussed the importance of science in making good decisions. She expressed the need for good, sound science but also the need to consult with tribes and native groups to add traditional knowledge to decision making as part of regulatory mandates for consultations around the Endangered Species Act and the Clean Water Act. A comment from the audience emphasized the importance of traditional knowledge and that western scientists have been trained in a certain process and language, but traditional knowledge is often not relayed in the same manner. The commenter reiterated that this could be a significant hurdle for incorporating traditional knowledge.

Ms. Mouritsen discussed the BLM science program's efforts to conduct baseline research and monitoring, use data for applied environmental impact research, and monitor impacts on activities to inform adaptive management. In Alaska, BLM has certain strategies and investments including baseline ecological characterizations, or Rapid Ecoregional Assessments. A North Slope ecological assessment has been conducted with information gathered from stakeholders, different state and federal agencies and the Corps of Engineers. Other strategies and investments include project-specific studies and monitoring as well as collaboration in broad-scale scientific studies including the North Slope Science Initiative (NSSI) and the Conservation of Arctic Flora and Fauna (CAFF) working group of the Arctic Council.

NSSI was established in 2005. BLM is the facilitator/convener of the initiative to work with partners to implement studies that collect and analyze data. Examples of projects they have implemented include air quality monitoring/modeling, subsistence monitoring, and watershed hydrology. The project website is newly updated and catalogues previous studies conducted by the collaboration. BLM has also worked with CAFF to conduct monitoring projects in marine, freshwater, coastal, and terrestrial environments. They are currently working on developing a coastal strategy for the Circumpolar Biodiversity Monitoring Program.

Donna Kirkwood, Chief Scientist
National Resources Canada
Ms. Kirkwood shared her excitement that Canada has recently elected the first minister of Science, which has spurred Natural Resources Canada (NRCan) focus on how science can influence not only decision-making but also decision-makers at the highest levels of government.

The North is a critical science frontier. Much of what is learned there can be related elsewhere throughout the world. This research is important for circumpolar communities to harness conservation opportunities.

As a government agency, it is important for NRCan to consider: How can we use big data, how can we be nimble and diversified, and what planning/resources need to be allocated toward science? NRCan's role is to conduct science that is directly related to the government of Canada's priorities to ensure that science informs public policy. Some of the current areas where science will need to be incorporated include Artificial Intelligence, the Arctic, climate change, safety, and security. Science is also key to international

collaboration including claims to the extended continental shelf under Article 76 of the United Nations' Convention on the Law of the Sea.

Open science can often act as an enabler to inform both policymakers and the general public. Ms. Kirkwood has found that the public wants to know all about the science that informs decisions, so the scientific community should ensure findings and data are available and discoverable through multiple platforms. Additionally, ensuring clarity in data and findings and replicability is important.

Ms. Kirkwood offered some advice for using science to inform environmental and regulatory issues. One of the primary pieces of advice she offered is collaboration and communication should occur early and often with stakeholders and the community. In response to a question, Ms. Kirkwood emphasized that not all scientists are natural communicators, so it is important to find someone who can work with them to communicate the results of the science. Additionally, science should include cumulative impacts and look across a wide spectrum of impacts, including physical sciences, economic analyses, statistics, and social sciences. Finally, traditional knowledge should be incorporated within all evidence-based decision-making projects. In response to a question, Ms. Kirkwood also identified the need to synthesize information to identify gaps in research and knowledge and strategies to address those deficiencies.

Scott Gedak
Northwest Territories Environmental Studies Management Board

Mr. Gedak introduced the Environmental Studies Management Board as a unique body to the Northwest Territories (NWT) designed to provide information for decision-makers. Citizens and community members are among the decision-makers in the NWT: their needs must be met in order to have a successful regulatory process.

The Board's fund is used to conduct environmental and social studies to look at exploration and development of oil and gas and transportation of energy across NWT. Five board members determine research priorities and develop annual study programs. Two board members are from government bodies of NWT, two are from the oil and gas industry, and one is a public representative. Currently the Board relies on industry funding based on the number of hectares in which an industry holds interest. Due to the current pause in industry activity, the fund has fallen to $300,000. The limited resources available make it critical to coordinate and leverage study programs in NWT.

The Board uses a combination of open calls for proposals, directed call for proposals, and unsolicited proposals to identify research projects. Current priorities of the Board include groundwater in Mackenzie valley associated with permafrost and wildlife, especially boreal caribou and potential for wildfires.

4 Panel: Community and Industry Perspectives – Priorities and Research/Monitoring Needs

Kasaŋnaaluk Marie N. Greene of the U.S. Arctic Research Commission chaired this panel. The panelists were:

- Taqulik Hepa, Director, North Slope Borough Department of Wildlife Management
- Michael Macrander, Former Science Team Lead, Shell Exploration & Production
- Jennifer Lam, Inuvialuit Game Council
- Paul Barnes, Director, Atlantic Canada and Arctic, Canadian Association of Petroleum Producers

Taqulik Hepa, Director
North Slope Borough Department of Wildlife Management
Ms. Hepa shared her experiences from her work for the North Slope Borough as well as having grown up in the area. Early researchers at the Naval Arctic Research laboratory like Max Brewer and John Kelley worked with Harry Brower, Sr. and developed strong relationships. These early researchers used science to help the Alaska Eskimo Whaling Commission set quotas for whales. Their work also led to bowhead whale studies, monitoring of the Endicott Causeway and Northstar oil field, and caribou studies at Teshepuk Lake.

Science works if:

- Objectives are clear, understood, and accepted locally
- Traditional knowledge is used
- Community members are involved and paid
- It does not interfere with subsistence activities, and
- It is communicated before, during, and after a research project.

The North Slope Borough's first mayor formed an environmental protection office in the 1970s, which has evolved into the Department of Wildlife Management. The Department works with hunters and state/federal agencies, as well as coordinating with other groups around the circumpolar North. The Department takes its direction from a management committee comprised of one member from each community in the Borough (and one at-large member). The purpose of each meeting – and the point on which the most time is always spent – is to understand the concerns and interests of the communities. Even when local values and scientific values are not obviously aligned, Ms. Hepa urges researchers to work with the Department to discuss, build relationships, and find the right local experts.
Ms. Hepa urged those interested in conducting research on the North Slope to involve community members as early in the project planning process as possible, and to compensate them appropriately. Communication should continue after the end of a project, including sharing results. It is also important to consider how research activities may disrupt communities; for example, the use of aircraft and its impact on wildlife or hunting activities. Ms. Hepa identified some priority studies identified with the communities: social science, ecosystems, understanding impacts, mitigation of impacts, and both baseline and long-term monitoring.

In addition to having a role in identifying research needs, local villagers can also provide logistical support, recommend mitigating measures (to reduce impacts to subsistence or other activities, as in the example above), and research methods. As an example, an experienced marine mammal hunter has assisted tagging efforts by helping researchers to locate the animals.

Through her work with the Department, Ms. Hepa also sees cases where research projects appear to duplicate each other. This can discourage community participation. Instead, the Department would like to see resources used more efficiently towards long-term monitoring or cross-disciplinary projects that address community concerns. It is also important to separate oil and gas-related impacts from climate change. For good science it is necessary to have collaboration, coordination, and trusting and respectful relationships.

Michael Macrander, Former Science Team Lead
Shell Exploration and Production
Mr. Macrander observed that different industries have historically played a significant role in Arctic research, including hosting naturalists on board early exploratory vessels and whaling ships, the early

exploration of the Northwest passage, mining, and the establishment of military installations. More recently, there have been many joint research projects related to oil and gas activity.

Industry invests in science to better understand the operating environment and ensure that equipment and infrastructure are appropriate, comply with permits or regulations, and meet stakeholder expectations. Research may take the form of baseline studies, engineering and technological development, and monitoring. Over the last 10 years, industry has focused research on ice and weather, integrated assessments, onshore environmental studies, and collaborative research. Mr. Macrander referenced a 2015 report by the National Petroleum Council that identifies research needed to support sustainable and responsible oil and gas development in the Arctic. Additionally, in 2014 the National Academies of Science released a report entitled, "Arctic and Anthropocene: Emerging Research Questions" which identified multiple research initiatives such as ice, weather monitoring and forecasting, oil spill prevention and response, ecological environment, and human environment.

Jennifer Lam, Chair
Inuvialuit Game Council
(presenting in place of John Lucas)
Ms. Lam described the Inuvialuit Game Council and its role in representing the Inuvialuit people's interests regarding wildlife and wildlife management. The Beaufort Regional Strategic Environmental Assessment is a current priority. This process is chaired jointly by the Government of Canada, the Inuvialuit Game Council, and the Inuvialuit Regional Corporation. The main objective of the Assessment is to promote activities and engagement to support evidence-based decision-making within environmental conservation efforts. It also includes reviewing the conditions under which the Inuvialuit will – or will not – endorse activity in the Inuvialuit Settlement Region.

A 2017 tour of communities identified several key themes which have been incorporated into the workplan: (1) meaningful inclusion of traditional knowledge and consultation with knowledge holders; (2) invasive species; (3) effect of marine traffic on water quality, key fish species, and marine mammals; and (4) relationship between environmental change and the preservation of marine tradition and culture. They also have developed sociocultural and cumulative indicators studies.

The use of traditional knowledge has been a strong theme for the Council. Integrating traditional knowledge within scientific methodologies is challenged by the fact that traditional knowledge has not been collected in a systematic way. In particular, there are gaps between traditional knowledge holders and scientists regarding the importance of sea ice to communities and the role of the harvest as a cultural activity in addition to the nutritional value. To develop the 2018-2019 Work Plan, they have identified the following priorities from community consultations: invasive species and ballast water, traditional knowledge themes, importance of ice in the Inuvialuit Settlement Region, key species assessments, role of harvest as a cultural activity, an Inuvialuit place names project, and Inuvialuit harvest study.

Finally, the Council remains concerned about a lack of spill response infrastructure, consultation, and information on marine vessel traffic. There is a clear need to improve communication and capacity related to the increase in shipping even as offshore oil and gas activity is currently halted under the moratorium. Ms. Lam also mentioned that there has been a lack of consultation by the Federal government on the offshore oil and gas moratorium.

Paul Barnes, Director
Atlantic Canada and Arctic, Canadian Association of Petroleum Producers
Mr. Barnes discussed the activities that the Canadian Association of Petroleum Producers is currently undertaking in the Arctic even with the moratorium on offshore oil and gas activity. This includes consultation with Beaufort Sea license holders, forming an Arctic policy framework, and potential

regulatory changes under the Canadian Petroleum Resources Act. There is a robust regulatory regime in place now and industry opposes any freeze on their activities: this impacts investment as well as research and development where the focus has shifted to Norway and Russia despite there being huge potential reserves in the Canadian Arctic. It will be important for the 5-year review of Canada's current moratorium to be completed on time and provide clarity to industry and others about what the future holds.

Arctic oil and gas activities bring benefits, including monitoring and data collection, technological advances, and modern and resilient infrastructure. Future research and development priorities include: (1) improving operations in the Arctic, designing facilities, oil spill response, and transportation networks that are suitable for the harsh environment, distance to shore, ice, fog, wind and waves, and icing; (2) digitization, including connectivity, advanced sensors, analytics, robotics, and remote control; (3) developing cold climate technological solutions and methods to lessen the industry's climate impacts and gain a competitive edge; and (4) cross-sectoral and community collaboration, including digitization and automated unmanned vehicles.

5 Lunch Speaker: Paul Decker, State of Alaska Department of Natural Resources

Paul Decker, Division Expert in Resource Evaluation at ADNR, described the Cretaceous Brookian sequence of the North Slope. From the State's assessment of this new oil play, there is significant "running room" across the North Slope area, as indicated by recently discovered resources both onshore and in state waters. The oils found to date are generally "light" oil that will flow well, and relatively accessible regarding depth. Based on the tests of flow rate, while this has not been fully evaluated at Smith Bay, the rates identified from both the new Willow discovery wells and within the Pikka Unit are considered quite robust. At Smith Bay, there is an expectation of at least 2 billion barrels of recoverable oil at a rate that could approach 200,000 bbl/day, but this needs to be confirmed with tests.

These newer areas of focus represent favorable, conventional reservoirs based on the metrics of porosity and permeability, indicating that there are still good reservoirs even in the highly explored North Slope area.

Overall, the USGS and BOEM estimate undiscovered, technically recoverable, conventional resources equal 40 billion bbl of oil and 207 trillion cubic feet of gas (both on and off shore). On-shore alone, including state lands, the National Petroleum Reserve-Alaska, and the Alaska National Wildlife Refuge, estimates are nearly 16 billion barrels of oil and natural gas liquids. Mr. Decker indicated that it is time to update these estimates and he is pleased that the agencies are working on this. An assessment should be done next year.

Seismic mapping has been key to understanding these new areas of focus. Much of this information has been kept confidential in the past, but Alaska's new tax credit program included a requirement for companies to share the data.

6 Environmental Technical Talks

Mark Miller of the NSSI chaired this session. Table 1 identifies the speakers and topics (alphabetical order).

Table 1. Environmental Technical Talk Presenters and Titles

Presenter	Presentation Title
John Pearce, U.S. Geological Survey	USGS Ecosystems Research to Inform Oil and Gas Development and Response of Wildlife in the Arctic
Kerri A. Pratt, University of Michigan	Research Related to Ultrafine Particulate Emissions from the Prudhoe Bay Field
Todd Sformo, North Slope Borough Department of Wildlife Management	Preliminary Results of Application of Oil and Dispersed Oil on Drag on Bowhead Whale Baleen
Elizabeth Sharp, Hilcorp	Environmental and Social Research in Central Beaufort Sea Oil and Gas Fields: Successes and Challenges
Melanie Smith, Audubon Alaska	Ecological Atlas of the Bering, Chukchi, and Beaufort Seas
Sheyna Wisdom, Olgoonik Fairweather LLC	An Integrated Look at the Alaska Beaufort Sea: Summary of the Arctic Nearshore Impact Monitoring in Development Area III 2014-2017

Presentations and discussions in this session provided the researchers and opportunity to share information about a diverse range of studies focused on the Alaskan Arctic. While most of these focused on technical research of some nature (including air emissions from Prudhoe Bay operations, impacts of oil in the water column on bowhead whale baleen, and wide-ranging nearshore monitoring of impacts associated with development), Audubon Alaska's effort to compile, align, and share geospatial data on the region was also highlighted. An industry perspective was offered on how research priorities are set and resources allocated.

Author-provided abstracts are below in the same author order shown in Table 1 (presenter may not be lead author).

USGS Ecosystems Research to Inform Oil and Gas Development and Response of Wildlife in the Arctic

Pearce, J. M., U.S. Geological Survey Alaska Science Center, jpearce@usgs.gov

Northern communities, industry and natural resource managers need greater certainty about how land and wildlife are responding to environmental change and human activities to guide near-term land use planning. The USGS is the scientific research agency for the U.S. DOI and provides timely and impartial information from across northern Alaska to inform energy development through energy and landscape change assessments, while quantifying changes and potential impacts to wildlife and habitats. This talk will highlight recent and on-going key studies from the USGS and collaborators based in the National Petroleum Reserve – Alaska, the Colville River Delta, Prudhoe Bay and the 1002 Area of the Arctic Refuge. These studies provide updated ecosystem information and forecasts of near-term expected conditions that allow for comparison of activity alternatives.

Atmospheric Particulate Matter from the Prudhoe Bay Oil Field

Pratt[1*], K.A., Gunsch[1], M.J., Kirpes[1], R.M., Kolesar[1], K.R., Moffett[2], C.E., Barrett[2], T.E., and Sheesley[2], R.J.

[1]University of Michigan
[2]Baylor University
[*]prattka@umich.edu

Atmospheric particulate matter has significant air quality and human health impacts and is therefore regulated by the Clean Air Act. In addition, atmospheric particles impact climate by interacting with radiation (warming or cooling the air), forming cloud droplet and ice crystals and impacting precipitation, and depositing onto surfaces (darkening snow). Unprecedented summertime Arctic sea ice loss is opening the region to increasing oil and gas extraction activities and ship traffic, which emit particulate matter and precursor gases through combustion. Yet, few measurements of particulate matter emitted from local combustion activities have been made in the Arctic. Detailed measurements of the concentrations and physical and chemical properties of atmospheric particles were made in August-September 2015 in Utqiaġvik (Barrow), AK and within the Prudhoe Bay oil fields at Oliktok Point, AK in August-September 2016. In particular, a single-particle mass spectrometer was deployed for real-time measurements of the size and chemical composition of individual atmospheric particles for source identification. In addition, long-term measurements of aerosol size distributions and concentrations at the National Oceanic and Atmospheric Administration (NOAA) Barrow Observatory were examined to compare air mass influence from the Arctic Ocean versus Prudhoe Bay to investigate the impacts of petroleum extraction activities. Particle sources impacting the North Slope of Alaska and transformations of these particles during atmospheric transport will be discussed.

Preliminary Results of Application of Oil and Dispersed Oil on Drag on Bowhead Whale Baleen

Todd Sformo[1*], Gary Shigenaka[2], Craig George[1], Teri Rowles[3], Geof Givens[4], Michael Moore[5], Tom Lanagan[5], and Alexander Werth[6]

[1] North Slope Borough/Department of Wildlife Management, Barrow, AK
[2] NOAA/Office of Response and Restoration/Emergency Response Division, Seattle, WA
[4] Givens Statistical Solutions, Fort Collins, CO
[3] NOAA/National Marine Fisheries Service/Office of Protected Resources, Silver Spring, MD
[5] Woods Hole Oceanographic Institution, Woods Hole, MA
[6] Hampden-Sydney College, Hampden-Sydney, VA
* todd.sformo@north-slope.org

We studied the effects of oil and dispersed oil on the functional characteristics of bowhead whale (*Balaena mysticetus*) baleen at a mesocosm scale at the Oil and Hazardous Materials Simulated Environmental Test Tank (Ohmsett) facility in Leonardo, NJ. The objective was to measure drag in baleen, estimate how it depends on various factors (control), and evaluate how drag changes when North Slope crude oil and Corexit 9500A dispersant are introduced (treatment). The principle assumption is that oil adhering to baleen plates and fringe "hairs" would increase drag. To secure baleen for movement through water at Ohmsett, a lever arm was fabricated at the Woods Hole Oceanographic Institution consisting of a baleen clamp, load cell, and pivot. An Omega load cell was used and bridge speeds data recorded. Baleen ranged from 1.1 to 2.7 meters in length, having 5 to 30 plates, orientated at 90° and 54°, and each sample was run through water from 0.2 to 1.6 knots, although only 54° and 0.6 knots were used for treatments. For analysis of the various independent racks of baleen, we calculated frontal area that combined plate number, length, and width per rack to create a single variable. For treatments, we applied oil and/or oil-dispersant in various ways, including submerging baleen with a crane and applying fresh oil to the water surface within a containing hoop. The baleen was then lifted through the oil. For dispersed oil

treatment, Corexit 9500A was premixed with oil and dispensed through a series of underwater nozzles. Due to the limited number of available baleen racks and the inability to remove oil and dispersant from water in the tank or the baleen itself, we could only apply treatments once, leading to a qualitative assessment. The overall results indicate that under various treatments of oil and/or oil-dispersant the drag does not appear to increase.

Environmental and Social Research in Central Beaufort Sea Oil and Gas Fields: Successes and Challenges

Sharp, E.D., Hilcorp Alaska LLC, esharp@hilcorp.com

In November 2014, Hilcorp Alaska, LLC purchased and assumed operatorship of several oil and gas fields from BP Exploration (Alaska) Inc. including the Milne Point Unit, Northstar Island, Endicott Island (and the Endicott Satellite Drilling Island), and the Liberty Development Project. Along with the acquisitions came the responsibility to continue supporting and/or executing existing environmental research projects from nearshore fish migration studies to monitoring the local annual bowhead whale hunt. Hilcorp Alaska, LLC is working with others to assess whether the existing studies are the most efficient way for us and the affected public to understand and mitigate the impacts of our operations.

Ecological Atlas of the Bering, Chukchi, and Beaufort Seas

Smith, M.A., M.S. Goldman, and E.J Knight, Audubon Alaska, masmith@audubon.org

To inform sustainable management in a time of growing human influence, there is a need to synthesize and disseminate spatial information to policy makers, scientists, and the public in a format that is useful and accessible. The goal of the *Ecological Atlas of the Bering, Chukchi, and Beaufort Seas* was to create a comprehensive, trans-boundary atlas that represents the current state of knowledge on subjects ranging from physical oceanography to species ecology to human uses. The Ecological Atlas provides a cumulative picture of what is happening in the region to better understand ecological patterns through spatial data, maps, and written summaries. The Atlas is organized into six topic areas that build, layer by layer, the ecological foundation of these three seas: physical setting, biological setting, fish, birds, mammals, and human uses.

Our process involved intensive research and consultation with experts, as well as gathering and analyzing the most recent and robust data available. We synthesized data to create more than 100 seamless maps that integrate disparate datasets of points, tracks, or polygons into cohesive data layers that visually describe a particular process or species' activity and movements across the three seas. This second edition atlas built upon the first edition published in 2010, as well as several subsequent mapping projects to identify important marine areas on the Arctic outer continental shelf, recommend ship routing measures in the eastern Bering Sea, and delineate globally significant marine Important Bird Areas throughout Alaska. We began work on the new atlas in July 2015 and completed it in August 2017.

The atlas was a project by Audubon Alaska, in collaboration with Oceana and somethingaboutmaps. Numerous agencies and organizations assisted by providing spatial data, expertise, and review, including the BOEM, Kawerak, NOAA, U.S. Fish and Wildlife Service, and USGS. The project was funded by the Gordon and Betty Moore Foundation. Community engagement focused on the Kawerak region, where a robust traditional knowledge spatial dataset was available for mapping walrus, ice seals, and other subjects. These data were integrated with science data and were reviewed by Kawerak and Bering Strait tribal representatives.

The Ecological Atlas represents a data-rich foundation upon which to understand the complex dynamics of the Arctic marine ecosystem. The atlas database will be publically available through the Alaska Ocean Observing System, and may be used by the U.S. and Canadian Arctic research communities for

understanding ecological relationships, assessing offshore energy development, oil spill response, vessel traffic routing measures, fisheries management, and so on. Future research at Audubon will focus on identifying important marine areas from the available data, and assessing development pressures and management implications for wildlife and people.

An Integrated Look at the Alaska Beaufort Sea: Summary of the Arctic Nearshore Impact Monitoring in Development Area III 2014-2017

Kasper[1], J., Dunton[2], K., Bluhm[3], B., Durell[4], G., Trefry[5], J., Coon[6], C., Wisdom[7], S.,

[1]University of Alaska Fairbanks, jlkasper@alaska.edu
[2]University of Texas at Austin, ken.dunton@utexas.edu
[3]Department of Arctic and Marine Biology, UiT - The Arctic University of Norway, bodil.bluhm@uit.no
[4]NewFields, gdurell@newfields.com
[5]Florida Institute of Technology, jtrefry@fit.edu
[6]BOEM, Alaska OCS Region, Anchorage, catherine.coon@boem.gov
[7]Olgoonik Fairweather LLC, Sheyna.wisdom@fairweather.com

The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) project phase III (2014-2017) is the latest in a series of BOEM funded ecosystem studies of the Beaufort Sea designed to describe parts of this shelf in terms of its physical oceanography, benthic infauna and epifauna, and contaminant foot print (e.g. hydrocarbons, trace metals). In contrast to the Chukchi, the shelf of the Beaufort Sea is well known for its strong physical gradients that distinctively influence the distribution of benthic fauna. We found infaunal and epifaunal communities were relatively depauperate in species richness and abundance/biomass near the 20-m isobath, but the absence of benthic biota was most pronounced in the Colville River delta, likely related to a combination of sediment transport, bottom fast ice, scour by deep-draft ice, and extreme temporal and spatial variations in salinity throughout the annual cycle. Deeper shelf areas were generally more species rich, but a region of high infaunal diversity and biomass were observed north of Barter Island from nearshore to the shelf break, an area historically known for upwelling events. Stable carbon and nitrogen isotopic composition of benthic organisms, particulate organic matter and zooplankton revealed a mixture of carbon sources available to benthic consumers, consisting mostly of phytoplankton, benthic microalgal matter and terrestrial sources. Contaminant concentrations in sediments and biota are near background levels throughout most of the Beaufort (with the notable exception of higher levels around historic exploratory drilling sites). Fish, amphipods, and clams also contained background levels of hydrocarbons. These patterns reflect the very dynamic nature of the Beaufort Sea shelf, which is characterized by strong land-ocean interactions that have likely contributed to the notable lack of accumulated contaminants despite decades of industrial activity in the region. In 2015 ANIMIDA scientists also successfully sampled the two newest lines in the Distributed Biological Observatory network at 152W and 143W. These two lines represent the first expansions of the Distributed Biological Observatory monitoring network that will eventually result in the formation of a circumpolar long term monitoring effort to understand ecosystem change due to climate change in polar Arctic regions.

7 Oil Spill Technical Talks I

Kristin Ryan of the Division of Spill Prevention and Response, Alaska Department of Environmental Conservation chaired this session. Table 2 identifies the speakers and topics (alphabetical order).

Table 2. Oil Spill Technical Talks I Presenters and Titles

Presenter	Presentation Title
Mark Fesmire, Alaska Region, BSEE	Capping Stacks and Containment Systems in the Offshore Arctic
Charles Greer, National Research Council (NRC) Canada	NRC Natural Attenuation Potential for Petroleum Hydrocarbons at Sub-zero Temperatures in the Canadian Arctic Marine Environment
Ken Lee, Fisheries and Oceans Canada	The Royal Society of Canada Expert Panel on the Behavior and Environmental Impacts of Crude Oil Released into Aqueous Environments: Research Recommendations and Follow-up Parts I and II
Eric Miller, Bureau of Safety and Environmental Enforcement	Arctic Council Emergency Prevention, Preparedness and Response (EPPR) Workgroup Circumpolar Oil Spill Response Viability Analysis
Tim Robertson, Nuka Research and Planning Group, LLC	U.S. Arctic Oil Spill Response Gap Analysis

Presentations in this session summarized current or completed research and analyses related to an Arctic oil spill response. Two of the studies focused on more technical issues (potential for natural attenuation of spills in cold climates and the fate and effect of crude oil spills), while the others emphasized more operational issues associated with capping stacks/well containment systems and oil spill response in Arctic conditions (the latter was considered for both the U.S. Arctic only as well as the entire circumpolar Arctic).

Author-provided abstracts are below in the same author order shown in Table 2 (presenter may not be lead author).

Capping Stacks and Containment Systems in the Offshore Arctic
Mark E. Fesmire, PE, JD, Regional Director, Alaska Region, U.S. DOI BSEE, mark.fesmire@bsee.gov

When drilling or planning to drill from a floating drill ship or jack-up in the U.S. Arctic, one of the major issues that we have had in the past is the need to plan for an oil spill response in open water or broken ice. But the most effective means available to operators to avoid or minimize the need for an oil spill response is a successful interdiction near the beginning of a well control event with source control equipment or a relief well. Which of these methods or what combination of the methods should be planned for and available for use is the subject of much debate among industry, regulators and stake holders.

This presentation attempts to explain what the two major source control processes and the equipment used in each. Capping stacks and containment systems will be introduced and explained, and their recent historical deployment to the Arctic will be discussed.

Additionally, BSEE will describe an ongoing research project under the Technical Assessment Program entitled “Suitability of Source Control and Containment Equipment vs. Same Season Relief Well in the Alaska OCS Region.”

This study will provide a description of the Alaskan Arctic (OCS) meteorological/oceanography (metocean) and operational conditions which, in the event of a loss-of-well-control situation, would: preclude the safe deployment of Source Control and Containment Equipment; preclude the operator from safely drilling a relief well; allow one method, but preclude the other and; provide historical statistical analysis of the Alaskan Arctic OCS drilling season, over the past 5 years, in which metocean and operational conditions would support either or both methods.

BSEE's purpose in commissioning this study was to be able to adequately access the risk associated with each type of response and to make risk based decisions on future deployments of source control equipment and relief well capabilities.

Natural Attenuation Potential for Petroleum Hydrocarbons at Sub-zero Temperatures in the Canadian Arctic Marine Environment

Greer[1*], C.W., Tremblay[1], J., Fortin[1], N., Elias[1], M., Sanschagrin[1], S., Wasserscheid[1], J., King[2], T.L., and Lee[2], K.

[1]National Research Council Canada, Energy, Mining and Environment
[2]Fisheries and Oceans Canada
[*]Charles.greer@cnrc-nrc.gc.ca

There is a high level of global concern regarding the environmental impacts of oil spills in the Arctic. As a result of climate change that has reduced the extent and season of sea-ice cover, as well as municipal and industrial growth, the region is more susceptible to accidental releases of crude oil, diesel fuel and bunker fuel associated with marine transport of passengers and cargo. Furthermore, significant oil reserves are known to exist in the Arctic. Although the transition towards renewable energy is well underway, due to the increasing global demand for energy, our dependence on fossil fuels, including crude oil will result in support of offshore oil and gas exploration activities over the next few decades. For an effective Arctic oil response strategy, having reliable baseline data represents one of the first requirements, against which change (impact or recovery) and performance can be measured. Microbes, and in particular bacteria, are the first and fastest responders to oil in the natural environment, so a better understanding of who's there and the ecosystem services they provide is critical.

Under a research program designed to evaluate the feasibility of natural attenuation and bioremediation as operational oil spill response technologies for the Arctic, a genomics survey of various Arctic marine environments has demonstrated that bacteria with the potential to degrade oil hydrocarbons are very widespread and active at sub-zero temperatures. This bodes well for the natural attenuation potential of oil in the Arctic marine environment. The bacterial populations that became dominant when exposed to crude oil with or without chemical dispersant were typical of the natural obligate oil degrading bacteria (mainly in the taxonomic orders *Alteromonadales* and *Oceanospirillales*) that inhabit most marine environments and that typically respond to the input of hydrocarbons. The results from laboratory microcosm and mesocosm studies demonstrated that these bacteria responded rapidly to the presence of oil products and were capable of degrading them at temperatures that are consistent with the Arctic marine environment at ambient winter temperatures (-1 to -2°C), indicating that temperature was not the main driver of the degradation process. The results show that natural attenuation of hydrocarbons in the Arctic marine environment is not only feasible but can occur at rates that were previously thought not possible, providing us with an important strategic approach to address future oil spills in this environment.

The Royal Society of Canada Expert Panel on the Behavior and Environmental Impacts of Crude Oil Released into Aqueous Environments: Research Recommendations and Follow-up

Kenneth Lee, National Senior Science Advisor – Oil Spill Research, Preparedness and Response, Environment and Biodiversity Science Branch, Fisheries and Oceans Canada, ken.lee@dfo-mpo.gc.ca

The analysis of case studies under the Royal Society of Canada Expert Panel, "The Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments" clearly illustrated that the behavior, fate and effects of oil spills in the aquatic environment were highly site-specific. The results of the Royal Society of Canada report, as well as the reports of Transport Canada's Tanker Safety Expert Panel and the U.S. National Academies Committee "Responding to Oil Spills in the U.S. Arctic Marine Environment" noted that the availability and quality of scientific advice played a key role in oil spill preparedness planning, spill response operations, and natural resource damage assessments.

The Oceans Protection Plan (OPP) is a comprehensive, transformative strategy to build a world-leading marine safety system within Canada to protect its marine ecosystems, while enabling inclusive economic growth. To enable Canada to compare favourably with some of the best international marine safety regimes in the world, a number of projects have been launched under Canada's OPP to foster:

- Leading-edge research on oil spill clean-up technologies;
- Enhanced oil spill preparedness and response through area-based planning;
- A greater role for Indigenous groups in the marine safety regime (training for prevention and response operations and shared decision making); and
- Partnerships and continuous improvements to our understanding of how oil spills behave and what impacts they may have, alternative response strategies, how best to mitigate impacts and accelerate ecological recovery after an incident.

This presentation provided insights on a proposed OPP initiative with the aim to promote interaction among scientists and technical experts from academia, industry and government agencies at a national/international level to enhance the level of science-based decision making for oil spill preparedness and response operations.

The challenges of spills from the transportation of oil include delayed response due to a combination of many factors, lack of pre-spill baseline data, measuring the effectiveness of response strategies, long-term stressors from other sources, and post-spill monitoring. It is important to:

- Understand environmental impacts in high-risk or poorly understood areas;
- Improve understanding of effects on aquatic organisms, communities, and ecosystems;
- Have a National Program for Baseline Research and Monitoring;
- Conduct controlled field trials to study behavior and effects;
- Improve effectiveness of oil spill response technology and strategies;
- Improve oil spill prevention and response decision-support systems; and
- Enhance oil spill risk assessments.

The Churchill Marine Observatory is a new research facility for the study, detection, and impact and mitigation of oil spills in icy waters.

Arctic Council's Emergency Prevention, Preparedness, and Response (EPPR) Working Group - Circumpolar Oil Spill Response Viability Analysis
Miller, E.J., EPPR U.S. Delegation representative, U.S. Bureau of Safety and Environmental Enforcement, eric.miller@bsee.gov

The Arctic Council's Emergency Prevention, Preparedness, and Response (EPPR) Working Group commissioned the Circumpolar Oil Spill Response Viability Analysis to better understand oil spill response options in Arctic conditions – focusing on the marine environment. In Arctic seas, the wind, waves, cold, visibility, and sea ice can affect the deployment of oil spill response systems. Consequently, concerns have been raised that overall, Arctic conditions may limit response viability. Arctic country-specific studies have previously borne these concerns and this project studies the issue from a pan-Arctic perspective. Co-sponsored through EPPR by Norway, the United States, and the Kingdom of Denmark, DNV GL and Nuka Research and Planning Group, LLC worked together to analyze the effects of various pan-Arctic metocean conditions on ten different oil spill response systems that globally support response strategies for mechanical cleanup, dispersant application, and in-situ burning. This presentation outlined the focus, execution, and findings from this study.

U.S. Arctic Oil Spill Response Gap Analysis
Robertson, T.R.,* Higman, B., and Fletcher, S.E., Nuka Research and Planning Group, LLC, *timrobertson@nukaresearch.com

Oil spill response operations may be impeded by a wide range of metocean conditions, including wind, waves, sea ice, visibility, and darkness. An analytical tool has been developed to estimate how often the deployment of different types of response systems may be affected by one or more of these conditions. In 2013, Nuka Research and Planning Group, LLC analyzed the frequency with which wind, sea state, temperature, ice coverage, and visibility may impede or preclude mechanical recovery, in situ burn, and dispersant deployment. The analysis used 5 years of observational data for the metocean conditions, pairing these with operational limits established through literature review, equipment standards, responder tactics, and best professional judgment. Results can be used to test or develop planning assumptions, consider tactic selection or potential modifications needed, explore seasonal variations, and inform research or development into system improvements. This presentation will emphasize the methodology and assumptions necessary to implement an oil spill response gap (or viability) analysis.

8 Panel: Scenario Planning

Jon Skinner of the University of Alaska Anchorage chaired this session. Presenters were:

- *Wendy Loya,* Coordinator, Arctic Landscape Conservation Cooperative Alaska**,** U.S. Fish and Wildlife Service
- *Amy Lovecraft,* Professor of Political Science, University of Alaska Fairbanks
- *Hajo Eicken,* Director, International Arctic Research Center, University of Alaska Fairbanks

Wendy Loya, Coordinator
Arctic Landscape Conservation Cooperative Alaska, U.S. Fish and Wildlife Service
Ms. Loya spoke about how scenarios are a critical component of Cumulative Effects Analysis, and something she has worked on in collaboration with the U.S. Fish and Wildlife Service, and NSSI. The Arctic Landscape Conservation Cooperative (LCC) has been trying to bring together fundamental science for use by managers since 2009. This collaborative effort has resulted in a conceptual ecosystem model that incorporates different scenarios and climate models quantitatively. While the drivers of change are

difficult to predict, the intent of this effort is to incorporate the potential effects of different drivers to inform management decisions.

One model under development is the Alaska Thermokarst Model, which models landform transition associated with increasing active layers under different climate scenarios. This will inform understanding of habitat change and landform stability.

NSSI is studying how factors driving land use change from energy development are related. Similar to the drivers of climate change, the drivers of development are complex and uncertain. The Arctic lease map of 2017 indicates the potential for significant change, but does not clarify what will actually be developed. The study considers different scenarios for development within the National Petroleum Reserve-Alaska, mapped over high value caribou habitat. They then quantify the extent of disturbance expected from different scenarios based on the proximity of the caribou habitat to the proposed infrastructure under different development scenarios. Similarly, different tools can be used to explore options for pipeline routing to consider costs and potential impacts. Scenario results can guide monitoring and research efforts.

Amy Lovecraft, Professor of Political Science
University of Alaska Fairbanks

Ms. Lovecraft posed the question of what the Arctic will look like in 2050, positing that the only certainty is that everyone in the Arctic will have to adapt in some way to changes occurring. Scenarios are a useful tool when developing priorities, such as for academic research. A scenario exercise is "a process for asking 'what if?' that enables risk management for the future." When done in a participatory manner, scenario exercises can draw on a wide range of expertise and experiences from participants. It is important to recognize that scenarios are not forecasts, nor are they ideal visions for the future.

Often, changes are studied one at a time, for example by species. In scenario planning, it is necessary to think of all of them together. This may encompass the future of permafrost, sea ice, climate generally, global politics, and national security among others.

Scenarios enable organizations to anticipate risk in the context of uncertainty. All predictions are inherently uncertain, and when faced with uncertainty we tend to imagine what may happen. A process of collaborative and informed imagination enables groups to consider scenarios for action in a way that is proactive rather than reactive. This is different from, for example, climate modeling.

The Arctic Council is using scenarios in an international context, but they are also useful down to the local level. What do Alaskans think of the possible futures of their communities? What is needed to have healthy, sustainable communities in 2040? This is something that can be answered locally, but it is also important to capture regional narratives or approaches as the Arctic faces a suite of interconnected transformations.

In the context of academic research, those working with science and data may use scenario-based input to identify what stakeholders think is important so you can better meet their needs. For example, understanding what communities believe is needed for their communities to be healthy can inform how effort and resources are spent studying these drivers.

Overall, scenarios help synthesize information from multiple sources to anticipate changes, striving for proactive adaptation rather than potentially costly reactive responses to change.

Hajo Eiken, Director
International Arctic Research Center, University of Alaska Fairbanks
Mr. Eiken described the use of participatory scenarios to guide long-term monitoring efforts in the Arctic. NSSI has 123 long-term monitoring projects ongoing. A scenario process was used to inform the development of priorities among these. Different energy development and resource extraction scenarios were developed for 2040 (the project was conducted from 2014-2016). Through three workshops, seven major stakeholder groups identified scenarios from low to high levels of development, then considered the implications of each and the research and monitoring needs associated with them. The assumptions underlying the scenarios considered climate change, environmental change, disasters (e.g., oil spills), the global oil and gas market, technological developments, infrastructure needs, and socio-political factors. All of these are also unpredictable by nature. Assumptions may also change – as of now, there is less development activity than was assumed for the "low development" scenario for the Chukchi Sea. However, this is changing. NSSI is still considering implications of the work.

Under the Northern Alaska Scenarios Project, diverse groups identified 21 key factors in determining or defining healthy, sustainable communities the future Arctic. Climate change was roughly in the middle of this list. A key theme was the decoupling of seasonal cycles of key factors as a major disruption of health and well-being. Many concerns related to coastal sea ice, for example. Combining local observations with satellite data, it was possible to determine shifts over time in the timing of breakup season *as it is defined by those using the ice.* The resulting determination that it has shifted by 2-3 weeks per decade since 1979 can be then be used to develop scenarios for the future. Overall, scenario planning is intended to help communities and others to be proactive in the face of change, rather than reactive changes as they come.

9 Panel: Meaningful Engagement of Indigenous Peoples in Oil and Gas Activities Beyond Consultation

Jeffrey Brooks, BOEM, chaired this panel. The panelists were:

- James Stotts, President, Inuit Circumpolar Council (ICC) Alaska
- Orville Lind, Native Liaison for the Office of Subsistence Management, U.S. Fish and Wildlife Service
- Rosanne D'Orazio, Director, Lands and Resources, Qikiqtani Inuit Association (QIA)
- Scott Gedak, NWT Environmental Studies Management Board

Mr. Brooks remarked at the start of the session that meaningful engagement is all about perspective: changing the way decisions are made to include all points of view. This requires broad frames of understanding; bridging gaps; involving community members in projects and plans early on; communicating before, during, and after a research project; and empathy and respect throughout.

James Stotts, President
Inuit Circumpolar Council (ICC) Alaska
Mr. Stotts described the ICC, a 40-year old international Inuit organization with consultative status to the United Nation and a permanent participant at the Arctic Council. Its mandate is to represent Inuit at the international level.

From a political and cultural perspective, there are three "Arctics": the Scandinavian, Russian, and North American/Greenland (where Inuit is the majority culture). Each of these regions has a different history with its indigenous people, resulting in different approaches to meaningful engagement today. Mr. Stotts focused his remarks on the North American Arctic.

The Arctic Council began a project entitled, "Meaningful Engagement of Indigenous Peoples and Communities in Marine Activities" under the Protection of the Arctic Marine Environment Workgroup. The ICC has been disappointed overall with the level of engagement the Arctic Council has sought with the permanent participants. To date, the ICC finds that the project is underfunded with a lack of enthusiasm from some countries. It is also not supposed to result in specific recommendations. A literature review of references on the topic of meaningful engagement was just completed with many identified gaps. Mr. Stotts would like to see a task force created to resolve the issue, but the Arctic Council may not be the appropriate venue as it is a consensus-based organization (and agreement may not be forthcoming from Russia and other European countries). Some Arctic states assert that their relationship to indigenous communities is a strictly domestic issue. There are also competing perspectives regarding what "engagement" means. To some, it is free, informed, and prior consent, while to others it is just "informing," which can lead to indigenous people being "Pawns in Politics." He then repeated "Trust, Respect, and Shared Responsibility" three times to emphasize what meaningful engagement means to Inuit.

The U.S. and Canada are similar in many ways. Both have similar histories with the Inuit, and in both places land or indigenous rights have been negotiated with the settlements including some of the concepts of meaningful engagement. Both also have strong language regarding consultation with the Inuit on the future of the Arctic. However, the two countries now appear to be on different trajectories regarding Arctic oil and gas development. From the ICC perspective, Canadian policy demonstrates a greater respect for indigenous peoples than currently seen in the U.S. This is a result of the fact that the Government of Canada and the Canadian Inuit have negotiated clear terms and processes around engagement. This is something ICC has called for in Alaska for years, but it has not been accomplished to date. Instead, it will be necessary to start with the agencies responsible for resource development and wildlife management as these are directly related to food security.

Mr. Stotts also noted the tendency for "consultation fatigue" in some communities, especially smaller ones.

Orville Lind, Native Liaison for The Office of Subsistence Management
U.S. Fish and Wildlife Service
Mr. Lind started by explaining that subsistence is a way of life, which is not always fully understood. In his role at the U.S. Fish and Wildlife Service, Mr. Lind is the primary contact for subsistence users in rural Alaska. While there were few calls when he started, there are now 6-7 per day from people who are finding it harder to get the food they need whether that is berries, salmon, or large game.

Alaska is a large area, with vast areas owned by different agencies and regulations regarding subsistence use that change depending on where someone lives or their background.

When striving for meaningful engagement, it is important to spend "village time" and find balance with the people. Identify the right people to work with who are both well-respected and can create the necessary linkages with other individuals or information. These types of facilitators can help researchers prepare for visits and understand how best to connect to the audience for any presentations. It is also important not to talk too loudly or quickly, and to avoid acronyms. Communication gaps across cultures and languages are common, but it is important to embrace – and encourage other visitors to embrace – the constant reminder that "these people live here, we're just visiting." Mr. Lind encourages agency officials and researchers to learn some words in the local dialect and plan to spend the time it naturally takes to overcome cross-cultural gaps in communication and perspectives.

Rosanne D'Orazio, Director, Lands and Resources
Qikiqtani Inuit Association
Ms. D'Orazio described the Qikiqtani Inuit Association's (QIA) role in representing some 15,000 Inuit in 13 communities on Baffin Island and the high Arctic. Each community is very different. QIA is consulted and also consults, reflecting both sides of the table. QIA must balance protection of the environment with social, cultural, and economic opportunities. QIA reviews applications for any activities on Inuit-owned land (resource exploration, cruise ships, research, etc.), working with representative boards in each community. When they support an activity, that support often comes with stipulations about providing QIA a compensated role for participating or monitoring outcomes or potential impacts. The types of industries present and whether or not a community has previous experience with oil and gas development affect people's familiarity with different issues and their concerns. It is important to identify: (1) with whom are you talking? (2) what are their past experiences? and (3) what is their baseline understanding? Sometimes it is also difficult for the community members to prioritize their involvement in engagement efforts, especially if it is unclear exactly what is being asked.

Engagement in Nunavut is unique because there is a regulatory system in place with established timelines for review, input, and engagement. The review timelines are designed to allow for communities to take the time they need to understand an issue and provide meaningful input. Time lines are viewed as an opportunity to engage, not a penalty. Benefits may include employment, training, and joint ventures.

QIA's work is built on trust and respect. QIA often uses maps when communicating with community members. Ms. D'Orazio described QIA's work to map input from communities using geographic information systems to give all information equal weight within QIA's decisions and actions. It is important to include areas that are important to the Inuit as well as to the species on which they depend. This information has been used to inform the development of marine protected areas. "True reconciliation is rarely, if ever, achieved in a court room."

A recent Supreme Court decision in Clyde River vs. PGS, Inc. (over seismic testing in Baffin Bay and Davis Strait) clarifies what consultation means under Canadian law. These include whether oral hearings were offered in the process, if there were other opportunities to provide comment, whether funding is provided for community members to participate in the process, and whether there was any documentation showing how input from communities was incorporated.

Meaningful engagement should be conducted with the goal of identifying and minimizing impacts to people or the environment where possible. Listening is critical to achieving this, but it is also important to document the way plans were changed based on input (or other indication that input was taken seriously). Inuit should be empowered to make decisions based on traditional knowledge, but this knowledge should not be just "thrown in" as a token effort -- it should be directly and transparently used in decision-making.

Scott Gedak
Northwest Territories (NWT) Environmental Studies Management Board
Mr. Gedak remarked that the provisions in place for meaningful engagement are not always met. He also called for awareness of the differences between the terms "partnership" and "meaningful engagement." While it may be that one chooses to strive for a true partnership, this goal may be challenged by a lack of shared understanding. For example, industry may speak of "risks associated with exploration," which, to them, may mean that their efforts do not yield recoverable resources. They may also be concerned broadly with the geopolitical context or uncertainty regarding whether their permit applications will be successful. A partnership relationship can also be challenged by the boom/bust nature of the oil and gas industry: it is difficult to sustain partnerships when people's jobs turnover or activities are slowed for economic reasons. Companies may also sell assets or trade interests, bringing a whole new company into the relationship with the local communities.

The NWT operates with a consensus government and has a relatively small population base. This eliminates the several degrees of separation that may exist in other places between the concerns within a community and the highest levels of government.

It is important that science be developed in conjunction with communities in the NWT. Industry leaders have conducted field trips to meet community decision-makers and discuss potential activities that are being proposed which may affect those communities. This practice should be repeated, and information about resource development activities and potential scenarios made accessible to community members.

Partnerships among industry, communities, and government will all have ups and downs. Mr. Gedak characterized the partnership as a "parent-child" relationship with industry as the teenager. Early, honest, and on-going dialogue is necessary. A project will not be approved in the NWT if the community is not satisfied that there is a chance for meaningful participation, clear benefits to the community, a safe working environment, and attention to both community and environmental well-being.

10 Ice, Ocean, and Air Technical Talks

Warren Horowitz of BOEM chaired this session. Table 3 identifies the speakers and topics (alphabetical order).

Table 3. Ice, Ocean, and Air Technical Talks Presenters and Titles

Presenter	Presentation Title
Hajo Eicken, University of Alaska Fairbanks	Tracking Sea-ice Seasonal Cycle, Dynamics, and Hazards Near Point Barrow, Alaska with a Coastal Ice Radar
Darlene Langlois, Canadian Ice Service	Sea Ice Trends and Variability
Andrew Metzger, University of Alaska Anchorage	Implementing the ISO 19906 Normative
Ralph Morris, Ramboll Environ, BOEM	Photochemical Modeling of Oil and Gas Development in the Arctic
Paula Fields Simms, Eastern Research Group, Inc.	Arctic Air Quality Modeling Assessment Study
Feiyue Wang, Churchill Marine Observatory	The Churchill Marine Observatory and the Oil Spills in Ice-Covered Arctic Waters (OSICA) Network

Presenters in this session shared research updates and findings on a diverse range of scientific studies, encompassing sea ice, air quality, and the fate and effect of spilled oil or other contaminants from shipping in the Canadian Arctic. Studies of sea ice from the US and Canada were presented, illustrating examples of the use of different data sources to understand changes in sea ice cycles. Andrew Metzger focused on more operational issues with a description of the opportunities and challenges associated with implementing International Standards Organization (ISO) guidelines for the construction of offshore structures in the Arctic.

Author-provided abstracts are presented below in the same order shown in Table 3 (presenter may not be lead author).

Tracking Sea-ice Seasonal Cycle, Dynamics and Hazards Near Pt. Barrow, AK With a Coastal Ice Radar

Eicken[1*], H., Mahoney[2], A.R., Jones[2], J., and Shapiro[2], L.H.

[1]International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK, USA
[2]Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK, USA
[*]heicken@alaska.edu.

Sea ice is a key component of Arctic coastal and shelf environments: It provides important services to people and wildlife, and it represents a major hazard to shipping and hydrocarbon development. Despite major technological advances, marine ice hazards remain challenging to track through satellite remote sensing, buoys or moored instruments. In order to achieve sufficiently high temporal and spatial resolution of ice characteristics and movement relevant in a hazards assessment and emergency response context, we have focused on advancing the use of coastal ice radar.

For more than a decade our group has operated marine shore-based radars at Utqiagvik (formerly Barrow) and developed methods to track sea ice movement, deriving velocity and deformation fields and identifying hazards. From this work, we have gained insights into major changes in the seasonal cycle of coastal Alaska sea ice, as well as an understanding of the extent and drivers of reduced stability of nearshore ice. Comparing data for the past decade with pioneering ice radar data collected in the 1970s at the same location, we find that within 5-10 km off shore, the number of days during which ice movement is observed (as opposed to stationary or landfast ice presence) has increased two- to three-fold for the time period November–April. Drawing on current meter mooring data collected within the radar footprint, we have derived data on mean along- and off/on-shore ice speed and direction in conjunction with information about wind and current velocities. Such data allows for evaluation of potentially anomalous ice motion and associated hazards. Examining detailed features in the movement of individual floes or velocity-field derived deformation patterns can help provide decision support for applications such as emergency response or infrastructure planning and deployment.

The University of Alaska Fairbanks sea ice radar was installed primarily as a science instrument and data from the system has been featured in at least one scientific publication per year for the last decade. However, in recent years the near real-time data have been increasingly used by local hunters in Barrow as well as by ice analysts at the National Weather Service in Anchorage, Alaska.

Sea Ice Trends and Variability

Langlois[1*], D. and Howell[2], S.

[1]Environment and Climate Change Canada, Canadian Ice Service
[2]Environment and Climate Change Canada, Science and Technology Branch
[*]Darlene.Langlois@Canada.ca

Sea ice concentrations and thicknesses in the Western Arctic have undergone dramatic changes in the past 20 years since records began at the Canadian Ice Service in 1968. Increasing use of satellite and other data have allowed improved understanding of the conditions which helps in forecasting for the short, seasonal and longer term.

Implementing the ISO 19906 Normative

Andrew Metzger, University of Alaska, 2900 Spirit Drive, Engineering & Industry Building Anchorage, AK 99508 United States, atmetzger@alaska.edu

The ISO 19906 - Arctic Offshore Structures document presents guidelines for a reliability-based approach to the design of offshore structures subject to demands encountered in an arctic environment. The philosophy presented in the standard is consistent with principles of probability theory and is fairly straight forward. However, it is up to the user of the document to provide values for environmental parameters that affect the structure. The parameters include meteorological, oceanographic, and sea ice metrics needed to determine external forces (i.e., actions) on the offshore structures being designed. These parameters must also be provided in a probabilistic, or statistical, format in order to calculate limit state actions. This presentation reviewed the fundamentals of reliability engineering and demonstrate how empirical measurements, collected during field campaigns, may be used to estimate limit state values of actions on offshore structures in Arctic conditions.

BOEM Photochemical Modeling of Oil and Gas Development in the Arctic

Morris[1*], R., Stoekensius[1], T., Fields Simms[2], P., Do[2], B. and Crowley[3], H.

[1]Ramboll Environ, Novato, CA
[2]Eastern Research Group, Inc., Sacramento, CA
[3]BOEM Alaska OCS Region
*RMorris@ramboll.com

BOEM is assessing air quality impacts from potential offshore oil and gas exploration, development and production on the Alaska OCS, as well as those in near-shore state waters, and related onshore activities. The BOEM Arctic Air Quality Impact Assessment Modeling Study is being conducted by the team of Eastern Research Group, Inc. and Ramboll Environ, Inc. under BOEM Contract M13PC00014. The Study included developing a bottom-up emissions inventory of impacting sources located on the North Slope of Alaska, evaluating detailed meteorological data sets for use in modeling, conducting far- and near-field photochemical and atmospheric dispersion modeling. All modeling protocols and draft reports were reviewed by a Science Review Group selected especially for the Study, with expertise in air quality analyses, modeling, and emissions.

The BOEM Study assessed the contributions of emissions from potential future oil and gas development on the OCS in the Arctic and related offshore (e.g., support vessels) and on-shore (e.g., processing plants) sources to air quality and air quality related values in northern Alaska. For the purposes of this analysis, the contributions to National Ambient Air Quality Standards, concentration increments, visibility and depositions were assessed under a hypothetical future year Full Buildout scenario that represents a conservatively-high level of potential OCS oil and gas activities. The CAMx photochemical grid model (PGM) was used in this analysis to estimate the mid- and far-field impacts and the AERMOD Gaussian plume model was used to estimate the near-source impacts of the offshore oil and gas and related emissions. The Weather Research Forecast (WRF) meteorological model was run for 5 year (2009-2013) using a 36/12/4 km nested grid structure with the 4-km domain covering northern Alaska and the Arctic Sea. The AERMOD near-source (within 50 km) air quality assessment used meteorological inputs derived from the 5-years of WRF data through the Mesoscale Model Interface (MMIF) processor, whereas the Comprehensive Air Quality Model with Extensions (CAMx) PGM modeling was conducted for the 2012 calendar year on the 36/12/4 km modeling domains. The SMOKE emissions model was used to generate the hourly gridded speciated emission inputs required by the CAMx PGM. Boundary Conditions BC for the outer 36 km domain that stretched into Russia in the west and Canada in the east were obtained from a 2012 simulation of the GEOS-Chem global chemistry model. CAMx was first run for a 2012 base case scenario and the modeling results compared against air quality observations in a model performance

evaluation. CAMx estimated higher $PM_{2.5}$ than observed with oil and gas visibility impacts exceeding 1 deciview at coastal areas of the Alaska National Wildlife Refuge that was attributable to overstated sea salt emissions, which combined with oil and gas NOx emissions to form sodium nitrate $PM_{2.5}$. An improved sea salt emissions algorithm was used with CAMx that produced much better $PM_{2.5}$ agreement with the observations as well as with historical (1997-2009) sodium measurements at Barrow and resulted in lower $PM_{2.5}$ and visibility impacts associated with the oil and gas emissions. CAMx was applied for a future year Full Buildout scenario and the results compared against the National Ambient Air Quality Standards and other thresholds of concern.

Arctic Air Quality Modeling Assessment Study

Fields Simms[1], P.G., Do[1], B., Stoeckenius[2], T., Morris[2], M., and Crowley[3], H.

[1]Eastern Research Group, Inc., Sacramento, CA
[2]Ramboll Environ, Novato, CA
[3]BOEM Alaska OCS Region
*Paula.Fields@erg.com

BOEM is assessing air quality impacts from potential offshore oil and gas exploration, development and production on the Alaska OCS, as well as those in near-shore state waters, and related onshore activities. For this assessment, BOEM is sponsoring the Arctic Air Quality Impact Assessment Modeling Study. The Study is being conducted by the team of Eastern Research Group, Inc. and Ramboll Environ, Inc. under BOEM Contract M13PC00014. The Study began in September 2013 and the final report will be completed in early 2018. The Study included developing a bottom-up emissions inventory of impacting sources located on the North Slope of Alaska, evaluating detailed meteorological data sets for use in modeling, conducting far- and near-field photochemical and atmospheric dispersion modeling, and evaluating the current emission exemption thresholds used by BOEM to determine if a source requires additional analysis to ensure no adverse impacts to onshore air quality. All modeling protocols and draft reports were reviewed by a Science Review Group selected especially for the Study, with expertise in air quality analyses, modeling, and emissions.

The emissions inventory provided annual criteria pollutant emissions for offshore and onshore oil/gas production, stationary sources located in North Slope communities, on road motor vehicles, nonroad equipment, marine vessels and airports for a base year and projections year. The projections year level of activity was based on BOEM's hypothetical Full Buildout scenario covering possible future levels of off-shore oil and gas production. Existing meteorological data sets were evaluated for use in dispersion and photochemical grid modeling (PGM) in the Study, however, none were found to be appropriate, so an optimized simulation of the Weather Research and Forecasting (WRF) model was performed. Local scale, or near-field (within approximately 50 km of the source) atmospheric dispersion modeling (ADM) was conducted using the WRF- MMIF-AERMOD modeling approach, with 5 years of meteorology from the BOEM Arctic WRF dataset. Also, the EET evaluation approach involved modeling "synthetic" offshore sources in the Chukchi and Beaufort Seas using WRF-MMIF-AERMOD and WRF-MMIF-CALPUFF (for synthetic sources places more than 50 km from the state seaward boundary). The PGM was conducted using the CAMx with the 2012 BOEM Arctic WRF data sets. Analysis of the PGM results focused on evaluating the impacts of new oil and gas sources under the Full Buildout scenario on regional concentrations of ozone and PM2.5 and on acid deposition and visibility impacts to Class I and Class II areas that are designated as national parks, national preserves, and national wildlife refuges.

The Churchill Marine Observatory and the Oil Spills in Ice-Covered Arctic waters (OSICA) Network

Wang, F. University of Manitoba, Winnipeg, MB, Canada, feiyue.wang@umanitoba.ca.

Two new Canadian programs dedicated to the study of spills of oil and other transportation related contaminants in Arctic waters will be introduced. The first is the Churchill Marine Observatory that is under construction at Port of Churchill, Manitoba, adjacent to North America's only Arctic deep-water port. The core Churchill Marine Observatory infrastructure is comprised of 1) an outdoor Oil-in-Sea-Ice-Mesocosm with two pools, which is designed to simultaneously accommodate contaminated and control experiments on various scenarios of oil and related contaminants in ice-covered waters; and 2) the Environmental Observatory system, which is a network of state-of-the-art sensors and equipment located in the Churchill Estuary and along the main shipping corridor across Hudson Bay to Baffin Bay. With a total infrastructure funding exceeding $44 million from the Canada Foundation for Innovation, POLAR, the provinces of Manitoba, Alberta, and British Columbia, and numerous partners, Churchill Marine Observatory is scheduled to become operational in 2018.

Taking advantage of the unprecedented controllability and scalability enabled by Churchill Marine Observatory, the second major program is the Oil Spills in Ice-Covered Arctic waters (OSICA) Consortium. Founded in March 2017, OSICA is a Canadian-led, multi-sectoral (academia, industry, government, communities) consortium with a mandate to improve policy and practices dealing with spills of oil and related contaminants in ice-covered Arctic waters by prioritization and communication of research and development activities. One of the first initiatives of the OSICA Consortium was to develop an OSICA Research Network to be funded by the Natural Sciences Engineering Research Council of Canada. A pre-application has been successful and we are now in the process of developing the full proposal.

This presentation described the status and progress of both programs, with an emphasis on identification and recruitment of new participants and partners as we develop these programs.

11 Community-driven Research and Monitoring Technical Talks

Henry Huntington of Huntington Consultants chaired this session. Table 4 identifies the speakers and topics (alphabetical order).

Table 4. Community-driven Research and Monitoring Technical Talks Presenters and Titles

Presenter	Presentation Title
Trevor Bell, Memorial University of Newfoundland	SmartICE: A Sea-ice Monitoring and Information Service for Coastal Communities and Industries
Mike Brubaker, Alaska Native Tribal Health Consortium	Local Environmental Observer (LEO) Network – A Citizen Observer System for Monitoring Environmental Change
Anna Bryan, Alaska Department of Fish and Game	Community Based Marine Mammal Research in Alaska
Rosanne D'Orazio, Lands and Resources, QIA	Inuit Qaujimajatuqangit in Decision Making and Inuit Led Research
Mark Everett, U.S. Coast Guard District 17	Prevention, Preparedness, and Response for Small Communities
Qaiyaan Harcharek, North Slope Borough Chris Campbell, BOEM	Traditional Knowledge Implementation: Accessing Community Panels of Subject Matter Experts

This session focused on research projects and other efforts that included community members in the design or implementation, ranging from monitoring sea ice via snow machine to data collection. Two sessions focused on indigenous-led decision-making and the incorporation of traditional knowledge. The interim results were shared from an Arctic Council survey of community perspectives on their oil spill response preparedness.

Author-provided abstracts are presented below in the same order shown in Table 4 (presenter may not be lead author).

SmartICE: A Sea-ice Monitoring and Information Service for Coastal Communities and Industries
Bell, T., Geography Department, Memorial University of Newfoundland, tbell@mun.ca

SmartICE (smartice.org) is a northern social enterprise that puts into the hands of communities the technology that helps them adapt to unpredictable sea-ice changes, resulting from climate change. Inuit knowledge of sea ice has been acquired from millennia of observation and use. But in the last decades this traditional knowledge has become less reliable in the face of unprecedented environmental changes.

SmartICE is the world's first climate change adaptation tool that integrates on-ice technology, remote sensing and Inuit knowledge to generate near real-time information on sea-ice conditions. It maintains a network of *in situ* and mobile sensors that measures and transmits sea-ice thickness data from community trails. It also maps sea-ice surface conditions from satellite imagery to inform safe travel choices. It uses information technology to generate accessible products that match the needs of community users.

In response to increasing community demand for its services and with the support of the 2016 Arctic Inspiration Prize (arcticinspirationprize.ca), SmartICE is expanding across the Arctic through the establishment of a northern social enterprise. The choice of a social enterprise business model is consistent with Inuit societal values such as caring for the environment and community and being innovative and resourceful. It also commits to maximizing social impact and creating positive community change, while applying an entrepreneurial approach to the delivery of novel sea-ice information services for the public and private sectors.

The SmartICE information system directly benefits public safety, food security, and health and wellbeing. In addition, SmartICE enables and supports economic activities for communities and industries alike. For example, winter shipping, ice-based fisheries and tourism, environmental monitoring, and emergency response are typically carried out in the landfast ice zone where SmartICE operates. SmartICE services reduce risk and improve performance and safety, especially during highly dynamic freeze-up and break-up periods. Through technological innovation and science, SmartICE strives to integrate and augment Inuit Qaujimajatuqangit (Inuit knowledge and values) about local sea-ice conditions, not replace it, while involving Inuit in all aspects of its operation and decision-making.

LEO Network – A Citizen Observer System for Monitoring Environmental Change
Michael Brubaker, Michael Brook, Erica Mitchell, Mary Mullan, Desirae Roehl, and Moses Tcheripanoff – The Alaska Native Tribal Health Consortium

In Alaska and the Canadian North, people who live and work close to the land are often witness to the symptoms of a rapidly changing environment. The LEO Network is an online platform for sharing information (photos and text) about unusual environmental events. The purpose is to raise awareness about climate and environmental change, to connect people who are sharing knowledge, and finding healthy, effective, ways to adapt.

The Alaska Native Tribal Health Consortium began developing the LEO Network in 2012 to create a system for understanding and addressing emerging environmental health threats. Today, the network has grown and expanded outside Alaska, developing membership in approximately 500 communities globally. The platform is available in all northern national languages, and translation in to First Nation languages is in progress. In addition, there are centers for LEO Network growth and implementation in Canada (BC, NWT) Mexico and in the Lower 48.

The network itself is part map, part social media, and part publishing platform. LEO members share observations of environmental change based on science, indigenous, and local knowledge using a mobile or web-based platform. Observers are then assisted by project administrators, and other network members, to connect with subject-matter experts.

Typical observations describe impacts to the built and natural environment from seasonal change, unusual weather, permafrost thaw and erosion. Observations can also roll into standing "projects". These are topic specific groups (e.g. "coastal erosion") and include additional data sets such as satellite imagery, environmental and weather data. The data is applied to identify local, as well as regional, trends with the searchable content organized by member, topic area, and community.

Local impacts of environmental change must first be understood before effective planning can occur. The LEO Network assists in describing these impacts, and supports members in identifying effective resources. This system is developing into a local and regional surveillance system, providing early detection and situation awareness about emerging environmental impacts in Alaska and the circumpolar north. Participation by the oil and gas sector could expand the surveillance capacity of LEO Network and engage new partners for topic consults, research or other partnerships.

Community Based Marine Mammal Research in Alaska

Bryan, A.
[1] Alaska Department of Fish and Game, 1300 College Road, Fairbanks, Alaska 99701, USA
Anna.Bryan@alaska.gov

The Alaska Department of Fish and Game's Arctic Marine Mammal Program conducts marine mammal research on ice seals, walruses, bowhead and beluga whales, and polar bears. Alaska Native hunters are experts regarding these animals and are valuable partners in all of our research projects. This presentation provided an overview of our community based projects and collaborative research.

Inuit Qaujimajatuqangit in Decision-making and Inuit Led Research

Lonsdale, S., and D'Orazio, R.
Qikiqtani Inuit Association, slonsdale@qia.ca

The Qikiqtani Inuit Association community-based monitoring project is a form of wildlife monitoring driven by local hunters recording information on their harvested marine mammals. It was developed in response to community concerns that seismic testing would impact people's food sources. The core of the project is a written survey that is filled out with each observation or each harvest of an animal. It is meant to track when and where animals are caught and to note general observations on the health of species. Over time the baseline data collected will identify areas of wildlife concentrations, track invasive species and changes in distribution, and allow for trend analysis. Data collected will feed into local and regional advocacy, create awareness on issues identified by locals, strengthen local decision making, can be factored into management plans, and be used to influence policy or legislation.

Prevention, Preparedness, and Response for Small Communities
Everett, M.L., United States Coast Guard, Seventeenth District, Mark.Everett@uscg.mil

In June 2015 the Arctic Council's EPPR working group approved a project to assess the level of community awareness of and preparedness for oil spills in the Arctic. The project is co-led by Norway, Canada, U.S., and Aleut International Association. The first phase of the project (2015-2017) developed a community self-assessment tool that gathered information to better understand community preparedness and risk exposure. The survey was distributed to 350 communities ranging from 150 to 15,000 people and/or significantly distant (120 miles) from response centers. Community leaders and local emergency response officials were asked to complete the questionnaire. The outcomes from this phase of the project are: greater awareness of risk and preparedness at the local level, and access to best practices; the ability for national governments to address misperceptions or lack of awareness; the identification of gaps in preparedness relative to risk. Three deliverables were approved by Ministers at the Fairbanks Ministerial in May 2017, an interactive map displaying the data from the survey tool, a database of survey responses, and a resource guide in the form of a short brochure to share with small communities. The second phase of the project – development and production of a series of community-focused educational videos – is underway.

Traditional Knowledge Implementation: Accessing Community Panels of Subject Matter Experts
[1]Campbell, C., [2]Harcharek, Q and [2]Suydam, R.

[1] Environmental Studies Management, Bureau of Ocean Energy Management, Alaska OCS chris.campbell@boem.gov
[2]Department of Wildlife Management, North Slope Borough, Utqiaġvik. qaiyaan.harcharek@north-slope.org; robert.suydam@north-slope.org.

BOEM's Environmental Studies Program entered into a cooperative agreement with the North Slope Borough Department of Wildlife Management. The primary purpose of this cooperative agreement is to better integrate traditional knowledge with scientific research. Traditional knowledge is knowledge based on empirical observations passed from one generation to the next regarding key environmental information. Integrating traditional knowledge and science will be accomplished through the organization of panels of traditional knowledge subject matter experts. The initial focus will be in the communities of Utqiaġvik, Nuiqsat, and Kaktovik, Alaska. The development and implementation of panels could take a phased approach and involve partnering among the North Slope Borough, BOEM, and other appropriate organizations.

There are two main drivers for this project. (1) We seek to refine and expand the use of traditional knowledge in the development and implementation of biological and oceanographic studies, which will help in reaching a broader audience across the Arctic to promote the utility of integrating traditional knowledge with scientific research. This process will help facilitate discussions about what type of research would be beneficial for community members, agencies, and scientists. (2) The project will document traditional knowledge that will assist BOEM in meeting its mandated mission of understanding baseline conditions and assessing potential effects of offshore oil and gas leasing, exploration, development, and production. But perhaps most importantly, the cooperative agreement is responsive to repeated requests from the Iñupiat people to be more engaged in scientific research, and to ensure that traditional knowledge is more completely used in the design, implementation and interpretation of results from research.

The result of integrating traditional knowledge with science will be an improved approach for specific research projects but will also lead to development of best practices, and improved scientific rigor for

future research. The role of the traditional knowledge panels will be to inform proposed research by providing a hunter and community perspective based on generations of observation that will potentially contribute to identifying new models of the natural world and our relation to it.

A possible first project for the traditional knowledge panels could be a multi-year near-shore lagoon ecology study by Dr. Ken Dunton, funded by the National Science Foundation. Future projects could include proposed variety of BOEM funded studies, such as: Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea; Arctic Slope Winter Fish, Invertebrates, and Arctic Cod Spawning Survey; or Village-based Satellite Tracking of ice seals. Evaluating impacts from aircraft on subsistence species and hunters may be another fruitful project for engagement of traditional knowledge panels.

Regardless of the study, the ultimate goals are to expand the incorporation of traditional knowledge into North Slope studies that would not typically include traditional knowledge, reach a broader public audience within the North Slope Borough, and to further demonstrate the utility of integrating traditional knowledge with scientific research as a model for the broader pan-Arctic area.

12 Lunch Speaker: Brad Chastain, Alaska Gasline Development Corporation

Brad Chastain explained that the Alaska Legislature founded the Alaska Gasline Development Corporation with an independent board of directors appointed by the Governor. The Alaska Liquid Natural Gas (AK LNG) project is a "mega mega" project intended to meet both the needs of the state but also to export LNG. The latter has already been approved by the Department of Energy.

A group of industry partners completed the front end, design stage of the AK LNG project prior to Alaska taking on the sole leadership role when the companies decided not to proceed. Mr. Chastain described his role as ensuring that technical information complied during that process is used to the greatest extent possible. This represents a more than $600 million investment into the process to date. Currently, the project enjoys strong support in Alaska, including from the Governor, and growing support in Washington, DC.

Mr. Chastain described the AK LNG project as comprising three mega projects: a gas treatment plant on the North Slope, a pipeline from the North Slope to Cook Inlet (comparable in length and complexity to the Trans-Alaska Pipeline System, including a subsea portion across Cook Inlet), and a world-class liquefaction facility in Nikiski. There will also be two large storage tanks and a jetty capable of berthing two LNG tankers near the facility.

Simply shipping all the materials needed for these three projects to Alaska will require a massive sea lift requiring a temporary material offloading facility. Just one of the 51 modules shipped to Alaska, for example, will be 9400 tons. (Most of the modules will be constructed in Asia, with some also from the Gulf of Mexico.) The current plan is that ocean going tugs and barges with equipment will clear customs in Dutch Harbor, then proceed to Port Clarence to stage and await the opening of sea ice in July before moving north to Prudhoe Bay in a group. A formal conflict avoidance agreement will be made with the Alaska Eskimo Whaling Association and other arrangements made with appropriate federal agencies.

13 Biological Observatories and Monitoring Technical Talks

Catherine Coon of BOEM chaired this session. Table 5 identifies the speakers and topics (alphabetical order).

Table 5. Biological Observatories and Monitoring Technical Talks Presenters and Titles

Presenter	Presentation Title
Seth Danielson, University of Alaska Fairbanks	AMBON: Arctic Marine Biodiversity Observing Network
Tahzay Jones, National Park Service	Development of a Pan-Arctic Coastal Monitoring Program
Sue E. Moore, National Oceanic and Atmospheric Administration Fisheries Office of Science and Technology	The Distributed Biological Observatory: An Expanding Change Detection Array for the Beaufort Sea and Beyond
Phil Osborne, Golder Associates	Integrated Beaufort Observatory
Christian Zimmerman, U.S. Geological Survey Alaska Science Center	Circumpolar Assessment of Trends in Arctic Freshwater Biodiversity

This session highlighted the work of several ongoing efforts to monitor a range of biological features in the U.S. and Canadian Arctic. Presenters focused on marine, coastal, and freshwater ecosystems and the use of different methods for both research and on-going management.

Author-provided abstracts are presented in the same order shown in Table 5 (presenter may not be lead author).

AMBON: The Arctic Marine Biodiversity Observing Network

Seth Danielson[1], Katrin Iken[1], Bodil Bluhm[2], Eric Collins[1], Lee Cooper[3], Jacqueline Grebmeier[3], Russ Hopcroft[1], Kathy Kuletz[4], Sue Moore[5], Franz Mueter[1], Kate Stafford[6]

[1]College of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK, 99775-7220, USA
[2]Department of Arctic and Marine Biology, UiT - The Arctic University of Norway, P.O. Box 6050 Langnes, 9037 Tromsø, Norway
[3]Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, PO Box 38, 100 Williams St, Solomons MD 20688, USA
[4]US Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK, 99503, USA
[5]Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, 7600 Sand Point Way NE, Seattle, WA 98115, USA
[6]Applied Physics Laboratory, University of Washington, 1013 NE 40th Street, Seattle, WA 98105-6698, USA
[*]sldanielson@alaska.edu and kbiken@alaska.edu

AMBON is a multi-agency funded endeavor that focuses on marine biodiversity in the Chukchi Sea. AMBON takes an end-to-end approach, documenting environmental conditions and the ecosystem's biota, from microbes to whales and all in-between. AMBON extends the efforts of prior field programs in order to maintain time series observations and place the biodiversity assessments within a broader framework of change through time. Here, we present overall patterns in biodiversity and their relations to environmental conditions from the first field effort in 2015. Biodiversity and community structure distribution across organizational levels was strongly linked to physical parameters. Linkages with water mass characteristics were overall strong, as were depth-related and latitudinal patterns. At higher trophic

levels, association with upwelling regions (seabirds) and shoals (walrus) were prominent. A recently completed field effort in August 2017 will show if the previously observed patterns are consistent between surveys. The eventual goal is to help design a cost-effective and useful marine biodiversity monitoring program that is appropriate to longer time scales within a rapidly changing Arctic.

Development of a Pan-Arctic Coastal Monitoring Program

Tahzay Jones, National Park Service, Alaska Region, Coastal Programs Lead and U.S. Co-Lead for Coastal Experts Monitoring Group of the Arctic Council Conservation of Arctic Flora and Fauna Working Group

The Coastal Experts Monitoring Group is an operational team within the Arctic Council's Conservation of Arctic Flora and Fauna working group, Circumpolar Biodiversity Monitoring Program. The latter established four operational teams covering marine, terrestrial, freshwater and coastal systems to develop monitoring plans and report on the status of ecosystems across the Arctic. The coastal monitoring plan is nearing completion and is the final developmental plan of the four ecosystem groups, bringing together elements of all three previous monitoring efforts to complete the ecosystem monitoring plan efforts. The coastal monitoring plan divides the Arctic Coast into "coastscapes" which are areas of the circumpolar Arctic coast with recurring physiographic attributes where similar terrestrial, marine and freshwater processes interact to create a predictable range of habitats that support characteristic populations of coastal species. Coastscapes are used in the Coastal Plan to stratify the identification and prioritization of key coastal species (Focal Ecosystem Components) for monitoring. The Coastal Experts Monitoring Group is currently convening an experts workshop to finalize the functional groups to be monitored, what characteristics of those groups will be monitored, and what metrics will be used. Completion of the draft plan is anticipated for early 2018.

The Distributed Biological Observatory: An Expanding Change Detection Array for the Beaufort Sea and Beyond

Moore[1*], S. E., and Grebmeier[2], J.M.

[1]NOAA/NMFS OST, Seattle, WA
[2]Chesapeake Biological Laboratory, University of Maryland, Solomons, MD
[*]sue.moore@noaa.gov

In 2009, in response to dramatic seasonal sea ice loss and other physical changes influencing biological communities, a Distributed Biological Observatory (DBO) was proposed as a change detection array to measure *biological responses* to physical variability along a latitudinal gradient extending from the northern Bering Sea to the Beaufort Sea in the Pacific Arctic sector. In 2010, the Pacific Arctic Group initiated a pilot program, focused on standardized sampling in five regions of high productivity and biodiversity on the continental shelves of the northern Bering and Chukchi seas. In 2012, the Interagency Arctic Research Policy Committee DBO Collaboration Team advanced the observatory from a pilot phase to a 10-year implementation phase, which included the: (i) addition of three sampling regions in the Beaufort Sea, (ii) goal of linking the DBO to existing community-based observation programs, and (iii) development of a plan for a periodic Pacific Arctic Regional Marine Assessment.

The three Beaufort DBO regions comprise a longitudinal array centered on productivity 'hotspots' along the outer continental shelf and slope, with S-N transects located offshore Cape Halkett (~152° W), Barter Island (~143.6° W) and a SW-NE transect offshore Cape Bathurst (127.7-126.8 W). Each transect is comprised of six sampling stations, with long-term oceanographic moorings sited in the Cape Halkett and Cape Bathrust regions to provide year-round sampling of the physical environment. Biophysical sampling was initiated in all three Beaufort DBO regions in 2015, although only the Cape Halkett transect was sampled in 2016 and only the Cape Bathrust region was occupied in 2017. This paucity of sampling,

compared to the DBO regions in the Bering-Chukchi, is due to comparatively few passages of international research vessels eastward from Point Barrow into the Beaufort Sea. It is important that sampling in the Beaufort DBO regions be continued and enhanced, if possible, as changes to sea ice, ocean temperature, salinity and river runoff have been dramatic in the Beaufort Sea over the past decade. Notably, bowhead whales (*Balaena mysticetus*), appear to be responding to an altered ecosystem in the Alaskan Beaufort Sea, as exemplified by their distribution across much of the shelf and slope during July-August 2016 and 2017. This broad distribution is roughly a month earlier than is typical and is likely linked to enhanced feeding opportunities associated with early sea-ice retreat followed by upwelling-favorable winds, in some cases augmented by river discharges in nearshore habitats. Additional sampling in Beaufort DBO regions would aid investigation of these biophysical drivers, contribute to ecosystem modeling efforts and (potentially) contribute information to issues important to Alaskan coastal communities.

The long-term future of the DBO will depend on active involvement of international and national partners focused on the common goal of improved pan-Arctic assessments of regional marine ecosystems in an era of rapid change. An Atlantic-DBO, comprised of five transect lines, is now being developed in the northern Barents Sea and Fram Strait, and DBO lines have been proposed for Baffin Bay. In the U.S., the Interagency Arctic Research Policy Committee Marine Ecosystem Collaboration Team now has the lead for coordinating DBO activities, while internationally the Pacific Arctic Group and the International Arctic Science Committee can support the development of the first Pacific Arctic Regional Marine Assessment in 2018.

The Integrated Beaufort Observatory

Osborne[1*], P., Forest[2], A., Melling[3], H., Lalande[4], C., Meredyk[2], S., and Fortier[2], M.

[1]Golder Associates
[2]ArcticNet
[3]Fisheries and Oceans Canada
[4]Université Laval
[*]Phil_Osborne@golder.com

The integrated Beaufort Observatory (iBO) was developed to maintain key oceanographic time-series and to integrate datasets collected in the southern Beaufort Sea over the last 30 years. This presentation will summarize objectives, drivers, activities and results from the first two years of iBO, a four-year program (2015-2018) managed by ArcticNet in partnership with Fisheries and Oceans Canada and Golder Associates Ltd. and supported by the Environmental Studies Research Fund ESRF and Imperial Oil Resources Ventures Limited IORVL. iBO aims to contribute key oceanographic information required for decisions on development and regulations in the offshore Canadian Beaufort Sea by extending existing time-series measurements and integrating regional understanding of the shelf and slope environment through year-round measurements acquired by autonomous instruments on submerged moorings. The iBO program will contribute to the development of regional syntheses of ocean circulation, sea ice observations and biogeochemical fluxes including: information on the magnitude, duration and return period of extreme ice features; ice and ocean datasets to document and interpret inter-annual variability of ice circulation, ocean circulation and particulate matter fluxes in relation to various environmental forcing factors; data to support the development and evaluation of accurate numerical prediction models for operational ocean forecasting and the validation/verification of regional research models for simulating ice, seawater and oil spill trajectories.

Circumpolar Assessment of Trends in Arctic Freshwater Biodiversity

Culp[1,2*], J., Goedkoop[3], W., Lento[2], J., and Zimmerman[4], C.E.

[1] Environment and Climate Change Canada, Dept. Biology, Univ. New Brunswick, Fredericton, NB, Canada
[2] Canadian Rivers Institute, Univ. New Brunswick, Fredericton, NB, Canada
[3] Dept. Aquatic Sciences and Assessment, Swedish Univ. Agricultural Sciences, Uppsala, Sweden
[4] U.S. Geological Survey, Alaska Science Center, Anchorage, AK, USA
[*]joseph.culp@canada.ca

The freshwater group of the Circumpolar Biodiversity Monitoring Plan (Arctic Council: Conservation of Arctic Flora and Fauna) has begun circumpolar assessments of freshwater flora and fauna to determine the state of Arctic freshwaters. This evaluation includes examination of data from both historical (paleolimnological data and records from 1800 to 1950) and contemporary time scales (post-1950), as well as traditional ecological knowledge of Arctic peoples. We highlight multiple-stressor scenarios that act on the biodiversity and biogeochemistry of Arctic freshwaters, and cause change in biological communities of lakes and streams. Assessments compare and contrast the regional state of Arctic freshwater ecosystems in North America, Iceland, Greenland, Fenno-Scandia, and Russia. In addition, circumpolar assessments for specific focal ecosystem components, namely fish, benthic invertebrates, benthic algae, macrophytes and plankton, provide novel analyses of how climate change and associated environmental drivers affect these biological components. For example, we explore driver-response relationships across latitudinal and longitudinal spatial scales to determine whether similar patterns are evident throughout the sub-, low-, and high-Arctic. This study represents the first circumpolar assessment of trends in Arctic freshwater biodiversity.

14 Oil Spill Technical Talks II

Mark Everett of the U.S. Coast Guard District 17 chaired this session. Table 6 identifies the speakers and topics (alphabetical order).

Table 6. Oil Spill Technical Talks II Presenters and Titles

Presenter	Presentation Title
Richard R. Bernhardt, Prevention and Emergency Response Program, Alaska Department of Environmental Conservation	Addressing Public Dispersant Comments with Scientific Literature Parts I and II
Suzanne Chang, BSEE	Arctic Oil Spill Response Research at BSEE
Amy Merten, National Oceanic Atmospheric Administration	International Oil Spill Response Tool: Arctic Environmental Response Management Application (ERMA)
Steven Pearson, Bureau of Safety and Environmental Enforcement	Arctic Spill Response Database
Louis Poirier, National Research Council of Canada	Beaufort Sea Engineering Database

Following the first round of oil spill technical talks, this session focused on a range of topics from the technical to the operational. Two very different databases were shared, one on Arctic spill response resources (a circumpolar effort of the Arctic Council) and the other on environmental data for engineering in the Beaufort Sea. Other presentations covered an approach to sharing information about dispersants

with the public, challenges and opportunities associated with the development of the Arctic Environmental Response Management Application (ERMA), and a summary of Arctic oil spill response research funded by BSEE.

Author-provided abstracts are below in the same author order shown in Table 6 (presenter may not be lead author).

Addressing Public Dispersant Comments with Scientific Literature
Bernhardt, R.R., Alaska Department of Environmental Conservation rick.bernhardt@alaska.gov

Efforts to generate a new oil spill dispersant policy for Alaska culminated in January 2016 when natural resource trustees on the Alaska Regional Response Team signed and enacted the Dispersant Use Plan for Alaska. The process involved extensive outreach, which generated over 700 public comments, which ranged from specific advice to optimize dispersant use to questions about what is known about their effectiveness in environmentally relevant arctic conditions. This presentation uses peer-reviewed, scientific literature to address the most common public questions/concerns about state of dispersant science and describes how scientific knowledge can shape effective response policies.

Arctic Oil Spill Response Research at BSEE
Chang, S., Bureau of Safety and Environmental Enforcement, Offshore Regulatory Programs, Oil Spill Response Division, Sterling, VA suzanne.chang@bsee.gov

This presentation will provide an update on BSEE's Oil Spill Response Research Program and its research projects with an Arctic focus. Activities, updates, and capabilities of Ohmsett in Leonardo, NJ will be included.

The Research Response Branch within the Oil Spill Preparedness Division spent $7.5 million on research and development projects in FY16 and anticipates approximately $8.4 million in FY 17. Currently there are 39 on-going research projects with three projects under peer review. Research projects funded as part of BSEE Oil Spill Response Research Program include areas of mechanical recovery, chemical treatments, in-situ burning, remote sensing, and decision making strategies.

International Oil Spill Response Tool: Arctic Environmental Response Management Application (ERMA)
Merten [1*], A. A., Wright[2], R.C., Bruns[3], P, and, Holst-Andersen[4], J.P.

[1] NOAA's Office of Response and Restorations, Seattle, WA
[2] NOAA's Office of Response and Restoration, Silver Spring, MD
[3] Arctic Council Secretariat, Tromsø, Norway
[4] Danish Ministry of Defense, Copenhagen, Denmark.
*Amy.merten@noaa.gov

This presentation will focus on the evolution of Arctic ERMA® as a pan-Arctic common operational picture for oil spill preparedness, response and injury assessment. This discussion included interactions with Arctic Communities in Alaska and Canada, and will showcase the work of the Arctic Council's EPPR working group. The work will discuss international planning for oil spills that require an international response effort, per the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response, a legally binding agreement under the auspices of the Arctic Council. ERMA has been used as the common operational picture for US-led international Agreement on Cooperation on Marine Oil Pollution Preparedness and Response drill in 2016, and is targeted for use for other international drills in the future. Other EPPR projects with geospatial elements will be highlighted, including a project on

small communities' preparedness capacity, a pan-arctic database on oil spill response assets, and a project on the viability of response measures under Arctic conditions. The presentation will highlight joint projects with the University of Alaska, Fairbanks and Anchorage, the Alaska Ocean Observing Systems, Environment Canada, and the local response communities to demonstrate functionality and data sharing.

Arctic Spill Response Database
Pearson, S., Bureau of Safety and Environmental Enforcement, steven.pearson@bsee.gov

The Arctic Council tasked the EPPR working group to develop a searchable oil spill response database and populate it with detailed information on Arctic specific equipment, vessels, dispersant stockpiles and application platforms, in-situ burn booms, well containment and cap and flow devices, and other resources owned by or regionally available to all member states of the Arctic Council.

Each Arctic country has at its disposal unique, geographically dispersed stockpiles of oil spill response vessels, equipment, and supplies. Some of these assets are owned and operated by the country, but in many cases assets are owned by cooperatives, for-profit firms, vessel owners, and operators of offshore oil and gas facilities. Equipment is described and classified in different ways with the types of locations of equipment not well understood by other Arctic states.

When EPPR approved this project in December 2014, a comprehensive database of available response assets in the Arctic did not exist; however, several Arctic States were in the early stages of developing their own databases. This project developed a complete database of all internationally available oil spill response equipment existing in the specified Arctic regions in a single uniform format which will allow for an internationally collaborative and prompt response in the event of an oil spill. Another benefit of this inventory will be to identify potential gaps in the cumulative response equipment inventory available, so that these areas may be addressed in a proactive manner.

The Beaufort Sea Engineering Database
Poirier, L. Ocean, Coastal, and River Engineering, National Research Council Canada, Louis.Poirier@nrc-cnrc.gc.ca

The National Research Council Canada has developed a framework for an integrated database, the Beaufort Sea Engineering Database, and linked to it many Beaufort Sea relevant environmental datasets that are of interest to Industry and regulators. The Beaufort Sea Engineering Database forms a basis for the storage, query and visualization of all key relevant environmental data for the Beaufort Sea with specific applications for the determination of design ice loads for offshore platforms (fixed and floating), and offshore marine operations. A database of this type will become a valuable reference for Industry and will provide a means of transparency for the regulatory process. The project has been carried out as a Joint Industry Project between ConocoPhillips, Imperial Oil, and the Government of Canada (Indigenous and Northern Affairs Canada's Beaufort Regional Environmental Assessment and the National Research Council Canada's Arctic Program).

The work will illustrate how the database is used to assess the past environmental conditions at a well site or licence area. The database includes 84 datasets in 11 different categories. In a demonstration of the software, key datasets such as the Canadian Ice Service Regional Ice Charts and the Global Surface Summary of the Day from the National Climatic Data Centre are used to assess the changing environmental conditions in the Beaufort Sea. Understanding the warming temperatures and thinning ice conditions is important to industry partners seeking to operate in the region over the long term as they may have a beneficial and/or detrimental impact on various exploration activities.

15 Panel: Shared Leadership and Governance: Perspectives from U.S. and Canada

Mary Cody, BOEM, chaired this panel. The panelists were:

- Craig Fleener, Arctic Policy Advisor, State of Alaska Office of the Governor
- Dale Nicholson, Regional Director**,** Ecosystems Management, Fisheries and Oceans Canada

Craig Fleener, Arctic Policy Advisor
State of Alaska, Office of the Governor
Mr. Fleener challenged the audience to re-think the role of government in the North. He contrasted the governance approaches of "force" (depending on mandates) and "freedom" (with minimal to no involvement). In the past, governance in the North has tended towards the freedom approach, but this has resulted in pollution, dangerous working conditions, and other problems that have resulted in a swing to the other side of the spectrum.

Governance in Alaska is made more difficult because government at the national level often swings sharply between the two sides of the spectrum. Instead, Mr. Fleener emphasizes the importance of sub-national governance in Alaska and encourages stronger East-West connections at this level, rather than the dominance of the North-South approach. As an example, the Yukon Territory neighbors Alaska, but there is no direct dialogue between the two about how they may collaborate to address energy or infrastructure issues even though the people and general context are similar. There is a similar need to coordinate with Russia. China has proposed a One Belt, One Road project to invest $1 trillion towards transportation linkages, including shipping, that would connect 65% of the world's population. Alaska can benefit from this type of initiative, but only if it plans ahead and invests in the necessary infrastructure; otherwise an increase in Arctic shipping will mean only greater potential for search and rescue missions or oil spills in Alaskan waters. While a direct linkage to Russia, such as the past vision for a Bering Strait tunnel, is less critical now, the opportunity to link to the Chinese market is key. Alaska could gain significant opportunities, for example, from a rail link including Russia, Alaska, and the Northwest Territories. While Alaska would largely serve as a "fly over" area, there would be a demand for energy and services along the way that could benefit Alaska.

Due to lack of planning in the past, Alaska has remained largely dependent on resources that are subject to boom/bust cycles. When things are going well, planning efforts can naturally stall. Today, the highest priority issue is the cost of energy at the consumer level. People in villages currently often need to decide between heating their homes and purchasing food or hunting supplies, let alone building or owning businesses or otherwise improving their quality of life. The second biggest problem is infrastructure, due to the lack of vision in the past and failure to take advantage of the economic gains during boom times. Sub-national governments can work together to develop plans for a future that includes a higher quality of living for people and the infrastructure necessary to capitalize on opportunities opening up globally. This can be achieved without destroying the environment, and can and must be done wisely.

Questions & Discussion
In response to questions, Mr. Fleener elaborated on the appropriate forum for the vision and coordination he encourages. He would like to see a 50-year infrastructure plan developed at the state level that includes a rigorous and realistic assessment of the costs of each component. Then a process would be needed to identify the options that will bring the greatest gains for the least cost. Regarding regional coordination, Alaska has recently rejoined the Northern Forum. Developing a North America-specific strategy within the Northern Forum will be important, and in keeping with the East-West approach to coordination.

Dale Nicholson, Regional Director
Ecosystems Management of Fisheries and Oceans Canada
Mr. Nicholson discussed that Canada has many programs that impact the North, and that all of the programs must be based on sound science. Canada is currently investing more in science and oceans management than any time in the past generation. Canada plans to invest $200 million over 5 years, and Fisheries and Oceans Canada has received $85 million for marine conservation and an Oceans Protection Plan. Mr. Nicholson emphasized how important the relationship to indigenous people is with Oceans Canada, and explained that it was time to renew a nation-to-nation relationship "based on respect and partnership," and he described that this is a relationship that he would like to put additional focus on in the future.

Canada's Fisheries Act is 149 years old and is an important piece of legislation that is amended periodically. For example, Mr. Nicholson discussed Canada's marine protected areas (MPA), Tarium Niryutait, protected in 2010. The 1,800 square kilometers are now designed to protect belugas and other marine species, with another Arctic MPA designated in November 2016 to protect beluga, Bowhead, seals, char, and cod. The areas were designated based on Inuvialuit indigenous knowledge of cultural importance as well as historical harvesting areas.

Mr. Nicholson also discussed a similar partnership with Canada's indigenous population. The Inuvialuit Final Agreement was the first comprehensive land claim in Arctic Canada. Originally formalized in 1984, its focus was to preserve Inuvialuit values, ensure equal participation in government, and to protect Arctic wildlife. These kinds of agreements create governance models to ensure a close working relationship.

Mr. Nicholson emphasized the importance of using governance models to work closely together. The Inuvialuit Final Agreement established a schedule for members of the Fisheries Joint Management Committee to meet regularly meet on the management marine areas as members of the Fisheries Joint Management Committee. Similarly, the Western Arctic Marine Protected Steering Committee, focuses on marine protection based on community interests to ensure meeting the conservation objectives.

Finally, the Beaufort Sea Partnership, based on the integrated oceans management plan for the Beaufort Sea (2009) brings together a wide variety of interests in the Beaufort Sea. There is a regional coordination committee that oversees it. With this partnership, the Inuvialuit need to be equal and meaningful participants in economy and work together with the Canadian Government to protect the Beaufort Sea. These partnerships take time and continual effort to improve, but it's in the best interest of all parties to continue working on them.

16 Panel: Role of Regional Studies, Environmental Assessments, and Cumulative Effects

Sharon Randall of BOEM moderated this session. Presenters included:

- *Serena Sweet,* Alaska Supervisory Planning and Environmental Coordinator, BLM
- *Mark Miller,* Deputy Director, NSSI
- *Heather Rasmussen*, Policy Advisor, Nunavut Impact Review Board (NIRB)
- *Tim Fullman*, Senior Ecologist, The Wilderness Society

Serena Sweet, Alaska Supervisory Planning and Environmental Coordinator
Bureau of Land Management
Ms. Sweet described the BLM's management of more than 72 million acres in Alaska, including the National Petroleum Reserve. Oil and gas leasing on these lands includes Cook Inlet, where exploration and production began in the 1950s, and the National Petroleum Reserve. Government began exploration for oil and gas in the National Petroleum Reserve in the 1940s/1950s, but industry took the lead in the 1970s/1980s. Lease sales continue today and production at Greater Mooses Tooth #1 is now underway.

BLM conducts two types of assessments: land use plans and project-specific authorizations (with associated environmental analyses as appropriate). Ms. Sweet finds data are critical to the decision-making process, but in some cases data collected on site or for a project-specific purpose are not useful in the long-term. Developing and maintaining a comprehensive set of baseline data is a high priority, and it is important that consistent monitoring data – essential to public lands managers – be incorporated over time. Ms. Sweet also described Rapid Ecological Assessments, which are done by examining trends over broad landscapes with similar eco-features. Data from these are made available to BLM analysts and the public.

Ms. Sweet observed that it is difficult and expensive to conduct data collection at remote sites during the short summer season, and that BLM must both authorize oil and gas activity while ensuring that vital subsistence resources are protected. She also noted that land conveyance from the federal government to the state and local tribes continues, causing uncertainty regarding future data collection responsibilities and priorities for everyone.

Mark Miller, Deputy Director
North Slope Science Initiative
Mr. Miller discussed the role of research and studies to help synthesize and apply new knowledge and make decisions regarding impact avoidance, minimization, mitigation, assessment, and disclosure. He observed that knowledge will be used most effectively if it is perceived to be credible, salient, and legitimate. For something to be perceived as credible, it must be technically adequate, relevant to the decisions being made, and respectful of stakeholders' sometimes divergent values and beliefs.
It is also important to manage boundaries between knowledge and action in ways that enhance credibility, salience, and legitimacy. Convening entities, or "boundary organizations" are sometimes needed to bridge groups, bringing together knowledge producers, users, and stakeholders. Overcoming boundaries can require translation (ensuring understanding between those with different knowledge systems), collaboration (co-producing and applying shared knowledge), and mediation (ensuring different interests are applied fairly). Mr. Miller concluded by posing the question of whether such boundary organizations exist for northern oil and gas issues?

In response to a question, Mr. Miller commented that identifying cumulative effects can be difficult. He gave the example of aircraft disturbance of wildlife/hunting. BLM does not have acoustical engineers in most field offices, but the disturbance issue is a frequent concern. What is the appropriate set of experts needed to refine the understanding of this undesirable impact, and whether it is strictly a noise issue or if the disturbance of wildlife by aircraft is broadly visual, seasonal, or related to species composition? And how can those experts be convened with the information they need on the typical short timeline required?

Heather Rasmussen, Policy Advisor
Nunavut Impact Review Board (NIRB)
Ms. Rasmussen described how the Nunavut Agreement established a requirement for a public government and co-management institutions with roles in land and resource management. Each of these was established to incorporate representation from Inuit organizations, the Nunvaut government, and the Canadian federal government. All of them administer processes with a strong focus on public engagement

and resource management. Development proposals in Nunavut, therefore, must satisfy the requirements of a number of different groups depending on their location or the types of impacts that may occur.

The Strategic Environmental Assessment for Baffin Bay and the Davis Strait will result in a recommendation regarding oil and gas activity in these areas. The objectives of the assessment are to consider what is possible, what is realistic, potential impacts, cumulative effects, and transboundary issues. Currently they are developing a gap analysis of missing information on a range of issues. NIRB will develop a final report and recommendations in 2019. Results from this two-year process will be used by the federal government's ongoing five-year review of the moratorium on offshore oil and gas activity across the Canadian North. The assessment is designed to draw on both traditional and scientific knowledge. Through the process, the Board documents the information they collect and makes sure to reflect back to the communities how the information they gained from that community was used.

Tim Fullman, Senior Ecologist
The Wilderness Society
Mr. Fullman shared a non-governmental organization perspective. From his background in wildlife ecology, he observes that the "best way to protect places is to use science to inform management and decision-making." Regional studies are important, but especially so when sparse resources require species to cover large distances to meet their needs. Thus, thinking and planning at regional scales is imperative to protecting them, often requiring considerations across jurisdictional or other boundaries.

In Northern Alaska, caribou use areas and subsistence use areas all cross federal, state, and private lands. Making decisions within one management unit will only capture part of a much larger environmental challenge. Fullman identifies the following challenges related to assessments of environmental impacts of different activities:

- Data are not necessarily consistent or at as fine a scale as can be obtained at lower latitudes.
- There are gaps in basic information about species, e.g., where the broad whitefish, an important subsistence species, breeds and overwinters, and how much time it spends at sea or in fresh water.
- Data are not always accessible: studies are often local in scale and challenging to scale up to the regional perspective needed.

Mr. Fullman praised DOI for convening cumulative effects workshops in Anchorage last year. When different parties examine cumulative effects in a collaborative way, this can build respect and understanding and facilitate information.

Questions & Discussion
One participant asked what the weaknesses are in the process when it comes to translating information into decisions, especially when considering cumulative effects. Ms. Sweet noted that BLM is working on changes to their land use planning process, with hope that there are opportunities to consider issues on a broader scale and engage stakeholders more in the process. Mr. Miller observed that there is a tremendous amount of information available but it is not effectively synthesized, nor is there a clear group with the responsibility to do this. Mr. Fullman offered that robust processes must consider scale regionally and temporally, and that it is important to ensure as much certainty as possible for all parties (both developers and those concerned with potential impacts from development). Robust opportunities for comment are also important, and this requires time to create and utilize feedback processes.

Panelists noted that it is important to consider *all* potential effects of projects – including research efforts themselves and not just industrial development.

Panelists also noted that datasets take time and resources to develop, and they appreciate why those who have done the work may not want to share all of their data openly. However, without the data, it is impossible to assess the quality of the data or resulting analyses.

17 Science in Area-based Management Technical Talks

Mark Miller of NSSI chaired this session. Table 7 identifies the speakers and topics (alphabetical order).

Table 7. Science in Area-based Management Technical Talks Presenters and Titles

Presenter	Presentation Title
Thomas Hoggarth, Ecosystems Management, Central and Arctic Region, Fisheries and Oceans Canada	Marine Conservation Targets in Canada's Marine Waters
Paul Leonard, Arctic LCC	Science-Informed Land Management Tools for Arctic Alaska and Canada
Cathy Coon, Environmental Sciences Management, BOEM	Arctic Council Ecosystem Approach to Management

These three final technical presentations shared different examples of the role of science in area-based management, ranging from a focus on the marine environment and Canada to a bi-national effort to the Arctic Council's circumpolar-wide approach to ecosystem management.

Author-provided abstracts are below in the same author order shown in Table 7 (presenter may not be lead author).

Marine Conservation Targets in Canada's Marine Waters: Area-based Management
C. Thomas Hoggarth. Department of Fisheries and Oceans and the Canadian Coast Guard
Canadian Center for Inland Waters, 867 Lakeshore Rd. Burlington ON, L7S 1A1
Thomas.Hoggarth@dfo-mpo.gc.ca

In 2010, Canada agreed to marine conservation targets established under the United Nations Convention on Biological Diversity to conserve 10 percent of coastal and marine areas by 2020 through effectively managed networks of protected areas and other effective area-based conservation measures (Aichi Target 11). This commitment was reconfirmed in 2015 by the United Nations General Assembly's 2030 Agenda for Sustainable Development.

In the 2016 Joint Statement on Climate, Energy, and Arctic Leadership, Canada and the United States reaffirmed their commitment to meet the global target of 10 percent by 2020 and committed to taking concrete steps to surpass these national goals in the coming years.

To meet the area-based targets and support the Aichi Target 11, the Department of Fisheries and Oceans and the Canadian Coast Guard have been leading the establishment of conservation measures in Canada's coastal and marine waters. Conservation measures include, designation of new Marine Protected Areas, identifying other effective area-based conservation measures, and development of Marine Protected Area Networks which support responsible area-based management and protection of marine resources. The approach to achieving the marine conservation targets is guided by three foundational principles: science-based decision making, including key information sources such as traditional ecological knowledge shared by Indigenous peoples and knowledge shared by the fishing industry and local communities; transparency; and, advancing reconciliation with Indigenous groups.

The science-based foundation which forms the basis of these marine conservation efforts includes the identification of ecologically and biologically significant areas throughout the Canadian Arctic. Identification of ecologically significant species, community properties and a habitat classification assessment is also applied in the Western Arctic Bioregion. In the development of Marine Protected Areas Networks, additional science-based criteria are incorporated to examine the concepts of representativity, connectivity, replicated ecological features and adequate and viable site selection. All of the science information is produced in collaboration with relevant experts and co-management partners to include traditional knowledge, as well as federal, provincial and territorial representatives via the Canadian Science Advisory Secretariat peer-review process.

Science-Informed Land Management Tools for Arctic Alaska and Canada

[1]Leonard, P.B., [2]Loya, W.M., [2]Wilson, R.R. and [3]Miller M.E.

[1]Office of Science Applications, U.S. Fish & Wildlife Service, Alaska. Paul_Leonard@fws.gov
[2]Marine Mammals Management, U.S. Fish & Wildlife Service, Anchorage, Alaska
[3]North Slope Science Initiative, Bureau of Land Management, Anchorage, AK

Warming Arctic ecosystems are undergoing changes from melting permafrost and changes in vegetation. At the same time, land management decisions on public land in the Arctic are being revisited for potential economic development and transportation access. However, uncertainty about where exactly that development might occur and how climate will alter ecosystems makes it difficult to quantify the cumulative effects of new development on flora and fauna, including species that are important subsistence resources. The Arctic LCC is working with partners to create new and improve existing models that describe possible impacts of development and climate change on wildlife. These models will account for multiple land allocation scenarios and the spatial uncertainty of development to highlight areas that may minimize impacts to multiple taxa. The presentation discussed the utility of using the best available science in area-based management and how these science products can help inform managers' consideration of alternative decisions. Early examples from work in the northeastern section of the National Petroleum Reserve – Alaska were shared.

Arctic Council Ecosystem Approach to Management and the Development of Arctic Marine Protected Areas

Phil Mundy[2*], Hein Rune Skjoldal[1], Catherine Coon[3], and Lauren Wenzel[4]

[1]National Oceanic and Atmospheric Administration, NMFS, Juneau, AK, USA
[2]Institute of Marine Research, Norway
[3]Bureau of Energy Management, Anchorage, AK, USA
[4]National Oceanic and Atmospheric Administration, NOS, Silver Spring, MD, USA
[*]phil.mundy@noaa.gov

The Ecosystem Approach to management also known as Ecosystem-based Management (EBM) has been a core principle of the Arctic Council since 2004 (*see* Arctic Marine Strategic Plans 2004-2014 and 2015-2025). The Arctic Council working group, Protection of the Arctic Marine Environment (PAME), has led efforts to develop the Ecosystem Approach within the Arctic Council. PAME established an expert group in 2007 that became a joint expert group in 2011, serving three additional Arctic Council working groups: the Arctic Marine Assessment Programme, CAFF and Sustainable Development Working Group. In 2013, when the foreign ministers of all Arctic States (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, United States) adopted an agreed upon formal definition of EBM, the expert group developed a framework for its implementation. The Ecosystem Approach implementation framework consists of six elements: 1) Identify the geographic extent of the ecosystem; 2) Describe the biological and physical components and processes of the ecosystem, 3) Set ecological objectives that define

sustainability of the ecosystem, 4) Assess the current state of the ecosystem, 5) Value the cultural, social and economic goods produced by the ecosystem, and 6) Apply 1 – 5 to manage human activities to protect and sustain the ecosystem. A series of five EA-EG workshops between 2011 and 2015, as well as an international conference (2016), have addressed the process and status of implementation. The development of Arctic Marine Protected Area (MPA) networks is an area of Ecosystem Approach implementation that has seen particularly rapid recent progress under PAME. The MPA Expert Group, established by PAME in 2013 has provided the *Framework for a Pan-Arctic Marine Protected Areas Network*. The framework recognizes that individual Arctic countries pursue MPA development based on their own authorities and priorities, and that MPA networks can be comprised of "both MPAs and other area-based measures that contribute to network objectives." The MPA Expert Group "Toolbox" (2017) developed guidance to assist countries in advancing MPA networks in the Arctic by cataloging of examples of diverse existing area-based measures, including different types of MPAs and of "other area-based conservation measures" that contribute to the long-term conservation of important categories of Arctic marine biodiversity (e.g. important species and habitats).

18 Panel: Role of Research in Regulation

Cheryl Rosa, U.S. Arctic Research Commission, chaired this panel. The panelists included:

- *James Kendall*, Alaska Regional Director of BOEM
- *Ryan Barry*, Executive Director of NIRB
- *Greg Balogh*, Anchorage Supervisor of the Protected Resources Division Alaska Regional National Marine Fisheries Service, NOAA

James Kendall, Alaska Regional Director
Bureau of Ocean Energy Management
Mr. Kendall discussed the role that BOEM plays in incorporating science into regulation. Mr. Kendall emphasized that when implementing BOEM's mission to "manage development of the United States Outer Continental Shelf energy and mineral resources in and environmentally and economically responsible way," the good days are when "everybody likes me and the second-best days are when everyone dislikes me equally."

Mr. Kendall discussed the BOEM process under the Outer Continental Shelf Lands which includes the broad Five-Year Program and may lead to development and production. There are many opportunities for rigorous public engagement. This entire endeavor can span years. The process is made more complicated by the laws that BOEM must follow to implement a the OCS Program: Marine Mammal Protection Act, Oil Pollution Act of 1990, National Environmental Policy Act, Endangered Species Act, Migratory Bird Treaty Act, National Historic Preservation Act, Magnuson-Stevens Fishery Conservation Act, Coastal Zone Management Act, Clean Air Act, and Clean Water Act. An important improvement to this process is switching from a "science informed bureau" to a "knowledge informed bureau" where traditional knowledge is incorporated along with data from scientific studies.

Mr. Kendall emphasized the importance of applied research, which in the case of oil and gas activities helps BOEM to predict environmental impacts and monitor for changes over time. This research is generated through BOEM's Environmental Studies Program, where around $500 million has been funded for studies over time, and current appropriation funds $12 million per year with an additional $5 million in leveraged funds.

When Shell lease operations were beginning, there were a lot of studies happening, including whale tagging and monitoring studies to consider what could be impacted by activities on their lease. Mr. Kendall discussed a current example of a study that will directly impact regulation. BOEM is conducting an Arctic Air Quality Assessment Modeling study to determine whether the existing air quality formulas are adequate to use when considering impacts to Arctic air quality.

Mr. Kendall closed his talk by discussing BOEM's strategic priorities, which are to advance security interests where energy resources are a core component of national security, responsible environmental stewardship, and international cooperation. He sees opportunities of efficiency through coordination to promote responsible and effective processing of energy-related authorizations, permits, regulations, and agreements and sees value in the International cooperation for safety and stewardship and improving the economic and living conditions of Arctic citizens.

Ryan Barry, Executive Director
Nunavut Impact Review Board
Mr. Barry discussed the unique role that science plays in Impact Assessments within Nunavut. Nunavut is a unique environment, with over 2 million square kilometers, but only 0.1% of the population of Canada residing there and four official languages being spoken in the region. Nunavut's government was only implemented 20 years ago with the Nunavut Land Claims agreement. This agreement sets up boards, which constitute the government of Nunavut, which carry out their respective duties. The NIRB satisfies requirements of land use planning, environmental impact assessments, and water and land use licensing.

Mr. Barry reviewed one of the main tasks of the NIRB, which is to screen project proposals to determine whether or not a review by the NIRB is required. NIRB considers environmental, social, and economic impacts when determining if a review is required. If it is, the Board recommends the form of the review. One primary component the NIRB incorporates is local knowledge. Mr. Barry discussed how there is often a lack of scientific studies on Arctic processes, which is where the board turns to traditional knowledge as a scientific baseline. Where there is a significant lack of scientific information, Mr. Barry explained that the board instead uses the "precautionary principle" where the responsible party must prove an effect will not occur, then monitor to ensure that is the case. The monitoring that is implemented can then inform other ongoing assessments and yield greater knowledge, which in turn yields better projects.

Mr. Barry then introduced the NIRB's Strategic Environmental Assessment as an additional tactic to increase the amount of scientific data that is available on Nunavut. This assessment collects environmental, social, and economic data and allows the Board to be proactive in data collection as opposed to reactive.

Greg Balogh, Anchorage Supervisor
Protected Resources Division Alaska Region National Marine Fisheries Service, National Oceanic and Atmospheric Administration
Mr. Balogh discussed the responsibilities that the National Marine Fisheries Service holds with respect to the Marine Mammal Protection Act, which gives the Service responsibility for listed Arctic species including Bearded seals, Bowhead whales, North Pacific right whales, Fin whales, Humpback whales, and Steller sea lions, as well as sperm, blue, sei, and gray whales. Mr. Balogh emphasized that the Marine Mammal Protection Act was established by Congress because people value marine mammals, which requires authorizations for "taking" marine mammals.

Mr. Balogh discussed how there is a substantial amount of information including scientific data required to receive a permit authorization. If a "take" of a listed species is likely to occur, the permit must undergo an Endangered Species Act Section 7 consultation, which will require that the party minimizes take and

authorizes a given level of take for the listed species. Mr. Balogh said one of the biggest factors in minimizing take in the Arctic is reducing acoustic harm or harassment, such as sound source verification and acoustic modeling. Mr. Balogh posited that often if adequate mitigation measures are conducted before the assessment, it may preclude a need for the incidental take permit in the first place.

Mr. Balogh emphasized that these permit processes are lengthy and often take many years. It's beneficial to expedite the process by beginning consultation early and allowing plenty of time for obtaining permits within a project timeline. Once the permit is implemented, the permittee is required to monitor and report takes which is then incorporated into additional studies to show how animals respond to specific stressors and inform whether mitigation measures are effective.

19 Concluding Session

Session conclusions consisted of informal remarks from technical session chairs, participants, and organizers. (Technical session summaries have been incorporated in the preceding sessions.) Participants offered the following general observations and recommendations for future Forums:

General Observations

- This Forum provides a unique and valuable opportunity to strengthen East-West ties in the Arctic, rather than the North-South paradigm that naturally arises because Washington, DC and Ottawa are located in the South.
- Ongoing Forums provide the chance to sustain or renew relationships among agencies or organizations even as staff change over time.
- Although the U.S. and Canada currently have different policies regarding oil and gas exploration in the North, there are many overlapping areas of activity related to understanding and assessing the impacts of such development.
- NSSI, established under the Energy Policy Act of 2005 (based on an existing long-term monitoring program), provides a possible focal point for ongoing sharing of information such as that exchanged at the Forum. Currently they are challenged by staffing and budget limitations, but if NSSI does return to its role of prioritizing research, perhaps Forum results could be more formally incorporated.

Forum Structure

- One participant observed that speakers were required to fit a wealth of subject matter into fairly short presentations, and expressed interest in having longer presentations in the future. Other participants offered that instead of longer presentations, they would like to have more time for discussion to maximize shared learning from the presenters' varied experiences.
- Forum organizers are encouraged to reach out to agency personnel at the staff level who actually write decisions, in addition to the researchers who develop the information. Some of these people may also be eager to help with research activities as well.
- Provide opportunity for in-depth discussions on select topics: one participant expressed interest in bringing together people who use and manage lands to identify research priorities. (For example: is it possible to dig into permafrost without disturbing existing infrastructure?)

Potential Future Topics

- Sustainability of ongoing projects is an important topic, and warrants direct attention in the future. This may be approached by combining research efforts to increase efficiencies, or by seeking funding from industry (for example, as is being done in the SmartIce program, which could sell data on ice thickness to industry operators in the region).

- A discussion would be welcome regarding how to bridge the gap between "one-off" scientific sampling and sustained monitoring more consistently.
- It would be interesting to follow one scenario from start to finish as an example: from who participated; how the research project was conceived, designed, and implemented; and how the results were used.
- There was enthusiasm for having the vast range of research presented in some way compiled or shared in a published volume or electronically for future access. This was accompanied by an understanding of the associated costs.
- Expand opportunities for critical assessment of projects, rather than short updates on current research.
- Directly address how efforts may be combined to increase efficiency and sustainability.
- Bring together land managers and land users on one topic to discuss research that has been – or would be – useful to inform policy decisions in that context.

Meaningful Engagement

- Appreciation was expressed for on-going work to incorporate traditional knowledge and western science and expand community-based monitoring; in the past these were spoken of as aspirations for the future. Since the first Forum in 2008, there have been significant changes in how western science understands traditional knowledge. The two may be used either together or separately.
- Meaningful engagement between researchers and traditional knowledge was a strong theme during many of the sessions. This engagement is necessary for successful projects. It requires flexibility in research methods or activities. There is no single correct way to approach either the research itself or associated engagement activities, as the needs will be unique to different communities. Other principles for engagement include:
    - Researchers should spend time establishing and then nurturing relationships, including visiting communities as frequently as possible. Spending at least 2-3 days without a rigid agenda is important at the beginning, as well as actively participating in community events or other opportunities to meet people directly.
    - Have a sense of humor and acknowledge mistakes.
    - Practice true listening with the goal of understanding, not just thinking about how to respond.
    - Involve community members in your research, including planning and managing research projects.
    - Minimize the travel time and costs for those who are willing to participate in your project: plan activities in rural communities, not just the central hub. Be flexible with all scheduling, and plan to arrive early and leave late.
- Consultation or meaningful engagement can also leave communities or indigenous governing organizations strapped for resources. "Consultation fatigue" is real, and if communities do not have the capacity to fully engage in the process, it can leave both sides frustrated (especially if government makes decisions thinking they have received sufficient input).
- While people may have the best intentions, it is possible that policies, regulations, or programs may cause unintended negative impacts in communities. This can make conversations difficult. There is a need to continue to bridge the gap between science and traditional knowledge in the generation of information, and then to determine how that information will inform policies or regulations. Sometimes government also lacks understanding of the perspectives of those with whom they are seeking to engage in their projects.
- Compensation is important. Time community members spend engaged in research or consultation efforts is time away from family, subsistence activities, or other work. In Nunavut, there is a call for a program to fund capacity building in communities to enable people to participate in processes. BOEM has in the past paid for an attorney to assist a community in responding to

comments. The National Energy Board (in Canada) has an established funding program. It would be important to have transparency up front regarding the ability to leverage funds.

- Sometimes there are limited people in a community who are willing and able to engage in these research and consultation processes. This relates both to community size as well as the quality of health and level of education of community members.
- There was also recognition that a truly meaningful engagement process is naturally less "fatiguing" than one that is not as effective.
- People in Northern communities want to understand the motivations of those who come to conduct research in or around their areas.
- Funding agencies should require upfront engagement with communities at the proposal stage. Currently, funders typically dictate the research topics. Because it costs money, most researchers are unable to seek community engagement until their projects have already been designed and funded. This makes it more difficult to truly incorporate input received through the engagement process.

20 Posters

The following posters were presented during Days 1 and 2 of the Forum (in alphabetical order by lead author).

Polar Bear Research to Address Information Needs for the Management of Petroleum Activities Along Alaska's North Slope
Atwood, T.C., Durner, G.M., Rode, K.D., Simac, K.S. and Pagano, A.
U.S. Geological Survey and Alaska Science Center. tatwood@usgs.gov.

In the Arctic Ocean's southern Beaufort Sea, an advancement of sea ice break-up in summer and freeze-up delay in fall has led to a 36 day increase of the open water season since the late 1990s. Historically, polar bears (*Ursus maritimus*) of the southern Beaufort Sea have mostly remained on the sea ice year-round, but recent changes in the extent and phenology of sea ice habitat have coincided with evidence that use of terrestrial habitat is increasing. Here, we present the findings of recent studies elucidating the links between changes to the sea ice ecosystem, increased use of terrestrial habitat by southern Beaufort Sea polar bears, and the escalating risk of human-polar bear interactions. The use of land by polar bears during summer and fall has increased substantially over the last two decades. Since the 1990s, the percentage of radio-tagged polar bears using land increased from ~4% to >20% annually, and the mean length of stay on shore has increased by 31 days. While on shore, the distribution of polar bears is influenced by the availability of subsistence-harvested bowhead whale (*Balaena mysticetus*) remains aggregated at Barter and Cross islands. Concomitantly, the frequency of land-based denning in winter has also increased and is directly related to the distance that sea ice has retreated from the coast. Human-wildlife conflicts are often clustered in space and time due to the juxtaposition of focal attractors for wildlife and areas of human activity. Because factors driving increased land use by polar bears from the SB are likely to remain unabated, proactive management of human-polar bear interactions will be needed to reduce the future risk of conflict.

Estimating Walrus Responses to Vessel Traffic and Oil and Gas activities in the Eastern Chukchi Sea

Jay, C.V., Fischbach, A.S.
U.S. Geological Survey, 4210 University Drive, Anchorage, AK, 99508, USA
cjay@usgs.gov

Resource managers need greater certainty about how animals respond to human activities to craft regulations that meet wildlife conservation goals, and yet do not place undue burden on resource users. An animal's behavioral and physiological response to human activities can have population-level effects through changes in their energy intake and expenditures. Only scant information is available on how Pacific walruses respond to human activities in the Arctic, particularly to vessel traffic, seismic surveys, and drilling activities in the Chukchi Sea. In a previous study, we used walrus tracking and behavioral data from 2008 through 2011 to map monthly walrus foraging areas. These maps have been used by regulators to mitigate potential disturbances to walruses in core foraging areas. We are now using these data, together with additional tracking data collected from 2012 through 2015, to estimate walrus behavioral responses to vessel traffic, and in a subsequent study, to estimate behavioral responses to seismic survey and drilling activities. These studies will provide information for improved management of oil and gas activities, and are part of a larger research framework that links walrus behavior, bioenergetics, and demographic rates.

Advanced Aquatic Ecosystem Mapping Techniques for Large Arctic Domains Using Calibrated High-Resolution and Time Series Imagery

Macander, M.J., Frost, G.V., Swingley, C.S., Dissing, D., Wells, A.F., and Seigle, J.C.
ABR, Inc.—Environmental Research & Services. Fairbanks, Alaska, United States.
mmacander@abrinc.com.

The increasing availability of high-resolution (≤2 m) imagery and ongoing advances in computing power and analysis tools raises the prospect of automating aquatic ecosystem mapping at fine spatial scales over large study domains. Here we demonstrate an automated mapping approach for a land mass covering a study area of ~35,000 km² on Alaska's North Slope using calibrated mosaics of high-resolution WorldView-2 and GeoEye-1 imagery. A spectral classification approach was used to rapidly map water extents across a diverse collection of high-resolution satellite images. GIS modeling was used to categorize water polygons into coastal, lake/pond, and stream/river types. Additional analyses allowed preliminary splitting based on water depth, salinity, and connectivity. To augment the single-snapshot-in-time, high-resolution imagery, a time-series analysis of an extensive collection of cloud-free bimonthly Landsat composites (1999–2015) was conducted to characterize seasonal fluctuations in water extents. These advanced mapping techniques deliver products which can provide essential information supporting a broad range of ecosystem science, land-use planning, and permitting applications in northern Alaska and elsewhere in the circumpolar Arctic.

Monitoring Caribou Distribution and Movements near Arctic Development

Prichard, A.K., Lawhead, B.E., and Welch, J.H.
ABR, Inc.—Environmental Research & Services, Fairbanks, Alaska. aprichard@abrinc.com.

Four caribou herds range across Arctic Alaska, constituting important subsistence, sport hunting, and tourism resources for multiple stakeholders. The potential impacts of industrial development on caribou distribution, movements, population size, and energetics are of concern for these stakeholders, including the oil and gas industry. Over the past 35 years, ABR, Inc. has conducted ground-based behavioral observations, aerial surveys, and radio-telemetry studies to examine the influence of industrial development on caribou distribution and movements in northern Alaska. Early observational studies in the oilfields examined the behavioral responses of caribou to infrastructure to assess impacts of linear

infrastructure and associated activities and to identify potential mitigative measures. Long-term monitoring conducted through systematic aerial surveys has produced valuable datasets that have been used to assess baseline conditions prior to development and to identify potential changes after development. As radio collars have improved, we have used satellite and GPS telemetry to understand movement patterns of individual caribou and to examine caribou distribution in relation to remotely sensed vegetation indices, snowmelt patterns, and digital elevation models. We have also examined bias in demographic and movement rates from telemetry data, habitat selection of the Teshekpuk Herd, and rates of interchange among neighboring herds. We continue to work collaboratively with agencies and industry, combining data and resources from multiple stakeholders, to provide new insights into caribou distribution, movements, and behavior near current and proposed developments.

Ecological Impacts of Oil and Gas Infrastructure Access on Alaska's North Slope
Sullender, B.K., Audubon Alaska, Anchorage, AK, bsullender@audubon.org.

Oil and gas extraction relies on a transportation network to move people, equipment, and materials. Historically, oil fields have been developed using a combination of gravel roads, winter-only ice roads, and aircraft. More recent drill sites have demonstrated that it is logistically possible to produce oil from a site with no permanent road connection to other infrastructure. Projects currently in the permitting phase have also considered aircraft-only access as an alternative approach. Audubon Alaska conducted a research synthesis to assess the relative impact of road-based versus roadless development access.

Regardless of the mode of access, roads and aircraft have direct and indirect impacts on wildlife. Direct impacts can be broadly classified as disturbance (behavioral change) or displacement (avoidance of a previously used area), and indirect impacts include habitat alteration or changes in food abundance. This study focuses on a few focal taxa: caribou, geese, loons, eiders, shorebirds, and freshwater fish. Each is examined for how road-based and roadless development may impact individuals and populations.

There is agreement among published research that roads and other linear infrastructure have individual-level impacts on wildlife such as caribou, with the magnitude of impact dependent on season, individual demographics, and a variety of other factors. However, there is little agreement on whether and how these individual-level impacts scale up to the population level. For example, the spatial arrangement of development may obstruct key habitat such as calving grounds. If infrastructure is constrained to a smaller footprint, rather than an expansive network, the same number of drill sites could have a lesser ecological impact.

Furthermore, gravel roads cause apparently permanent geophysical changes to the landscape, altering permafrost freeze-and-thaw cycles and creating topographic features known as thermokarst. The biological implications of thermokarst are not well understood—significant changes in vegetation communities may displace preferred forage species, although fine-textured terrain roughness and beaded streams provide suitable habitat for some wildlife species.

Alternatively, roadless development typically involves a larger gravel pad to accommodate an airstrip and necessary facilities and increased air traffic. The biological impacts of low-flying aircraft are likely to be short-term and localized, and can be mitigated with seasonal, geographic, or species-specific flight restrictions similar to existing best management practices. Roadless development appears to be the least ecologically damaging mode of oil-field access on Alaska's North Slope. This is due to the short duration of aircraft disturbance, the limited additionality of disturbance given already dense aircraft traffic, and apparent effectiveness of temporal and spatial mitigation measures.

21 References

BGES, Inc. 2009. Proceedings of the Eleventh MMS Information Transfer Meeting. OCS Study MMS 2009-005. Prepared by BGES, Inc., Anchorage, Alaska. Prepared for the U.S. Dept. of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage, AK., 121 pp.

Appendix A: Agenda

AGENDA

Dena'ina Convention Center, Anchorage, Alaska
Unless otherwise noted, all sessions occur in the Tubughnenq' Room.

Wednesday, October 11

7:30 am **Registration Opens**

8:30 am **Welcome**

8:40 am **Opening Remarks by Officials from the U.S. and Canada**

- *Mark Hopkins,* Director General, Natural Resources and Environment, Indigenous and Northern Affairs Canada
- *Walter Cruickshank*, Acting Director, Bureau of Ocean Energy Management

9:30 am **Opening Panel: Science-informed Decision-making**
Chair: *Mark Fesmire,* Alaska Regional Director, Bureau of Safety and Environmental Enforcement

- *James Kendall*, Alaska Regional Director, Bureau of Ocean Energy Management
- *Karen Mouritsen,* Alaska State Director, Bureau of Land Management
- *Donna Kirkwood,* Chief Scientist, Natural Resources Canada
- *Scott Gedak*, Northwest Territories Environmental Studies Management Board

10:30 am **BREAK**

10:50 am **Panel: Community and Industry Perspectives – Priorities and Research/Monitoring Needs**
Chair: *Kasaŋnaaluk Marie N. Greene***,** Commissioner, U.S. Arctic Research Commission

- *Taqulik Hepa,* Director, North Slope Borough Department of Wildlife Management
- *Michael Macrander,* Former Science Team Lead, Shell Exploration & Production
- *Jennifer Lam,* Inuvialuit Game Council
- *Paul Barnes,* Director, Atlantic Canada and Arctic, Canadian Association of Petroleum Producers

11:50 am **LUNCH (provided)**
SPEAKER: Paul Decker, State of Alaska Department of Natural Resources, *New Petroleum Potential on the Alaska North Slope*

Wednesday, October 11 *(continued)*

1:10 pm **Concurrent Technical Talks**

	Tubughnenq' Room	*K'enakatnu Room*
	Environmental Technical Talks Chair: *Mark Miller*, North Slope Science Initiative	**Oil Spill Technical Talks I** Chair: *Kristin Ryan*, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation
1:10	**Todd Sformo**, North Slope Borough Department of Wildlife Management, *Preliminary Results of Application of Oil and Dispersed Oil on Drag on Bowhead Whale Baleen*	
1:30	**Melanie Smith**, Audubon Alaska, *Ecological Atlas of the Bering, Chukchi, and Beaufort Seas*	**Ken Lee**, Fisheries and Oceans Canada, *The Royal Society of Canada Expert Panel on the Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments: Research Recommendations and Follow-up Part I*
1:50	**John Pearce**, U.S. Geological Survey, *USGS Ecosystems Research to Inform Oil and Gas Development and Response of Wildlife in the Arctic*	**Ken Lee**, Fisheries and Oceans Canada, *The Royal Society of Canada Expert Panel on the Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments: Research Recommendations and Follow-up Part II*
2:10	**Sheyna Wisdom**, Olgoonik Fairweather LLC, *An Integrated Look at the Alaska Beaufort Sea: summary of the Arctic Nearshore Impact Monitoring in Development Area III 2014-2017*	**Mark Fesmire**, Alaska Region, Bureau of Safety and Environmental Enforcement, *Capping Stacks and Containment Systems in the Offshore Arctic*

2:30 pm **BREAK**

3:00 pm **Concurrent Technical Talks – continued**

	Tubughnenq' Room	*K'enakatnu Room*
	Environmental Technical Talks, continued	**Oil Spill Technical Talks I, continued**
3:00	**Elizabeth Sharp**, Hilcorp, *Environmental and Social Research in Central Beaufort Sea Oil and Gas Fields: Successes and Challenges*	**Charles Greer**, National Research Council Canada, *NRC Natural Attenuation Potential for Petroleum Hydrocarbons at Sub-zero Temperatures in the Canadian Arctic Marine Environment*
3:20	**Kerri A. Pratt**, University of Michigan, R*esearch Related to Ultrafine Particulate Emissions from the Prudhoe Bay Field*	**Tim Robertson**, Nuka Research and Planning Group, LLC, *U.S. Arctic Oil Spill Response Gap Analysis*
3:40		**Eric Miller**, Bureau of Safety and Environmental Enforcement, *Arctic Council Emergency Prevention, Preparedness and Response (EPPR) Workgroup Circumpolar Oil Spill Response Viability Analysis*

Wednesday, October 11 *(continued)*

4:00 pm **Panel: Scenario Planning**
Chair: *Jon Skinner*, University of Alaska Anchorage

- *Wendy Loya,* Coordinator, Arctic Landscape Conservation Cooperative Alaska**,** U.S. Fish and Wildlife Service
- *Amy Lovecraft,* Professor of Political Science, University of Alaska Fairbanks
- *Hajo Eicken,* Director, International Arctic Research Center, University of Alaska Fairbanks

5:00 pm **POSTER SESSION AND RECEPTION**

Thursday, October 12

8:30 am **Panel: Meaningful Engagement of Indigenous Peoples in Oil and Gas Activities**
Beyond Consultation - Understanding Differences, Trust and Respect, Indigenous Knowledge
Chair: *Jeffrey Brooks,* Bureau of Ocean Energy Management Alaska

- *James Stotts,* President, Inuit Circumpolar Council Alaska
- *Orville Lind*, Native Liaison for the Office of Subsistence Management, U.S. Fish and Wildlife Service
- *Rosanne D'Orazio,* Director, Lands and Resources, Qikiqtani Inuit Association
- *Scott Gedak,* Northwest Territories Environmental Studies Management Board

9:30 am **Concurrent Technical Talks**

	Tubughnenq' Room	***K'enakatnu Room***
	Ice, Ocean, and Air Technical Talks Chair: *Warren Horowitz,* Bureau of Ocean Energy Management	**Community-driven Research and Monitoring Technical Talks** Chair**:** *Henry Huntington,* Huntington Consultants
9:30	**Andrew Metzger**, University of Alaska Anchorage, *Implementing the ISO 19906 Normative*	**Qaiyaan Harcharek**, North Slope Borough **Chris Campbell**, Bureau of Ocean Energy Management, *Traditional Knowledge Implementation: Accessing Community Panels of Subject Matter Experts*
9:50	**Darlene Langlois**, Canadian Ice Service, *Sea Ice Trends and Variability*	**Mike Brubaker**, Alaska Native Tribal Health Consortium, *LEO Network – A Citizen Observer System for Monitoring Environmental Change*
10:10	**Hajo Eicken**, University of Alaska Fairbanks, *Tracking Sea-ice Seasonal Cycle, Dynamics, and Hazards Near Point Barrow, Alaska with a Coastal Ice Radar*	**Mark Everett,** U.S. Coast Guard District 17, *Prevention, Preparedness, and Response for Small Communities*

10:30 am **BREAK**

Thursday, October 12 *(continued)*

11:00 am **Concurrent Technical Talks – continued**

	Tubughnenq' Room	*K'enakatnu Room*
	Ice, Ocean, and Air Technical Talks, continued	**Community-driven Research and Monitoring Technical Talks, continued**
11:00	**Feiyue Wang**, Churchill Marine Observatory, *The Churchill Marine Observatory and the Oil Spills in Ice-Covered Arctic waters (OSICA) Network*	**Trevor Bell**, Memorial University of Newfoundland, *SmartICE: A Sea-ice Monitoring and Information Service for Coastal Communities and Industries*
11:20	**Paula Fields Simms,** Eastern Research Group, Inc., *Arctic Air Quality Modeling Assessment Study*	**Rosanne D'Orazio**, Lands and Resources, Qikiqtani Inuit Association, *Inuit Qaujimajatuqangit in Decision Making and Inuit Led Research*
11:40	**Ralph Morris**, Ramboll Environ, *BOEM Photochemical Modeling of Oil and Gas Development in the Arctic*	**Anna Bryan**, Alaska Department of Fish and Game, *Community Based Marine Mammal Research in Alaska*

12:00 pm **LUNCH (provided)**
SPEAKER: Brad Chastain, Project Services Manager, Alaska Gasline Development Corporation, *Overview of the Alaska LNG Project*

1:20 pm **Concurrent Technical Talks**

	Tubughnenq' Room	*K'enakatnu Room*
1:20	**Biological Observatories and Monitoring Technical Talks** Chair: *Catherine Coon,* Bureau of Ocean Energy Management	**Oil Spill Technical Talks II** Chair: *Mark Everett*, U.S. Coast Guard District-17
1:20	**Richard Leonard**, National Ecological Observatory Network, *The National Ecological Observatory Network (NEON): Data to Support Natural Resource Management*	**Amy Merten,** National Oceanic and Atmospheric Administration, *International Oil Spill Response Tool: Arctic Environmental Response Management Application (ERMA)*
1:40	**Phil Osborne**, Golder Associates, *Integrated Beaufort Observatory*	**Louis Poirier,** National Research Council of Canada, *Beaufort Sea Engineering Database*
2:00	**Seth Danielson,** University of Alaska Fairbanks, *AMBON: Arctic Marine Biodiversity Observing Network*	**Suzanne Chang**, Bureau of Safety and Environmental Enforcement, *Arctic Oil Spill Response Research at BSEE*
2:20	**Tahzay Jones**, National Park Service, *Development of a Pan-Arctic Coastal Monitoring Program*	**Steven Pearson**, Bureau of Safety and Environmental Enforcement, *Arctic Spill Response Database*

Thursday, October 12 *(continued)*

Concurrent Technical Talks, continued

	Tubughnenq' Room	*K'enakatnu Room*
	Biological Observatories and Monitoring Technical Talks, continued	**Oil Spill Technical Talks II, continued**
2:40	**Sue E. Moore,** National Oceanic and Atmospheric Administration Fisheries Office of Science and Technology, *The Distributed Biological Observatory: an expanding change detection array for the Beaufort Sea and beyond*	**Richard R. Bernhardt,** Prevention and Emergency Response Program, Alaska Department of Environmental Conservation, *Addressing Public Dispersant Comments with Scientific Literature Part I*
3:00	**Christian Zimmerman**, U.S. Geological Survey Alaska Science Center, *Circumpolar Assessment of Trends in Arctic Freshwater Biodiversity*	**Richard R. Bernhardt,** Prevention and Emergency Response Program, Alaska Department of Environmental Conservation, *Addressing Public Dispersant Comments with Scientific Literature Part II*

3:20 pm **BREAK**

4:00 pm **Panel: Shared Leadership and Governance – Perspectives from U.S. and Canada**
Chair: *Mary Cody*, Bureau of Ocean Energy Management

- *Craig Fleener,* Arctic Policy Advisor, State of Alaska Office of the Governor
- *Dale Nicholson,* Regional Director**,** Ecosystems Management, Fisheries and Oceans Canada

5:00 pm **ADJOURN**

Friday, October 13

8:30 am **Panel: Role of Regional Studies, Environmental Assessments and Cumulative Effects**
Chair: *Sharon Randall*, Chief, Environmental Assessment, Bureau of Ocean Energy Management

- *Serena Sweet,* Alaska Supervisory Planning & Environmental Coordinator, Bureau of Land Management
- *Mark Miller,* Deputy Director, North Slope Science Initiative
- *Heather Rasmussen*, Policy Advisor, Nunavut Impact Review Board
- *Tim Fullman*, Senior Ecologist, The Wilderness Society, Anchorage

9:30 am **Science in Area-based Management Technical Talks**
Chair: *Mark Miller*, North Slope Science Initiative

9:30 **Thomas Hoggarth**, Acting Regional Director, Ecosystems Management, Central and Arctic Region, Fisheries and Oceans Canada, *Marine Conservation Targets in Canada's Marine Waters*

9:50 **Paul Leonard**, Science Coordinator, Arctic Landscape Conservation Cooperative, *Science-Informed Land Management Tools for Arctic Alaska and Canada*

10:10 **Cathy Coon**, Chief, Environmental Sciences Management, Bureau of Ocean Energy Management, *Arctic Council Ecosystem Approach to Management*

Friday, October 13 *(continued)*

10:30 am **BREAK**

11:00 am **Panel: Role of Research in Regulation**
Chair: *Cheryl Rosa,* Deputy Director U.S. Arctic Research Commission

- *James Kendall,* Alaska Regional Director, Bureau of Ocean Energy Management
- *Ryan Barry,* Executive Director, Nunavut Impact Review Board
- *Greg Balogh,* Anchorage Supervisor, Protected Resources Division Alaska Region National Marine Fisheries Service, National Oceanic and Atmospheric Administration

12:00 pm **LUNCH (on your own)**

1:20 pm **Wrap-up Panel: What did we learn? Strategy for the future**

- Read out from Panel and Session Chairs
- Summary of 2017 Forum Findings and Recommendations

2:00 pm **Discussion with Audience**

2:55 pm **Closing Remarks**

3:00 pm **Close of Forum**

Department of the Interior (DOI)

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)

The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program

The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).