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The future of arctic conservation

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ARCTIC CONSERVAT

Contents

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*Polar bears (*Ursus maritimus*) on ice pack.*
PHOTO: © www.JSGrove.com/WWF

Cover: Raja Serotetto reindeer herding at the Yamal peninsula (brigade no. 8 of Yarsalinskoye) in April 2007.
Photo: Ellen Inga Turi.

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Arctic conservation in times of rapid climate change

CONSERVATION IS a difficult concept. With nature under pressure and limited resources at hand, it implies conscious decisions about what is worth keeping, and how this should be done. This process becomes even more difficult in an environment which is changing so rapidly that no one fully understands what the future will look like. Time could be running out for much of what we would like, or indeed need, to conserve.

This edition of The Circle focuses on arctic conservation in times of rapid climate change. We invited conservation experts from a variety of disciplines and organizations to share their thoughts, and are proud to present a very distinguished group of authors who, thanks to their different perspectives, have a lot of inspiring and challenging arguments and opinions.

Dr NEIL HAMILTON
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Some ask questions, some propose concrete solutions, but common to them all is the fact that they highlight the urgent need to rethink the current approach to arctic conservation. As pointed out by Terry Chapin, 'conservation' suggests an effort to sustain current species and ecosystems and 'keep things the same'.

A 'business as usual' approach when the world around us is rapidly changing is futile. New ways of thinking are needed. There are uncertainties related to what these new approaches should be, but a rough direction and certain elements seem to emerge already where the issue is discussed, for example in the jointly organized WWF/Royal Swedish Academy of Sciences workshop on Arctic Conservation Science in Times of Rapid Change earlier this year.

> **"We may not be able to maintain the status quo, so our decisions need to be based around desirable alternatives for arctic ecosystems, including the arctic peoples.**

WWF is actively redefining its conservation agenda in light of these challenges in a manner which we hope will develop answers that will have a lasting impact for arctic ecosystems. We may not be able to maintain the status quo, so our decisions need to be based around desirable alternatives for arctic ecosystems, including the arctic peoples. These desirable alternatives must be based on sound principles and values – both for their definition but also for the process that will get us there. This publication is part of WWF's effort to fuel a discussion for a clear and shared understanding of what these principles and values might be.

On a broader note I would like to thank all of you who have praised the first edition of The Circle. It is a big step to change a longstanding and respected publication like the Arctic Bulletin, and, despite our best efforts to ensure we 'got it right' before publication, it is very reassuring to hear that the format and content work even better than we had hoped. Many thanks!

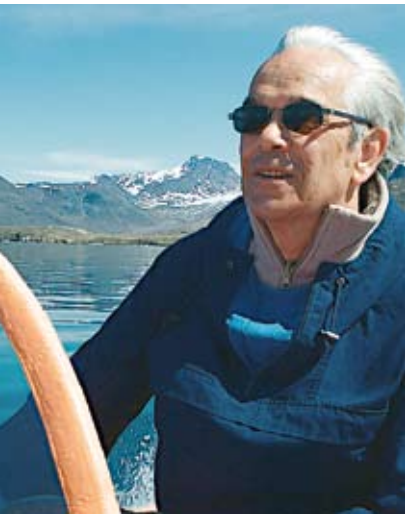

Photo: Rie Oldenburg

Finn Lynge on his way through the Narsaq Strait.

WWF award to Finn Lynge

GREENLANDER Finn Lynge was the recipient of one of the five WWF Awards for Conservation Merit given out at this year's WWF Annual Meeting. Lynge has had a long and outstanding career as priest, social worker, head of Greenland's Radio Broadcasting, politician, NGO activist, civil servant, author and an active commentator and writer. He is the only Greenlandic politician to be elected a Member of the European Parliament.

Lynge has worked over many years to broaden the understanding and bridge the traditional gap between Indigenous peoples' hunting interests and environmental organizations. This award recognizes the role he has played in bringing about a change in perspective for both parties.

In his 1992 book, *Arctic Wars, Animal Rights, Endangered Peoples,* Lynge wrote: "It is very strange for the Indian trapper in the Canadian forests or for the Greenlandic seal hunter in a kayak - people who live as their forebears did further back in history than anyone can remember – to hear comments made about the suffering of the poor animals. Who cares about the suffering that the hunter and the trapper themselves endure in order to secure the daily food for their families? All living things suffer; it has always been this way. Suffering is the price of life, and life feeds on death. Have the city dwellers forgotten this truth of life?"

Arctic climate change and security

A WWF COMMISSIONED study to be released later this year shows that the threat to world security from a melting Arctic is prompting widespread international concern. The *Arctic climate change and security* report is led by Dr. Rob Huebert, a well-known Canadian expert on Arctic security issues. The report is expected to provide important additional angles to the climate change debate, besides the environmental perspectives.

At a WWF-sponsored 'Climate wars 2030' event at the 2030 North Conference in Ottawa in June, Huebert gave participants a sneak preview of where his research is heading, drawing the attention to the fact that climate change is not just about disappearing ice, and thinner polar bears, but a global problem that requires an urgent global solution. Huebert detailed the recent build-up of military interest and capacity in the north. While not suggesting that conflict in the north is imminent, his research shows that various parties are certainly preparing for that possibility.

Huebert was joined on the stage by Gwynne Dyer, a distinguished London-based broadcaster and author. Dyer's latest book is called *Climate wars*, and details how a warming world can easily boil over in series of global flashpoints. Projections for a global temperature increase above two degrees mean many of the world's people will go hungry. The temperature tolerance of the world's main food crops will be exceeded in tropical and subtropical regions. "India will lose 25 percent of its agricultural production at two degrees hotter," says Dyer. He says figures published only fleetingly from China suggest the giant nation could lose up to 38 percent of its agricultural production.

The end of a 'gruelling' expedition

THE WWF-SPONSORED Catlin Arctic Survey team has returned after 73 days of mental and physical challenges on the arctic ice. "It was a gruelling but successful expedition," said expedition leader Pen Hadow. The survey route covered 440 km, during which the team captured around 16,000 observations and took 1,500 measurements of the thickness and density of the ice.

"The average thickness was 1.77 meters," said Hadow. "We had been led by scientists to expect a good mix of old and new ice, but found younger, thinner ice. There is a high probability that sea ice will be a seasonal feature only." The team is now in the process of analysing the data, and expect the first results to be released in the next months.

Photo: Martin Hartley www.martinhartley.com

Photo: Eric Regehr, USFWS.

Nikita Ovsyanikov weighing a sedated polar bear.

Polar bear collaboration

IN MAY, RUSSIAN biologist Nikita Ovsyanikov participated in polar bear research in the Alaskan Chukchi Sea led by the U.S. Fish and Wildlife Service. The scientific exchange was sponsored by WWF as a continuation of the organization's support of US/Russian polar bear conservation and research efforts. During the stay, USFWS biologist Eric Regehr familiarized Ovsyanikov with the methods used to immobilize polar bears for research, and the measurements, samples, and demographic information obtained from them.

"Ovsyanikov's knowledge of polar bear behaviour brought a unique perspective to the project, and provided ideas about how to improve handling methods," said Regehr. Polar bears in the Chukchi Sea move freely across the international border, and depend upon habitats in Russia for critical aspects of their life history, such as maternal denning. To understand the status of the entire Chukchi population and ensure its sound management, coordinated research programs must be initiated in both countries, he emphasized.

"This collaboration will be critical in coming years as we try to understand the current status of the shared Chukchi polar bear population," said WWF polar bear coordinator Geoff York.

31 Alaskan villages 'face imminent threats' from climate change

A US GOVERNMENT agency is recommending more concerted action from the US government to address Alaskan villages threatened by climate change impacts. A new report by the Government Accountability Office updates a 2003 assessment when it found that most of the more than two hundred native villages in Alaska were affected by flooding or erosion.

The report says, "While the flooding and erosion threats to Alaska Native villages have not been completely assessed, since 2003, federal, state, and village officials have identified 31 villages that face imminent threats." It adds, "Since 2003, state officials have identified the growing impacts of climate change, increasing the urgency of federal and state efforts to identify imminently threatened villages and assess their relocation options." Impacts quoted in the report include millions of dollars of property damage, and in some cases imminent threats to lives and homes from flooding and erosion.

Of the 31 villages facing imminent threats, 12 have either decided to relocate, or to look at relocation options. However, many of the Alaskan villages threatened are not eligible for federal government assistance programmes to relocate, because federal rules do not recognize their local governments.

"This is a clear example of how climate change threatens to transform our world," said Bill Eichbaum, WWF-US Vice President for marine and arctic policy. "The speed and severity of the changes we are now witnessing, here in Alaska and worldwide, both underscore and amplify the profound urgency with which the countries of the world must now act to cut their green house gas emissions in order to slow and eventually reverse the effects of climate change."

Closer to Canadian conservation wins

REPRESENTING a major reform in planning approach, and ably helped along the way by WWF-Canada President Emeritus Monte Hummel, the government of the Ontario province announced its Far North Planning Act, outlining the government's conservation and economic development vision for Northern Ontario. "This Act stands to make a precedent-setting contribution to freshwater conservation, help build ecosystem resilience in a changing climate, and protect huge natural carbon reserves in boreal peat lands," said Monte Hummel. The Act could become the largest conservation commitment in Canadian history.

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Arctic conservation:

An opportunity lost or an opportunity not to be missed?

If we had to define a totally new conservation strategy for the Arctic, would we be thinking about anything like the policies, structures and activities that we have now, ask **MICHAEL USHER** and **PHILIP WOOKEY**.

OF COURSE THIS is an unanswerable question because over the years there has been activity both in the Arctic and worldwide, and all of this must be taken into consideration when we think of the future. So, where have we got to and where do we want to go?

Perhaps the one piece of work that has most shaped recent thinking about the Arctic is the *Arctic Climate Impacts Assessment*, ably led by Robert Corell and launched in Reykjavík in November 2005. The most important key message from this assessment is that the climate of the Arctic is changing and that it is changing faster than in most other parts of the planet. A second key message is that the Arctic's climate affects the climates of many other parts of the world. The ongoing change in the Arctic is occurring even more rapidly than most global climate models predict, and these models already include an element for polar amplification.

IN CONSTANT CATCH-UP

Conventional wisdom suggests that biodiversity should increase with warming in the medium to long term, but the rapid rates of climate change will mean that ecosystems (and species) are always in a 'catch-up' mode and may not have the capacity to adapt. Taking just one example, the tundra biome is being compressed between the boreal zone, which is moving northwards, and the shore of the Arctic Ocean, which is more or less fixed (although rapidly eroding in many places through both wave action and the processes of thermokarst; the melting of permafrost). Many of the species and habitats are potentially highly vulnerable to change, especially those of the northern tundra, semi-deserts and polar deserts (see vegetation zones map on the following page), as well as those that are specialists of snow-beds.

Globally there is a suite of policies and mechanisms for the conservation of biodiversity. The Convention on Biological Diversity stems from the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The majority of the planet's nations have signed and ratified this convention, which places responsibility on individual nations to conserve their biodiversity, to use biodiversity resources sustainably, and to share the benefits. The Convention on Migratory Species was adopted in 1979 and entered into force in 1983. Many of the Arctic's species of birds and sea mammals would be covered by this convention. The Ramsar Convention, one of the oldest of the international biodiversity conventions (1971), is focussed on wetland conservation and the delivery of ecosystem services to human populations, not only in the wetlands themselves but more widely. The Convention on International Trade in Endangered Species has perhaps not been reflected so much in the Arctic, but its growing focus on invasive alien species could become increasingly important in a warming Arctic.

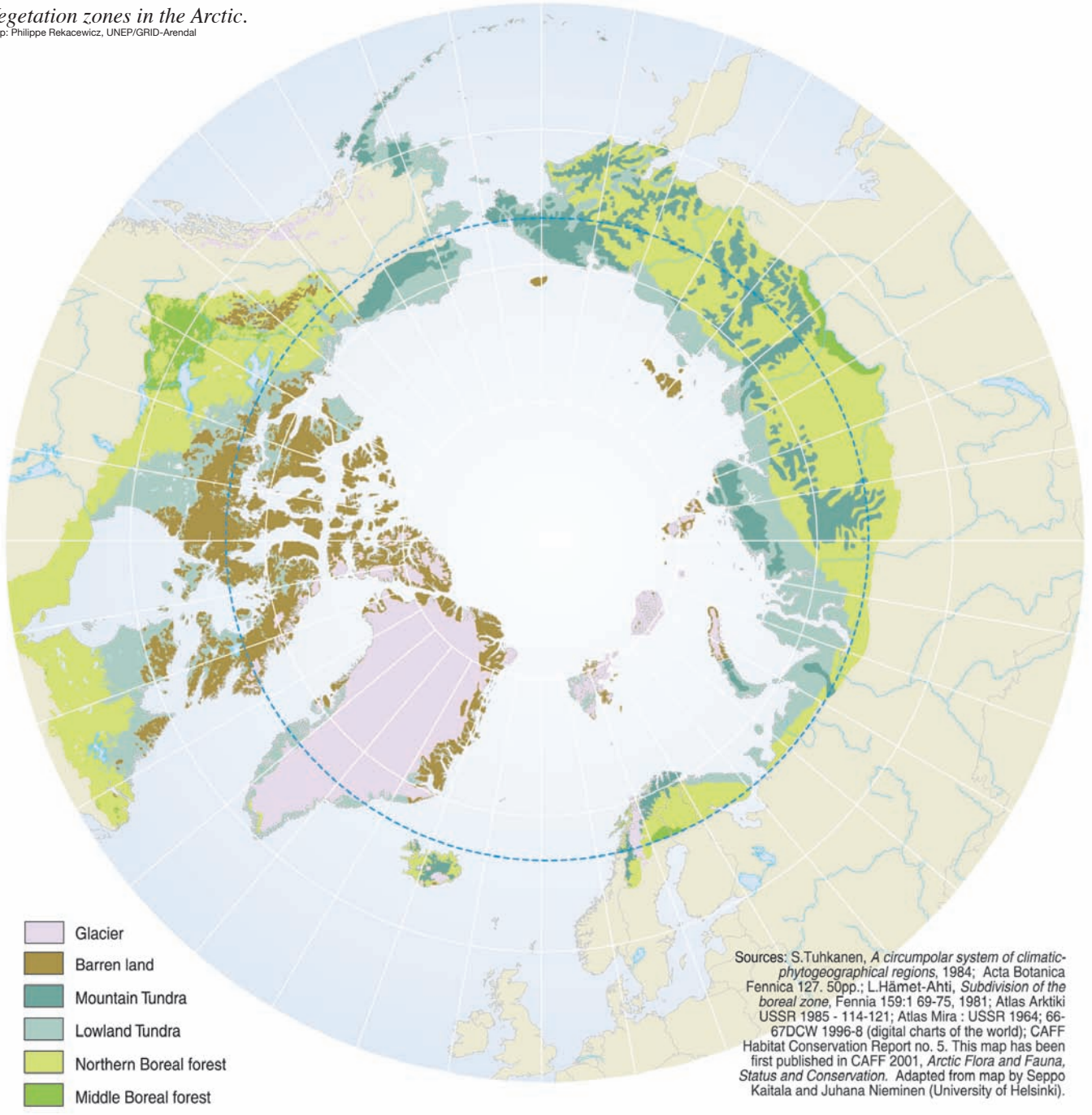
PROTECTED AREAS AND MONITORING

There are also many legal instruments that apply to just one nation or a group of nations.

Prof. MICHAEL USHER (OBE, FRSE) is Chair of the Inter-Agency Climate Change Forum of the UK's Joint Nature Conservation Committee and Honorary Professor at the universities of Aberdeen, Edinburgh and Stirling. Since retiring in 2001, he has worked on reports on the effects of climate change on biodiversity in the Arctic and protected areas of Europe.

PHILIP WOOKEY is Professor of Ecosystem Ecology at the University of Stirling, Scotland. He has worked since 1991 on the potential effects of environmental change on the structure and function of terrestrial ecosystems in the Fennoscandian mountains, Svalbard, northern Iceland and the North Slope of Alaska.

Vegetation zones in the Arctic.
Map: Philippe Rekacewicz, UNEP/GRID-Arendal



Sources: S.Tuhkanen, *A circumpolar system of climatic-phytogeographical regions*, 1984; Acta Botanica Fennica 127. 50pp.; L.Hämet-Ahti, *Subdivision of the boreal zone*, Fennia 159:1 69-75, 1981; Atlas Arktiki USSR 1985 - 114-121; Atlas Mira : USSR 1964; 66-67DCW 1996-8 (digital charts of the world); CAFF Habitat Conservation Report no. 5. This map has been first published in CAFF 2001, *Arctic Flora and Fauna, Status and Conservation.* Adapted from map by Seppo Kaitala and Juhana Nieminen (University of Helsinki).

In Europe, the most important would be the Birds and Habitats Directives of 1979 and 1992 respectively. Much of this legislation, whether it be national, regional or international, calls for the establishment of networks of protected areas. And indeed such networks have come into being, with the Circumpolar Protected Area Network (CPAN). However, CPAN needs to be completed and reviewed in order to ensure that it does actually cover the full range of the Arctic's present biodiversity (terrestrial, freshwater and marine). An assessment needs to be made for every one of the protected areas of the likely effects of climate change, and other drivers of change, on its biodiversity. In light of these assessments, decisions must be made about which adaptive management techniques are most appropriate for the long-term conservation of that protected area's biodiversity.

As well as protected areas, there are two other essential activities. First, and one that has long been used by conservationists, is monitoring (or the terms 'surveillance' or 'observatory' may be preferable). In the Arctic this has been developed as the Circumpolar Biodi-

versity Monitoring Program with its associated Arctic Biodiversity Monitoring Strategy, both facilitated by The Arctic Council's organisation 'Conservation of Arctic Fauna and Flora' (CAFF). As well as highlighting what has been changing, the monitoring data should assist us in understanding why it has changed, and, given the sensitivity of the Arctic, is set to provide an early detection system for the impacts of environmental change on the whole planet.

'ECOSYSTEM APPROACH'

Second, and of more recent origin than monitoring, is 'The Ecosystem Approach', advocated by the Convention on Biological Diversity. This approach recognises the importance of uniting both human (social and economic) and environmental concerns. The inclusion in biodiversity plans of the Indigenous peoples is central to the ecosystem approach. Perhaps the Arctic is the greatest geographical area on planet Earth where this overarching approach to managing our environment for all species, including the human species, can be applied.

It must be acknowledged, however, that the geopolitical climate is complex. The wealth of natural resources in the Arctic, as well as the prospect of an ice-free Arctic Ocean, will all mean that resource exploitation and the development of industrial and transport infrastructure will gather rapid pace. Set against this highly dynamic background the urgent need for biodiversity action seems obvious, and there is scope for CPAN to raise its ambitions accordingly. Furthermore, although the terrestrial and freshwater realms might be recipients of the strongest direct impacts of human activity, and to date have experienced the greatest amount of conservation activity, current protection of marine systems is trailing far behind. An international convention for the conservation of the Arctic's marine resources is long overdue. These are all opportunities which cannot and should not be missed. ○

Conservation in an age of urgency

The world as we have known it will look strikingly different in the next century or two. Climate change adds new dimensions of urgency to conservation programmes, says **MARK NUTTALL**. New approaches to arctic conservation need to be increasingly human-centred.

CLIMATE CHANGE is not a phenomenon peculiar to the end of the 20th century and the beginning of the new millennium. In the Arctic, for example, we can certainly point to numerous examples of past climatic change in the geological and glaciological records, as well as in the oral history of arctic peoples. But there are a number of differences between past climate change and that currently being experienced, as well as the changes predicted for the coming decades. Firstly, our awareness of the nature, extent and reach of climate change is profoundly more so than a generation or two ago, so that our discussion of it is now at the forefront of debate about how we imagine ourselves and the planet in the future. Secondly, scientists increasingly talk of 'tipping points', thresholds beyond which ecosystems will change irreversibly. We are at the point of no return, it seems. Climate change is happening, it is going to get worse and far more extreme, and the world as we have known it will look strikingly different in the next century or two.

EARLY WARNINGS

Both of these aspects of our understanding of climate change and its impacts and consequences influence discussion about the urgency of appropriate responses in terms of policy and action. When I read earlier accounts of climate change, I am struck by the fact that even fifty years or more ago, scientists were sounding alarm bells about ecological transformation yet nothing was acted upon. In *Late Lessons from Early Warnings*, a 2002 report by the European Environment Agency (EEA), a number of case studies were presented that show how adequate information was available about potential hazards long before decisive regulatory advice was taken. The information was either not brought to the attention of decision-makers or was ignored or discounted for many different reasons (skepticism being chief amongst them). Early warnings were also ignored because of political or economic considerations. As the world's leaders prepare to meet in Copenhagen to thrash out a new post-Kyoto deal at COP15 in December 2009, it is to be hoped that they will consider this EEA report, learn from the mistakes of failing to heed early warnings, and familiarize themselves with the report's recommendations.

The implications of climate change for biodiversity and cultural diversity, for plant and animal species and for human societies, will be significant and they present immediate and far-reaching challenges to nature conservation. In the Arctic, there is clear evidence from both Indigenous/local observations and scientific research to show that animal populations – their habitats

and ranges, seasonal and migration patterns and their reproductive behaviour – are already being affected by climate change. This and more has been reported on extensively in the *Arctic Climate Impact Assessment* and subsequent scientific research. In the course of my work, I talk with people in Greenland, northern Canada and Finland who remark how the very *taste* of animals is now different. Although all are careful not to attribute this to climate change, they nonetheless see this as indicating something is changing in the environment that affects the animals they hunt, herd and ultimately eat. Such effects are likely to become more apparent, extensive and extreme as the climate of the arctic continues to change. Although a few animal species will find a niche in which to thrive, many will struggle to adapt in habitats that have changed dramatically. Some will probably face extinction or lose genetically important parts of their populations. No animal appears to be more iconic than the polar bear in this regard. So what does all this mean for conservation and its underlying ideas, methods and philosophies?

*Killer whale (*Orcinus orca*).*

© Kevin SCHAFER / WWF-Canon

NATURAL SCIENCE DOMINATION

Climate change adds new dimensions of urgency to conservation programmes. Globally, extreme, radical conservation strategies are being considered, such as 'managed' or 'assisted' location, which usually involves moving species – manually – into habitats where they can thrive. It is a controversial strategy, especially given concern over invasive species, but only one of many which are being taken seriously by some conservationists. Other examples of radical conservation include plans to establish vast migratory corridors that extend thousands of kilometers, preserving the genetic diversity of threatened and endangered species in seed banks, fertilizing the oceans so that they can increase their absorption of greenhouse gases, and geo-engineering the Earth to control rising temperatures.

> **"The reasons for protecting polar bears or whales, for instance, are very different to members of environmental NGOs living in European cities and to members of hunting households in northern Greenland.**

Conservation takes the environment and the 'natural' world as its focus – often assuming that it can define it, engineer it, and also mould it in a shape that will enable adaptation. Perspectives from the natural sciences have long dominated biodiversity conservation theories, methods and practices. At the same time, perspectives from social scientists are contributing to the redefinition of conservation as being first and foremost a thoroughly human issue. The reasons for putting conservation measures in place are because impacts leading to loss of biodiversity are largely caused by human activity. Conservation is also a human issue because the administrative dimensions of conservation are based on human decision-making processes; species and ecosystems are often conserved for human use; and the success of conservation measures rely on human action, politics, cultural attitudes and behaviour.

MARK NUTTALL is a social anthropologist. He holds the Henry Marshall Tory Chair in the Department of Anthropology at the University of Alberta, Canada, and is also Academy of Finland Distinguished Professor at the Thule Institute, University of Oulu, Finland.

CONSERVATION SOCIAL SCIENCE

As we strive to rethink conservation science and management in an age of rapid climate change, new approaches to arctic conservation need to be based increasingly on conservation social science rather than just conservation science. They need to be grounded firmly and securely in better knowledge of the complexity of social systems and social relations, the complexity of human-environment relations and how they intersect with regional and global processes, an understanding of the cultural importance of what is being conserved, and an understanding of the politics of

environmental governance. They need to be attentive to societal inequalities and processes of social exclusion (for example, what are the impacts of protected areas and management regimes on people's livelihoods?) and be appreciative of diverse social, cultural and political meanings and understanding of conservation. The reasons for protecting polar bears or whales, for instance, are very different to members of environmental NGOs living in European cities and to members of hunting households in northern Greenland. But contested ideas of conservation are also often profoundly local – for instance, as work carried out by myself and colleagues on the conservation of wolves and other large predatory carnivores in Finland's southeast reindeer herding area shows. There, reindeer herders, farmers, hunters, tourist entrepreneurs, wildlife officials, environmentalists, and a range of other local actors all have very different ideas of what conservation actually means. And so a local conflict plays itself out within a national context and solutions or even compromises seem difficult to reach.

Social science approaches to conservation also recognize the crucial importance of involving a range of stakeholders and actors – members of local communities in particular, as well as scientists and policymakers – as partners in designing and implementing what are essentially human-centred approaches to conservation. A fundamental first step for conservation is to be attentive to ways of improving relations between different actors who often have diverse and contested perspectives. The way we will respond to the effects of climate change on arctic ecosystems, species and habitats – and the prospects for the sustainability of ecosystems and human livelihoods – depends on a critical engagement with conservationist ideas, and a recognition of the primacy of community and rights-based conservation. ○

Thresholds of climate change in arctic ecosystems

Nowhere are the ecological threshold concepts arguably more applicable than to arctic ecosystems, where fundamental changes seem to be transforming ecological relationships and landscapes at rates that surprise inhabitants, managers and policymakers, says **DANIEL B. FAGRE**. The Arctic is experiencing effects now that are decades ahead of those projected for the rest of the globe.

MANY ECOSYSTEMS have persisted for centuries to millennia with relatively little change and, therefore, appear to be stable. Yet ecologists have long understood that ecosystems can go through very rapid change, and even collapse, when critical tipping points or thresholds are reached. New species assemblages, adaptations, and even new species often result, depending upon the length of ecological recovery. However, these threshold events pose very real problems for human societies that are dependent on the natural resources and ecological services that ecosystems provide. History is replete with examples of civilizations that largely disappeared due to rapid ecosystem change, most recently chronicled in Jared Diamond's book *Collapse*.

As defined in a recent report from the U.S. Climate Change Science Program, titled *Synthesis and Assessment Product 4.2 Thresholds of Climate Change in Ecosystems*, "an ecological threshold is the point at which there is an abrupt change in an ecosystem quality, property, or phenomenon, or where small changes in one or more external conditions produce large and persistent responses in an ecosystem". Thresholds can also be described as rapid nonlinear change with positive feedbacks – changes that reinforce themselves and accelerate the whole process. Nowhere are these concepts arguably more germane than to arctic ecosystems where fundamental changes seem to be transforming ecological relationships and landscapes at rates that surprise inhabitants, managers and policymakers.

ARCTIC THRESHOLD CHANGES

The Arctic has warmed more rapidly than the rest of the planet. In Alaska, for instance, the warming rate is more than twice the rate of the rest of the United States. The annual average temperature has increased by 1.9°C since the mid-20th century, and the increase is much greater in winter (3.5°C). Not surprisingly, there are numerous responses to the warming such as earlier snowmelt in the spring. However, there are simple physical mechanisms that amplify the warming, accelerate the pace and create a threshold of ecological change. When snow melts earlier, the exposed, darker land surface absorbs more solar radiation and transfers the heat to warm the local atmosphere, causing further snow melt which, in turn, leads to more land surface to absorb more solar

radiation. This positive feedback is in addition to the external driver, regional warming, which is already among the globe's strongest. The relatively rapid change in absorption of heat by the landscape also leads to more growth of shrubs and trees that further absorb solar radiation, increase local heating, and facilitate growth of more shrubs and trees. In northern Alaska, Terry Chapin and others calculated that this positive feedback effect on snowmelt and local heating was similar in magnitude to the doubling of atmospheric CO_2! Thus, the area is experiencing effects now that are decades ahead of those projected for the rest of the globe. Of equal significance is that the vegetation growth is 'permanent' because it will tend to reinforce earlier snowmelt and local heating that are optimal for the vegetation. It can be argued that a threshold of climate change in this ecosystem was crossed. Several research teams cited in the report document that there has already been a 16 percent increase in shrub cover and the process is continuing.

The report examines a number of other potential threshold changes in the arctic environment. These include substantial changes in ecological systems such as dramatic changes in the wetlands of interior Alaska and Siberia, major increases in the frequency of large-fire years in interior Alaska, vegetation changes in the tundra, and ecological changes that are affecting fisheries in the Bering Sea. One example of potential threshold change that is relevant to both regional and global scales is the thawing of permafrost. A documented decrease in the area of closed-basin lakes (that is, lakes without stream inputs and outputs) during the latter half of the 20th century is linked to sudden drainage associated with thawing of permafrost in areas where the temperature of permafrost is close to melting. As more permafrost area warms, the decrease in closed-basin lakes could abruptly accelerate in a threshold fashion for the entire region. With regard to global greenhouse gas emission, the release of methane from thawed permafrost could increase warming and, in turn, accelerate more permafrost thawing.

BIG CHALLENGES

Thresholds present big challenges for managers of ecosystems and ecological services. First, thresholds are often surprises if not in their occurrence, then in their rapidity and scope. Presently, there are few indicators as to when an ecosystem is near an imminent threshold and there is little collective experience in managing ecosystems while crossing a threshold. The report on thresholds concludes by looking at what can be done given that climate change is global in nature but manifests itself at local and regional scales. To improve our understanding of thresholds, one suggestion is that interdisciplinary models of ecosystems be improved but also used more interactively. The aim would be to provide a framework to organize observations and assess changes in ecosystems in response to management actions. Another suggestion is to improve ecosystem resilience by using existing management tools more aggressively. These include restoring connectivity, protecting refugia for key species, and reducing other stressors such as pollution.

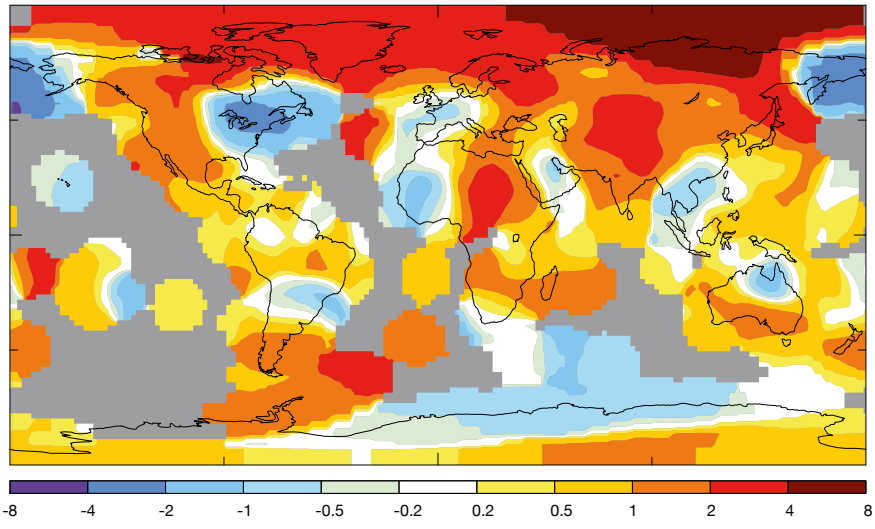
Threshold threats to many ecosystems are threats to long-term sustainability of human users as well as biodiversity and biological adaptive capacity. Given the magnitude of climate change effects on ecosystems, the added factor of sudden threshold changes complicates societal responses. This underscores the importance of continued integration of research and management to develop appropriate strategies for coping with thresholds. ○

Dr DAN FAGRE is Research Ecologist for the Northern Rocky Mountain Science Center of the U.S. Geological Survey and Director of the Climate Change in Mountain Ecosystems Project. He is stationed at Glacier National Park, Montana and is a faculty affiliate at the University of Montana, Montana State University, University of Missouri-Columbia, University of Arizona and several other universities. He is an author on more than 120 publications and has co-published three books recently.

The Arctic has warmed more rapidly than the rest of the planet. The map shows the significant temperature increase in the Arctic areas compared to the rest of the world.

Map: NASA Goddard Institute for Space Studies

Surface anomaly January 2009 vs 1951-1980 (°C)



Sources and parameters: GHCN_GISS_1200km_Anom01_2009_2009_1951_1980. Note: Gray areas signify missing data.

Climate change and the prospects for biodiversity conservation in the Arctic

In the face of climate change, conservation of biodiversity in the Arctic presents formidable challenges to planners and requires new approaches, says **SAHOTRA SARKAR**. Unfortunately, almost all discussion of biodiversity conservation in the Arctic has been based on species.

IN THE UNITED STATES, the polar bear has already been listed as endangered because of climate change but, globally, every ice-dependent marine mammal species is probably equally at risk. (In the United States, efforts are already underway to provide legal protection to bearded, ringed, and spotted seals because of climate change.) Migratory birds that summer in the Arctic are also experiencing habitat declines though the extent of the declines remains unclear. To make matters worse, in much of the Arctic, these problems are exacerbated by oil and other mineral exploration and extraction activities that act synergistically with climate change to degrade natural habitats.

SAHOTRA SARKAR is Professor of Integrative Biology and of Philosophy at the University of Texas at Austin. He is the author of over 100 articles on environmental conservation and five books including *Systematic Conservation Planning*, co-authored with Chris Margules (Conservation International). His laboratory specializes in the creation of software decision support tools for the prioritization of areas for biodiversity conservation.

It is imperative that a plan for conserving and monitoring biodiversity in the Arctic is formulated and implemented on the ground as soon as possible—before the irreversible results of climate change make it impossible to prevent the extinction of a large fraction of arctic species. Adequate biodiversity conservation in the Arctic will require three elements: a comprehensive area evaluation and prioritization exercise to identify those areas that represent most biodiversity and are least subject to degradation due to climate change; transnational planning and implementation of a network of protected areas with science-based adaptive management protocols; and large-scale reduction of industrial activities.

AREA PRIORITIZATION FOR CONSERVATION

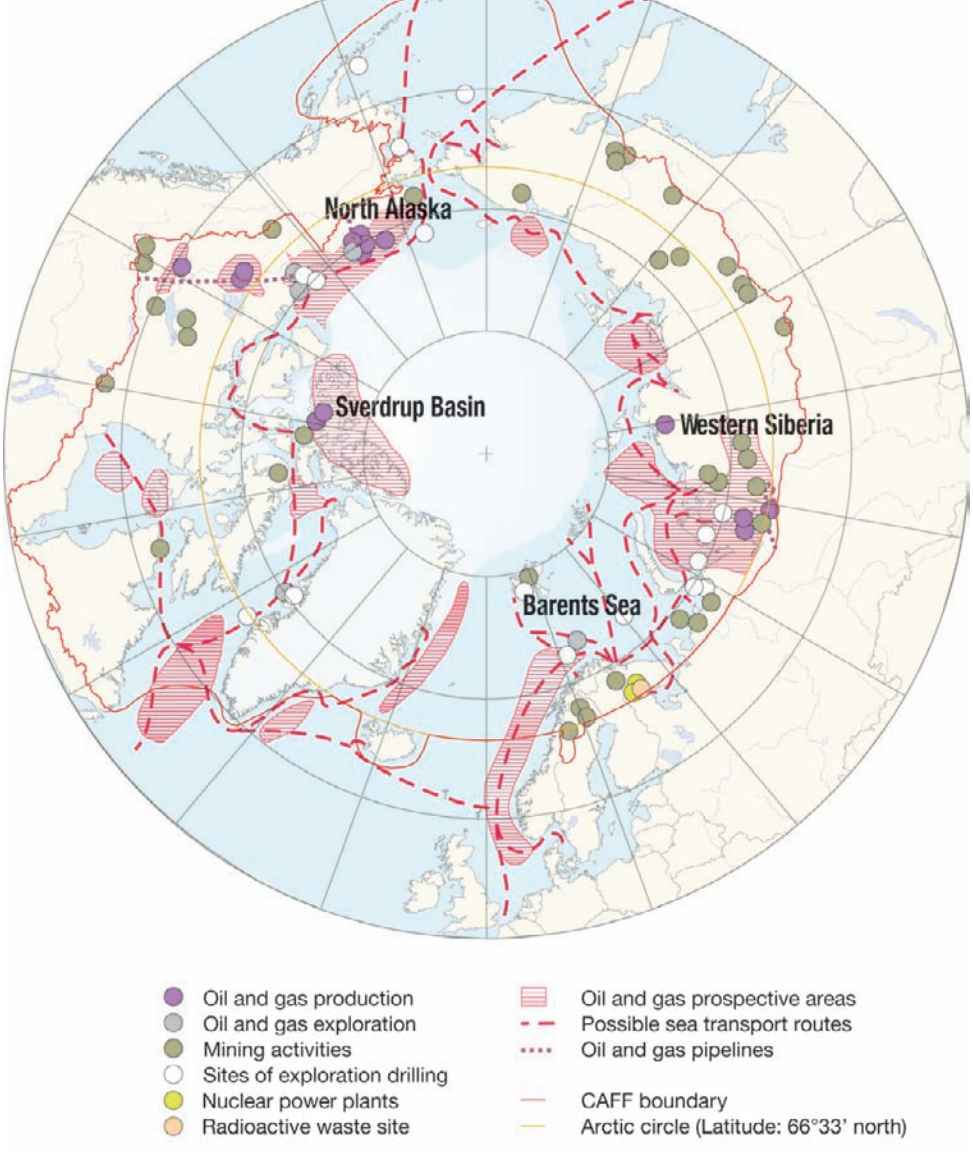
There is no comprehensive evaluation of how climate change will induce species' ranges shifts in the Arctic. Tools to map and model species' distributions in the face of climate change do exist, as does an adequate knowledge base for their deployment. Unfortunately, so far, no agency or organization has taken the lead to coordinate the most rudimentary systematic conservation planning exercise: collate all species' distributional data, model their global distributions as they shift under climate change, assess the models to the extent possible, analyze the performance of existing protected areas, and prioritize networks of areas that would include all species most economically.

While species, especially at-risk species, are important, they are not the only components of biodiversity. Unfortunately, almost all discussion of biodiversity conservation in the Arctic has been based on species. Conservation plans must be supplemented by at least including all habitat types (ecosystems) in the networks of prioritized areas. Tools to identify these based on remote-sensed data are also available but have only been used to a limited extent.

Finally, these conservation plans and sets of prioritized areas should be refined to include the effect of industrial activities likely to occur in the Arctic under different regulatory scenarios. At this stage our uncertainties about the future should be explicitly incorporated to the extent possible. My laboratory has carried out one such analysis for northern Alaska. This establishes that such planning is scientifically feasible but, otherwise, it is of limited significance in the context of the entire Arctic.

TRANSNATIONAL PLANNING

It goes without saying that plans to implement such a network of protected areas must incorporate political opportunities and address constraints. The Arctic includes areas claimed by seven countries (Canada, Denmark/



Industrial activities and oil and gas reserves in the Arctic.
Map: CAFF (Conservation of Arctic Flora and Fauna) 2001. Arctic Flora and Fauna: Status and Conservation. Helsinki:Edita

Greenland, Finland, Norway, Sweden, the Russian Federation, and the United States). Establishing networks of protected areas nationally (or using even smaller planning regions) typically results in sub-optimal plans, that is, more area is required to meet the same conservation goals and targets. Moreover, species do not carry passports or respect national boundaries which also usually do not follow habitat type boundaries. An optimal plan for arctic conservation must be transnational with each species or habitat type protected wherever it makes most sense to protect it. What makes this process even more difficult is that not only must protected areas be established transnationally, but they must also be managed that way.

Transnational agencies and organizations, including WWF, have an important role to play in fostering the trust and cooperation between the arctic countries that will be required to make this process successful. A useful beginning would be the establishment of a transnational team to carry out the systematic conservation planning exercise emphasized earlier. More public discussion of goals and constraints for the entire region would also help move the project forward.

MINERAL EXPLORATION AND EXTRACTION

Next only to climate change, the main threat to the Arctic is oil and other mineral exploration and extraction activities. In many of the arctic countries, there continues to be strong political pressure to persist in these practices, perhaps most vividly exemplified by the conflict over oil and gas exploration in the Arctic National Wildlife Refuge in Alaska. There must be a global consensus that all industrial activities in the Arctic that potentially cause environmental damage must stop. Otherwise, because of the fragility of many arctic habitats and the extent and immediacy of the threats posed by climate change, the Arctic will disappear as a natural habitat within our lives.

In much of the Arctic a reduction of further industrial activities will consist of less fossil fuel extraction. This has the added benefit of encouraging less fossil fuel consumption and, therefore, less carbon emissions which will feed back into efforts to limit the effects of climate change. Yet another added benefit is that a cessation of industrial activities will help conserve the traditional livelihoods of those Indigenous groups which prefer to persist in that way. There will be costs, though it remains open to question whether these have typically been exaggerated. In any case, every country in the Arctic has the economic resources to meet these costs provided that there is political will. Moreover, if oil extraction in Alaska is typical, the costs of restoring habitats in the future after industrial damage far outweighs the economic benefits of current exploitation. ○

“ Every country in the Arctic has the economic resources to meet these costs.

Resilience-building to conserve a rapidly changing future

Policy makers face a severe dilemma in addressing conservation issues in a rapidly changing Arctic, says **F. STUART CHAPIN, III**. 'Conservation' suggests an effort to sustain current species and ecosystems and 'keep things the same'. However, climate change is rapidly altering the biophysical environment of the Arctic. How is conservation possible in such a rapidly changing world?

ARE CONSERVATION EFFORTS doomed to simply slowing the loss rates of species and ecosystems, or are there proactive approaches to conservation that could bring a brighter future?

The 2007 assessment by the Intergovernmental Panel on Climate Change (IPCC 2007) concluded that there is at least a 90 percent probability that human activities have contributed to climate warming, and that global warming during the last half-century results from the increased concentrations of greenhouse gases such as carbon dioxide in the atmosphere. Because these gases remain in the atmosphere for a long time, this human influence on the climate system is certain to persist for at least the next half-century. The last time polar regions showed persistent warming of this magnitude was 125,000 years ago. Ecologically important environmental changes that are already well documented and likely to continue include retreat of sea ice, earlier snowmelt, warming of permafrost, wetland drying, declining flows of non-glacial rivers, and more extensive wildfires. These changes will not occur every year, but this trend will likely characterize the Arctic in the coming decades.

F. STUART CHAPIN, III is an ecosystem ecologist whose research addresses the sustainability of ecosystems and human communities in a rapidly changing planet. This work emphasizes the impacts of climate change on Alaskan ecology, subsistence resources, and Indigenous communities, as a basis for developing climate-change adaptation plans.

These environmental changes already affect and will likely continue to affect many of the species and peoples of the Arctic. Walrus, for example, use sea ice as a feeding and nursing platform. When sea ice retreated north of the continental shelf in summer 2007, walrus could no longer reach the sea floor where they feed. Six thousand walrus moved ashore near the village of Wainwright Alaska for the first time in recorded history. This and similar changes in the ecology of other ice-dependent marine mammals have sobering implications for conservation of both the ecological and cultural attributes of the Arctic. Like it or not, the Arctic has changed and is virtually certain to continue changing within our lifetimes. How can policy address conservation concerns, given this likely future?

> **"Six thousand walrus moved ashore near the village of Wainwright Alaska for the first time in recorded history.**

BUILDING RESILIENCE

Resilience is the capacity of a system consisting of people and nature to sustain and shape its fundamental structure and functioning in the face of perturbations such as climate change. Resilience approaches advocate a shift from *reactive* policies to prevent change to *proactive* policies to shape change in rapidly changing world. Given that future changes are uncertain, resilience places a strong emphasis on building and maintaining a multitude of options that allow flexibility to adapt to change rather than pursuing what might currently seem like the single best option.

There are four basic tenets to building resilience: (1) Sustain the fundamental ecological and social processes that have shaped the current system, but allow enough disturbance for the system to adjust to change. (2) Foster social, economic, and ecological diversity to provide a wide range of pathways for potential future

change. (3) Experiment with different approaches to provide opportunities to learn what works and what does not. (4) Adapt governance to allow implementation of potential solutions under novel conditions.

RESILIENCE AND CONSERVATION

These resilience principles suggest many examples of policies to address the changing needs of arctic conservation. (1) Reduce human impacts on the climate system, so the rates of arctic change will decline, giving species and ecosystems more time to adapt. (2) Broaden the range of habitat opportunities for arctic species and peoples. For example, if sea ice continues to decline, create onshore preserves that partially protect walrus from hunting and predation. Establish arctic marine reserves adjacent to terrestrial conservation areas to protect fish such as salmon that are beginning to colonize the Arctic Ocean. Protect stream gravels from extraction to provide potential spawning habitat for northward moving salmon. (3) Encourage local community-agency initiatives to create novel subsistence arrangements such as community quotas for newly arrived fish species or multi-species harvest regulations that allow hunters to target marine or terrestrial game species when they are locally abundant. Develop a knowledge-sharing network to facilitate widespread learning from such experiments. (4) Explore new governance arrangements at a wide range of scales. For example, create bridging mechanisms between pan-arctic conservation strategy bodies, state or federal regulatory agencies, and hunter-based community monitoring programs.

Resilience-based stewardship seeks no explicit structural outcome but fosters the underlying ecological and social conditions required for conservation. By doing so, it opens multiple pathways for potential adaptation to new conditions. ○

Ensuring marine mammal conservation in a rapidly changing Arctic

Climate change is already having significant effects on arctic marine ecosystems and component species, including marine mammals, say **PETER O. THOMAS** and **TIMOTHY J. RAGEN**. Research and monitoring, although important, are not sufficient to conserve arctic marine mammals.

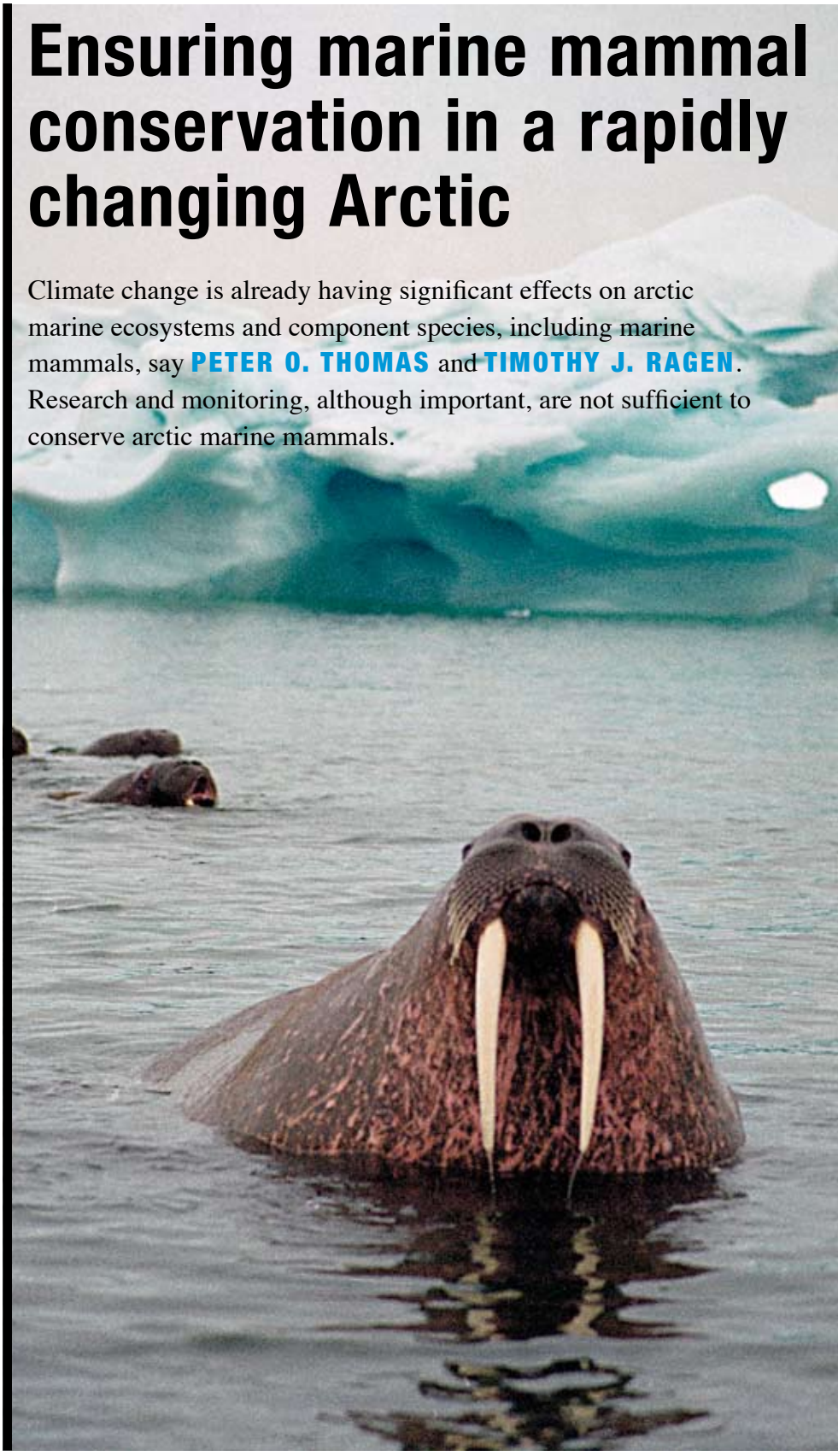


Photo: © Wim VAN PASSEL/WWF-Canon

*Atlantic walrus (*Odobenus rosmarus rosmarus*).*

MARINE MAMMAL SPECIES at risk include those that remain in the Arctic year-round (i.e., polar bear, walrus, ringed seal, bearded seals, beluga whale, narwhal, and bowhead whale), and those that inhabit the Arctic on a seasonal basis (e.g., ribbon, spotted, harp, and hooded seals, and gray, minke, fin, humpback, and killer whales).

Climate change is causing a wide range of physical, chemical, biological, and ecological changes. The physical effects are most evident in the loss of sea ice habitat, which is forcing a number of biological and ecological changes. Species that have relatively fixed life history traits and that are highly dependent on seasonal sea ice will likely be the most affected. The ringed seal, for example, requires certain ice and snow conditions to build lairs where the females give birth to and nurse their pups. Polar bears depend on ice as a hunting platform and are already being stressed by the growing, ice-free summer and seasonal changes in the accessibility of hunting and denning areas. Walruses are able to access certain foraging areas only if they can haul out on ice near those areas. The loss of sea ice is thereby reducing their access to prey. Other species with more flexible life history traits and habitat requirements (e.g., the bearded seal) may be able to adapt successfully, and a few species (e.g., the gray whale) may actually benefit from increasing access to ice-free foraging areas. Species by species analysis is only one part of the story. The reduction in sea ice has significant impacts on the basic arctic marine food web, which is built on ice algae, amphipods, and polar cod. Loss of marine mammal habitat may therefore be accompanied by a loss of prey, as well.

The effects of physical, chemical, biological, and ecological changes associated with climate change are exacerbated by current and increasing human activities. In various parts of the Arctic, commercial shipping, coastal development, tourism and oil, gas and mineral exploration and development, now pose, or will pose, additional risks to arctic marine ecosystems and marine mammals. Such activities may increase the threats of noise, entanglement, disturbance, contaminants, ship strikes, competition for prey, introduction of disease, and loss of essential habitat. All of these changes, taken together, will result in cumulative impacts that may be greater than the sum of individual effects (i.e., synergistic). The end result may be a severe decline of some species, leading to extirpation in parts of their range and, possibly, extinction.

LACK OF COMMITMENT

Scientists' ability to detect changes in the size of many marine mammal populations is limited. To date, such research and monitoring efforts for arctic marine mammals have been woefully inadequate. In fact, the uncertainty surrounding population estimates for many species is so great that only a precipitous decline could be detected and documented. For this reason, management efforts often have been implemented only after populations are already severely depleted and options for recovery are limited (i.e., a crisis-oriented approach). To some extent, the problems stem from the difficulty of working in the arctic environment. However, the larger problem is a lack of resources and commitment on the part of the responsible management agencies. It is conceivable that a number of arctic species have already experienced severe declines that have gone undetected because of inadequate monitoring. Better research and monitoring, and funding for such, will be essential if scientists and managers are to identify and mitigate risk factors effectively.

However, research and monitoring alone are not sufficient to conserve arctic marine mammals. Absent effective measures to prevent climate change by reducing emissions of greenhouse gases, conservation efforts will be insufficient to address the physical and chemical changes that are occurring now and will continue into the future. Nor will those efforts address the biological and ecological responses of arctic marine life. A great deal of emphasis has been placed on adaptation, but species (which have developed over evolutionary time scales) simply may not be able to adapt at the current rapid pace of climate change. This is especially true of species like marine mammals that have life history traits that lead to slow recruitment into the breeding population.

At present societies are struggling to address the underlying causes of climate change in a meaningful way, an effort which requires fundamental re-examination of our overwhelming pattern of ever-increasing consumption, energy use, economic activity and population growth. Societies can no

Dr PETER O THOMAS has a Ph.D. in animal behavior from the University of California, Davis. He is currently International and Policy Program Director at the Marine Mammal Commission where he has been since 2008.

Dr TIMOTHY J. RAGEN is a marine mammal biologist with a Ph.D. in Oceanography from the University of California, Scripps Institution of Oceanography. He came to the U.S. Marine Mammal Commission in 2000 as Scientific Program Director and was appointed to his current position of Executive Director for the Commission in 2006.

"The reduction in sea ice has significant impacts on the basic arctic marine food web, which is built on ice algae, amphipods, and polar cod.

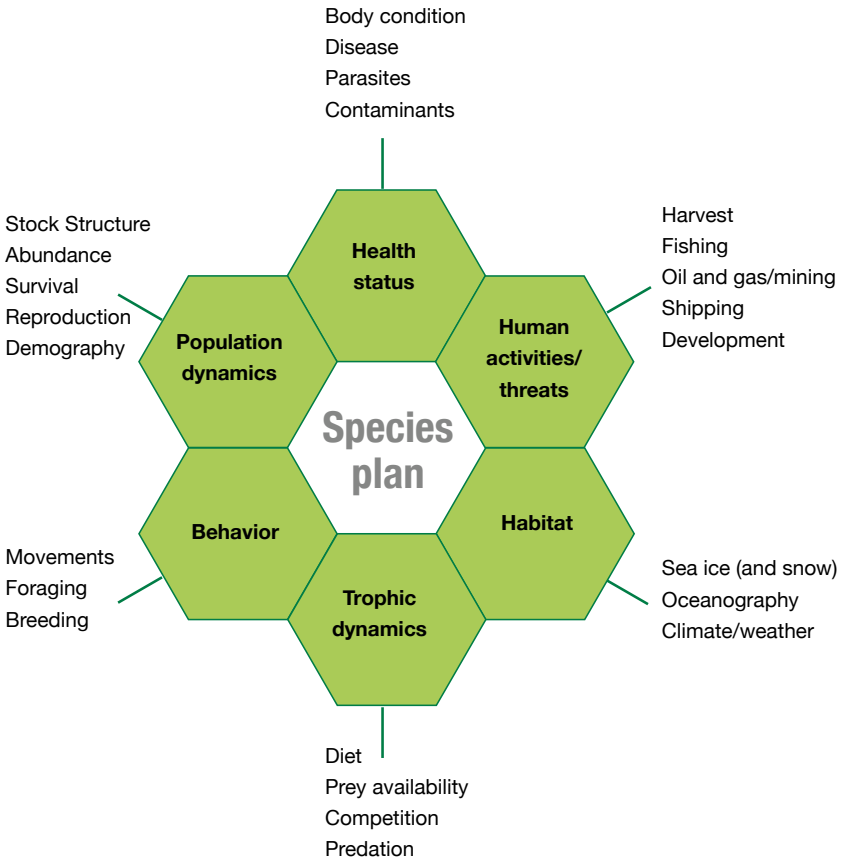


Figure 1: The components of a comprehensive plan for monitoring the status of a marine mammal species or stock. From: Simpkins, M., K.M. Kovacs, K. Laidre, and L.Lowry, A Framework for Monitoring Arctic Marine Mammals – Findings of a Workshop Sponsored by the U.S. Marine Mammal Commission and the U.S. Fish and Wildlife Service, Valencia, March 2007. CAFF International Secretariat, CAFF CBMP Report No. 16.

longer afford to ignore the consequences our socio-economic choices on our atmosphere and on our ecosystems and must change accordingly.

RESILIENCE TOOLS

At the same time, we have a number of tools that must be used to safeguard the resilience of arctic marine mammal populations from the effects of human activities and give them the best possible chances of survival in the face of long-term climate change. Among other things, we can:

- identify areas of essential habitat and zone human activities to ensure that they do not destroy or adversely modify that habitat
- manage fisheries to ensure that they neither take marine mammals as bycatch nor threaten them ecologically, such as through competition
- constrain activities that might result in release of contaminants (e.g., oil, gas, or mineral extraction)
- confine shipping routes and impose speed restrictions where those ships pose a risk of colliding with whales
- impose strict regulations on disposal of debris that might otherwise entangle marine mammals
- site coastal activities away from areas important to marine mammals (e.g., denning polar bears)
- maintain vital migration corridors for marine mammals moving between feeding and reproductive areas
- examine the possibility of developing vaccines for diseases that will likely be introduced into the Arctic
- provide response capacity for emergencies (e.g., ship wrecks, oil spills) to minimize their impact
- ensure that treaties, laws, and regulations establishing the above measures are implemented and enforced

Sound decision making on the conservation of arctic marine mammals in the face of global change is a difficult and complex endeavor (see figure 1). Efforts to monitor marine mammal responses to changing conditions, conduct informative science, and implement essential protective measures will be confounded by considerable uncertainty in our understanding of climate change effects. At the same time expanding human activities will have increasing impacts on arctic marine mammals and the health and stability of the ecosystems upon which they depend. Arctic countries are focusing a large number of initiatives and activities on various aspects of monitoring, basic science, management, and governance, but it is not clear that these efforts are sufficiently well developed and coordinated to provide the desired level of protection for the arctic environment. Multi-national and multi-disciplinary communication and coordination among these efforts are essential to understanding how ecosystems are changing and to launching concerted and effective responses.

At all levels, from local arctic native cultures to national and international organizations, societies must consider the root causes of climate change – that is, how we got to this point – and what our future will be if we fail to make hard choices in the near future. Reynolds et. al., in a 2009 article in *Endangered Species Research*, wrote "The value of conservation must be elevated from an aesthetically pleasing concept championed when convenient, to a fundamental construct of our lives and futures. Without the social will to make such changes, the future of marine mammals looks bleak." We would extend that admonition to the future of conservation generally. We are capable of making the necessary changes – that is not the question. The question is whether we are sufficiently inspired to do so. ○

Resilience in reindeer husbandry

Reindeer pastoralism is likely to be adversely affected by climate change, says **ELLEN INGA TURI**, and outlines recommendations to the policy makers of the Arctic Council.

REINDEER PASTORALISM is an Indigenous circumpolar livelihood involving more than 20 different Indigenous peoples around the entire Arctic and sub-Arctic area, in the countries of Norway, Sweden, Finland, Russia, Mongolia, China, Alaska, Canada and Greenland. This includes approximately 100,000 people and 2.5 million semi domesticated reindeer (*rangifer tarandus)* grazing on natural pastures covering an area of around five million km² stretching from the North Sea to the Pacific Ocean. This area amounts to 10-15 percent of the entire land area of the world.

ELLEN INGA TURI
is PhD student at EALÁT, Sámi University College in Kautokeino in Norway.

As a nomadic livelihood relying on natural pastures and functioning ecosystems, reindeer pastoralism is likely to be adversely affected by climate change. Regional projections for arctic climate change suggest a constant increase in annual mean temperatures. The likely local manifestations of climatic change vary from area to area. For the central Sámi reindeer herding area of Kautokeino in Northern Norway, climate change projections suggest an accelerated warming in all seasons, although that warming will be strongest in the winter. An indirect effect of climate change is increased access to arctic areas, manifested by an explosion of human activity. As reindeer husbandry represents a highly extensive form of land use, loss and fragmentation of pasture due to natural resource extraction and infrastructure development are major challenges to the maintenance of reindeer husbandry.

The Association of World Reindeer Herders (WRH) initiated the project 'EALÁT: Reindeer Herding and Climate Change' in order to address the challenges of climate change and loss of pastures and maintain and develop robust and resilient reindeer herding societies for the future. EALÁT is a consortium of different activities endorsed by the International Polar Year and the Arctic Council. It is coordinated by the International Centre for Reindeer Husbandry and the Sàmi University College, located in the heart of the Sámi region, Guovdageaidnu-Kautokeino, Norway.

EALÁT focuses on resilience of reindeer pastoralism to climate variability and change by integrating reindeer herders' knowledge in the project and analysing their ability to adapt to environmental variability and change. Reindeer herders' traditional knowledge is based on experience that is accumulated, conserved, developed and adapted to the climatic and socio-economic systems of the north. As such, traditional knowledge represents a keystone in the resilience-building of reindeer herding societies. Studies conducted in the framework of the EALÁT have documented how reindeer husbandry's resilience to climate change is embedded in the social institutions and practices based on traditional knowledge.

Based on field work studies and community based workshops held in different reindeer herding regions of the world, the EALÁT project has developed a preliminary list of recommendations to the policy makers of the Arctic Council:

Photo: Ellen Inga Turi.

Liev Serotetto reindeer herding, Yamal peninsula (brigade no. 8 of Yarsalinskoye) in April 2007.

■ It is important to support knowledge-sharing on impacts and adaptation measures connected to climate change and loss of grazing land, while recognizing the value of traditional knowledge as a foundation for adaptation and resilience.

■ It is important to support capacity-building for Indigenous societies facing climate change and loss of grazing land, through recruitment of young scientists from reindeer herding communities, and supporting institution-building in these communities.

■ We are concerned about the explosion of human activity linked to climate change and loss of grazing land for reindeer and caribou. Grazing land used for reindeer has to be protected as an adaptive measure to ensure sustainable arctic societies.

■ It is important to define institutional mechanisms which constrain Indigenous peoples' original resilience and ability to adapt to climate change.

Key measures for resilience-building in reindeer husbandry will be to work towards integrating traditional knowledge in governance and adaptation strategies for reindeer herding areas, as well as working towards limiting the increasing trends of loss and fragmentation of pasture land. ○

Communities, change, and conservation:

Comparing the Arctic and the Himalayas

To disrupt the environment is to disrupt traditional patterns and cultures, both at high altitudes and high latitudes, says **HENRY P. HUNTINGTON**. As the environment is changing rapidly, the challenges of adapting are increasing.

I WAS RECENTLY in eastern Nepal with colleagues Dan Mann and Pam Groves from the University of Alaska Fairbanks and Jagadish Parajuli from WWF-Nepal. We explored (with funding from from the U.S. National Science Foundation) the prospects for comparing climate change impacts and responses at high altitudes with those at high latitudes, the Himalayas and the Arctic. Our experience provided me with some new insights into circumstances in the Arctic, where I have worked for two decades, and some new though very limited understanding of the social-ecological system in rural Nepal.

HENRY HUNTINGTON is an independent researcher in Eagle River, Alaska. His work examines human-environment interactions, primarily among indigenous peoples in the Arctic. He has worked throughout Alaska and the Arctic, and recently in Nepal. He lives with his wife Kathy and sons Caleb and Thomas.

We met with community leaders and visited schools in the Sankhuwa-Sabha district in eastern Nepal. Despite differences of language, culture, and landscape, much seemed familiar from the Arctic. In both regions, I have heard similar observations of and concerns about climate change: "We are seeing insects we have never seen before." "We are worried that the hotter weather will be harmful to us and our animals." "We used to get snow every winter but now it is rare here." "Will new diseases spread into our area?" "The ice no longer forms the way it used to."

LOOPED CONNECTIONS

And in both regions, people live close to the land, relying on farming, fishing, hunting, herding, or gathering to provide food, clothing, building materials. To disrupt the environment is to disrupt traditional patterns and cultures. In such a social-ecological system, it is also true that to disrupt traditional practices and culture often means disrupting the environment. This, too, is a concern I have heard in both regions. As one man asked us, "How do we conserve the forest, which is so important to our livelihoods and well being?" The connections between people and environment are a loop, not a one-way path.

In the Arctic and in the Himalayas, climate change combines with other environmental change as well as social change. The result is often a different way of engaging with one's surroundings. Dog teams give way to snow machines. Trails become roads. Mines or hydroelectric dams offer new sources of income and employment. Sometimes, cash is a means of continuing to pursue traditional activities. At other times, it is an opportunity to do something different.

So what does it mean when both society and environment are changing? This is a new challenge for many communities around the world. In the past century or two, a relatively stable climate has at least offered some degree of environmental consistency in the face of rapid social change. For many arctic communities, traditional practices have provided a touchstone of continuity amid enormous change in language, economy, education, and just about every other aspect of daily life. Now that the environment is also changing rapidly, the challenges of adapting are even greater.

ADAPTATION STRATEGIES

In addition to global measures to address climate change, some local actions can be adaptive in a wide range of scenarios. In Nepal, planting trees can help sustain the forest and all the services it provides. In the Arctic, protecting vegetation cover can help reduce the loss of permafrost and consequent landscape upheaval. Keeping animal populations healthy can help reduce the consequences of shocks like drought or, in the Arctic, winter icing.

Old knowledge and practices may not be entirely appropriate today, but they are still a solid foundation for assessing change and developing new ways. Many of the new environmental conditions that are being seen or are expected are similar to extreme events in the past. What did people do when the rains failed? What did people do when the ice formed late? Drawing on past experiences can help with adaptation strategies. Furthermore, the attitudes and practices of flexibility that have helped people cope with uncertainty and change in the past can provide a degree of psychological resilience for

> **“Many of the new environmental conditions that are being seen or are expected are similar to extreme events in the past.**

the future as well.

New ideas are also valuable. As residents in the Arctic and Himalaya experience new conditions, they will learn and can share new ways of doing things. Collaboration with researchers, conservationists, and others from outside the communities can also help stimulate adaptations. Iñupiat hunters in northern Alaska use satellite imagery of sea ice and talk with scientists to better understand current ice conditions. As Albert Einstein said, “We can’t solve problems by using the same kind of thinking we used when we created them.” Collaboration and cooperation are often important steps in developing better ways of thinking and acting, both within communities and between local communities and the wider world. ○

Adapting to climate change:

Uncertainty on several levels

A number of uncertainty factors emerge when we talk about adaptation to climate change, emphasizes **GRETE K. HOVELSRUD**. These uncertainties are related to models which we use to project future climate changes, natural variations in climate, and how the climate will behave as a result of human influence, including greenhouse gas emissions.

IT IS NOT JUST CLIMATE factors that are uncertain; we also find uncertainty in the various other drivers of ecological change, such as politics, the economy or social conditions. Linkages between these drivers of change are not entirely clear. Climate change affects fisheries directly, but fisheries are also regulated through quotas and management systems which do not necessarily consider climate change. The combined changes in management and climate change may reveal surprising consequences for fisheries. Furthermore, there is considerable uncertainty about the adaptive capacity of any given natural system to climate and related changes. A number of research projects currently focus on the extent of these relations.

Climate change occurs together with societal and environmental changes, and can have both positive and negative consequences for a community. Adaptation occurs largely locally; it is at the local level that the effects of increased rainfall, flooding and landslides and the change in temperature of sea and land are felt first. Assessments of which areas are most vulnerable to climate impacts, which adaptive measures are necessary, and who should pay for these must, however, be done through local, regional and national cooperation.

In cooperation with the Norwegian meteorological institute, the Center for International Climate and Environmental Research-Oslo (CICERO) employs the latest techniques in meteorological climate research to obtain local, downscaled maps of future climate changes. While such maps do not provide any answers, they do give an indication of what can be expected. This is a balancing act, no one can predict the future but there are nevertheless clear trends that society must deal with.

At the municipal level, seasonal or daily changes in precipitation patterns, temperature and wind speed require preparations to secure against avalanches in new areas, regulations of construction in exposed areas and destruction of infrastructure and roads. Knowledge of future changes will aid the municipality in developing adaptation strategies.

Despite all these uncertainties, we have enough knowledge to understand the direction and trends of the changes to take the first steps for taking measures and political decisions. ○

(Translated from Norwegian by Bob van Oort, CICERO)

Dr GRETE K. HOVELSRUD is Research Director at the Center for International Climate and Environmental Research (CICERO) where she has been since 2004. She has earlier been General Secretary for the North Atlantic Marine Mammal Commission (NAMMCO). Her current research focuses on local adaptation and vulnerability to climatic and other changes in the context of multiple stressors.

Protecting biodiversity in a rapidly changing world – issues for the Canadian arctic

DONALD MCLENNAN addresses the challenges posed for protected areas (PAs) by rapid climatic and ecological change in the Canadian arctic, and identifies key needs for mitigating this change in the context of protected areas management and regional planning.

CANADA'S ARCTIC today encompasses some of the world's most outstanding remaining examples of wild nature. There are few other places on the Earth where such vast and diverse ecosystems are as intact and thriving.

DONALD MCLENNAN is the National Ecological Integrity Monitoring Ecologist at Parks Canada Agency in Ottawa, Canada. He is presently leading an intergovernmental team to develop inventory and monitoring methods for arctic national parks.

The opinions expressed here are those of the author and not Parks Canada Agency.

The Canadian arctic is also the homeland of several groups of Indigenous people including Inuit, First Nations and Metis, who have pursued a land-based lifestyle for millennia, and now sit with one foot in the Old Ways, and the other in the Computer Age. The recent settlement of native land claims across almost the entire Canadian arctic has created a new socio-political landscape where northern Indigenous people have the opportunity to significantly control their own destinies. Our success in adapting to climate change will benefit significantly from the inclusion of their rich traditional knowledge, especially the observations of hunters and others using the land.

Decision-making in Canada's arctic national parks takes place through regional co-management boards composed of Parks Canada managers, representatives from local Indigenous communities, and other regional stakeholders. Ensuring the ongoing pursuit of traditional lifestyles within Canadian arctic national parks is an integral part of the Parks Canada management objective to 'maintain or restore park ecological integrity'. This policy in itself differs from almost all other protected areas jurisdictions in North America that exclude Indigenous people from pursuing traditional resource harvesting in their homelands, in the name of conservation.

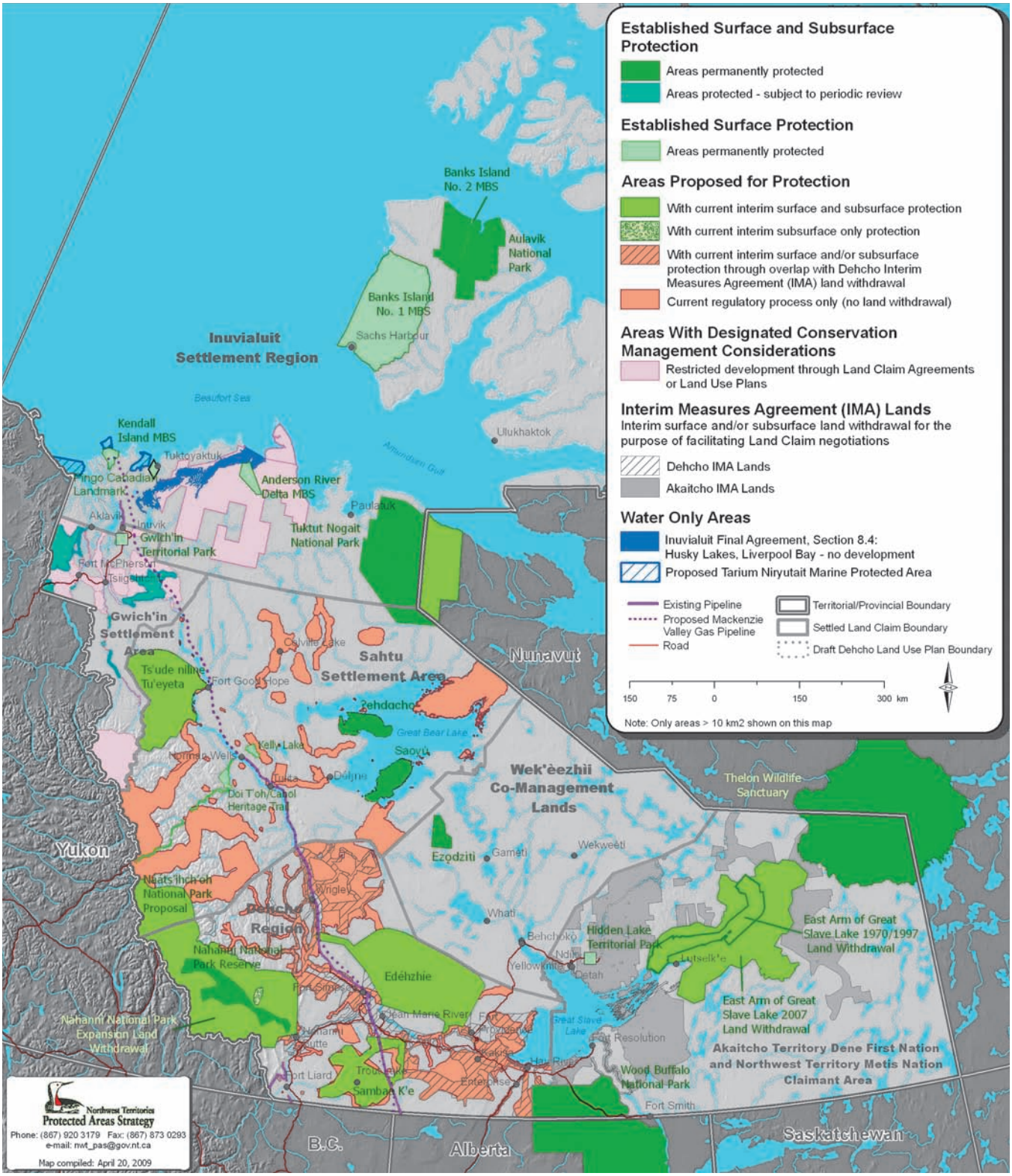
REDUCING UNCERTAINTY

The global situation of climate change is most immediate at high latitudes in the Canadian arctic where, according to *Arctic Climate Impact Assessment* (ACIA) projections, climate change effects are twice the projected global rate of increase. There is ample evidence as well that arctic and sub-arctic ecosystems in Canada and Alaska are already changing, and will continue to change at an accelerated rate in complex and interactive ways that are not well understood.

The main challenge for protected areas managers, and for planning arctic-wide conservation strategies and initiating adaptive actions, is the complexity of the ecological change, and the lack of key kinds of information. Four key areas are:

1. The IPCC (Intergovernmental Panel on Climate Change)/ACIA models predict change for very broad areas, but it is regional climate and weather variability within these cells that will directly affect how local and regional ecosystems will change, and this is largely unknown.
2. Related to this is the problem that IPCC/ACIA models provide little more than probabilistic predictions with wide confidence intervals of important local and regional weather phenomena such as storm frequencies and intensities, or frequencies of icing events – events that can lead to catastrophic ecological change.
3. The myriad of species and environmental interactions of ecosystems over a range of temporal and spatial scales are very complex, and few researchers have dared speculate how ecosystems will respond to predicted climate change, except in the most general terms.
4. Predicted increases in industrial activity add to this complexity of change, and the potential impacts of planned developments will be difficult to distinguish from climate-related effects.

The key to understanding, predicting,



Map 1: The Northwest Territories Protected Areas Strategy.

and adapting to the inevitable ecological change that will occur at local and regional scales is a proactive adaptive management system that includes:

1. ecological inventories that link ecological communities to the ecological processes that control their distribution, provide baselines for assessing change, and utilize standardized vegetation and ecosystem classification approaches
2. focussed and standardized ecosystem monitoring programs that measure and report key elements of ongoing ecological change, and link through common protocols to international initiatives such as the Circumpolar Biodiversity Monitoring Program
3. targeted scientific research that interprets the measured changes in terms of ecological drivers and constraints

This new knowledge could be used to develop five to 15 year predictive models that estimate ecosystem change on a local and regional scale so that managers can begin to understand and proactively mitigate potential changes in the park or community. The cycle would reiterate on a five year state-of-the-park reporting basis (presently required for all national parks), with continued monitoring and research to evaluate and refine the modelling. This model for five year reporting of ecosystem change in Canada's national parks could be expanded through coordinated monitoring to produce a state of the arctic report nationally and, through the Circumpolar Biodiversity Monitoring Program, to the circumpolar area. Over time this approach will develop information required to decide where, and what kind of management interventions will be feasible and potentially effective for the maintenance of arctic biodiversity in and around protected areas.

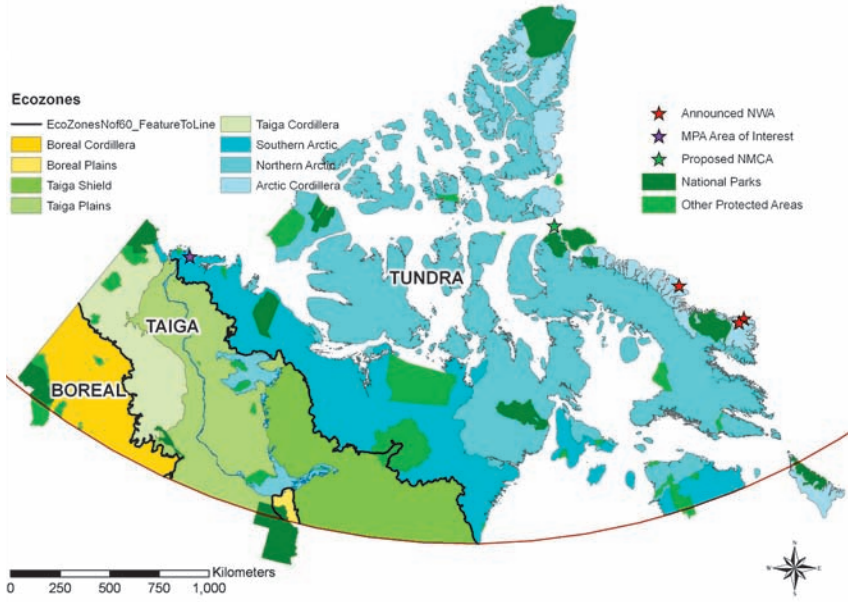
Given their broad ecological representation, inventory, monitoring and research focussed on national parks could also serve as the knowledge engine that will drive our understanding of overall arctic ecological change as it occurs. Such knowledge could also provide criteria for defining and designing functionally connected matrix lands (lands between protected areas), and provide ecological benchmarks for assessing ecological impacts of development change in the absence of industrial disturbance.

> **"It is now clear that modern climates and arctic ecosystems in protected areas are changing at rates that can no longer be regarded as stationary, and that present ecosystem composition and structure is not 'likely to persist'.**

Photo: Staffan Widstrand

PLACE-BASED CONSERVATION

The predicted rate of climate-driven ecological change undermines the present legislation and management paradigm for how Canada's northern national parks were established, and presents a significant challenge for park managers who are presently charged with maintaining their ecological integrity. Social expectations and scientific paradigms for the conservation of biodiversity are predicated within a concept of relative 'stationarity', where the management goal typically is to protect representative sections of targeted biomes, and their typical biota and focal species. It is now clear that modern climates and arctic ecosystems in protected areas are changing at rates that can no longer be regarded as stationary, and that present ecosystem composition and structure is not 'likely to persist'. Protected areas will eventually require new regulatory



Map 2: The locations and ecological context for national parks and other protected areas 'North of 60' in Canada.

and policy directions that acknowledge this inevitable ecological change.

It has been suggested that protected areas of the future may need to be mobile (not 'place based'), so that they continue to protect valued ecological components of the arctic landscape as it evolves in response to climate change. While this seems logical enough, there are practical considerations that complicate its implementation.

In the first place, establishing a single protected area is a lengthy process that has a considerable financial cost, requires complicated negotiations, planning, and the passing of legislation, and involves the considerable efforts of many players. So the feasibility of replacing old protected areas with new ones as ecological change evolves will be difficult, and will take time.

Secondly, a key reason for establishing a system of protected areas is to identify and protect areas of ecological, social and cultural value, so that community and industrial development, and other land use can proceed in a thoughtful manner. The recent Northwest Territories Protected Areas Strategy (see Map 1) is an excellent example of a bottom up, community–based planning process for identifying a system of protected areas using a number of legislative tools that meet the needs of stakeholders. In conjunction with effective environmental legislation and enforcement for the lands between protected areas, the establishment of such a network identifies a clear conservation strategy, and provides the social licence for proceeding with well-planned development. Changing this situation will be problematic, and seriously reduce community and industry buy in to protected areas establishment.

That being said, it is inevitable that specific conservation issues will arise, and some form of protection or regulation will be required as the intensity and pattern of ecological drivers change with warming climates. Caribou calving areas may shift and walrus haul outs may change as the sea ice melts. For these special cases a new legislative category of temporary or shifting protection will be necessary.

SETTING AN EXAMPLE FOR THE WORLD

Lastly, the existing and planned system of very large national parks and other protected areas across the Canadian arctic represents and protects a broad range of ecological conditions. PAs will continue to protect from development the evolving ecosystems within the area, even in a rapidly changing arctic (see Map 2). In-park monitoring will determine whether or not a protected area continues to be relevant in the context of protecting important components of arctic ecosystems, even as they change.

Even the most well designed system of protected areas will not by itself be effective in achieving long-term conservation goals in the Canadian arctic. Given the accelerated rate of ecological change, it is clear that maintenance of the functional ecological connectivity of matrix lands will be the key to sustaining arctic biodiversity, and for maintaining the conservation effectiveness of PAs. The potential for developments to impact already climate-stressed arctic ecosystems in the matrix lands between PAs must be understood through focussed research, identified in ecological assessments, and mitigated through careful development planning and implementation.

Ecosystems of the Canadian arctic are still largely intact, but this stability is imminently threatened by a combination of ecosystem-driven climate change and accelerating industrial development. There is an unequalled opportunity to establish and enforce effective policies that will maintain native biodiversity while permitting controlled industrial and other commercial development. Ecological change is happening in the arctic first, and how we respond in the arctic will set an example for conservation efforts around the world. The indigenous people of the Canadian arctic are well known for their close connection to the land. Given the political powers they now have through the land claims process and the co-management boards, it is critical that they work with northern governments and industry to lead the way in maintaining healthy ecosystems, while permitting and engaging in sustainable developments that bring long term prosperity to their communities. ○

Biodiversity and the Arctic: CAFF's view

We are in the midst of a cycle of intense pressure and change. This involves a new array of challenges and forces such as climate change, all of which are having consequences for arctic environments. New tools and strategies are required which will allow for the effective management of this new environment in which we find ourselves, says **TOM BARRY**.

TOM BARRY is Executive Secretary at the CAFF (Conservation of Arctic Flora and Fauna) Working Group of the Arctic Council. He is a geographer specialising in spatial information/analysis.

WHAT CAN WE DO in times of rapid change? How can we mitigate and adapt to these new circumstances and ensure the sustainability of the Arctic's living resources? Do we need a conservation approach which is better suited to the environmental and ecological changes that are approaching? In order to answer these questions effectively we need better information and understanding of the arctic environment and of what is happening to arctic biodiversity.

It is important to acknowledge the crucial role arctic Indigenous peoples and traditional knowledge plays. Climate change has heightened the need for strong and coordinated action, to allow us to identify and fill the knowledge gaps on various aspects of biodiversity and monitoring. Coordinated action is essential to facilitate agreement on joint action plans and strategies with which to meet these challenges.

Traditionally arctic research has tended to focus on the physical environment and on more easily quantifiable issues. Research on a circumpolar scale into arctic biodiversity has however proved challenging to address. *The Arctic Climate Impact Assessment (ACIA)* has helped to point us in the right direction by providing us with a glimpse of what is happening. However, it has also highlighted our current lack of knowledge. Unfortunately we do not yet have enough baseline information available to fully understand the status and trends of arctic biodiversity. In order to resolve this situation we need to address the basic problem of gaps in information for both marine and terrestrial environments in the Arctic.

CAFF, which is the Conservation of Arctic Flora and Fauna Working Group of the Arctic Council, has responded to these challenges and questions with a twofold strategy. The strategy acknowledges that it is necessary to improve the capacity to generate baseline data and long-term monitoring of arctic biodiversity:

- CAFF is in the process of conducting an Arctic Biodiversity Assessment (ABA) which will be used to identify gaps in the data record, identify the main stressors and key mechanisms driving change. It will synthesize existing data and research on arctic biodiversity to form a baseline which will provide policy makers and conservation managers with a synthesis of the most current scientific research and traditional ecological knowledge. The ABA will serve as a baseline for use in global and regional assessments of arctic biodiversity and form a key piece in the process of understanding what is happening and focusing efforts on those areas where it is most needed. The availability of such information in an easily accessible format will be of great value to the governments, organisations, and peoples of the Arctic region in their struggle to ensure the sustainability of arctic biodiversity and arctic communities.

The ABA will be an important Arctic Council input to the United Nations 2010 Biodiversity Target and the International Biodiversity Year in 2010. It will also form the Arctic Council's input to the Global Outlook and a regional input to the UN Convention of Biological Diversity (CBD). Its first product, the *Arctic 2010 Highlights report* will be completed by 2010 during the international year of biodiversity. This report will help to address the conservation of arctic biodiversity by communicating the findings in a popular way and providing a preliminary assessment of the status and trends of key arctic biodiversity indicators. The full ABAs scientific report now underway with participation of scientists from across the Arctic is scheduled for

> **"In order to resolve this situation we need to address the basic problem of gaps in information for both marine and terrestrial environments in the Arctic.**

completion in 2013.

■ To complement this baseline assessment CAFF is also in the process of implementing a Circumpolar Biodiversity Monitoring Programme (CBMP). The goal of the CBMP is to facilitate more rapid detection, communication, and response with respect to the significant biodiversity-related trends and pressures affecting the circumpolar world. The CBMP is creating an integrated interdisciplinary and collaborative arctic biodiversity monitoring program that enhances our ability to detect important trends and to make such information available to the public and for policy development.

These activities are essential in order to allow us to determine how to effectively manage and cope with the challenges and changes facing arctic environments. For example how can protected areas be managed in the most beneficial way as biodiversity composition and nature changes in response to climate change? The task to find ways in which to respond to the challenges we face will require not only increased knowledge and monitoring but also better and improved cooperation between all involved parties, to allow us to consider the most effective way forward.

Increasingly more international focus and attention are directed towards the Arctic and the possibilities it presents. The Arctic Council as the relevant regional body covering the Arctic faces the challenge of fostering the cooperation necessary to find the best way forward. This presents a range of new policy challenges and implications for CAFF and the Arctic Council. An example of CAFF's efforts to place the Arctic within the global framework can be seen in its recent Memorandum of Understanding with the CBD which aims to contribute to building and sharing knowledge and creating awareness regarding biodiversity in the Arctic region. ○

The European Environment Agency and the Arctic

Even though the 32 EEA member countries have entered into a number of multi-lateral environmental agreements relevant to the Arctic, further efforts are now needed in order to ensure that member states fully implement their obligations, says **JACQUELINE MCGLADE**.

THE WORLDWIDE loss of biodiversity is accelerating as a result of climate change, nowhere more so than in the Arctic. Two recent reports from the European Environment Agency (EEA) on *The Impacts of Europe's changing climate EEA Report 4/2008* and *Streamlining European Biodiversity Indicators EEA Report 4/2009* show just how fast the pace of environmental change on land and sea really is. Organic carbon in arctic soils is declining, ocean acidification is spreading, there have been significant northward movements of plankton and fish displacing coldwater species, and there have been major impacts in some areas on the abundance of large mammals such as polar bears and seals.

Whilst territorial claims and international governance remain the major attention-seeking issues, efforts to halt the loss of biodiversity and ensure sustainable development in the Arctic also need to be intensified. These efforts will involve addressing the status, trends and outlooks for arctic ecosystems, biodiversity and conservation efforts in light of the impacts of a range of sectoral activities. Such activities include the exploitation or damage to natural resources, the overharvesting of certain key fish stocks, the mismanagement of areas of arctic forest and unsustainable logging practices and severe pollution from mining activities and metal ore processing plants that has already laid waste to taiga and tundra. Furthermore, the impacts of infrastructure developments and operational accidents in the oil and gas sector on land fragmentation, biodiversity, reindeer husbandry, and the overall quality of surface and marine waters are continuing to grow.

Prof. JACQUELINE MCGLADE became Executive Director of the European Environment Agency in Copenhagen in 2003. She is on leave from her post as Professor in Environmental Informatics in the Department of Mathematics at University College London. Her research has focussed on the spatial and nonlinear dynamics of ecosystems, with particular reference to marine resources, climate change and scenario development.

Photo: © Kevin Schafer/WWF-Canon

*Horned puffin (*Fratercula corniculata*).*

NEED FOR NEW LEGISLATION

The European Environment Agency (EEA) was established in Denmark 14 years ago as an independent EU institution, to provide European citizens and policy-makers with timely, targeted and relevant information on the state and outlooks for the environment. Its member countries include five arctic member countries, namely Iceland, Norway, Denmark, Sweden and Finland, and six permanent observes in the Arctic Council. The EEA thus has a responsibility to ensure that there is a good understanding amongst Europeans of the environmental changes occurring in the Arctic, their underlying causes and the policy changes needed to address them.

Even though the 32 EEA member countries have separately, and en bloc as the European Union, entered into a number of multi-lateral environmental agreements relevant to the Arctic, further efforts are now needed in order to ensure that member states fully implement their obligations under the wide range of relevant agreements including the Convention on Biological Diversity and the Kyoto protocol. New international and national agreements and legislation are also needed, and in this, Europe has an important role to play. Decision-makers need to take the current challenges seriously, and find solutions to them through a structured process of consultations and subsequent policy development and implementation.

The EEA coordinates the project on Streamlining European Biodiversity Indicators 2010 which covers much of the Arctic. These indicators provide early warnings of ecosystem and biodiversity gains and losses, thus informing decision makers of progress being made and where further action is needed. Our indicator-based assessment illustrates that European biodiversity remains under serious pressure and our policy responses have been insufficient to halt its general decline. It is disappointing that we have to conclude that the European 2010 target will not be met.

The context of biodiversity losses, ecosystem changes and the growing vulnerability of the arctic environment will be fully addressed in the EEA's next *State and Outlook of the Environment report* (SOER2010) and in the *European Ecosystem Assessment* (EURECA 2011). EURECA is designed to help improve our knowledge of how ecosystems function, particularly those at the extremes such as the Arctic, the services they provide, involving stakeholders and developing tools for political decision-making in Europe. It will provide a platform for people to exchange knowledge and bring national assessments together at a European level. Information on biodiversity and ecosystems will also be fed into the European Clearing House to be established by 2011 as part of the framework of adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change.

CHANGING ATTITUDES

The Arctic's unique animal and plant species survive under extreme conditions, and in turn sustain the lifestyles of its Indigenous peoples. The EEA has been in discussion with the Arctic Council's working group on the Conservation of Arctic Fauna and Flora (CAFF) on the development of the Arctic Biodiversity Assessment (ABA) for the period 2009-2013. CAFF includes Indigenous and lay knowledge to complement the scientific information in their work. This approach is supported wholeheartedly by the EEA and will be adopted in its own upcoming assessments in order to strengthen the links between biodiversity and cultural diversity.

Attitudes are beginning to change in response to the challenge of biodiversity losses. The Arctic Council ministers at their recent meeting in Tromsø welcomed continued work to better understand climate change and its consequences, including the loss of sea ice which is a major stressor to the Arctic's biodiversity. The ministerial declaration also emphasised the important role of arctic Indigenous peoples and their traditional knowledge in conservation and sustainable use of arctic biological resources.

Government leaders at the G8 environment meeting in Syracuse, Italy and the high-level EU conference in Athens, Greece, publicly recognised the close links that exist between climate change and biodiversity loss and that neither can be solved without addressing the other. An integrated approach, aimed at greening our economy was called for. The EEA echoes this and hopes to help bring about a change in policies by contributing timely, targeted, relevant and reliable information on biodiversity and climate change especially in the Arctic. ○

Arctic conservation – where do we go from here and how fast do we get there?

Arctic conservation as a discipline, policy and practice is at a cross roads. The message is clear: evolve rapidly, or settle with gradual defeat. **MIRIAM GEITZ** isn't ready to accept the latter, and sketches out ways to overcome the weaknesses of today's approach.

AS MORE AND MORE people are learning about the uniqueness, challenges and threats to the Arctic, the region's environment and societies are changing to an extent which is hard to comprehend. The context for arctic conservation has changed considerably in the past few years: warming temperatures and its spin-off effects, changing ecological processes, coupled with a race for territorial power and natural resources. The two elements of critical importance for successful conservation in this turbulent environment are urgency and direction.

Direction, because the conservation paradigm which has served us well in the 20th century and ensured great conservation successes is challenged. Challenged because the species, habitats and ecosystems we aim to protect in the Arctic are poorly understood to science and conservation managers. Challenged because unprecedented rates of climate change amplified by other pressures make it increasingly hard to predict ecosystem dynamics in space and time, let alone plan for or manage. Challenged also because people and the environment have for far too long been looked at as two separate and even competing elements in conservation, rather than as closely linked and interdependent units.

Urgent, because arctic climate science tells us that the changes underway as well as the self-enforcing effects from those changes, will be stronger and harder to address with every day that passes. At the same time, industrial activities in this vulnerable environment proceed with full force exactly in the places with the biggest ecological changes - such as new ice free areas - creating a reality that can be difficult to retreat from. Thus, development charges ahead without a common understanding of what is at risk or what the arctic community, or let alone the global community, want the Arctic to look like in the future.

THE ARCTIC AS A GLOBAL PRIORITY

As the only conservation organization represented in all arctic countries, WWF has worked for conserving the Arctic's unique nature for more than two decades. Together with partners, WWF is involved in discussions about arctic conservation from local field projects to intergovernmental fora. Based on this firsthand knowledge of the changes and challenges the Arctic is facing, WWF has focused on making the Arctic one of its few worldwide conservation priorities. This underlines the importance of this region's future in its own right, and for the rest of the world. All work done by our organization in the Arctic is directed at slowing down global warming, and on promoting resilience-based management of land, sea, ecosystems and species. One obvious thing for building resilience to climate change is to limit or remove the threats to biodiversity and ecosystems that can be managed directly, like unsustainable fisheries, or oil and gas exploration. But it also requires that we expand and update our planning and management practices so that they increase the resilience of

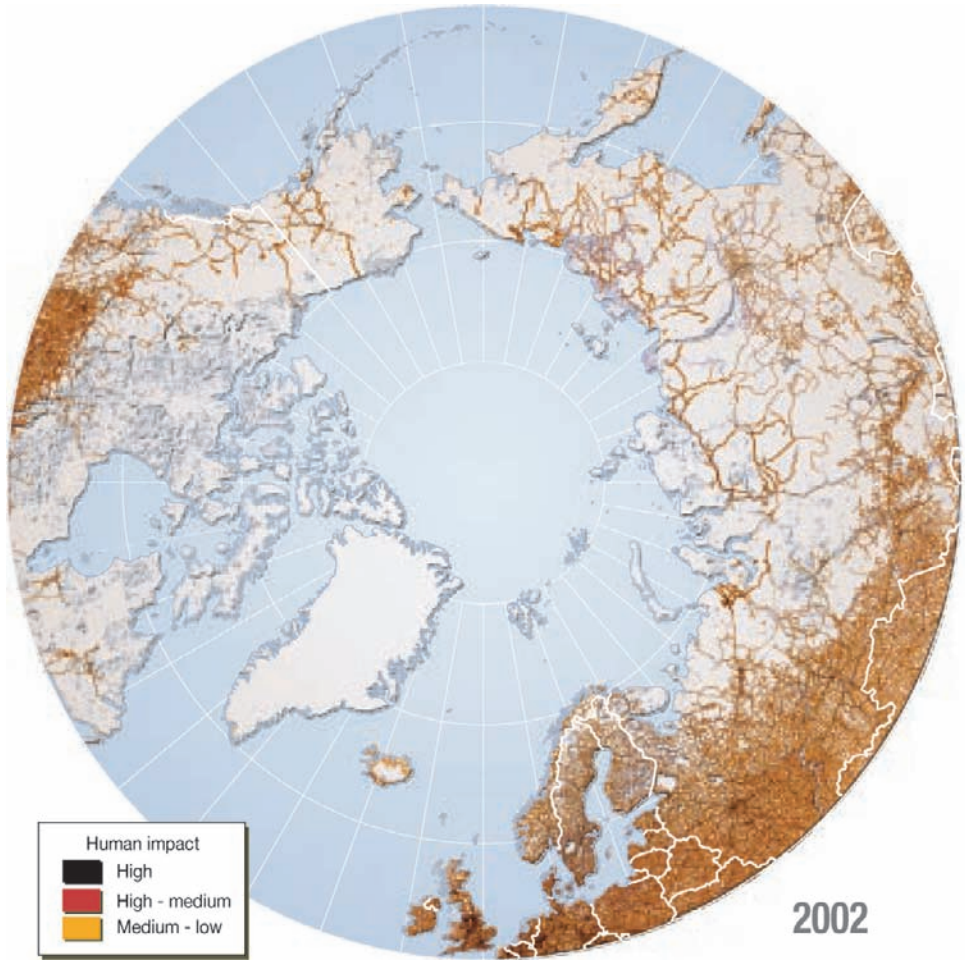
> **"The two elements of critical importance for successful conservation in this turbulent environment are urgency and direction.**

MIRIAM GEITZ is Senior Conservation Officer with the WWF International Arctic Programme where she is coordinating WWF's efforts to tackle the climate change challenge to arctic conservation.

both human and natural systems.

With this in mind, WWF believes that we need to take critical inventory of the current conservation approach and tool box: Which tools and practices have the potential to be adapted to conservation under rapid change, and if so, can they adapt fast enough? One 'tool' that for good reasons is regarded a cornerstone of conservation are protected areas (PAs) and protected area networks. If PAs want to hold their ground in the future, today's concepts need to internalize the implications that climate change brings to place-based conservation by moving beyond their stationary approach, and integrating more strongly with other spatial management measures outside PA boundaries.

Research and monitoring is also often looked to in this context, implicitly suggesting that if we only knew more, we would be better able to manage and cope. The fact is that with a 'moving target' and with limited resources, monitoring and research need to cooperate across disciplines, focus on resilience-building and feed back into management and decision-making processes in a timely manner.



Arctic development scenarios, human impact in 2050.
Map: Hugo Ahlenius, UNEP/GRID-Arendal. http://maps.grida.no/go/graphic/arctic-development-scenarios-human-impact-in-2050.

TOWARDS A SOLUTION

So what needs to be done to give the Arctic as we know it a fighting chance, and conservation a new boost?

Like with so many complex and urgent challenges, the pursuit of answers to these pressing questions requires parallel and well-coordinated work at several levels.

At the political level, it is long overdue that the impacts and threats to the Arctic's social-ecological systems are integrated in all aspects of policy and regional development, and are followed up with the vision, leadership and resources that match the challenge. The Arctic Council could assume such a leadership role, for instance by establishing a clearly defined, mandated, time-limited and resourced task force across its working groups.

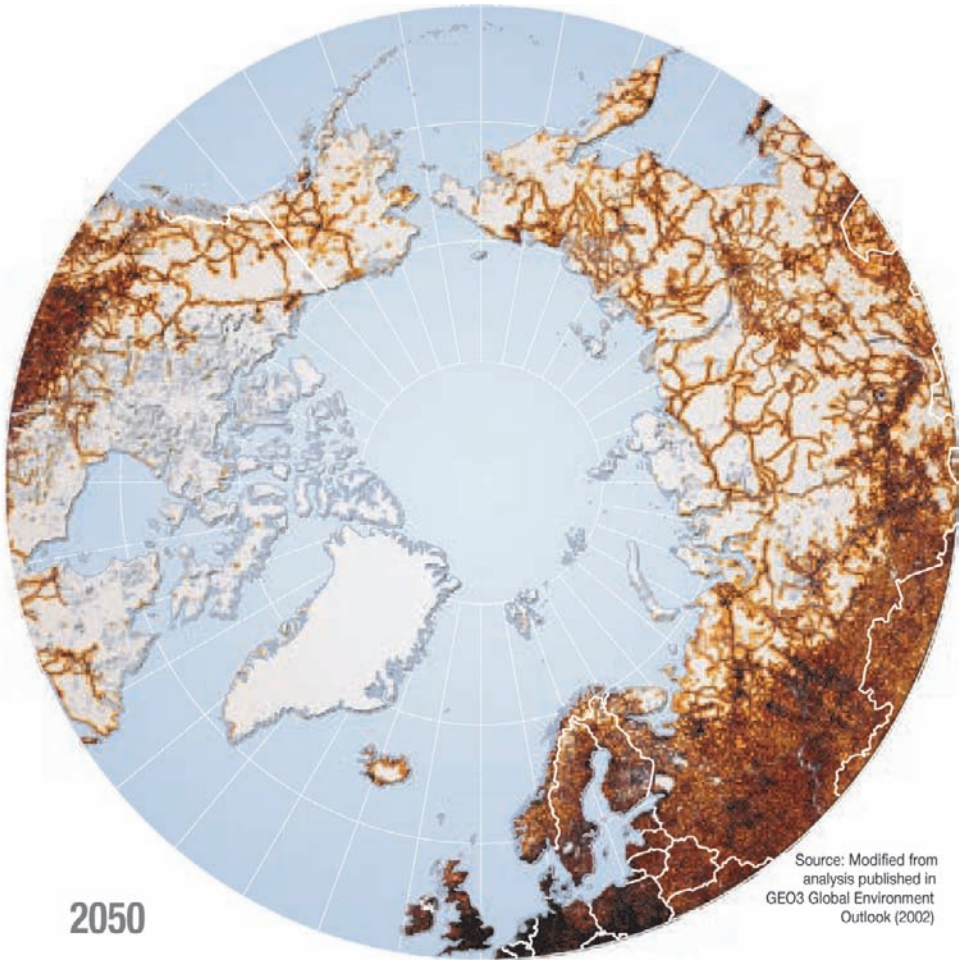
From a natural resource and regional development perspective it is important to integrate efforts across sectors and scales or we will miss out on important indicators for ecosystem health. A truly holistic and integrated management approach to the Arctic with resilient social-ecological systems as a guiding objective could provide the much needed framework for a sustainable development of the region.

At the same time, conservation science needs to develop new theory and practice to provide relevant hands-on guidance for conservation planners and practitioners in the Arctic. Whether you are planning a nature reserve or a new housing area, planners and practitioners need to do more than wait for tools from outside: We need to proactively consider the implications of climate change and its indirect effects into our ongoing efforts and try out local measures that leave room for flexibility and adaptive management.

Perhaps most importantly, it requires a shift in mindset at all levels: the Arctic is changing, and will change even more. We won't be able to control or even manage many of the changes, but we can work towards limiting their negative impacts by strengthening the natural and human systems' adaptive capacity and resilience.

PRINCIPLES FOR THE FUTURE?

WWF is determined to contribute to solutions, and as a first step gathered



more than 20 leading natural and social scientists to discuss the evolution of arctic conservation under rapid environmental change earlier this year. A paper with the findings from this workshop will be published later this year, but the discussions are already informing and reflected in WWF's arctic work. This is only one of many steps towards a conservation approach that steps up to the climate challenge by

- shifting from an ecosystem and species preservation focus to one that builds resilience in ecosystems, especially their functions and structures:
- broadening the scope of conservation efforts from ecologically-centred to human-environment systems
- anticipating change and considering different possible futures when making management decisions
- accepting that the Arctic is changing
- learning to better manage risk and uncertainty
- cooperating more proactively with stakeholders, across scientific disciplines, and the region

> **"At the same time, conservation science needs to develop new theory and practice to provide relevant hands-on guidance for conservation planners and practitioners in the Arctic.**

NEED FOR BOLD ACTION

Every day we lose a bit more of the Arctic as we have known it, and it becomes clear that with the pace of climate change and development pressure on arctic nature and peoples we need to act fast on what we know today. This is in addition to continuously improving our knowledge base and adapting our responses.

We need urgent and clear political decisions, from community councils to heads of state, recognizing and taking on the Arctic's social-ecological challenge. At the same time we need quick guidance on where we should focus our conservation efforts for the long-term benefit of nature and people. Current thematic maps of the Arctic describe the state and sometimes the trends of different themes, whether it is human health, activities, or biological data. In order to increase resilience of arctic people and nature, we need to identify the ecological cornerstones and pillars of the Arctic – and where those are found and likely to endure even under rapid climate change. Once identified, those cornerstones will give us a clear indication of what the conservation priorities in the 21st century's Arctic are.

In an Arctic faced with changes of this magnitude, uncertainty is the only constant. Instead of relying on historic data, doing 'conservation business as usual' and hoping that things might not become as bad as predicted, arctic conservation needs to become an integral and proactive element of a sustainable development vision for the Arctic.

Bold, quick and innovative steps are needed soon. Multiple tools in our current toolbox can in revised and newly assembled combinations help us bridge the gap into a new conservation paradigm. ○

B-economique
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The Picture

Photo: Underwood & Underwood. Wikipedia Commons

Founding fathers of national parks

U.S. President Theodore Roosevelt (left) and nature preservationist John Muir, founder of the Sierra Club, on Glacier Point in Yosemite National Park. In the background: Upper and lower Yosemite Falls.

Roosevelt and Muir were central in developing the national park concepts and in establishing the US National Parks System. Muir convinced Roosevelt to protect Yosemite and a number of other areas as national parks. The president made conservation a central policy issue of his administration and advocated for the sustainable use of the nation's natural resources, believing that conservation, as a utilitarian tool for sustained economic growth, strengthened American democracy. The US area placed under public protection by Roosevelt, as national parks, national forests, game and bird preserves, and other federal reservations, is said to be a total of approximately 230,000,000 acres or almost a million square kilometers.

Sources: http://www.theodoreroosevelt.org/life/conservation.htm, http://pantheon.cis.yale.edu/~thomast/essays/filler/filler.html, http://www.nps.gov