Annex 1. Clippings from recent AC products offering key messages and recommendations of relevance to the AMSP

Content:

AOR

From chapter 9, Conclusion and Recommendations

Overview

Each of the preceding chapters identifies a number of opportunities for cooperative action to provide guidance for a coordinated and integrated approach to the management of activities within the Arctic marine environment. This concluding chapter presents certain key recommendations for consideration by the Arctic Council. The recommendations were developed by considering the full range of opportunities for action, and choosing or modifying the most important and timely actions.

The majority of chapters of this AOR Final Report highlight the importance of integrated or ecosystem-based approaches for advancing sector governance or management and for addressing cross-cutting issues. Altogether, this emphasizes the importance of ecosystem-based management (EBM) for a coordinated and integrated approach for Arctic Ocean governance. EBM is recognized to achieve all four goals of the Arctic Council Arctic Marine Strategic Plan, namely: reduce and prevent pollution in the Arctic marine environment; conserve Arctic marine biodiversity and ecosystem functions; promote the health and prosperity of all Arctic inhabitants; and advance sustainable Arctic marine resource use.

The AOR Final Report reveals similar opportunities have been identified among the different sectoral chapters, again highlighting this interconnectedness of ecosystems and management actions, and emphasizing their importance. The five recurrent opportunities include: Finalizing and implementing the Polar Code; Addressing Special, Protected or Critical Areas; Better monitoring of the Arctic

marine environment; Increasing understanding of the Cumulative Effects; and Implementing Ecosystem-based Management to address stressors in an integrated manner.

While the recommendations are organized by sector, as a general observation, they could also be categorized under the following five broad types of cooperative activity:

- ✓ *Coordination across Institutions*
- ✓ *Cooperation on Knowledge*
- ✓ *Amending Existing or Developing New Instruments*
- ✓ *Improving Implementation and Compliance*
- ✓ *Investing in Infrastructure*

There are qualitative differences among these five types of cooperative activity and the ways they are carried out. For example, cooperative activities to improve knowledge of the Arctic engage different processes than actions to amend or create new legal instruments. However, all five types of cooperative activity are imperative for the improved implementation or functioning of legal instruments

Recommendations

The following recommendations are considered important actions in the face of the dynamic changes occurring in the Arctic marine environment.

Chapter 2: Indigenous Peoples and Cultures

(1) The Arctic states in cooperation with the Arctic Council should assist, as appropriate, the Permanent Participants with the documentation of current and historical a) timing and geographical extent of local uses of the marine environment, and b) levels of traditional marine resources harvests, taking into account the differing documentation needs and capacities of Arctic states.

(2) The Arctic states should work with Arctic residents to identify and promote effective models for enabling inclusion of traditional knowledge and input into decision-making processes for marine development and sustainable resource management.

Chapter 3: Arctic Marine Operations and Shipping

(3) The Arctic states should support work at the IMO and other international organizations with recognized competence to promote and advance safe, secure, reliable and environmentally sound shipping, including through: timely completion and implementation of the Polar Code; efforts regarding training requirements for officers and crew of ships operating in polar waters; adoption as appropriate of ship routing and reporting measures (including vessel traffic services); and discussions regarding enhancement of weather and ice forecasting and nautical charts to aid navigation. Arctic states should also encourage ratification to enable entry into force and implementation of the Ballast Water Management Convention and research into ballast water management systems that are effective in colder settings of polar regions.

(4) Arctic states should explore the possibility of developing voluntary guidelines and, if appropriate, best practices in implementing such guidelines for sustainable tourism. Moreover, that the role the cruise industry plays in facilitating tourism in the region and the impacts of this industry on Arctic peoples, ecosystems and the environment should be acknowledged. The Arctic Council should also give consideration towards the development of a broader sustainable tourism initiative.

(5) Arctic states should explore, within an appropriate time after the mandatory Polar Code has been adopted, collaborative approaches to encourage effective implementation of any future related IMO measures for the Arctic, including the possible development at IMO of port state control guidelines and/or initiatives within existing port state arrangements.

(6) Arctic states should support ongoing work at the IMO to address black carbon emissions from international shipping in Arctic waters including considering amendments to MARPOL or other IMO instrument.

(7) Arctic states could consider approaches, including at IMO, to address safety and environmental concerns with respect to other types of vessels that, due to their size, routes, and nature of activity, may not be subject to the Polar Code.

Chapter 4: Marine Living Resources

Part A: Fisheries Resources

(8) Fisheries resources should be managed in accordance with the law of the sea, relevant fisheries agreements and modern principles of fisheries management, including the precautionary and ecosystem approaches, also being mindful of the interests of the indigenous peoples of the Arctic.

(9) Fisheries resources should be managed based on the best scientific knowledge available, and necessary scientific understanding should be enhanced, including on changes in fish stocks.

(10) Fisheries resources in areas beyond national jurisdiction should be managed based on cooperation in accordance with international law to ensure long term sustainability of fish stocks and ecosystems.

Part B: Marine Mammals and Seabirds

(11) The Arctic Council should increase collaboration with IMO, IWC and NAMMCO for information sharing and cooperation between their respective working groups and sub-groups on cetacean-related issues such as ocean noise and ship strikes and consider Ecosystem-based Management (EBM). Additionally, Arctic states should consider taking more proactive efforts in the IMO, IWC and NAMMCO on these issues such as by contributing to the IWC ship strike database.

(12) Arctic states, to the extent practicable, should continue to create and/or share seabird and marine mammal density and distribution maps, including through common databases such as the National Oceanic and Atmospheric Administration (NOAA) CetMap for Cetaceans (http://cetsound.noaa.gov/index.html) and CAFF's CBird online tools for timely tracking of seabird populations (www.caff.is/seabirds-cbird/seabird-information-network).

(13) Arctic states should advance conservation of Arctic marine ecosystems by considering management measures in ecologically significant areas of the Arctic Ocean that Arctic states might pursue at the IMO, building on the results of the AMSA Recommendation II(D) Report on Specially Designated Arctic Marine Areas.

Chapter 5 Arctic Offshore Oil and Gas

(14) The Arctic Council should urge its members to support, as appropriate, efforts in the ISO and other processes to develop standards relevant to Arctic oil and gas operations.

(15) Arctic states should move toward circumpolar policy harmonization in discrete sectors such as, e.g., environmental monitoring based on existing studies such as the Arctic Council's Arctic Offshore Oil and Gas Guidelines and the EPPR Recommended Prevention Practices report.

(16) Arctic Council should promote interactions with the appropriate international treaty bodies on offshore oil and gas issues that address for example discharges, oil spill preparedness and response, and environmental monitoring. This could include coordinating information exchange on reporting, monitoring, assessment and/or other requirements under relevant entities, encouraging inclusion of science and traditional knowledge, and keeping abreast of Arctic-specific developments relevant to the appropriate instruments.

(17) Arctic states should further engage industry and regulator involvement, as appropriate, in PAME and EPPR initiatives on offshore oil and gas activity by utilizing existing industry forums, or by convening an Arctic-specific oil and gas dialog for industry and contractor groups.

Chapter 6 Arctic Marine Pollution

(18) Arctic states should continue to identify, monitor and assess the combined effects of multiple stressors - inter alia climate change, ocean acidification, shipping, living marine resource use, regional and long-range pollution, and offshore oil and gas exploration and extraction - on Arctic marine species and ecosystems. Support the on-going work under EBM, AMAP and CAFF including the initiative "Adaptation Actions for a Changing Arctic" to achieve this endeavor and strengthen the link between the current known status and future management of Arctic marine species and ecosystems.

(19) Arctic states should reaffirm the importance of their engagement in the UNFCC to reduce global greenhouse gas emissions as a matter of urgency, recognizing the significant potential threats posed to Arctic marine ecosystems and Arctic biodiversity from climate change and ocean acidification identified by AMAP and CAFF. Arctic states should also increase their leadership role in the study of ocean acidification in Arctic waters.

Chapter 7 Ecosystem-based Management in the Arctic

(20) Arctic states should recognize, in accordance with the recommendations from the Arctic Council EBM Expert Group and the PAME lead Ecosystem Approach expert group, the importance of the following elements when implementing marine Ecosystem-based Management in the Arctic Council Working Groups: identification of the ecosystem, description of the ecosystem, setting ecological objectives, assessing the ecosystem, valuing the ecosystem and managing human activities.

(21) The Arctic Council should promote common understanding and the mutual exchange of lessons learned by periodically convening Arctic Council-wide meetings on EBM to:

- ✓ share knowledge and experiences with respect to management and science across Large Marine Ecosystems; and
- ✓ review information on integrated assessments.

Chapter 8 Arctic Marine Science

(22) The Arctic states should promote coordination and collaboration in providing for access to marine scientific research in their marine areas, and the Arctic states should consider developing an Arctic science instrument, inter alia, to facilitate marine scientific cooperation and promote data sharing

(23) The Arctic Council could consider directing its working groups to collaborate to developing a list of research gaps and priorities, taking into account the knowledge and process needs for the Arctic EBM intersessional document as well as key global and regional instruments.

(24) The Arctic states should improve scientific cooperation and coordination by increasing linkages with relevant organizations, sharing infrastructure and platforms, and facilitating the gathering

and exchange of information under relevant agreements. The improvements could be supported by:

- ✓ developing a network map that identifies the relationships of research/science organizations and governance organizations to Arctic-relevant instruments;
- ✓ building on science, local and traditional knowledge, and other information gathered to fulfill reporting or assessment obligations;
- ✓ informing ecosystem based management approaches;
- ✓ improving communication between science and policy arms of existing treaties; and, moving toward coordinated assessment, monitoring, and reporting, where appropriate; and
- ✓ improving data and information management, interoperability and accessibility through mechanisms such as the Arctic Spatial Data Infrastructure and the Sustained Arctic Operating Network (SAON).

EBM expert group

From: Expert Group On Arctic EBM: Report To Senior Arctic Officials

PROPOSED RECOMMENDATIONS OF THE EXPERT GROUP ON ARCTIC EBM

The Expert Group on Arctic EBM has developed the following recommendations for consideration by Senior Arctic Officials and Arctic Council Ministers:

1) It is proposed that the Arctic Council adopt a policy commitment to EBM, and that the following statement be considered as that commitment:

> We will work together to advance Ecosystem-Based Management in the coastal, marine and terrestrial environments of the Arctic and, where relevant, work through the Arctic Council structure to coordinate ongoing and prospective EBM approaches to maximize the benefits of such efforts within and across boundaries and for the Arctic as a whole.

2) It is proposed that the Arctic Council adopt a definition of EBM relevant to its work in the Arctic, as follows:

> Ecosystem-based management is the comprehensive, integrated management of human activities based on best available scientific and traditional knowledge about the ecosystem and its dynamics, in order to identify and take action on influences that are critical to the health of ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.

3) It is proposed that the Arctic Council adopt the following nine principles for its work in the Arctic:

> 1. EBM supports ecosystem resilience in order to maintain ecological functions and services.
>
> 2. EBM recognizes that humans and their activities are an integral part of the ecological system as a whole, and that sustainable use and values are central to establishing management objectives.
>
> 3. EBM is place-based, with geographic areas defined by ecological criteria, and may require efforts at a range of spatial and temporal scales (short-, medium- and long-term).
>
> 4. EBM balances and integrates the conservation and sustainable use of ecosystems and their components.
>
> 5. EBM aims to understand and address the combined, incremental effects (known as "cumulative impacts") that multiple human activities impose upon ecosystems, resources, and communities.
>
> 6. EBM seeks to incorporate and reflect scientific knowledge as well as expert, traditional, and local knowledge.
>
> 7. EBM is inclusive and encourages participation at all stages by various levels of government, indigenous peoples, stakeholders (including the private sector) and other Arctic residents.
>
> 8. Transboundary perspectives and partnerships can contribute significantly to the success of EBM efforts.

9. Successful EBM efforts are flexible, adaptive, and rely on feedback from monitoring and research because ecosystems and human activities are dynamic, the Arctic is undergoing rapid changes, and our understanding of these systems is constantly evolving.

4) It is proposed that the Arctic Council consider the following recommendations for activities to be undertaken by the Arctic Council, Permanent Participants, Arctic Council Working Groups, and Arctic States, as appropriate, to advance EBM in the Arctic:

Policy and Implementation

Advancing further EBM efforts across the Arctic will build upon existing EBM implementation and involve transboundary and sub-national or regional arrangements, integrated approaches, shared goals, and consideration of traditional knowledge as appropriate. The Expert Group on Arctic EBM recommends the following actions:

- Develop an overarching Arctic EBM goal, derived from established Arctic Council goals and visions, and provide guidance on how to develop and operationalize objectives supporting this goal.
- Explore ways in which Arctic States can cooperate to advance conservation and management of biologically, ecologically, and culturally significant areas.
- Develop and adopt a policy and best practices for incorporating traditional knowledge into EBM activities as appropriate.
- Encourage initiatives between two or more Arctic States to advance implementation of EBM in the Arctic and demonstrate how knowledge is collected, shared, processed and used to contribute to EBM in the Arctic.
- Review, update and adjust the Observed Best Practices in Ecosystem-based Ocean Management in the Arctic, endorsed by the 2009 Arctic Council Ministerial, to be applicable to all environments, including marine, coastal and terrestrial.

Institutional

Recognizing the important ongoing EBM work within the Arctic Council, particularly in the marine environment, sustaining and strengthening EBM will require building greater coordination and integration capacity across the Arctic Council and taking steps to further advance EBM in terrestrial environments. The Expert Group on Arctic EBM recommends the following actions:

- Identify a lead to assure coordination of a common approach to the work of the Arctic Council on EBM in the Arctic and ensure appropriate reporting of progress to the Senior Arctic Officials.
- Institute periodic Arctic Council reviews of EBM in the Arctic to exchange information on integrated assessment and management experiences, including highlighting examples from Arctic States.

Science and Information

Advancing Arctic EBM will require the identification of important coastal, marine, and terrestrial areas, improved data comparability and compatibility, enhanced information exchange and monitoring, and improvements in the development and use of integrated assessments. In order to achieve this, the Expert Group on Arctic EBM recommends the following actions:

- Encourage the use of the revised map of 17 Large Marine Ecosystems to inform EBM implementation; and explore the development of terrestrial assessment units (landscape equivalents to LMEs) based upon ecological criteria or existing ecoregions.
- Identify biologically, ecologically, and culturally significant areas in the coastal, marine and terrestrial environments, and consider EBM-related needs for these areas. Identify the coastal, marine and terrestrial areas most vulnerable to human impacts.
- Assess the value of significant Arctic ecosystem services relevant to the well-being of local communities and regional economies, and those of particular global significance.
- Enhance access to, and use of, the multidisciplinary data required for the implementation of EBM by building upon ongoing work in the Arctic Council to contribute to an Arctic Council data portal.
- Exchange information and experiences with integrated assessments of ecosystem status, trends and pressures for coastal, marine, and terrestrial areas and provide guidance on approaches for integrating existing assessments.

From: Advancing Ecosystem Based Management (EBM) in the Work Of The Arctic Council

The EBM definition that has been proposed for use within the Arctic Council includes four elements: integrated management, knowledge about ecosystems, addressing influences on ecosystems, and conservation and use objectives.

Measures to advance EBM in the context of the Arctic Council

a. Integrated management

- Where appropriate, future assessments which Working Groups consider undertaking should be integrated assessments.
- A “how to” manual for integrated analyses/assessments, or guidelines for undertaking integrated assessments, could be developed
- Building scientific cooperation among Arctic Council members could be done through a pilot project between two or more Arctic Council states, and can demonstrate how data is collected, shared, processed and used to contribute to EBM in the Arctic.
- A cross-Working Group project on consistency and comparability of data could be undertaken.
- A workshop could be held to identify and discuss approaches to, and experiences with, integrated management and the design of assessments for this purpose, including the role of indicators.
- A workshop could be held to discuss experiences with previous Arctic Council assessments and to learn from those.
- An inventory of ecosystem status reports could be prepared.
- Data/information from all Working Groups could be identified and compiled, e.g., what type of information is available and how it can be accessed.
- Socio-economic and cultural data should be reflected in SAON
- A common data framework that can be used across all AC working groups should be developed.
- A manual to be used as a guide for how to use integrated assessments to identify cumulative impacts should be developed

- Regular reporting on high risk Arctic systems that are most threatened by cumulative impacts would help the Arctic Council focus its Working Group activities.

b. Knowledge

- Support should be given to dedicated EBM research programmes under, for example, IASC.
- A workshop could be developed on the design of EBM monitoring programmes.
- A workshop could be developed on methods for selection of valuable and vulnerable areas.
- Support could be provided for pan-Arctic monitoring of ecosystems and pressures (SAON).
- The Arctic Council should adopt some means to compile and compare the results of ongoing scenario-building and predictive efforts in the Arctic. Such "future-casting" will advance the ability to implement effective EBM initiatives.
- A PAME/CAFF expert group could be established, with a one-time task of improving understanding regarding ecosystem interactions (between marine, coastal, terrestrial, aquatic in the Arctic Region).
- A compilation of existing/ongoing efforts to incorporate traditional and scientific expert knowledge would be useful. This would allow an examination of useful methods and best practices.
- An explicit Arctic Council Working Group policy or agreement could be developed focusing on the incorporation of traditional and local knowledge in Working Group activities, where relevant and appropriate.

c. Addressing influences on ecosystems

- A workshop could be held to address common issues in defining ecosystems, both marine and terrestrial.
- A workshop could be held to share experiences in identifying and monitoring valuable and vulnerable areas.
- Compilation of information on implementation of EBM across Arctic ecosystems would be useful.
- A joint Working Group project to assess the value of ecosystem services, perhaps associated with sea ice and permafrost could be value added.
- A terrestrial equivalent of "large marine ecosystems" (LMEs) should be developed, possibly by CAFF.
- Ecologically sensitive terrestrial areas should be identified (in addition to already identified marine areas) based on best available scientific and traditional information
- Working Groups should all be engaged in helping to suggest ecological objectives for the marine and terrestrial areas identified.
- At the Working Group level, there could be a joint meeting of WG chairs to develop input for a common EBM work plan, from which specific activities would be reflected as an element in each of the Working Groups' ongoing two year work plans.
- Alternatively, or in addition to the above, a mechanism to coordinate a common approach to the work on EBM within the Arctic Council, focusing on both marine and terrestrial EBM and engaging representatives from all of the Working Groups, could be considered.
- A regular meeting/workshop on EBM in the Arctic could be organized – focusing on the integration of economic, social, ecological components of EBM and highlighting examples of how EBM is implemented in each of the Arctic States.

- Pilot projects between two or more Arctic States could be developed (ideally one with a marine focus and one with a terrestrial focus), which would showcase movement towards EBM implementation in the Arctic.

d. Conservation and use objectives

- Establish an inventory of conservation and use objectives relevant to EBM, including how they can promote and/or prevent the implementation of EBM.
- Hold a workshop to address examples of practical implementation of conservation standards in an EBM context, with a view to learning and dissemination of experiences.
- Hold a workshop to identify methods and criteria for developing Ecological Quality Objectives.

SWIPA

From SWIPA full report

12.5.2. RECOMMENDATIONS

The focus for the SWIPA assessment report has been to summarize the evidence for recent cryospheric change in the Arctic, and the effects and consequences of this change for the entire Arctic system. The objective of the SWIPA program was not to focus on the ultimate cause of the cryospheric change (see Chapter 1). Instead, the syntheses embodied in the preceding chapters of this Science Report highlight the present state of knowledge within the various disciplines, and the follow-on effects of present and ongoing change on Arctic ecosystems and humans. The following recommendations aim to increase that knowledge base and facilitate its use.

NEAR-TERM NEEDS

- Increase the nature, spatial and temporal resolution, and availability of data from all observational platforms, all continuing into the future – including data for physical, ecological and human elements of the overall system and with a specific focus on feedback linkages within the system (e.g., enhanced methane releases due to cryospheric change) and other gaps.
- Modeling approaches provide insight into future possibilities, but efforts are required to reduce uncertainties in projections and enhance their spatial resolution, to parameterize and incorporate important feedbacks; and to downscale model results to appropriate regional levels.
- Enhance existing efforts to understand causal linkages across all aspects of the Arctic system, both among cryospheric components and between the cryosphere and other components of the Arctic system.
- Integrate and foster seamless availability of data products associated with the cryosphere, the consequences of change, and additional potential drivers.
- Identify and resolve impediments to inter-disciplinary linkages within and among cryospheric components, thereby fostering cross-disciplinary and integrated studies of changes in this system and their consequences for the Arctic.
- Link existing or develop new quantitative models to provide an integrated perspective of climate and cryospheric changes for the Arctic.
- Assess risks, or develop approaches to do so, of cryospheric changes for ecological and human systems in the Arctic across all relevant scales to allow effective planning and remediation. Identify shortfalls in design or approaches presently in place to address future changes in the cryosphere.
- Assess the consequences of cryospheric change for other physical and ecological systems (e.g., enhanced gas exchange driving acidification of Arctic aquatic systems).
- Evaluate roles and cumulative effects of potential drivers of continued cryospheric change across spatial scales to better understand causation and interactions, thus informing mitigation efforts.

MEDIUM-TERM NEEDS

- Identify and resolve impediments to linking all drivers and consequences of Arctic change into an overall understanding ranging from the physical to human levels of the system.
- Link or develop quantitative and qualitative approaches to enable cross-disciplinary analyses of change, causation and consequences.
- Initiate regional assessments focused on inter-disciplinary integration of recent changes, drivers of change and consequences; and develop projections of future possible outcomes to better inform planning and preparedness.

LONG-TERM NEEDS

- Develop and implement an overall strategy to assess Arctic change from all causes on a regular basis within which major proximate drivers such as cryospheric changes can be assessed.
- Integrate regional and sectoral assessments into regular Arctic-wide assessments.

12.6. CONCLUSION

The findings summarized in the SWIPA Science Report provide insights into the scope and nature of cryospheric changes in the Arctic. These, in turn, in combination with widespread climate variability, over large spatial and temporal scales, and with human adaptive capacity will ultimately determine whether particular changes in the cryosphere are viewed as opportunities or challenges. The overwhelming consequence appears to be a highly variable and uncertain future for the Arctic. This is perhaps the main challenge resulting from cryospheric change in the Arctic. Strategies and approaches that incorporate such uncertainty as a basic consideration underpin effective solutions. Thus, past trends, expectations of smooth transitions, expectations of slow rates of change, and expectations of low frequencies of extreme events appear to be becoming less trustworthy predictors of future situations and risks. As a consequence, planning for surprises or unanticipated events is increasingly important.

From SWIPA Overview Report

WHAT SHOULD BE DONE

Everyone who lives, works or does business in the Arctic will need to adapt to changes in the cryosphere. Adaptation also requires leadership from governments and international bodies, and increased investment in infrastructure. (Key finding 14)

There remains a great deal of uncertainty about how fast the Arctic cryosphere will change in the future and what the ultimate impacts of the changes will be. Interactions ('feedbacks') between elements of the cryosphere and climate system are particularly uncertain. Concerted monitoring and research is needed to reduce this uncertainty. (Key finding 15)

ADAPTATION IS URGENT AND NEEDED AT ALL LEVELS

Cryospheric change affects people at the local level first, and local communities will need to devise strategies to cope with emerging risks.

At national and regional levels, adaptation requires leadership from governments and international bodies to establish new laws and regulations. For example, new fishing regulations will be required as fish stocks change. New standards will need to be developed for construction, particularly in areas affected by thawing permafrost.

Governments will need to invest in transport networks to cope with the shorter ice road season. Search and rescue operations will need to be enhanced to respond to increasing traffic and risks at sea, and accurate forecasts of weather and sea conditions are required to ensure travel safety.

Arctic communities are resilient and will actively respond to cryospheric change. However, rapid rates of change may outpace adaptation capacity. Knowledge and research are needed to foresee how living conditions are likely to change, and to evaluate possible adaptation options. Concerns of indigenous peoples need particular attention in this regard.

Changes in the cryosphere are not the only driver of change in the Arctic. Cryospheric change and climate change occur in the context of societal change, which may be even more challenging. The combined effects of societal, climatic and cryospheric change must be taken into account in adaptation strategies.

CUTTING GREENHOUSE GAS EMISSIONS GLOBALLY IS URGENT

Climate change represents an urgent and potentially irreversible threat to human societies. Global climate modeling studies show that deep and immediate cuts in global greenhouse gas emissions are required to hold the increase in global average temperatures below 2 °C above pre-industrial levels. Combating human induced climate change is an urgent common challenge for the international community, requiring immediate global action and international commitment.

Following the ACIA report, published in 2005, Ministers of the Arctic Council acknowledged that "timely, measured and concerted action is needed to address global emissions." They endorsed a number of policy recommendations for reducing greenhouse gas emissions, including to "Adopt ...

strategies ... [to] address net greenhouse gas emissions and limit them in the long term to levels consistent with the ultimate objective of the UNFCCC [United Nations Framework Convention on Climate Change]."

The key findings of the SWIPA assessment, especially the rapid and accelerated rates of change in Arctic cryosphere conditions, emphasize the need for greater urgency in taking these actions.

UNCERTAINTY CAN BE REDUCED BY FURTHER RESEARCH

Current monitoring, research and model results provide high confidence that significant changes are occurring in the Arctic cryosphere and that these changes will continue in the future. Some of the observed changes align with expectations but one major component of the cryosphere (sea ice) has reacted faster than anticipated just five years ago. Even so, substantial uncertainty remains, particularly concerning the future timing of changes, and the effects of interactions (feedbacks) between components of the cryosphere and climate system.

To reduce the uncertainty in future assessments, more robust observational networks are needed. Satellites and airborne measurements have improved the ability to observe some elements of the Arctic cryosphere such as sea-ice extent and snow cover. Monitoring of other key elements of the cryosphere, notably sea-ice thickness, snow depth, permafrost and glaciers, requires surface based observations.

Many surface-based snow, freshwater ice, and precipitation gauge networks have diminished or have been completely lost, and sites for measuring sea ice, land ice, and physical properties of snow are sparse. Observational networks need to be expanded to provide a robust set of cryospheric data for monitoring, model improvement and satellite product validation. The biggest unanswered questions identified by this report are:

- What will happen to the Arctic Ocean and its ecosystems as freshwater is added by melting ice and increased river flow?
- How quickly could the Greenland Ice Sheet melt?
- How will changes in the Arctic cryosphere affect the global climate?
- How will the changes affect Arctic societies and economies?

Answering some of these questions requires improved monitoring networks. A better understanding of the complex interactions between the physical, chemical and biological environments in the Arctic is needed. There is a lack of systematically collected information on the effects of cryospheric change on human society.

COMMUNICATING ABOUT CRYOSPHERIC CHANGE AND ITS EFFECTS

The SWIPA assessment documents the importance of climate-induced changes in Arctic snow, water and ice conditions and the profound implications for the local, regional, and global society. Active communication of this new knowledge, to enhance global, national, and local awareness, will help to ensure that the SWIPA assessment generates benefits for people in the Arctic.

A CO-ORDINATED RESPONSE TO CRYOSPHERIC CHANGE

The combined effects of the changing cryosphere, climate change, and rapid development in the Arctic will create political challenges for Arctic societies, as well as the global community. Traditional livelihoods are most vulnerable to changes in the cryosphere. There is a need for cooperation and co-ordinated effort at all levels, to respond to change and increase the resilience of Arctic ecosystems and societies.

RECOMMENDATIONS

Based on the SWIPA key findings, the AMAP Working Group have agreed to the following recommendations:

ADAPTATION

Members of the Arctic Council and governments at all levels in the Arctic should work to:

• Develop regional-scale assessments of cryospheric change and the associated risks.
• Develop and implement Arctic adaptation strategies appropriate to the scale and character of anticipated changes. Such strategies must take account of other relevant drivers of change.
• Ensure that standards for environmental management are in place, or can be adapted, to take account of cryospheric change. Develop regulations where necessary.
• Upgrade the capacity for search and rescue operations and environmental hazard responses.
• Facilitate measures to increase the accuracy of forecasting for ice, weather, and sea conditions, and make forecasts accessible to all Arctic residents and organizations.

MITIGATION

International negotiations to reduce global greenhouse gas emissions should be pursued as a matter of urgency. Member States of the Arctic Council should increase their leadership role in this process. Observation Arctic countries and international organizations should:

• Improve and expand systematic, comprehensive surface-based monitoring of the cryosphere.
• Maintain and support development of remote sensing methods for observing the cryosphere.
• Develop and enhance systems to observe the cascading effects of cryospheric change on ecosystems and human society.
• Expand research into processes that are important for modeling the cryosphere, to reduce uncertainty in predicting cryospheric change. In particular, improvements are needed in modeling permafrost dynamics, snow-vegetation interactions, and mass loss from glaciers, ice caps, and the Greenland Ice Sheet.

OUTREACH

The Members and Observers of the Arctic Council should individually and collectively inform and educate Arctic societies and the global society about the changes in the Arctic linked to climate change, and how they affect people locally, regionally and globally.

POLICY NEEDS

Governments and institutions at all levels should increase co-operation and co-ordinate efforts to respond to the challenges and opportunities associated with cryospheric change. The Arc tic Council should conduct an integrated assessment of the combined impacts of change in the Arctic, focused on how to minimize environmental damage and enhance human well-being.

ABA

From summary for policy makers

RECOMMENDATIONS

The following recommendations are aimed primarily at the Arctic Council, its member states and Permanent Participants. Success in conserving Arctic biodiversity, however, also depends upon actions by non-Arctic states, regional and local authorities, industry and all who live, work and travel in the Arctic. These recommendations may, therefore, also provide a guide for action for states, authorities, and organizations beyond the Arctic Council. Some of the ABA recommendations directly encourage cooperation with those outside the Arctic Council process.

Large tracts of the Arctic remain relatively undisturbed providing an opportunity for proactive action that can minimize or even prevent future problems that would be costly, or impossible, to reverse. The key findings of the ABA are interrelated and responding to them would benefit from a holistic approach. When taken together, three cross-cutting themes are evident:

1) the significance of climate change as the most serious underlying driver of overall change in biodiversity;

2) the necessity of taking an ecosystem-based approach to management; and

3) the importance of mainstreaming biodiversity by making it integral to other policy fields, for instance by ensuring biodiversity objectives are considered in development standards, plans and operations.

A comprehensive and integrated approach is needed to address the interconnected and complex challenges facing biodiversity and to ensure informed policy decisions in a changing Arctic. In addition to many Arctic Council initiatives underway, there are other conventions and processes addressing these cross-cutting themes and many of the individual stressors acting on biodiversity. This includes many regulatory and non-regulatory measures that are in place or under development to provide consistent standards and/or approaches to development in the Arctic. Many of these can, or do, provide safeguards for biodiversity.

Care was taken in the development of the ABA recommendations to review recommendations from other major Arctic Council initiatives. Many of the recommendations overlap and are mutually supportive, emphasizing the importance of considering all recommendations together. Some of the ABA recommendations reinforce the significance to biodiversity of recommendations or actions already underway, others build upon existing recommendations or processes, and others are more specifically focused on biodiversity issues. All are important to ensure the conservation of Arctic species, ecosystems and the services they provide.

CLIMATE CHANGE

1. **Actively support international efforts addressing climate change, both reducing stressors and implementing adaptation measures, as an urgent matter.** Of specific importance are efforts to reduce greenhouse gas emissions and to reduce emissions of black carbon, methane and tropospheric ozone precursors.

2. **Incorporate resilience and adaptation of biodiversity to climate change into plans for development in the Arctic.**

ECOSYSTEM-BASED MANAGEMENT

3. **Advance and advocate ecosystem-based management efforts in the Arctic as a framework for cooperation, planning and development.** This includes an approach to development that proceeds cautiously, with sound short and long-term environmental risk assessment and management, using the best available scientific and traditional ecological knowledge, following the best environmental practices, considering cumulative effects and adhering to international standards.

MAINSTREAMING BIODIVERSITY

4. **Require the incorporation of biodiversity objectives and provisions into all Arctic Council work and encourage the same for on-going and future international standards, agreements, plans, operations and/or other tools specific to development in the Arctic.** This should include, but not be restricted to, oil and gas development, shipping, fishing, tourism and mining.

IDENTIFYING AND SAFEGUARDING IMPORTANT AREAS FOR BIODIVERSITY

5. **Advance the protection of large areas of ecologically important marine, terrestrial and freshwater habitats, taking into account ecological resilience in a changing climate.**
    a. Build upon existing and on-going domestic and international processes to complete the identification of ecologically and biologically important marine areas and implement appropriate measures for their conservation.
    b. Build upon existing networks of terrestrial protected areas, filling geographic gaps, including under-represented areas, rare or unique habitats, particularly productive areas such as large river deltas, biodiversity hotspots, and areas with large aggregations of animals such as bird breeding colonies, seal whelping areas and caribou calving grounds.
    c. Promote the active involvement of indigenous peoples in the management and sustainable use of protected areas.
6. **Develop guidelines and implement appropriate spatial and temporal measures where necessary to reduce human disturbance to areas critical for sensitive life stages of Arctic species that are outside protected areas, for example along transportation corridors.** Such areas include calving grounds, den sites, feeding grounds, migration routes and moulting areas. This also means safeguarding important habitats such as wetlands and polynyas.

7. **Develop and implement mechanisms that best safeguard Arctic biodiversity under changing environmental conditions, such as loss of sea ice, glaciers and permafrost.**
    a. Safeguard areas in the northern parts of the Arctic where high Arctic species have a relatively greater chance to survive for climatic or geographical reasons, such as certain islands and mountainous areas, which can act as a refuge for unique biodiversity.
    b. Maintain functional connectivity within and between protected areas in order to protect ecosystem resilience and facilitate adaptation to climate change.

ADDRESSING INDIVIDUAL STRESSORS ON BIODIVERSITY

8. **Reduce stressors on migratory species range-wide, including habitat degradation and overharvesting on wintering and staging areas and along flyways and other migration routes.**
    a. Pursue or strengthen formal migratory bird cooperation agreements and other specific actions on a flyway level between Arctic and non-Arctic states with first priority given to the East Asian flyway.
    b. Collaborate with relevant international commissions, conventions, networks and other organizations sharing an interest in the conservation of Arctic migratory species to identify and implement appropriate conservation actions.
    c. Develop and implement joint management and recovery plans for threatened species with relevant non-Arctic states and entities.
    d. Identify and advance the conservation of key wintering and staging habitats for migratory birds, particularly wetlands.
9. **Reduce the threat of invasive alien/non-native species to the Arctic by developing and implementing common measures for early detection and reporting, identifying and blocking pathways of introduction, and sharing best practices and techniques for monitoring, eradication and control.** This includes supporting international efforts currently underway, for example those of the International Maritime Organization to effectively treat ballast water to clean and treat ship hulls and drilling rigs
10. **Promote the sustainable management of the Arctic's living resources and their habitat.**
    a. Improve circumpolar cooperation in data gathering and assessment of populations and harvest and in the development of improved harvest methods, planning, and management. This includes improving the use and integration of traditional ecological knowledge and science in managing harvests and in improving the development and use of community-based monitoring as an important information source.
    b. Develop pan-Arctic conservation and management plans for shared species that are, or will potentially be, harvested or commercially exploited that incorporate common monitoring objectives, population assessments, harvesting regimes, guidelines for best practices in harvest methodology and consider maintenance of genetic viability and adaptation to climate change as guiding principles
    c. Support efforts to plan and manage commercial fisheries in international waters under common international objectives that ensure long-term sustainability of species and ecosystems. Encourage precautionary, science-based management of fisheries in areas beyond national jurisdiction in accordance with international law to ensure the long-term sustainability of species and ecosystems.
    d. Support efforts to develop, improve and employ fishing technologies and practices that reduce by-catch of marine mammals, seabirds and non-target fish and avoid significant adverse impact to the seabed.
    e. Develop and implement, in cooperation with reindeer herders, management plans that ensure the sustainability of reindeer herding and the quality of habitat for grazing and calving.
11. **Reduce the threat of pollutants to Arctic biodiversity.**
    a. Support and enhance international efforts and cooperation to identify, assess and

reduce existing and emerging harmful contaminants.

b. Support the development of appropriate prevention and clean up measures and technologies that are responsive to oil spills in the Arctic, especially in ice-filled waters, such that they are ready for implementation in advance of major oil and gas developments.

c. Encourage local and national action to implement best practices for local wastes, enhance efforts to clean-up legacy contaminated sites and include contaminant reduction and reclamation plans in development projects.

IMPROVING KNOWLEDGE AND PUBLIC AWARENESS

12. **Evaluate the range of services provided by Arctic biodiversity in order to determine the costs associated with biodiversity loss and the value of effective conservation in order to assess change and support improved decision making.**

13. **Increase and focus inventory, long-term monitoring and research efforts to address key gaps in scientific knowledge identified in this assessment to better facilitate the development and implementation of conservation and management strategies.** Areas of particular concern identified through the ABA include components critical to ecosystem functions including important characteristics of invertebrates, microbes, parasites and pathogens.

14. Recognize the value of traditional ecological knowledge and work to further integrate it into the assessment, planning and management of Arctic biodiversity. This includes involving Arctic peoples and their knowledge in the survey, monitoring and analysis of Arctic biodiversity.

15. **Promote public training, education and community-based monitoring, where appropriate, as integral elements in conservation and management.**

16. **Research and monitor individual and cumulative effects of stressors and drivers of relevance to biodiversity, with a focus on stressors that are expected to have rapid and significant impacts and issues where knowledge is lacking**. This should include, but not be limited to, modeling potential future species range changes as a result of these stressors; developing knowledge of and identifying tipping points, thresholds and cumulative effects for Arctic biodiversity; and developing robust quantitative indicators for stressors through the Circumpolar Biodiversity Monitoring Program.

17. **Develop communication and outreach tools and methodologies to better convey the importance and value of Arctic biodiversity and the changes it is undergoing.**

From ABA synthesis

1.5. Stressors and their alleviation

1.5.1. Stressors originating from within the Arctic

1.5.1.1. Direct human impacts on habitats

Possible conservation actions

- To succeed, biodiversity conservation needs to be a cornerstone of natural resource management and land and marine planning throughout the Arctic for the benefit of Arctic residents and biodiversity en general. To achieve this, a diversity of legal, regulatory and best management practice tools could be employed at diverse scales. Possible detrimental cascading effects on nearby endemic Arctic biodiversity and unique Arctic habitats are important considerations in land and marine planning and monitoring.
- Comprehensive national approaches to protected area planning and establishment are effective biodiversity conservation mechanisms. Eco-regional representation, connectivity, critical areas for various life stages, biodiversity hotspot analyses and maintenance of the most productive and/or resilient areas are important approaches to consider.14 This work could build on work already done, such as AMSA IIC (AMSA 2009) and RACER (Christie & Sommerkorn 2011).
- Given the scale of changes forecast for the Arctic that will often result in substantial habitat displacements (c.f. Section 1.5.2.1), it is important that protected areas are: (1) large enough to safeguard critical habitat for target populations, (2) strategically selected (i.e. forming ecological networks of sites) and (3) managed in coordination with other approaches that support the overall resilience of regional ecosystems and species.
- To secure species representation, protection of areas with many unique species should be given high priority, so that a total Arctic network is based on the 'complementary species richness' method and covers as much of the entire biodiversity as possible (Vane-Wright et al. 1991, Myers et al. 2000).
- Productive and varied areas deserve high priority in protected area planning and management. Especially in the high Arctic, such areas often constitute 'oases' that may function as source habitats for surrounding areas (Hodkinson, Chapter 7, Daniëls et al., Chapter 9, Michel, Chapter 14). Such hotspot areas are found in terrestrial, marine and freshwater biomes, and include biologically important polynyas, persistent areas of perennial sea ice, large river deltas, unique lake systems, hot springs and cold seeps, and seasonally important areas for reproduction, molt and fattening of many birds, fishes and mammals (Reid et al., Chapter 3, Ganter & Gaston, Chapter 4, Wrona & Reist, Chapter 13). The same priority applies to important areas for endangered species and particularly sensitive or vulnerable populations (see also Sections 5.1.2).
- The design and implementation of mechanisms to ensure the maintenance of ecosystem structure, functions and processes and the representativeness of marine habitats and refugia with low human impact should be considered. A circumarctic Marine Protected Area (MPA) network could be an important part of such an effort. As many important areas cross jurisdictional boundaries, cooperation is essential. Such a network could include the establishment of an effective management system of deep-sea areas and large estuaries,

which contain a relatively high proportion of endemic invertebrate species as well as several members of the species-rich fish families (Christiansen & Reist, Chapter 6, Josefson & Mokievsky, Chapter 8).

- Arctic fish species are largely bottom-living (Karamushko 2012), and since Arctic groundfish fisheries are expected to increase in the coming years, the development and deployment of fishing practices that minimize by-catch and seabed destruction are critical. Since protected areas are of little conservation value if their legal protections are moderated when economic or other conflicting interests appear (see section on protected area failure in Sutherland et al. 2011), the status of protected areas needs to be maintained and enforced.
- When unavoidable alteration of high priority areas takes place, these impacts could be mitigated by improved protection of other important habitat. However, true compensatory measures in the form of 're-wilding', which are used in other parts of the world, are of little relevance in the Arctic where there is almost no modified habitat to return to a more natural state. Areas already impacted by bottom trawling and heavy grazing and trampling by reindeer are exceptions to this, as there is room for recovery of affected areas by reducing the impacts and allowing for re-generation.
- Mitigation and restoration of disturbed or damaged habitat needs to be incorporated into development projects at the planning stage. This should include consideration of the full cost of restoration and remediation activities.

1.5.1.2. Harvest of mammals, birds and fish

Possible conservation actions

- To maximize the adaptive capacity of harvested populations of mammals and birds, with respect to harvest, climate change and genetic viability, populations should be allowed to achieve and maintain healthy population levels that meet sustainable harvest management goals. This step includes allowing depleted populations to recover (see text above for examples). Maintaining viable populations can be achieved by, for example, regulation of the take itself, harvest methods and the establishment of protected zones e.g. for reproduction, molting and feeding.
- The principles of ecosystem-based management (EBM) distribute risk such that ecosystem sustainability is enhanced and ecosystems do not disproportionately suffer the impacts of tradeoffs resulting from management decisions concerning utilization of Arctic resources. This approach would help support the resilience and sustainability of ecosystems in the face of harvests and the many other uses of and impacts to Arctic resources and areas.

1.5.1.3. Displacement of animals from important habitats

Possible conservation actions

- The affects of human disturbance on population size and fecundity is largely unknown. As human activities increase, the impact of this as a stressor needs to be better understood and monitored.
- Human disturbances should to be kept at a level that does not significantly alter animals' patterns of utilizing existing food resources, natural behaviors and ability to breed, molt and rest. One of the tools for achieving this is the establishment of reserves and other low-

disturbance areas as refugia especially for hunted populations (see e.g. Madsen & Fox 1995). Other tools include seasonal restrictions, speed limits, reducing or minimizing travel in key areas during sensitive periods16, height restrictions for aircraft and minimizing noise in marine ecosystems including stand-off distances and a ramp-up period at the start of seismic activities.

- For species coming under severe pressure from climate change, alternative habitat should be or safeguarded such as safe coastal haul out sites for walrus, in areas where ice haul out sites are no longer suitable due to loss of ice or distance from feeding areas.

1.5.1.4. Pollutants originating in the Arctic

Possible conservation actions

- A major oil spill in ice filled Arctic waters would be detrimental to biodiversity and very difficult to clean up, particularly under problematic weather, light and ice conditions. However, if oil development is undertaken, a precautionary approach adhering to regulations and guidelines specific to the Arctic based on the best available science would reduce risks, including that development activities in the most sensitive areas are avoided.
- Research efforts into understanding the consequences of oil spills in sea-ice environments remain essential to ensure advances in knowledge and development of improved technologies specific to oil and gas development in the Arctic.
- Some tools that may help to reduce other pollution originating from within the Arctic are: (1) for ship operations in the Arctic, a mandatory polar code encompassing vessel construction, maintenance and operations (e.g. routes, speeds) would help minimize the risks, (2) best management practices for local waste management are desirable throughout the Arctic, (3) minimizing black carbon emissions would reduce the impact of this important driver of climate change, and (4) ongoing clean-up of legacy contaminated sites from military activity and historic mining and oil and gas exploration will continue to reduce contaminant inputs to the environment.

1.5.2. Stressors originating from outside the Arctic

1.5.2.1. Climate change

Possible conservation actions

- Sufficient efforts to reduce global greenhouse gas emissions, and thereby human-induced climate change, are needed if the threat of climate change is to be addressed. Continued warming is overwhelmingly the most serious predicted threat to Arctic biodiversity, as it will fundamentally alter Arctic biodiversity at the habitat, species and ecosystem level. In fact, the global goal that world leaders have set for climate change mitigation, i.e. 2 °C (UNFCCC 2010), may not be adequate to protect Arctic biodiversity since the Arctic is warming twice as fast as the global average. Mechanisms to address climate change are presented by IPCC (2007b), UNEP et al. (2011) and elsewhere, recognizing that urgent and far-reaching global actions are required to address this problem that has worldwide causes and worldwide impacts.21 This assessment provides additional evidence pointing to the urgency of addressing this issue.

- The reduction of black carbon emissions is a high priority, since a reduction in the emissions of black carbon (and tropospheric ozone) is the fastest way to reduce the 'polar amplification' of global warming in the Arctic (Lenton 2012).
- High priority for conservation planning should be given to the protection of networks of large, representative tracts of habitat. This should include northern 'refugia' areas to support and maintain the resilience of Arctic ecosystems, such as Arctic islands and mountainous areas together with the remaining multi-year sea ice areas, where unique Arctic biodiversity has the best chance of surviving climate change.
- Furthermore, the reduction or minimization of all other stressors to biodiversity will help mitigate the effects of climate change (IPCC 2007c).

1.5.2.2. Pollutants originating outside the Arctic

Possible conservation actions

- Efforts to identify and assess emerging contaminants that may pose a threat to Arctic biodiversity should continue, combined with implementation of appropriate control mechanisms to limit their input into the Arctic.
- The successful international efforts already made to ban the most problematic substances should continue, and could be expanded to limit the discharge of the rest.
- Enhanced integrated, multi-disciplinary research and monitoring could be established to improve our understanding of the fate, distribution and effects of contaminants on biota and ecosystem structure and function, including achieving an improved mechanistic understanding of interactions with other relevant environmental stressors (e.g. climate variability/change) and cumulative effects.

1.5.2.3. Invasive species

Possible conservation actions

- Cost-effective early detection monitoring networks for invasive alien species linked to a common repository would facilitate immediate and thereby effective response.
- Preventative approaches that block pathways of invasive species introduction are important to implement at both the national and international levels.22
- Expanded inventory efforts at points of entry into the Arctic (e.g. roads, airports and harbors) are needed to enhance rapid response capabilities to eradicate introductions such as rats on seabird islands early in the invasion process.
- For marine species, support for ongoing international efforts to reduce the risk of introducing alien species such as ballast water treatment and the effective cleaning and treatment of ship hulls and drilling rigs brought in from other marine ecosystems is important.

1.5.2.4. Stressors on migratory species

Possible conservation actions

- Cooperation with non-Arctic states is crucial to address threats on the staging and wintering grounds of migratory species. This includes international cooperation through multi-lateral and bi-lateral agreements. One example is the Convention on the Conservation of Migratory

Species of Wild Animals together with its agreements and management plans (see Scott 1998).

- Habitat loss is the most serious stressor today for most migratory birds, and hence conservation action should include conservation of wetlands and other important habitats for staging and wintering Arctic birds.
- Overharvest and poisoning of birds by lead shot should be reduced where these are still a problem.
- To protect Arctic seabirds from oil spills on their staging and wintering grounds, it is important that Arctic nations continue efforts to reduce this risk.
- For endangered species, such as the spoon-billed sandpiper, international recovery programs need to be developed and implemented (see also Section 1.5.1.2).
- Caribou/reindeer migrations could be facilitated by protecting calving grounds and major travel routes (see Section 1.5.1.3).
- Regulation of the take of fish and whale stocks through existing international agreements should be supported, adhered to and further developed in accordance with the best scientific advice.
- The large goose numbers established during the last half century need to be carefully monitored. Where not already existing, management plans could be developed, implemented and followed up in cooperation between range states of the populations involved.

1.6. Knowledge gaps

Possible actions

- The lack of basic knowledge about many aspects of Arctic biodiversity hampers our ability to evaluate the effectiveness of conservation actions. The threat of overharvest has been greatly reduced in the Arctic in part because sufficient knowledge exists to develop effective conservation measures and to build support for those actions. This success applies, however, only to a relatively few harvested species. Other conservation measures make up for a lack of specific knowledge with a broad approach, as is the case with protection of large areas of habitat. A comprehensive approach to gathering data about species and ecosystems is needed to better understand how environmental change and changes in human activity will affect Arctic biodiversity and the conservation thereof.
- The lack of monitoring and modeling capability for many aspects of Arctic biodiversity makes it difficult to assess change and its implications. Change cannot be measured without a baseline. For many species and ecosystem processes, that baseline of knowledge does not exist. Similarly, modeling efforts have focused on the physical environment and a few key species or ecosystem parameters. A coordinated monitoring and modeling effort is needed to support biodiversity conservation efforts in a time of rapid change.
- The lack of specimens and museum collections means that a firm foundation for assessing biodiversity and changes thereto is missing. A solid baseline requires hard data and definitive specimens. This area has received insufficient attention to date. A collaborative approach to collection and archiving of specimens could help ensure that further change can be assessed and quantified.

- A great deal of research has been done on various aspects of Arctic biodiversity, but overall databases and knowledge bases do not exist for most topics. The circumpolar study of Arctic biodiversity is further hindered by barriers to the access of field sites. Broad support for open science, from field work to analysis to archives, would help address this issue and provide a means to pool collective knowledge and expertise.
- The shortage of trained professionals in appropriate fields related to biodiversity means that filling knowledge gaps will remain a challenge. Too few scientists are available to work on many aspects of biodiversity, from taxonomy and systematics to integrative problem solving. Greater efforts could be made to recruit and support specialists in these fields, so that needed knowledge can be generated in a timely fashion to support conservation of Arctic biodiversity.
- The lack of awareness of most aspects of Arctic biodiversity, combined with the limited degree to which Arctic residents are involved in biodiversity research and conservation, reduces public and political support for important conservation actions. Charismatic species get a great deal of attention, which can help support species-oriented conservation measures. A commitment to conserving overall biodiversity as a vital legacy for all of humankind, however, will require broader public understanding of what is at stake, and broader participation in generating information and solutions.

1.7. Suggested conservation and research priorities

The erosion of global biodiversity is not the only global crisis of our time. It has been argued that changes in climate, biodiversity, infectious diseases, energy supplies, food, freshwater, human population and the global financial system are part of one contemporary global challenge, and that they need to be addressed as such (Steffen et al. 2011). If this is not done in an integrated and sustainable way, efforts to address one challenge may very well worsen one or more of the others considerably. Also, global markets seek the exploitation of Arctic resources, resulting in greater interconnections between the Arctic and the rest of the world.

To safeguard Arctic biodiversity and the services we receive from it, three spatial levels of stressors must be addressed: (1) global and circumpolar stressors like climate change and long-range transport of contaminants by air and sea water, (2) regional stressors like overexploitation and invasive alien species, and (3) more 'localized' stressors like mineral extraction, oil development and ship accidents. Here we provide a set of suggested priorities for actions defined according to these three geographical scales. These priorities flow from the suggested actions in the technical chapters and this synthesis. They are intended to provide guidance to CAFF in development of recommendations from this report.

The alleviation of stressors with circumpolar effects on species and ecosystems generally requires international cooperation for effective management (Steffen et al. 2011).23

- Conserving the unique Arctic biome will require all possible efforts to curb human-induced global warming.

- Global and regional actions to reduce both legacy and new environmental contaminants entering Arctic ecosystems should continue and, where necessary, intensify under existing international conventions.
- Effective conservation of Arctic biodiversity needs to be global in scope and requires significant international cooperation to succeed. Any action to solve one global challenge should take others into account so that measures to solve one stressor do not worsen others.

Since many fish, birds and mammals move between different regional and national jurisdictions, management can benefit from regional cooperation.

- To maximize the resilience of Arctic ecosystems, effective protection of large representative tracts of habitat, including hotspots for unique Arctic biodiversity and northern 'refugia' areas, is of paramount importance. This includes Arctic islands together with mountainous areas and multi-year sea-ice refuges, where unique marine Arctic biodiversity has the best chance of surviving climate change.
- A major oil spill in ice filled Arctic waters would be detrimental to biodiversity and very difficult to clean up, particularly under problematic weather, light and ice conditions. However, if oil development is undertaken, a precautionary approach adhering to regulations and guidelines specific to the Arctic and based on the best available science would help reduce risk, and development activities in the most sensitive areas should be avoided.
- Focused harvest management of fish, birds and mammals is needed on those species and populations that have experienced major declines for which harvest is one of the causal factors (see Section 1.5.1.2).
- To protect staging and wintering wetland areas for Arctic waterbird migrants from both habitat loss and overharvest, concerted international efforts should be conducted to conserve a network of key areas and address overharvest.
- To effectively protect Arctic native species and ecosystems from devastating effects of invasive alien species, appropriate efforts are needed to prevent their establishment in the Arctic. Early detection and preventative actions should focus on areas of human activity and disturbance.

Although local stressors can entirely be managed by national or local authorities, bilateral or international cooperation on common standards can be beneficial.

- To protect Arctic biodiversity from severe impacts from local development and industrial activity, biodiversity conservation needs to be a cornerstone of natural resource management and land and marine planning.
- Improved monitoring and research is needed to survey, map and monitor Arctic biodiversity including integrated, repeated data collection following recommended standardized protocols, and involving Arctic citizens in the survey and monitoring, if we are to move ahead with science-informed decisions in the Arctic. Support for national and international coordinated efforts such as the CBMP and the BAR Code of Life is important to fill critical data gaps on population abundances and trends for many Arctic terrestrial and marine species.

In order to effectively respond to these suggested priorities, international cooperation and direct action at the national level are required. Many such efforts are already underway, and the Arctic

countries possess strong legal frameworks that can form the basis for effective conservation of Arctic biodiversity. The Arctic Council has also established mechanisms for regional cooperation and scientific collaboration on research and monitoring e.g. the CBMP. Nevertheless, such agreements and initiatives are of little use if not backed up by secure funding, enforcement and popular support.

AOA

from Arctic Ocean Acidification Assessment: Summary for Policymakers

What can the Arctic Council States and members do to address this serious issue for our future?
Because more than a quarter of global carbon dioxide emissions from fossil fuels come from the Arctic Council States, the Arctic Council has an opportunity to provide leadership by addressing the global ocean acidification issue. It is increasingly clear from the scientific evidence that immediate cuts in carbon dioxide emissions are essential to slow the acidification of the Arctic Ocean. The biological, social, and economic effects of ocean acidification are potentially significant for the Arctic nations and their peoples, as well as global society. Effects on the marine ecosystems and northern societies due to ocean acidification are likely to have significant impacts, particularly on future fisheries and potentially on harvesting of marine mammals and marine tourism. There remain large gaps in knowledge that currently prevent reliable projections of these impacts.

It is recommended that the Arctic Council

1. Urge its Member States, Observer countries, and the global society to reduce the emission of carbon dioxide as a matter of urgency.
2. Call for enhanced research and monitoring efforts that expand understanding of acidification processes and their effects on Arctic marine ecosystems and northern societies that depend on them.
3. Urge its Member States to implement adaptation strategies that address all aspects of Arctic change, including ocean acidification, tailored to local and societal needs.

Key findings

As predicted by chemistry, change in the Arctic Ocean is accelerating as temperatures warm faster than the global average, as the sea ice melts, as northern rivers run stronger and faster, delivering more fresh water farther into the northernmost ocean, and as we continue blasting an ever increasing quantity of greenhouse gases into the atmosphere. The Arctic Ocean Acidification Assessment, a new report from the Arctic Monitoring and Assessment Program (AMAP), presents these 10 key findings:

Acidification in the Arctic Ocean:

1. Arctic marine waters are experiencing widespread and rapid ocean acidification. Scientists have measured significant rates of acidification at several Arctic Ocean locations. In the Nordic Seas, for example, acidification is taking place over a wide range of depths— most rapidly in surface waters and more slowly in deep waters. Decreases in seawater pH of about 0.02 per decade have been observed since the late 1960s in the Iceland and Barents Seas. Notable chemical effects related to acidification have also been encountered in surface waters of the Bering Strait and the Canada Basin of the central Arctic Ocean.

2. The primary driver of ocean acidification is uptake of carbon dioxide emitted to the atmosphere by human activities. When carbon-rich materials such as coal or oil are burned (for example, at power stations), carbon dioxide is released to the atmosphere. Some of this gas is absorbed by the oceans, slowing its build-up in the atmosphere and thus the pace of human-induced climate warming, but at the same time increasing seawater acidity. As a result of human carbon dioxide

emissions, the average acidity of surface ocean waters worldwide is now about 30% higher than at the start of the Industrial Revolution.

3. The Arctic Ocean is especially vulnerable to ocean acidification. Owing to the large quantities of freshwater supplied from rivers and melting ice, the Arctic Ocean is less effective at chemically neutralizing carbon dioxide's acidifying effects, and this input is increasing with climate warming. In addition, the Arctic Ocean is cold, which favors the transfer of carbon dioxide from the air into the ocean. As a result of these combined influences, Arctic waters are among the world's most sensitive in terms of their acidification response to increasing levels of carbon dioxide. The recent and projected dramatic decreases in Arctic summer sea-ice cover mean that the amount of open water is increasing every year, allowing for greater transfer of carbon dioxide from the atmosphere into the ocean.

4. Acidification is not uniform across the Arctic Ocean. In addition to seawater uptake of carbon dioxide, other processes can be important in determining the pace and extent of ocean acidification. For example, rivers, sea-bottom sediments, and coastal erosion all supply organic material that bacteria can convert to carbon dioxide, thus exacerbating ocean acidification, especially on the shallow continental shelves. Sea-ice cover, freshwater inputs, and plant growth and decay can also influence local ocean acidification. The contributions of these processes vary not only from place to place, but also season to season, and year to year. The result is a complex, unevenly distributed, ever changing mosaic of Arctic acidification states.

<u>Biological responses to ocean acidification</u>

5. Arctic marine ecosystems are highly likely to undergo significant change due to ocean acidification. Arctic marine ecosystems are generally characterized by short, simple food webs, with energy channeled in just a few steps from small plants and animals to large predators such as seabirds and seals. The integrity of such a simple structure depends greatly on key species such as the Arctic cod. Pteropods (sea butterflies) and echinoderms (sea stars, urchins) are key food-web organisms that may be sensitive to ocean acidification. Too few data are presently available to assess the precise nature and extent of Arctic ecosystem vulnerability, as most biological studies have been undertaken in other ocean regions. Arctic-specific long-term studies are urgently needed.

6. Ocean acidification will have direct and indirect effects on Arctic marine life. It is likely that some marine organisms will respond positively to new conditions associated with ocean acidification, while others will be disadvantage, possibly to the point of local extinction. Examples of direct effects include changes in growth rate or behavior. The best-studied direct effects include effects on shell formation and organism growth: experiments show that a wide variety of animals grow more slowly under the acidification levels projected for coming centuries. Some seagrasses, in contrast, appear to thrive under such conditions. Indirect effects include changes in food supply or other resources. For example, birds and mammals are not likely to be directly affected by acidification but may be indirectly affected if their food sources decline, expand, relocate, or otherwise change in response to ocean acidification. Ocean acidification may alter the extent to which nutrients and essential trace elements in seawater are available to marine organisms. Some shell-building Arctic mollusks are likely to be negatively affected by ocean acidification, especially at early life stages. Juvenile and adult fishes are thought likely to cope with the acidification levels projected for the next century, but fish eggs and early larval stages may be more sensitive. In general, early life stages are

more susceptible to direct effects of ocean acidification than later life stages. Organisms living in environments that typically experience wide fluctuations in seawater acidity may prove to be more resilient to ocean acidification than organisms accustomed to a more stable environment.

7. Ocean acidification impacts must be assessed in the context of other changes happening in Arctic waters. Arctic marine organisms are experiencing not only ocean acidification, but also other large, simultaneous changes. Examples include climate change (which fundamentally changes physical, chemical, and biological conditions), harvesting, habitat degradation, and pollution. Ecological interactions—such as those between predators and prey, or among competitors for space or other limited resources—also play an important role in shaping ocean communities. As different forms of sea life respond to environmental change in different ways, the mix of plants and animals in a community will change, as will their interactions with each other. Understanding the complex, often unpredictable effects of combined environmental changes on Arctic organisms and ecosystems remains a key knowledge gap.

Potential economic and social impacts of ocean acidification on Arctic fisheries

8. Ocean acidification is one of several factors that may contribute to alteration of fish species' composition in the Arctic Ocean. Ocean acidification is likely to affect the abundance, productivity, and distribution of marine species, but the magnitude and direction of change are uncertain. Other processes driving Arctic change include rising temperatures, diminishing sea ice, and freshening surface waters.

9. Ocean acidification may affect Arctic fisheries. Few studies have estimated the socio-economic impacts of ocean acidification on fisheries, and most have focused largely on shellfish and on regions outside the Arctic. The quantity, quality, and predictability of commercially important Arctic fish stocks may be affected by ocean acidification, but the magnitude and direction of change are uncertain. Fish stocks may be more robust to ocean acidification if other stresses—for example, overfishing or habitat degradation—are minimized.

10. Ecosystem changes associated with ocean acidification may affect the livelihoods of Arctic peoples. Marine species harvested by northern coastal communities include species likely to be affected by ocean acidification. Most indigenous groups harvest a range of organisms and may be able to shift to a greater reliance on unaffected species. Changing harvests might affect some seasonal or cultural practices. Recreational fish catches could change in composition. Marine mammals, important to the culture, diets and livelihoods of Arctic indigenous peoples and other Arctic residents could also be indirectly affected through changing food availability.

ARR

(from ARR update and summary for policy makers)

INTRODUCTION

Societies and ecosystems are interdependent, but they are often analyzed separately and managed as if they were distinct systems. The Arctic Resilience Report (ARR) is an Arctic Council project that analyses the resilience of these closely coupled social-ecological systems in the Arctic. The following are the KEY MESSAGES from the ARR Interim Report.

1. The Arctic is subject to major and rapid changes in social and economic systems, ecosystems and environmental processes. These interact in ways that have profound implications for the wellbeing of indigenous and non-indigenous peoples.

   The Arctic is changing rapidly in ways that interact and fundamentally affect the region's ecosystems and societies. Climate change is important, but it is not the only driver of rapid change in the Arctic. In many contexts, social, political and economic drivers may be of greater importance than global warming. Social processes driving Arctic change include increasing resource demand and transportation needs, migration, geopolitical changes and globalization. As a result, many Arctic social-ecological systems are facing multiple social and environmental stressors at once.

   Functioning ecosystems serve as a foundation for human wellbeing by providing basic necessities such as food and water and other ecosystem services. Moreover, for indigenous peoples and many rural communities, culture is constructed around livelihood activities such as reindeer husbandry, farming, fishing, and hunting and gathering. Changes in the environment can thus lead to the erosion or loss of core cultural elements.

   Adaptive capacity depends on knowledge (including traditional knowledge and languages), capacity to work collectively as a group to solve problems, skills and leadership, financial resources, and infrastructure. Adaptive capacity also depends on the availability of and access to diverse ecological resources. Social changes can affect many of these sources of resilience. Moreover, economic development leads both to new opportunities and to increased competition for resources, including the risk of loss of ecosystem services that provide for options for future adaptation.

   A major task for the second phase of the ARR is to analyze how environmental and social changes affect adaptive capacity, and how adaptive capacity can be strengthened.

2. A resilience framework provides an integrative approach for assessing linked social and ecological changes across scales, identifying the risk of threshold effects, and building capacity to respond.

   While some Arctic changes are already upon us, others will be avoidable, and yet others are necessary to ensure the long-term viability of Arctic social-ecological systems. For example, observations show that the Arctic climate is changing, but the ultimate amount

of warming and the nature of society's response to anticipated changes are largely matters of societal choices and capacities. An understanding of resilience – the ability of human and natural systems to adapt or transform in the face of change – is essential for such choices. Society's options for action can be shaped by an understanding of resilience and the risks associated with crossing thresholds of change.

The resilience concept focuses on change, and how social and environmental processes interact across time and space in ways that can reinforce change, potentially causing abrupt and irreversible shifts or threshold effects. It also includes attention to how social and environmental changes shape the capacity to respond. The resilience approach recognizes that dynamics of change are shaped by feedbacks that can act at multiple scales of space and time. Global trends are playing out in the Arctic, while at the same time local Arctic changes can have consequences on larger scales. Understanding the coupled social and environmental dynamics of Arctic change is an important step for identifying and implementing strategies for adaptation and transformation.

The risk for cascading interactions of ecological and social effects across scales need further analysis in order to inform decisions about future development in the Arctic. This will be a focus in Phase 2 of the ARR.

3. Abrupt changes have been observed in the environment across the Arctic. Such changes risk crossing environmental thresholds that can have long-term consequences affecting options for future development.

   There is widespread evidence of major changes in Arctic landscapes and marine environments. Many of these changes involve abrupt, large scale and sometimes irreversible thresholds. Climatic changes are affecting the Arctic cryosphere, hydrology, habitats and species. Examples of climate-related thresholds include the formation of wetlands and new lakes in some areas and the rapid draining of lakes and loss of freshwater resources in other areas as permafrost degrades. Changes in temperature, sea-ice cover, snow cover and water regimes are related to the loss of important habitats for Arctic species, shifts in the species composition of ecosystems, and landscape transformations, with impacts on ecosystem services and livelihoods.

   Ecosystem shifts often arise from extreme events. Such shifts have been observed for drainage of shallow lakes, insect outbreaks and wildfires. Many Arctic species are long-lived and well-adapted to a wide range of climate variability, but cannot recover from catastrophic events beyond that range.

   Phase 2 of the ARR will further analyze the biophysical and social feedbacks that increase the risk for crossing environmental thresholds.

4. Arctic change has global effects, with potential impacts on societies, ecosystems and options for development across the world.

   Ecological and social changes can cascade across scales. Strong evidence points to the importance of the Arctic in the physical functioning of the Earth's climatic regulatory systems. The current sea ice loss in the Arctic may represent a threshold change of global

significance. Because the ice-capped poles play a vital role in cooling the global climate, the extensive loss of ice in the Arctic is causing a positive warming feedback. It has been linked to changes in persistent weather patterns and to extreme conditions in the northern hemisphere. It is also an indicator that climate change is entering a new phase. Other examples of impacts of environmental change that extend far beyond the Arctic region include the role of melting ice caps and glaciers in sea level rise, and the release of carbon dioxide and methane as a result of thawing permafrost. The changing global role of Arctic natural resources in the world's economy exemplifies the importance of the links between social and ecological systems.

5. The range of options for responding to change may be compromised by past decisions and interventions, particularly those that have eroded traditional safeguards of resilience.

   Arctic indigenous cultures have evolved in a highly variable environment. Well-known cultural adaptations that enhance flexibility, such as nomadic lifestyles and ways of making decisions that include attention to diversity in food sources and subsistence practices, have provided important sources of resilience when environmental conditions vary. Forced settlement, loss of land, and management strategies that do not allow for diversity have eroded some of this flexibility, as have policies that have led to erosion diversity of ways of knowing. The notion of the inherently highly adaptive northerner may no longer be valid, raising the need to better understand how policy decisions today can increase flexibility and capacity to respond to ecological and social changes in the immediate and long-term future.

   Understanding traditional sources of resilience is an important part of a resilience assessment. Phase 2 of the ARR will continue to engage with and explore the role of traditional and indigenous knowledge.

6. Rapid Arctic change is likely to produce surprises, so strategies for adaptation and, if necessary, transformation, must be responsive, flexible and appropriate for a broad range of conditions.

   Planning for the future in the Arctic needs to take rapid environmental and social change into account, including inevitable uncertainty about the details of future conditions. The decline in sea ice has been more drastic than anticipated and similar surprises are likely as ecosystems pass thresholds that affect their ability to provide ecosystems services. The ability of society and individuals to respond successfully is likely to depend on a diversity of perspectives and innovative problem-solving. Some innovative adaptive solutions have already emerged in the Arctic, along with a stronger focus on co-management and social learning, the devolution of power to local decision makers, and the incorporation of local and traditional knowledge. However, more work is needed to understand and facilitate local responses to rapid environmental and social changes. New networks can build social relations and trust and enhance the ability to respond to surprises.

7. Governing in the Arctic will require difficult choices that require grappling with different and sometimes conflicting priorities. The resilience approach helps capture the complex

interrelated processes that need to be better understood for effective decision-making. Participatory processes can more effectively ensure that diverse voices are represented and that all relevant forms of knowledge are included in decisions.

Governing for resilience raises questions about “resilience for whom” and “resilience of what”. A useful adaptation for some people can be maladaptive if viewed from a different perspective. Sometimes socio-economic transformation can be desirable for some but not for others. Governing for transformation can include political decisions that reduce the barriers for change and inevitably include choices about a desirable future. Such choices benefit from broad engagement in decision making. Effective engagement across the Arctic requires investing in capacity-building, including skills and knowledge, and finding ways to stimulate creativity and motivation. Innovative participatory processes in the Arctic can provide examples for other parts of the world.

Task Force on Arctic marine oil pollution preparedness and response; Recommended Practices in the Prevention of Arctic Marine Oil Pollution (RP3)

From: Summary report and recommendations prevention of marine oil pollution in the Arctic

RECOMMENDATIONS

Based on the information and findings in the RP3 technical report, the EPPR working group has identified the following recommended prevention initiatives that would contribute to safer operations and increase knowledge of Arctic-specific risks and possible mitigation measures.

1. Hazardous ice detection, forecasting and monitoring
In order to improve the detection and forecasting of hazardous sea ice in areas of offshore oil and gas operations and shipping, it is recommended that Arctic Council states cooperate to improve the hazardous ice detection and monitoring programs for Arctic waters. This includes satellite services, and the production and dissemination of ice maps in real time. It is also recommended that the Arctic Council expand the investigation into the use of Unmanned Aerial Vehicles (UAV) in the Arctic to include monitoring ice conditions in major Arctic shipping lanes and providing operational support for oil spill response.

2. Standards for Arctic oil and gas activities
International standards bring social and economic benefits by fostering the harmonization of specifications and practices. Standards are relevant to Arctic operations as the Arctic Council jurisdictions share similar operating environments. It is recommended that the Arctic Council catalog all applicable oil and gas standards for Arctic activities (e.g.: facilities, ice management, escape route and drills, training, logistics, security) and highlight differences in the standards. This will provide states an opportunity to learn from practices in other jurisdictions and possibly apply them in their own region.

3. Circumpolar marine environment risk assessment
It is recommended that the Arctic Council inventory existing risk assessments in the Arctic, identify common elements and environmental differences, as well as methodologies for undertaking these activities, and conduct a circumpolar marine environment risk assessment, if appropriate, in order to better link the sensitivities of the Arctic marine environment with scientific calculations on risks caused by shipping and offshore oil and gas activities in the Arctic Ocean both presently and in the future.

4. Facilitate oil spill prevention research and regulatory cooperation
It is recommended that the Arctic Council establish a mechanism whereby regulators are able to share information on best practices, processes, regulatory approaches as well as compliance and operational information (e.g. near-miss data). Analysis of identified trends can be undertaken and various data collection done in an effort to identify Arctic-specific prevention practices while fostering circumpolar collaboration through the pooling of resources. The initial results of this initiative could include the creation of a joint database and regular meetings of regulators. Over time, it has the potential to develop into an Arctic Oil Pollution Prevention Centre of Excellence.

5. Ensure appropriate infrastructure is in place for emerging Arctic shipping lanes

To ensure safe development and mapping of emerging Arctic shipping lanes in order to prevent oil pollution incidents, it is recommended that the Arctic Council conduct an analysis of existing and emerging shipping lanes, identify gaps in infrastructure and mapping, and work towards enhancing the safety of Arctic shipping lanes.

Life linked to Ice report

From section 6. Looking Ahead

RECOMMENDATIONS

1. Facilitate a move to more flexible, adaptable wildlife and habitat management and marine spatial planning approaches that respond effectively to rapid changes in Arctic biodiversity.

> Rapid reduction of sea ice shifts baselines and increases the urgency for biodiversity conservation. Planning and management systems are challenged by the pace of change and increased uncertainty. Decision-makers at local, regional, national and international levels face common challenges in anticipating and adapting to new conditions and addressing conflicting needs, all within a context of heightened global concern for Arctic biodiversity. Designing support for good decision-making should include:
>
> a) analysis of existing systems and how well they are equipped to conserve biodiversity impacted by change in sea ice;
>
> b) identification of common needs and of areas where collaboration through the Arctic Council community would be effective
>
> c) preparation of resources and tools, such as guidelines and best practices.

2. Identify measures for detecting early warnings of biodiversity change and triggering conservation actions.

> Move towards a stronger reliance on early warnings of ecosystem change, rather than on population trends as triggers for making decisions. Aside from catastrophic die-offs and breeding failure, impacts from changes in sea ice are often incremental, such as a reduced rate of reproduction or survival, or less energy intake from prey. Impacts may take years to be detected in population trends, especially for long-lived animals. Measures such as reduced body condition or changes in ice-dependent prey species are evidence of impacts that can be acted on before declines are detected in abundance or distribution. In some cases these earlier actions will prevent or lessen population declines. Factors to consider in selecting such measures of change include long-term costs and benefits, support by research, ability to be updated, and suitability for determining thresholds for action.

3. Make more effective use of local and traditional knowledge in Arctic Council assessments and, more broadly, in ecological management.

> We need the best available knowledge to detect and respond to rapid Arctic ecosystem change. Local and traditional knowledge sources, by their nature, bring a depth of knowledge and understanding of ecosystems, as well as early warnings of change, that complement science-based studies. However, these knowledge sources are generally underutilized in assessment and management except at the scale of the knowledge holders' communities. Arctic Council can provide a leadership role in improving this through:

a) developing methods or tools for more effective presentation and analysis of local and traditional knowledge sources in Arctic Council assessments, and

b) placing a focus on this issue through Arctic Council ecosystem-based management initiatives.

4. Target resource managers when communicating research, monitoring and assessment findings.

Increase efforts to communicate results of research and monitoring relevant to conservation of sea-ice-associated biodiversity. Focus particularly on meeting the information needs of those making on-the-ground wildlife conservation decisions on, for example, conditions of development permits or fish and wildlife harvest regulations. Available information, including from recent Arctic Council assessments, may be hard for managers to sift through or to know what is most relevant to them. Work in this area should engage users of the information in designing content and delivery and should consider methods beyond print media. It should take into account time and resource constraints of the users and considerations such as keeping information up to date. Communication may best be delivered at a national or regional level, but benefits and efficiencies of collaboration through Arctic Council could be explored.

ARCTIC COUNCIL RECOMMENDATIONS

Arctic Council has recently released several assessments and experts group reports that address or are relevant to sea-ice-associated biodiversity. Review of these reports reveals a high degree of congruence in themes and content of the recommendations. All the assessment recommendations emphasize the need to improve Arctic monitoring. As a whole, the recommendations provide comprehensive guidance on priorities and actions of particular relevance to conservation of sea-ice-associated ecosystems.

Recommendations to Reduce Black Carbon and Methane Emissions to Slow Arctic Climate Change - Task Force on Short-Lived Climate Forcers

- Nations of the Arctic Council are well positioned to reduce black carbon and methane emissions to slow the rate of Arctic climate change over the next few decades. Existing technologies and proven best practices are available to reduce these emissions. Arctic nations have different policy options—regulatory and voluntary—that already have been and can continue to be used to deliver black carbon and methane emission reductions. Measures that reduce methane and especially black carbon emissions provide significant health and environmental co-benefits.
- The Arctic Council can encourage the exchange and sharing of knowledge and data; facilitate collaboration and collective action where needed among Arctic nations; and incentivize sustained actions to reduce emissions of black carbon and methane. The Arctic Council can also facilitate the pursuit of common objectives among Arctic nations to reduce short-lived climate forcers in collaboration with other international forums and Observer nations.
- For science and policy reasons, the Arctic Council is especially well suited to play a leadership role in addressing black carbon emissions.

Context and Key Messages

1 Immediate reductions in black carbon and methane emissions can slow Arctic warming over the next few decades. Simultaneously, reducing emissions of carbon dioxide (CO_2)—the largest contributor to global and Arctic climate change—is the most important means of preventing dangerous levels of climate change over the long term.

2 The geographic location of black carbon reductions influences the Arctic climate effect, meaning that measures taken in or near the Arctic can have the greatest impact per unit of emission. Methane emission reductions anywhere in the world slow both Arctic and global climate change. For both black carbon and methane, there are therefore opportunities for Arctic nations to engage with Observer and other nations to pursue measures that protect the Arctic climate.

3 Reducing emissions of methane and particularly black carbon results in significant health benefits.

4 Anthropogenic emissions of black carbon and methane in Arctic nations are significant for the Arctic climate relative to global emissions. Without further action over the next few decades, anthropogenic methane emissions from Arctic nations are projected to increase. Current policies to reduce PM have reduced or are expected to reduce black carbon emissions, most significantly from diesel vehicles. However, without further action, emissions from several other sources may remain significant, or even increase.

Recommendations for Individual Arctic Nations and the Arctic Council to Reduce Black Carbon and Methane Emissions

Recommendation 1: Arctic nations can achieve significant methane mitigation to curtail the projected increase in these emissions over the next few decades. Arctic nations should take actions to ensure broad implementation of the many methane mitigation technologies and practices currently available.

Recommendation 2: Arctic nations can pursue further PM control options that reduce black carbon to ensure the overall downward trend in these emissions continues, and to prevent emission increases for certain sectors.

Recommendation 3: The Arctic nations should continue to improve, develop, and share black carbon emission inventories. The Arctic Council could play a role in synthesizing policy-relevant information from the national inventories.

Recommendation 4: The Arctic Council can facilitate a common “Arctic voice” among Arctic nations to pursue black carbon and methane reduction objectives through engagement with other international forums and with Observer nations.

Recommendation 5: The Arctic Council can request that Arctic nations submit periodic progress reports and action plans, with indicators to measure success.

Recommendation 6: As noted by the Arctic Environment Ministers, the Arctic Council could consider establishing a process to enhance efforts to reduce black carbon emissions from Arctic nations.

Recommendation 7: The Arctic Council has a role to play in raising awareness about the effects of short-lived climate forcers on the Arctic climate and, more broadly, about the need to avoid further Arctic climate change with cascading global effects.

Recommendation 8: The Arctic Council should consider the linkages between efforts to reduce short-lived climate forcers and other work under the council

Recommendation 9: The continued pursuit of known research needs will improve our understanding of how mitigating methane, black carbon, and possibly other short-lived climate forcers, can slow near-term rates of Arctic climate change. There is confidence that actions recommended here could generate climate and health benefits for the Arctic—even if some are currently unquantifiable—despite a number of known uncertainties.

Taking Stock of Adaptation Programs in the Arctic (AACA Part B)

The Arctic Council recognizes that Arctic residents require appropriate information, expertise and tools to better inform and implement adaptation activities. In May 2012, Arctic Council Deputy Ministers adopted a new initiative, "Adaptation Actions for a Changing Arctic" (AACA). The overarching goal of the AACA is to enable more informed, timely and responsive policy and decision-making for adaptation to a rapidly changing Arctic.

AACA has three components:

> A) a synthesis of key findings and recommendations from existing Arctic Council assessments and other relevant national and international reports;
>
> B) a compilation and analysis of existing climate change adaptation efforts within or relevant to the Arctic; and,
>
> C) work with other scientific organizations to consider Arctic-focused climate and integrated environmental frameworks/models than can improve predictions of climate change and other relevant drivers of Arctic change.

This report represents Component B of the AACA. While AACA is framed to address multiple drivers of change, Component B focused solely on adaptation efforts in response to the impacts of climate change. The project is titled "Taking Stock of Adaptation Programs in the Arctic" and was co-led by Canada and Russia. It involved surveying and characterizing climate change adaptation actions, projects and tools that are currently being developed or were completed since 2008, at national, sub-national, regional and local levels within or relevant to the Arctic region. The year 2008 was selected to avoid duplication with the former Arctic Council project "Vulnerability and Adaptation to Climate Change in the Arctic" (VACCA) that was completed in that year. The findings of the VACCA report were considered in the new project.

7. Opportunities for the Arctic Council

This report has underlined the breadth and complexity of climate change adaptation activities underway in the Arctic. All participants in this project expressed strong interest in the Arctic Council continuing work to address climate change adaptation. They noted that many resources are already being devoted to adaptation planning and implementation, and that the demand for concrete action is growing. There is a desire to learn more about others' experience and to share knowledge so that adaptation efforts can be efficient, effective and successful.

It was also noted that the many changes facing Arctic residents are linked in one way or another to the impacts of climate change. For example, the increased attention to resource exploration and extraction relates to the accessibility of these resources as a result of a warming climate. Therefore, discussions on adapting to climate change need to be integrated with broader discussions on adapting to new economies and lifestyles.

The Arctic Council has an important role to play in facilitating the generation and exchange of information aimed at decision-makers at all levels on circumpolar issues. The following are some potential directions for further work on climate change adaptation by the Arctic Council that have emerged from the analysis of information collected for this project and in consultations with project

representatives. These recommendations for consideration are not necessarily discrete and a combination of initiatives or a phased approach could be prudent.

7.1 Focus on a particular sector

A survey, broad assessment or case study approach could be useful if it is focuses narrowly on a particular sector. This specific focus could assist in targeting resources, support an in-depth analysis and facilitate the identification of relevant experts and practitioners to contribute to the initiative. Sectors of high interest and concern across Arctic Council states for climate change adaptation efforts include infrastructure, transportation, human health, fisheries and natural resource development.

7.2 Focus on tools and their dissemination

Further scoping an initiative to focus on tools could facilitate capturing concrete and practical adaptation activities. Tools could include guidelines, protocols, processes and techniques to implement adaptation activities. Guidance is also required for practitioners and decision-makers at the community level to assess which tool is appropriate for their particular circumstances. In addition, learning about how tools are communicated and assessing the effectiveness of these methods would be useful. For example, a variety of mechanisms were cited in the information collected for this project including workshops, handbooks, newsletters, traditional and social media, sector associations, and non-government or academic organizations.

7.3 Focus on adaptation at the community level

This project has underlined the challenge in collecting information at the community and individual level. At the same time, it is felt that there is considerable practical adaptation experience that is occurring that could be very useful if it was shared. While “consultation fatigue” was mentioned as a concern in some smaller communities, more often the message conveyed was that there is a desire for additional mechanisms to discuss impacts being witnessed, and the projects and changes in behaviour being undertaken to respond to these changes. Therefore, it was recommended that further delving into successful methods to access and communicate personal accounts at the community level would be beneficial.

7.4 Focus on particular success or challenge factors

This report has identified a number of issues that are perceived as contributing to the success of an initiative and issues that present challenges or barriers. Additional analysis of these cross-cutting issues could advance an understanding of best- practices related to implementing adaptation activities. For example, as noted in the report, partnerships are integral to adaptation activities; however, it was not always clear what elements determined whether or not a partnership arrangement would be effective. The inclusion of traditional and/or local knowledge was also cited as important but, more specific details on how best to do this in the context of implementing adaptation measures could be helpful. Overall, how success can be measured in the realm of adaptation could also warrant further examination.

7.5 Develop a database of adaptation activities

A comprehensive database, potentially building on the templates collected for this project could be considered. In determining the scope for a database, it would be helpful to evaluate processes that would be required to gather information to populate it. For example, this project faced process challenges as mentioned earlier, and the previous VACCA project encountered similar challenges, namely in reaching relevant project proponents and in collating consistent information. A streamlined database approach that provides a basic description of adaptation activities and related contact information might be feasible. This would require users of the database to directly communicate with the identified contacts for the adaptation activity to obtain details and insights. The scope, management and long-term value of a database would require further analysis.

7.6 Establish a network for sharing information and expertise

The Arctic Council could consider playing a facilitative role to support capacity building, knowledge development and the exchange of experience related to adaptation by providing mechanisms for this to occur. A web-based platform or portal that provides access to adaptation activities, tools and links to other resources is one option. A portal could also support greater accessibility and increase the utility of the reports produced by Arctic Council working groups that could inform adaptation action. Another, or complimentary option, would be a network of sector-related or other practitioners that could be organized to meet on- line (e.g. shared workspaces, webinars) and/or at face-to-face workshops.

7.7 Assess other international or regional organizations' treatment of adaptation

There are a number of international and regional organizations that provide data, advice, tools, strategies and general information on adaptation for a variety of target audiences. It could be useful to survey these resources to assess if there is a particular gap that could be filled by the Arctic Council and to determine good models for the exchange of information.