PREVENTING UNREGULATED COMMERCIAL FISHING IN THE CENTRAL ARCTIC OCEAN (CAO)

A Compilation of Reports from Meetings of Experts in Shanghai (China), Incheon (Korea) & Sapporo (Japan)

Photo: CCGS *Louis S. St-Laurent* Icebreaker, Beaufort Sea, August 2009, Peter Harrison

Content

Photo: NOAA

Preface

Overview

The Arctic Ocean and its ecosystems are experiencing rapid change. For roughly 800,000 years the Arctic Ocean has been largely ice-bound. Within the past couple of decades sea ice loss has been well documented, and the prospect of human industrial uses in the region such as shipping, oil and gas extraction, tourism, and commercial fishing have grown. The impacts of such industrial activities on Arctic Ocean marine ecosystems are largely unknown. There is a critical need for enhanced scientific research to better understand the effects of change on these ecosystems and the possible effects of increased human activity.

The rapid loss of summer sea ice in the Arctic Ocean has for the first time in human history opened international waters to the prospect of commercial fishing. These waters lie outside the Exclusive Economic Zones (EEZs) ..... fisheries here would not be "illegal".

A likely scenario is that, with shrinking summer sea ice, high seas fishing fleets will have the possibility to access previously ice-covered areas and execute an unregulated commercial fishery on the High Seas of the Central Arctic Ocean (CAO) outside the Exclusive Economic Zones (EEZ's) of the five Arctic Ocean Coastal States: Canada; the US; Russia; Norway; Greenland/Denmark). Such commercial activity would not be "illegal", but because it would be unregulated, it could potentially devastate a rapidly changing and inadequately understood marine ecosystem (Annex I).[1]

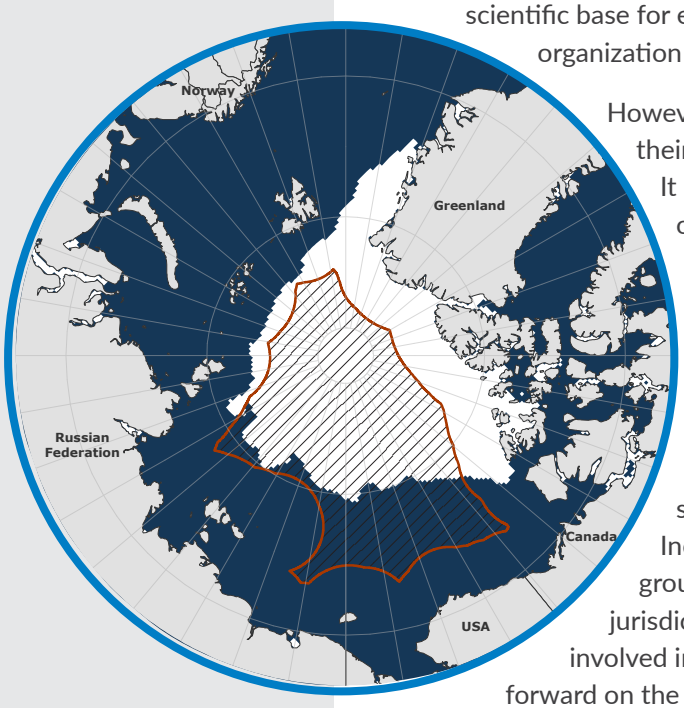
The geographic distribution of summer "open water" (defined as water with less than 15% ice cover) in the CAO is highly variable from year to year and geographically, with ice-free stretches occurring more extensively in the Pacific sector of the Arctic Ocean, particularly the Chukchi Plateau. While this region is thousands of kilometers from fishing fleet bases in Asia and North America, it is significantly closer than the Southern Ocean where high seas fleets already travel to fish for krill. Will it be long before they will head north?

Steps to prevent unregulated fishing have already been taken in a number of different ways. The potential problem in the CAO was recognized in 2008 by the US Senate in Public Law 243 which called for a "Prevention of Unregulated Commercial Fishing". In 2012, an "open letter" signed by 2,000 science experts from around the world urged governments to prevent a potential ecological catastrophe by applying the "precautionary principle" and developing appropriate regulations for the CAO.[2]

[1]The best – or worst – example of the destruction of fish stocks in international waters in the north is the fate of the Pollock stocks in the "doughnut hole" in the Bering Sea. This "maritime anomaly" is surrounded by the EEZ's of the US and Russia but, as the "high seas", was open to unregulated fishing by fleets from a number of jurisdictions. By the time an international agreement to manage the stocks was reached "Central Bering Treaty" (1994), they had been decimated, and they have yet to recover. The CAO is another, though larger, "maritime anomaly" where a similar scenario could play out.

Overview

The US "closed" its Arctic EEZ to commercial fishing in 2010, as did Canada in its Beaufort Sea EEZ in 2014. And, importantly, the Arctic Coastal States signed the *"Oslo Declaration"* on July 16, 2015 whereby they committed to prevent their domestic fishing fleets from operating in the CAO until there is a sufficient scientific base for effective fisheries management and a management organization has been created.



However, by definition the CAO is the "High Seas" and, despite their direct interests, is not controlled by the coastal states. It is therefore accessible to the commercial fishing fleets of any jurisdiction. Subsequently, negotiations have been underway between the Arctic Coastal States and major jurisdictions with high seas fishing capacity: China; the EU; Iceland; Japan and Korea.[3] Given existing political will, it is expected that an *Agreement* will be finalized soon.[4]

In parallel to the official government negotiations, a series of *dialogues* has been held in Shanghai, China; Incheon, Korea; and Sapporo, Japan to engage a broad group of experts (mostly non-government) from a variety of jurisdictions — including Asian countries — to outline the issues involved in the CAO, and to address the challenge of how to move forward on the organization of the needed scientific effort.[5] Generous support was provided by the *International Arctic Program* of The Pew Charitable Trusts and the host academic and research institutions.

This report is a compilation of the "Co-Chairs' Summaries" from these events, as follows:

- *"Roundtable on Central Arctic Ocean (CAO) Fisheries issues"*: Tongji University/Jia Tong University, Shanghai, 15th and 16th January, 2015. Co-chairs: Professor PAN Min (Tongji University, China); Professor Peter HARRISON (Emeritus, Queen's University, Canada)
- *"Roundtable on Central Arctic Ocean (CAO) Issues"*, Korea Polar Research Institute, Incheon, Korea, 30th March and 31st March, 2016. Co-chairs: Dr. Hyoung Chul SHIN (KOPRI, Korea); Professor Peter HARRISON (Canada)
- Working Session on *"An International Marine Science Coordinating Organization for the Central Arctic Ocean"*. Co-chairs: Professor Fujio OHNISHI (Arctic Research Center, Hokkaido University, Japan); Professor Peter HARRISON (Canada).

These "dialogue sessions" brought together a broad group of individuals with highly varied academic/work/official backgrounds (Annex II) and from a large number of prestigious institutions (Annex III).

Common themes

At all three events there was consensus that international action is required to prevent unregulated commercial fishing in the CAO until there is a sufficient scientific base and appropriate regulatory regime is in place and with the direct involvement of Arctic indigenous peoples. Since there is no fishing activity at present, this presents a major opportunity to *"apply the precautionary principle"* by acting *before* a problem occurs. The Asian countries in particular have very strong Arctic research platforms that already contribute to the knowledge base about the Arctic Ocean and could be leveraged even more so in the future.

The *Shanghai* roundtable urged the inclusion of non-Arctic states in a negotiation process – especially China, Korea and Japan – and in any eventual scientific process and organization.

The *Incheon* roundtable took place after such negotiations had begun. Participants underlined the relevance of the *"United Nations Convention on the Law of the Sea (UNCLOS)"* and the *"United Nations Fish Stocks Agreement (UNFA)"* and the need for all jurisdictions involved to be on an "equal footing".

The "working session" in *Sapporo* confirmed the need for an international agreement and focused on the question of what an international scientific organization for the CAO would "look like". Participants proposed a definition of the purpose and mandate of such an organization, as well as a set of key principles

that should apply in deciding the nature and structure of the organization – whether existing or new.

At all three events there was consensus that:

- There is a need for a stand-alone science organization specifically focused on research in the Central Arctic Ocean and, as appropriate, adjacent areas under national jurisdiction. This organization should be established by governments, where all parties having equal standing.
- An ecosystem approach to research should be adopted to better understand the oceanography and biology, the effects of loss of sea ice, and various related ecosystem processes at work in the CAO – and to inform decisions regarding potential future fisheries in the region.
- Provision should be made for the active participation by indigenous peoples and organizations in the development and implementation of science programs in the Arctic, and related institutions.

[2]The letter was widely circulated and discussed at the *"International Polar Year (IPY) Conference: From Knowledge to Action"* that took place in Montreal in April 2012.

[3]Negotiating sessions have taken place in Washington DC (1-3 December, 2015; 19-21 April, 2016), Iqaluit (6-8 July, 2016) , and Tórshavn (Faeroe Island) (29 November – 01 December, 2016). The next session will be in Reyjkjavik in March 2017.

[4]On March 10, 2016, and again on December 20, 2016, President Obama (USA) and Prime minister Trudeau (Canada) committed to a legally binding agreement to prevent unregulated commercial fishing in the CAO. On September 3, 2016 President Obama and President XI Jinping (China) committed to: *"Work with other relevant governments toward reaching an instrument to prevent unregulated commercial fishing in the High Seas of the CAO by the end of 2016".*

[5]In fact the first roundtable in Shanghai occurred prior to, and pre- figured, the inclusion of Asian countries in the negotiation process.

1) ROUNDTABLE ON CENTRAL ARCTIC OCEAN (CAO) FISHERIES ISSUES

Tongji University, January 15–16, 2015

CO-CHAIRS' SUMMARY

Over 40 Arctic experts attended the "Roundtable on Central Arctic Ocean (CAO) Fisheries Issues", which was held on January 15th and 16th, 2015 at Tongji University (Shanghai), to assess how *precautionary approaches* can be applied in the CAO prior to any commercial fishing activity taking place.

Photo: Scott Highleyman

This included Chinese experts from:

- Tongji University
- Ocean University of China
- Shanghai Ocean University
- Shanghai Jiao Tong University
- Dalian Maritime University
- Shanghai University of International Business and Economics
- Shanghai Institutes for International Studies
- Shanghai International Studies University

International experts came from:

- United States
- Russia
- Canada
- Greenland
- Iceland

Notes

It was noted that the effect of global warming on the Arctic Ocean is leading to the shrinkage of sea ice, ocean acidification and increased water temperatures.

The result is greater access to areas of the CAO where commercial fishing could be feasible, and changes in the distribution and migratory patterns of marine species.

Of particular note are the changes in the marine environment in the Western Arctic Ocean, which is accessible through the Bering Strait.

The topics that were covered in the Roundtable included:

- The state of research and knowledge about the Arctic Ocean
- Arctic marine biological systems and ecosystems
- International laws and conventions
- State practice in the EEZ's of countries such as the US, Russia, and Canada
- Existing management instruments

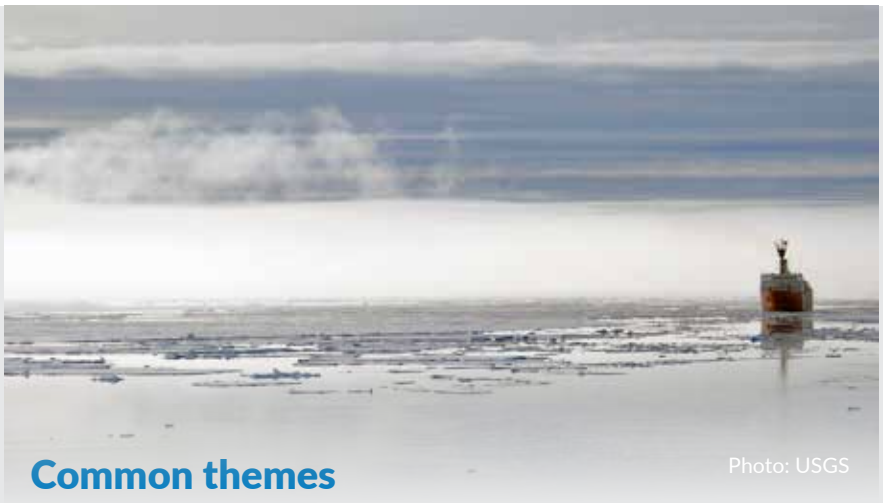


Photo: USGS

Common themes

A number of common themes emerged during the Roundtable, including:

- Commercial fishing in the CAO is unlikely in the near future, but could occur at some point
- There is an opportunity to develop management approaches *before* any unregulated fishing occurs, better knowledge base and scientific analysis is a *high priority*
- International scientific cooperation on CAO/Arctic Ocean issues should also be a *high priority*
- The importance of involving non-Arctic states in the dialogue and development of management options will be a key determinant of success
- Consideration should be given to an international scientific advisory body
- Based on current projections, it is premature to consider a Regional Fisheries Management Organization (RFMO) for the CAO
- However, there is a pressing need for the development of "interim measures", such as a "free-standing" agreement consistent with international Conventions and obligations, to ensure that unregulated commercial fishing does not begin before adequate scientific knowledge and sustainable management measures are in place
- China has significant Arctic research capacity, and stronger links with the international scientific community need to be developed and supported
- China clearly has an interest in being involved in the process related to the CAO, and to collaborate in the development of management approaches

The lack of scientific knowledge and the prospect of future unregulated commercial fishing in the CAO have led to a series of meetings between officials of the five Arctic coastal states to develop and propose a management regime for the CAO. In the interim they have agreed that — for an indeterminate period — their domestic commercial fleets will not operate in the CAO.

Furthermore, the United States and Canada have developed fisheries management plans in their Arctic EEZ's which delay the start of commercial fishing until adequate science confirms its feasibility.

The participants at the Roundtable observed that the immediate challenge is – how to extend interim measures to the entire CAO with the involvement and support of non-Arctic States with major fishing capacity, such as China.

It was observed that involvement of key non-Arctic States with significant fishing capacity in the high seas will be a key to the success of developing and implementing precautionary measures in the CAO.

Successfully meeting this challenge is an important opportunity to apply the precautionary principle and international cooperation in the Arctic.

Signed by Co-Chairs: Prof. Pan Min & Prof. Peter Harrison, January 16th, 2015

Photo: Scott Highleyman

2) ROUNDTABLE ON EOCSYSTEM AND FISHERIES ISSUES IN THE CENTRAL ARCTIC OCEAN (CAO)

Kopri, March 30–31, 2016 | CO-CHAIRS' SUMMARY

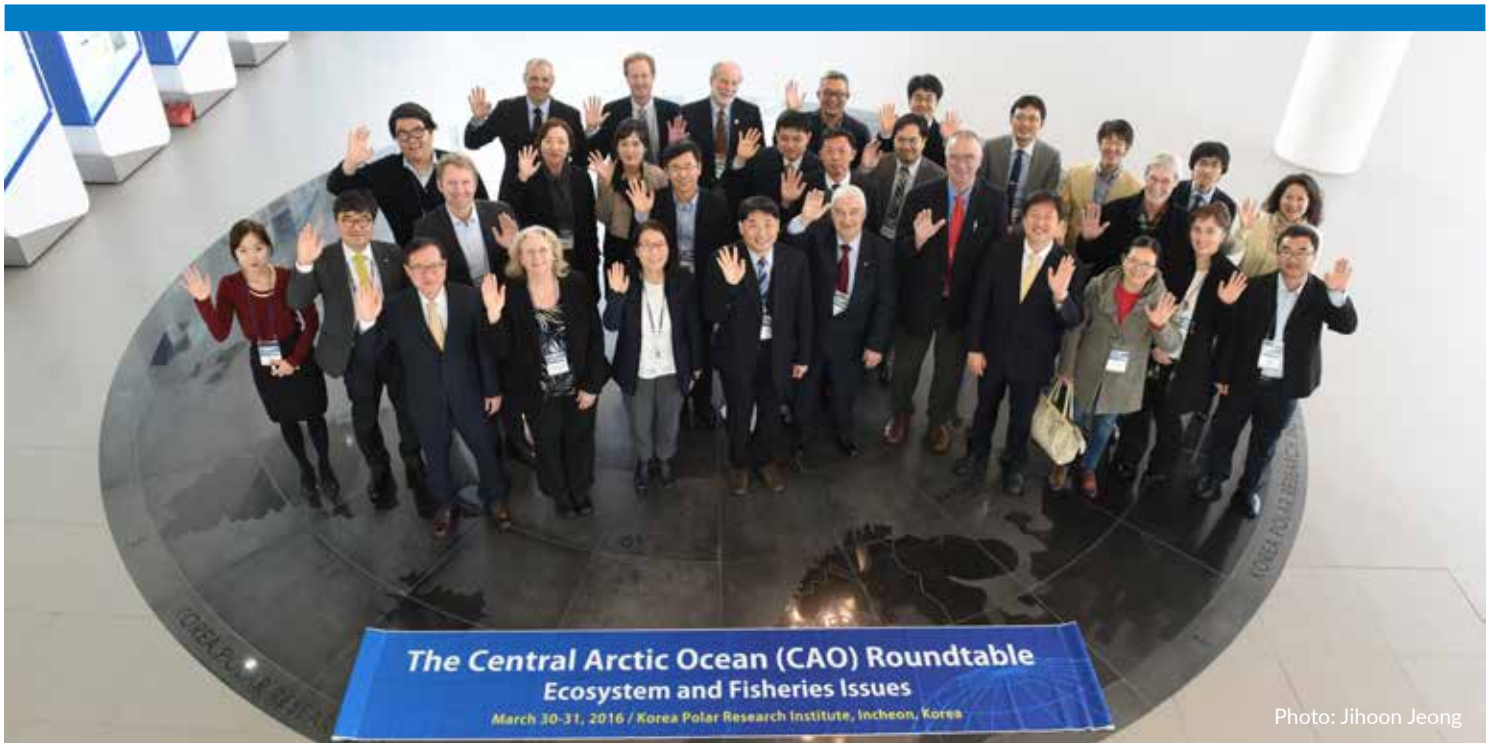


Photo: Jihoon Jeong

Session 1: "National and International Approaches to Arctic Issues"

In the first session, participants were informed about the growing global interest in the circumpolar Arctic, the current state of international relations, and the specific policies of the experts' respective jurisdictions. Emphasis was placed on the spirit of cooperation in the Arctic region, and the key role that is being played by the Arctic Council. The importance of involving indigenous peoples in all aspects of research and resource management was noted. The collapse of Pollock stocks in the "Donut Hole" of the Bering Sea, and the decimation of Northern Cod in the Northwest Atlantic were presented as unfortunate precedents to be avoided in the Arctic: they are key practical examples of "the tragedy of the commons".

Key themes that emerged in discussion included:

- A consistent goal of national Arctic policies of Arctic and non-Arctic states is to ensure a *sustainable future* and avoid the *"tragedy of the commons"*
- In the Arctic "high seas" all interested and affected states must be on an equal footing, based on the rights and duties of all parties as reflected in international conventions (e.g. UNCLOS/UNFA)
- There is an opportunity to build on existing trust and peaceful relations in the Arctic region
- There are several Arctic/northern examples of the failure to manage key fish stocks – Russian and Canadian examples underscore the *"tragedy of the commons"*

- There is a unique opportunity to "get things right" and apply the "Precautionary Principle" pro-actively *before* problems occur in the CAO
- Effective management of Arctic marine resources requires both scientific understanding and the involvement of stakeholders and communities (including indigenous peoples)
- There was consensus that until we have the right information and knowledge *it is unwise to allow a commercial fishery in the CAO*

Session 2: "The CAO: Science Activities/Science Questions"

The second session probed further into the level of current understanding of the Arctic oceanic system and the emerging importance of chemical and biological links between the continental shelves and the deep basins of the Ocean. Specific reports were made on current research relating to zooplankton, overall fisheries research in polar waters, and the outcomes of focused research cruises by the research icebreakers "T/V *"Oshoro-Maru"* (Japan) and *"Araon"* (Korea). The challenge of linking small-scale and local analysis to broad over-arching oceanic processes suggests the need for the inclusion of links between different geographic and biological scales of analysis. This was underscored within the context of international fisheries studies that have been undertaken in the Arctic.

Key themes that emerged from the discussion included:

- Scientific cooperation in the CAO will support effective governance to achieve a sustainable future
- Scientific cooperation is a form of international agreement and supports political/legal agreements: there is a need to develop mechanisms for generating and sharing information
- An ecosystem approach is required (not just analysis of individual species) which builds on existing research and fills key gaps (e.g. "the middle")

CAO

The collapse of Pollock stocks in the "Donut Hole" of the Bering Sea, and the decimation of Northern Cod in the Northwest Atlantic were presented as unfortunate precedents to be avoided ... key practical examples of "the tragedy of the commons".

- There is a need to establish shared goals, data stands, and data bases
- Research under *CCMLAR* and *PAG* provide good examples to learn from
- There is a need for more interdisciplinary collaboration
- An international science coordinating organization and, eventually, a marine resource management organization should be considered

Session 3: "Looking to the Future"

The final session focused on ways of moving forward on international scientific collaboration in the CAO, and was provided a review of existing organizations in the region and their respective roles.

Because the CAO is the "high seas", and outside the Exclusive Economic Zones (EEZ's) of the five Arctic coastal states (Canada, USA, Russia, Norway, Denmark/Greenland), involvement of non-Arctic states in both science activities and eventual management regimes is seen as necessary.

The principles of co-operation, and the potential role of non-Arctic states as "equal partners" through existing conventions, were presented, as well as practical ways of moving forward. Comparisons were made with the

"Looking to the Future" (cont'd)

management of potential trans-Arctic shipping and the IMO Polar Code.

A specific proposal was presented for the creation of an international institution to co-ordinate research on the ecosystems and living resources of the Arctic Ocean, with a view to developing custom-built policies for the future management and conservation of potential fish stocks and other living resources.

Key themes that emerged in the discussion included:

- The United Nations Convention on the Law of the Seas (UNCLOS) (the "Constitution of the Oceans") provides a robust framework for ocean resource management
- Even though the US has not ratified UNCLOS, it still respects its principles as a matter of "common law"
- The United Nations Fish Stocks Agreement (UNFA) is key in managing fish stocks – particularly "straddling stocks"
- The International Maritime Organization (IMO) has developed the "Polar Code" for shipping: it can serve as a useful example in the CAO
- There are a number of existing institutions which research or manage in some way various aspects of the Arctic region that could be built on; none focus on the CAO; and none include the fishery
- Which organization is in a position to very date and research findings in the CAO?
- Many key questions remain regarding the applicability of existing non-CAO science to the CAO, and the need to focus on key species (e.g. Arctic cod and capelin) in the Arctic marine ecosystem
- A stand-alone neutral scientific body is needed with a balanced composition (some questioned the appropriateness of ICES and/or PICES to do this)

Signed by Co-Chairs: Dr. Hyoung Chul Shin & Prof. Peter Harrison, March 31st, 2016

Photo: Henry Huntington

3) WORKING SESSION ON "AN INTERNATIONAL SCIENCE COORDINATING ORGANIZATION FOR THE CENTRAL ARCTIC OCEAN (CAO)"

Arctic Research Center, Hokkaido University, December 16–18, 2016

CO-CHAIRS' SUMMARY

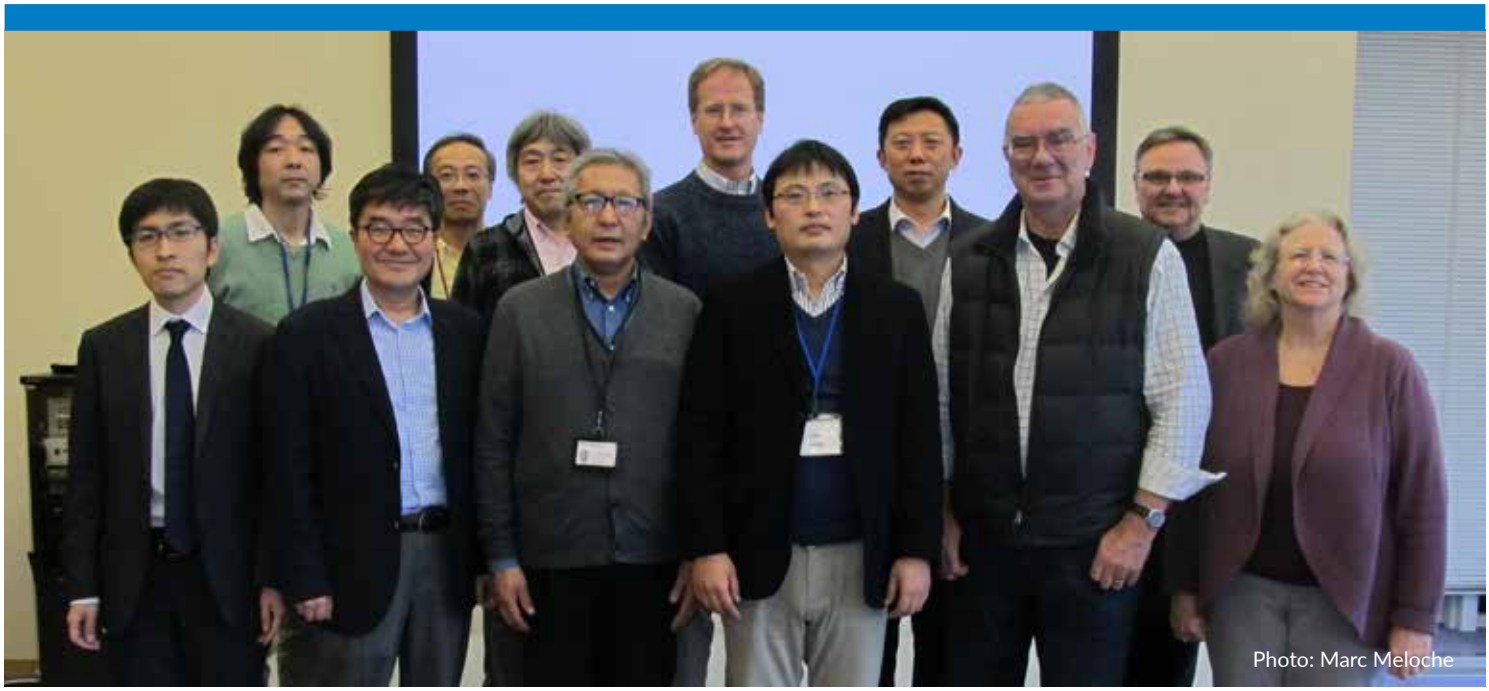


Photo: Marc Meloche

1. Background

The "Central Arctic ocean (CAO) Working Session" that took place at the Arctic Research Center, Hokkaido University from December 16-19, 2016 was organized in response to the negotiations that have taken place between the five Arctic coastal states (Canada; US; Russia; Norway; Denmark/Greenland) and five major commercial fishing jurisdictions (EU; Iceland; China; Japan; Korea) to develop an international agreement to prevent unregulated commercial fishing in the CAO until there is sufficient scientific knowledge about the marine ecosystems of the CAO, and an appropriate management structure is in place.

An overview of changing Arctic sea ice conditions is presented at Annex I.

2. Objectives

Generating the appropriate scientific knowledge will require significant cooperation between the signatories to an eventual agreement, and many of the existing organizations performing Arctic Ocean research. This working session focused on how best to achieve this objective.

The working session brought together a small group of Arctic experts from Canada, China, Japan, Korea and the United States to discuss the options for creating a new *"International Science Coordinating Organization for the Central Arctic Ocean (CAO)"* (referred to below as the scientific organization).

3. Considerations

The participants noted, and were guided by, a number of key events and related documents and reports which are outlined in Annex III.

4. Principles and issues raised during the "Working Session"

The following is a summary of the key principles and issues concerning a stand-alone science organization for the CAO that were raised during the first day of the working session.[6]

Purpose of the scientific organization

Provide scientific support for the CAO agreement

Mandate of the scientific organization

To achieve its purpose, the organization has four principal tasks to carry out the necessary scientific work to develop the information required by the signatories:

- Create a platform for participation on equal terms by all signatories, focused on the CAO and taking an ecosystem approach
- Determine the scientific priorities for research and monitoring in the CAO (to be done in the first year of the agreement, and reviewed every few years)
- Facilitate the integration of CAO research and monitoring in existing and planned Arctic efforts (to start in the first year of the agreement and continue), including data management and access
- Share, analyze, and interpret available data to provide evidence to [the governing body of the agreement] on the state of CAO fish stocks and the supporting ecosystem (to be provided on a regular basis to the governing body; e.g., every two years if the governing body meets biennially)

Some of these tasks will be best carried out in partnership with existing organizations, drawing on existing and planned research projects (see table for a partial list of examples, to which more can be added as they are identified). Doing so will foster efficiency and effectiveness, as outlined in the Principles below.

Principles underlying the scientific organization

To carry out its tasks efficiently and effectively, the organization should be based on the following set of principles:

- Arctic focus with high visibility
- An ecosystem approach
- Geographical scope is the CAO, with reference to boundary EEZs as ecologically relevant
- Participation on equal terms by all signatories

TASK	PARTNERS	EXAMPLE PROJECTS
Create a platform	(No existing organization)	
Determine priorities	AC, AEC, ICES, PAG, etc.	WGICA assessment, FiSCAO, national efforts, etc.
Facilitate CAO integration	FARO, PAG, MWG, SAON, PICES, ICES, IOOS, data management efforts, etc.	MOSAIC, DBO, SAS, national efforts, etc.
Analyze data, provide evidence	(No existing organization)	

[6]The working session took place according to "Chatham House Rules", under which comments and interventions are not attributed to specific participants without their explicit agreement.

- Involvement of indigenous peoples and indigenous knowledge
- Open data sharing and transparency for all data acquired in the CAO under this agreement
- Signatory delegations led by scientists or science managers authorized by their governments
- Meetings and activities can include other experts (from signatories or other countries) as appropriate
- Role of the scientific body is limited to coordination, analysis, etc.; the scientific body will not finance or undertake research itself, except in exceptional circumstances
- Maximize the effective use of existing international scientific resources and capacity (intellectual, logistical, organizational)
- Small secretariat to serve as coordinator of activities, keeper of records, and point of contact

Implementation issues

Several matters will need to be addressed as the scientific organization is created. The details will depend on decisions made by the signatories, so cannot be determined yet. These include:

- Secretariat structure, size, location, budget, etc.
- Funding of the secretariat
- Frequency of meetings, size of meetings, location of meetings
- Organization of intersessional work
- Rules of procedure & governance (chairmanship, executive committee, bylaws, etc.)
- Committees, working groups, etc.
- How indigenous peoples will be involved
- Legal status & standing & structure

Governance issues

Similarly, a number of aspects of the governance of the scientific organization will need to be addressed as the organization is created. The details will again depend on decisions made by the signatories, so cannot be determined yet.

These include:

- Chairmanship (term, rotation, etc.)
- By-laws
- Rules of procedure
- Frequency of meetings
- Committee authorization & structure
- Working group authorization & structure
- Finances
- Legal standing

Necessary conditions for success

For the scientific organization to succeed, it requires commitments of two kinds:

- Commitment by signatories to provide the resources needed to integrate CAO efforts into their research and monitoring activities, including the use of ship (icebreaker) capacity
- Commitment by the scientific community to use an ecosystem based approach inclusive of fishes in CAO research efforts

5. Recommendations

- Follow the principles outlined above in setting up the scientific organization.
- Set up a small secretariat to support the scientific organization as it fulfills its purpose and carries out the tasks in its mandate.

6. Next steps

The results of this working session, drawing also on the previous roundtable discussions, will be shared with those negotiating the CAO agreement, and with the participants in the meetings on Fisheries Science in the CAO (FiSCAO).

The ideas concerning scientific activity and the organization thereof will also be shared with potential partner organizations and with the wider scientific community.

Signed by Co-Chairs: Prof. Fujio Ohnishi & Prof. Peter Harrison, December 18th, 2016

Photo: Marc Meloche

Annex I

BACKGROUND: DISAPPEARING ARCTIC SUMMER SEA ICE

According to the National Snow and Ice Data Center (NSIDC; Boulder Colorado) in 2012 the minimum summer Arctic sea ice extent was the lowest on record. The 2016 extent was the second lowest – comparable to that of 2007.

However, the current freeze-up (2016-2017) is the slowest on record (see blue line in Fig. 1), which is continuing an observed and disturbing trend (Figure 2) that will affect ice patterns in future summer months. Sea ice thickness is also in sharp decline, as is the amount and extent of multi-year ice.

The disappearance of summer sea ice is geographically variable, with the greatest loss occurring in the "Pacific sector" of the Arctic Ocean.

Figure 3 shows the 2012 minimum sea ice extent in relation to the Exclusive Economic Zones (EEZ's) of the five Arctic Ocean coastal states (Canada; Denmark/Greenland; Norway; Russia) (red line), and the High Seas (red hatching) of the Central Arctic Ocean (CAO). The yellow area indicates notional "fishing depths" (< 2,000 metres) that became more accessible in 2012, even for short periods of time.

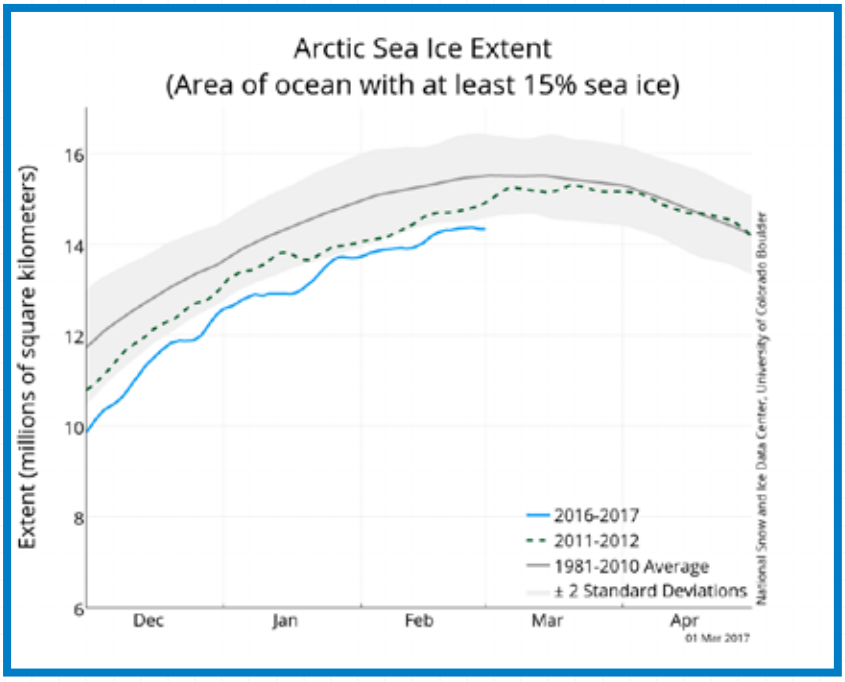


Figure 1. Data Source: NSIDC

It is projected that in future years the duration and extent of ice-free areas in the summer will increase significantly. This could allow access by unregulated commercial fishing vessels. An international agreement would prevent such activities until there is a sufficient scientific base and a regulatory regime is in place.

Despite the changing ice conditions, the Arctic Ocean remains a dangerous and sensitive environment where conditions can change extremely quickly. It is to be hoped that this will be understood by any fishers who may try to venture there!

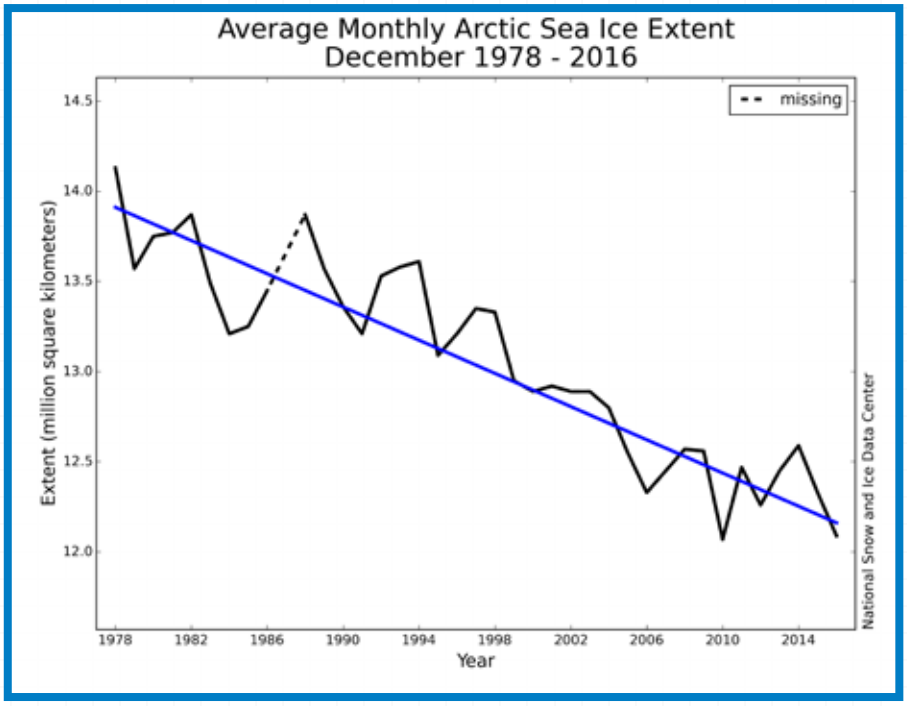


Figure 2. Data Source: NSIDC

Annex I (cont'd)

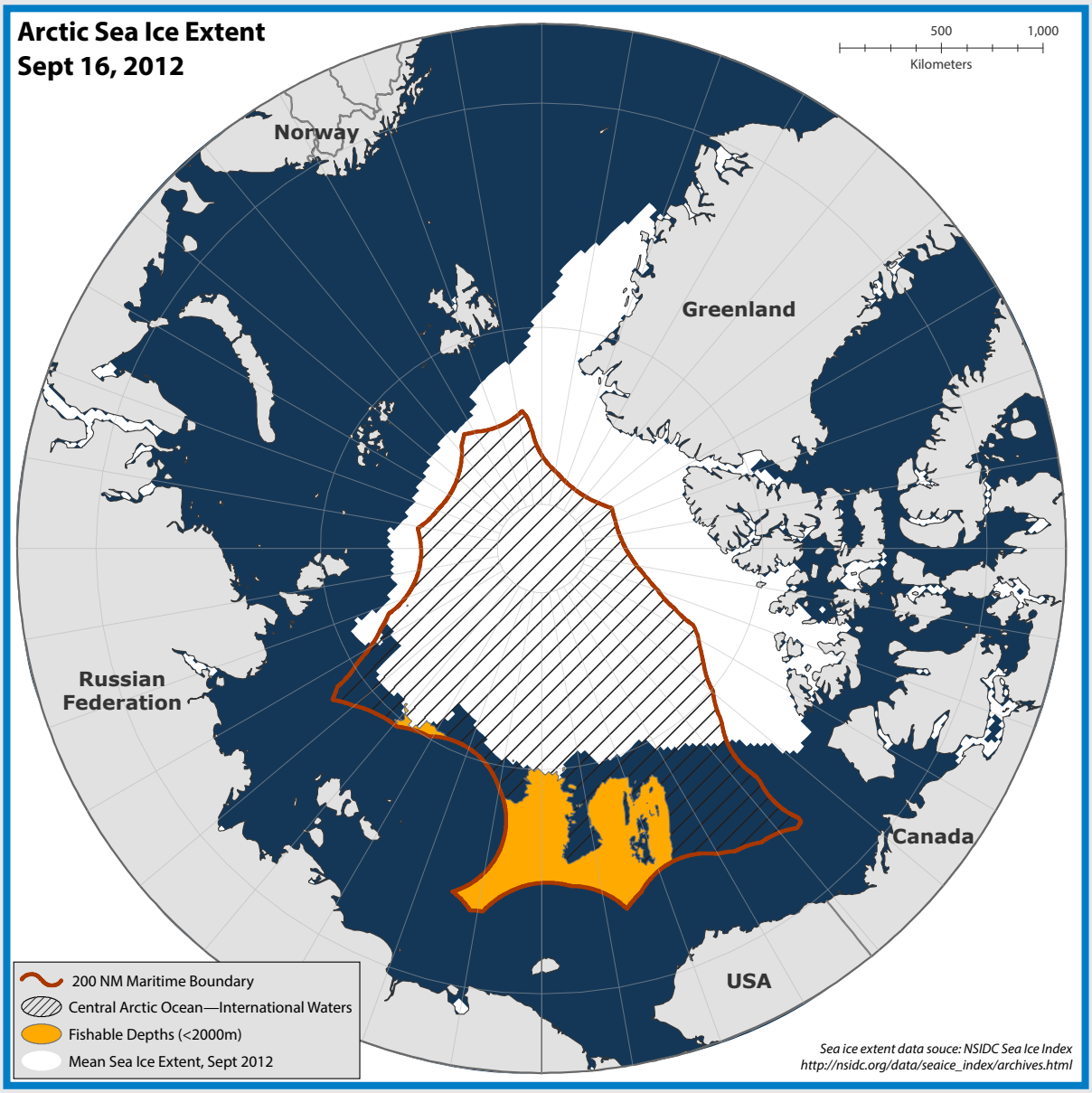


Figure 3: Arctic EEZ's; 2012 summer sea ice extent; and fishable depths. Data Source: NSIDC

Annex II

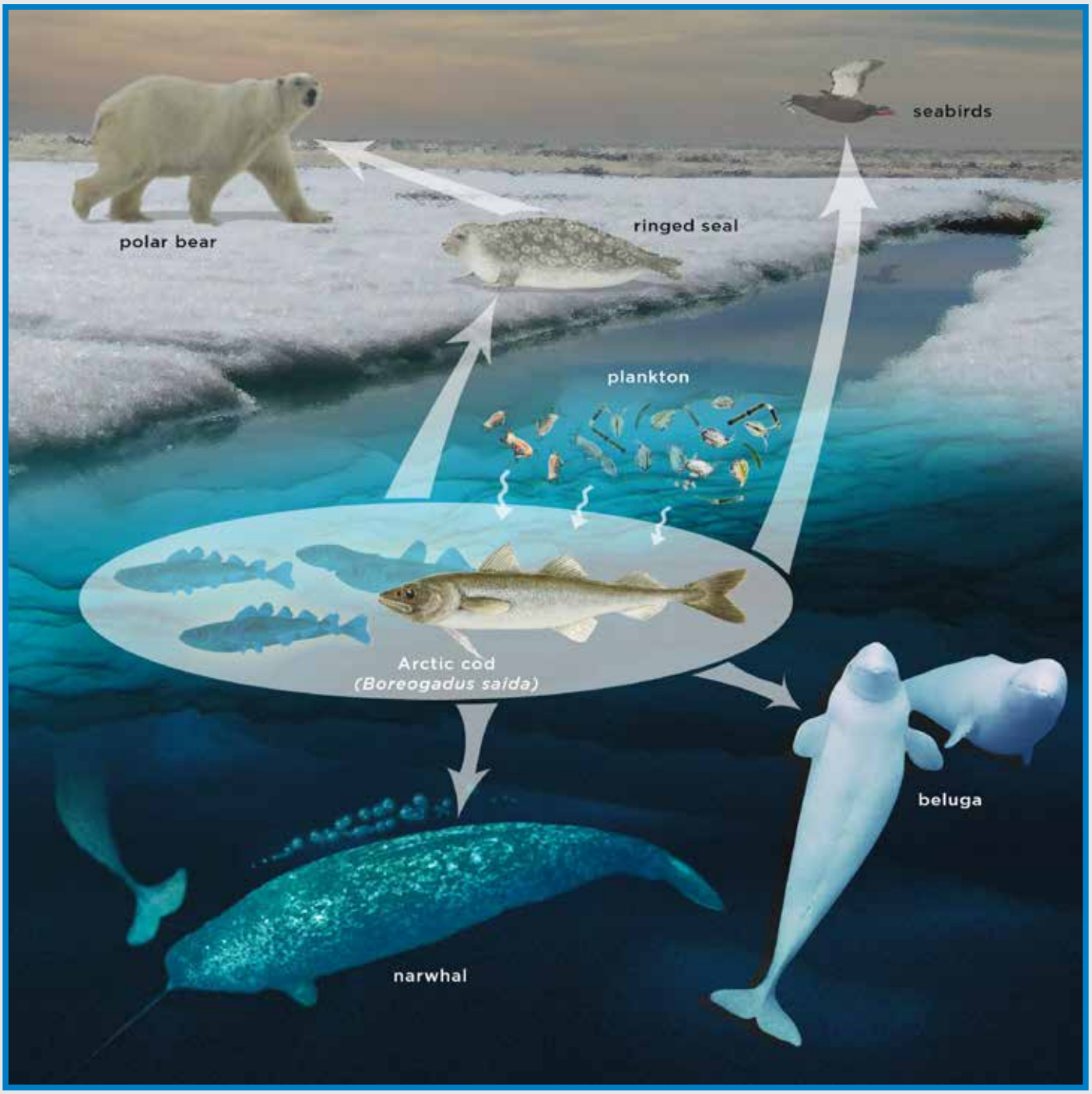
Areas of Expertise/Backgrounds Represented in the Roundtables and Work Session

- Academia
- Oceanography
- Marine biology
- Fisheries science
- International relations
- International law
- Economics
- Political science
- Public administration
- Public policy
- History
- Geography
- Engineering
- Climatology
- Cryosphere
- Business
- Civil society
- Conservation organizations
- Diplomacy
- Fishers
- Government agencies
- Indigenous peoples
- Media
- National Institutes
- Politics

Annex III

Participants' Institutions and Organizations

- Dalian Maritime University (China)
- Department of Fisheries and Oceans (DFO) (Canada)
- Department of Foreign Affairs and International trade (Canada)
- Fudan University (China)
- Hokkaido University (Japan)
- Iceland
- Inuit Circumpolar Council: Greenland
- Kobe University (Japan)
- Korea National Fisheries Research and Development Institute (Korea)
- Korea Polar research Institute (KOPRI) (Korea)
- Murmansk Technological University (Russia)
- Nihon University (Japan)
- Oceans North Canada (Canada)
- Ocean University of China (China)
- The Pew Charitable Trusts (USA)
- Polar Research Institute of China (PRIC)
- Queen's University (Canada)
- Russian Federal Research Institute for Fisheries and Oceanology (Russia)
- Shanghai Institutes for International Studies (China)
- Shanghai International Studies University (China)
- Shanghai Jiao Tong University (China)
- Shanghai Ocean University (China)
- Shanghai University of International Business and Economics (China)
- State Department (USA)
- State Oceanic Administration (China)
- Tongji University (China)
- Transboundary Ecologic LLC (USA)
- United States Arctic Research Commission (USARC) (USA)
- University of Maryland (USA)



Arctic Marine Food Web

This diagram outlines the central importance of the Arctic cod *(Boreogadus saida)* — which could eventually be a target commercial species — in Arctic ecosystems.

北海道大学
HOKKAIDO UNIVERSITY

Queen's Institute for Energy and Environmental Policy

同濟大學
TONGJI UNIVERSITY

Printed March 2017