CAFF Technical Report No. 6 **AMAP Report 2:00**

CAFF/AMAP Workshop on a Circumpolar Biodiversity Monitoring Program, Reykjavik, 7-9 February 2000.

Summary Report

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CAFF International Secretariat 2000

Preamble

The CAFF/AMAP Workshop on a Circumpolar Biodiversity Monitoring Program was held to advance work on biodiversity and climate change monitoring in the circumpolar Arctic region under the aegis of two of Arctic Council's working groups, Conservation of Arctic Flora and Fauna (CAFF) and Arctic Monitoring and Assessment Programme (AMAP).

CAFF's "Strategic Plan for the Conservation of Arctic Biological Diversity (1998)" identifies biodiversity monitoring as one of the program's key objectives. In addition it identifies assessment of climate change and UV-B impacts on Arctic ecosystems as an important task of CAFF. In Iqaluit (1998), the Arctic Council ministers directed CAFF to "identify elements of a program to monitor circumpolar biodiversity" and to "assess, in collaboration with AMAP, the effects of climate change on Arctic ecosystems".

Since 1997, AMAP has a ministerial mandate to continue "monitoring, data collection, exchange of data on impacts, and assessment of the effects of contaminants and their pathways, increased ultraviolet-B (UV-B) radiation due to stratospheric ozone depletion, and climate change on Arctic ecosystems".

AMAP and CAFF have organised two workshops on climate change research and monitoring, in Rovaniemi, March 1998 and in Tromsø, September 1998. AMAP and CAFF both participate in the US led Arctic Climate Impact Assessment (ACIA). The CAFF Working Group discussed monitoring at its 7th meeting in Yellowknife, April 1999. The report and relevant background documents are available at *www.grida.no/caff/biodiversity.htm*.

TABLE OF CONTENTS

I. INTRODUCTION

The three-day CAFF/AMAP Workshop on Circumpolar Monitoring Program gathered experts from all Arctic countries (Canada, Finland, Denmark/Greenland, Iceland, Norway, Russia, Sweden and the United States), Russian Association of Indigenous Peoples of the North and the United Kingdom, altogether 38 participants (see Appendix 1).

The workshop began by a half-day overview session providing context and scope for the discussions, followed by three modules focusing on the terrestrial, freshwater and marine environments. Each module was introduced by 3-4 short presentations, providing examples of relevant ongoing work in the Arctic. The modules discussed circumpolar monitoring needs and opportunities but focused on identifying a few (2-4) biotic elements for each environment, which are current foci of national/international work and can serve as pilots for a fully-fledged circumpolar biodiversity monitoring program. Different methodologies (i.e. plot/population based monitoring, community/college networks, and aerial/remote sensing techniques) were also discussed. The third day was used for workshop wrap-up and development of conclusions and recommendations (see Appendix 2).

Prior to the Workshop a Drafting Committee[1] had prepared a *Conceptual Framework for a Circumpolar Biodiversity Monitoring Network*, which provided a backdrop for the discussions at the workshop (available at *http://www.grida.no/caff/biodiversity.htm*).

This Report provides a summary of the presentations and discussions at the workshop with full presentations attached as appendices.

II. WELCOME

Ingimar Sigurðsson, Head of Office, Ministry for the Environment.

Mr. Sigurðsson welcomed participants to the workshop. In his address he emphasised Iceland's interest in advancing Arctic environmental cooperation, as evident e.g. through hosting the secretariats for CAFF and PAME (Protection of the Arctic Marine Environment). Since its establishment in 1990, the Ministry's main focus has been on protecting the marine environment and its living resources, especially through pollution prevention and control. Monitoring of biodiversity has not been a high priority so far, but has increasing weight in the Ministry's new work plan. A new remote sensing facility is being established by the Mapping Agency in co-operation with other relevant institutions, and Iceland will enhance work towards to fulfilling its obligations to the Convention of Biological Diversity. Thus the Ministry is very interested in the workshop topic and looks forward to its recommendations. The Ministry believes that Iceland, due to its strategic geopolitical situation between the two continents, could be an excellent platform for circumpolar cooperation and efforts of this kind. Mr. Sigurðsson, finally emphasised that the purpose of everything we do in the environmental arena must be to ensure human life in peace with Mother Nature.

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[1] Drafting Committee: Kevin McCormick (Canada), Aevar Petersen (Iceland), Christopher Brodersen (Norway), Natalia Vassilieva (Russia) and John Bengtson (USA).

III. MODULE 1: OVERVIEW PRESENTATIONS

The first Module was devoted to six overview presentations providing a background for the discussions:

Ulla Pinborg - Biological monitoring: Current Approach by the European Environmental Agency

The European Environment Agency (EEA) mission is to deliver timely, targeted, relevant and reliable information to policy-makers and to the public for the development of sound environmental policies in the European Union and other EEA member countries.

EEA relies completely on data and information already collected in national or international monitoring activities as well as from a wide range of environmental institutions. EEA uses this information as the necessary background for performing integrated analyses and reports for decision-makers, aimed at understanding what happens to the environment, and whether the political instruments are effective in improving the environment. The working framework for collecting data, for analysis and reporting is called the DPSIR-chain; from understanding the socio-economic Driving forces and the Pressures on the environment caused by these to assessing the Status and Impact on the environment to the effectiveness of political and societal Responses adopted and used.

EEA as a user of data has a basic interest in ascertaining the coverage of data and its quality. In some fields there is a long history for precisely defined data collections based on equally well defined monitoring, e.g. for climate, air conditions, forest and to some extent also water conditions. For biodiversity the case is different. The term biodiversity as it is defined under the global Convention for Biological diversity (CBD) is a very broad and variegated term, encompassing both wildlife and domesticated organisms as well as natural and cultivated habitats and genes. Indicators for biodiversity as such need to be developed with careful consideration as to level and component elements as well as to representativity. At the global and European level, several institutions are developing and producing indicators and data for indicators, e.g. OECD, Eurostat, and EEA. Furthermore, nearly all European countries are developing their own official indicator concepts and data collection strategies.

Brad Griffith - Remote Sensing: Possibilities and Opportunities for Biodiversity Monitoring.

Remote sensing may be used to monitor animal distribution and movement, to inventory habitats, and to assess within and among year habitat dynamics. Satellite radio-collars may be used to identify heavily used seasonal habitats, delineate migration corridors, and assess population affinities and interchange for animals.

Remote sensing of habitats is limited by the resolution of the sensors. Spatial resolution (pixel size) ranges from 10 m to several km. Temporal resolution ranges from twice daily to once in 26 days. Image cost, data storage requirements, and temporal resolution are inversely related to pixel size. Spectral and radiometric resolution determines the number of distinct plant communities that may be identified on an image. All raw data requires substantial processing and quality control by qualified and experienced personnel. Multi-Spectral Scanner (20-50 m) and Thematic Mapper (30 m) sensors are most useful for mapping plant communities. The ability of these sensors to detect plant community change is limited by the accuracy of a particular classification. The rate of plant community change must exceed the inaccuracy of vegetation maps (typically 15-25%) to be detectable; this rate of change is unlikely to be observed in the Arctic except in cases of surface disturbance or wetland drying. Microwave sensors are most useful for assessing ice pack dynamics, and Advanced Very High Resolution Radiometry (1 km) is most useful for assessing plant phenology dynamics on landscapes.

Remote sensing has been used to 1) develop models of species/habitat affinities and overlain these models to identify areas of high species diversity; 2) document sub-Arctic wetland drying during 1973-1998; and, 3) to establish linkages between caribou demography and climate warming induced habitat changes in the Arctic. Strategic implementation of remote sensing for monitoring biodiversity will require testing the upward scalability of site based estimates of the effects of climate warming on vegetation phenology, stratifying the Arctic into zones of documented warming and cooling, and using these strata as the basis for a circumpolar biodiversity sampling plan.

Struan Simpson - Monitoring Biodiversity and Change in the Russian Arctic: Using Community Networks and Indigenous Knowledge

RAIPON (Russian Association of Indigenous Peoples of the North) represents Russian indigenous minority peoples, including the two million inhabiting the Russian Arctic.

Among RAIPON's planning priorities is Environmental Impact Assessment (EIA). Enhancing its capacity to conduct EIA could be of considerable added value to Russian biodiversity monitoring endeavours, to the work of CAFF/AMAP and the international scientific community. A partnership is planned between RAIPON, the Conservation Foundation's London Initiative on the Russian Environment (LIRE) and the World Conservation Monitoring Centre (WCMC, Cambridge), to adapt EIA methodologies to take account of traditional ecological knowledge (TEK).

Sparse population densities in the Russian Arctic is one of the limiting factors in using TEK, but in any event an approach to indigenous peoples has to be based upon the principles of partnership and equity. Methodologies have to yield information of value to all participants.

It is proposed therefore to develop relief model (3-D) **community mapping** techniques as the basic monitoring method both for nomadic and non-nomadic groups, to facilitate origination and community ownership of vital (ecological) knowledge while furnishing them with an empowerment tool in their negotiation for enhanced political status.

Christopher Brodersen - Environmental Monitoring in Svalbard and Jan Mayen (MOSJ): Hopes, Facts, and Lessons Learned

The goals of MOSJ are to: (1) contribute to maintaining Svalbard and Jan Mayen as some of the best managed wilderness areas in the world, and (2) to detect abnormal changes in climate, biodiversity and cultural heritage weathering in the area. The scope of MOSJ is to make an integrated system for generating, analysing and presenting environmental data in a comprehensive, accurate and economic viable way. To this effect, several activities have been initiated, including on: monitoring of species, habitats, main threats, climate change impacts and cultural heritage condition; quality control at all stages; analysis, interpretation and distribution of data to decision-makers and public; initiation of relevant research. MOSJ strategies are to: build on existing monitoring, build warning systems from low to high resolution; link up with other relevant international monitoring and to focus on cost/benefit relations.

Lessons learnt can be grouped into several categories. From an organisational point of view it is evident that: monitoring is too weakly expressed in national long term planning and poorly linked to the most innovative part of the science community; the value of nature differs vastly between responsible national and international authorities; there is still a wide gap between research and monitoring and monitoring seldom challenges integrated approaches. In terms of financial constraints, research funding appears often to be short-term and opportunistic and there is a need for better national and international division of labour to cope with monitoring costs. Professional challenges include the following: research is a vital part of monitoring, but research and monitoring data are not always the same - there is abundance of research data but lack of monitoring data; monitoring levels of disturbances is very different from monitoring impacts – critical loads and background values are known in many cases, but the knowledge about status and natural variability in most key parameters of the Arctic environment is unsatisfactory; the nature of biodiversity monitoring demands a multidisciplinary approach in interpreting data and management officials often lack such skills; there is insufficient knowledge about combining traditional knowledge and research and; finally, we need more "Super-beasts" for indicators.

O.W. (Bill) Heal - Climate Change and Biodiversity: Next Steps?

The **aims and principles for monitoring** of biodiversity have been identified by CAFF and AMAP earlier meetings and in circulated papers. Monitoring is just one approach in the portfolio of techniques used to address of inter-related environmental questions. Monitoring focuses on the questions How is it changing? But to be useful it must be linked to Research (Why is it changing?), Prediction (How will it change?), Policy (How should it change?) and Assessment (Is the policy working?).

Why Monitor? To detect genetic, species, habitat, and ecosystems responses. To distinguish natural and short-term fluctuations from long-term trends. To identify causes of change. To test predictions. To provide early warning of change. To evaluate effects of policies.

Where to Monitor? A logical spatial sampling strategy is critical. GTOS has identified 3 main scales - local intensive monitoring; extensive monitoring of fewer variables less frequently; comprehensive or census by remote sensing. Observations should focus on areas predicted to show warming or cooling, oceanic to continental gradients, variation in wet or dry conditions. Local and regional climatic gradients provided powerful opportunities. Sensitive locations are at climatically determined margins of species or habitat range or where key factors are changing e.g. permafrost.

How to monitor? Phonological observations provide sensitive measures specific to climate change e.g. arrival of migratory species. Phenology is particularly suited for extensive change measurement by "amateur observers" in dispersed human communities.

Next steps? Based on the general principles and priorities, and building on existing knowledge and predictions of change, a feasible list of species (with distinct trophic and habitat characteristics) and habitats are identified as primary targets for intensive monitoring.

Kevin McCormick - Framework for a Circumpolar Biodiversity Monitoring Network: Work of the Drafting Committee.

In 1998, the Ministers of the Arctic Council directed CAFF to identify elements of a program to monitor circumpolar biological diversity and to assess, in collaboration with AMAP, the effects of climate change and UV-B radiation on Arctic. At the 1999 CAFF Working Group meeting it was decided that the preparation of a conceptual framework was a key first step in the long-term development and implementation of the monitoring program. The propose of this framework is to:

- describe, in a succinct manner, the goal, objectives and other key parameters upon which the initiative will be developed.
- establish a process to identify the key elements of circumpolar biodiversity which merit priority attention.

- provide a guide for those parties developing various components of the monitoring network so that it may be implemented in a consistent, efficient and cost-effective manner.

The Framework (available on request from the CAFF Secretariat) describes the goal, objectives, scope and key planning considerations, which form the foundation of the monitoring network. It is proposed that the network be based on a decentralised organisational structure, which takes full advantage of existing programs and institutions in the Arctic. Initial efforts will focus on priority elements of three large ecosystems - terrestrial, freshwater and marine - which have been selected on the basis of accepted criteria. It is recognised that Consideration must be given to the management of information, particularly the selection of variable to be measured, the manner in which they are measured and the approach to storing and sharing information.

IV. MODULE 2: TERRESTRIAL ENVIRONMENT

A. PRESENTATIONS

The Module opened with four introductory presentations:

Ingibjörg S. Jónsdóttir - The International Tundra Experiment (ITEX).

ITEX is a Man and the Biosphere (MAB)/Northern Sciences Network (NSN) initiative and it began in December of 1990 when researchers from North America, Europe and Russia met at Michigan State University and agreed to undertake similar experimental studies on plants throughout the tundra biome. The primary focus was to be on species responses to natural variation in climate and experimental warming, with a secondary focus on ecosystem processes and community dynamics and genetics. The warming manipulation is aided by hexagonal Open-Top Plexiglas Chambers (OTCs) that increase the temperature within the chambers by 1-3 ºC above ambient temperature. The individual sites and research groups that build the ITEX network have been responsible for their own funding. The Danish Polar Centre provides co-ordination and ITEX has a valuable collaboration with the International Permafrost Association (IPA) in monitoring active layer depth at ITEX sites. ITEX work has already resulted in several site-specific international publications on short-term (2-5 years) effect of temperature enhancement and two major syntheses. ITEX has now entered a new phase of long-term manipulations and monitoring and of modelling individual species response as well as whole plant community responses.

Ingibjörg S. Jónsdóttir - Two Tundra Expeditions

Data from two tundra expeditions (organised by the Swedish Polar Research Secretariat in 1994 and 1999, respectively), provides valuable information on variation in biodiversity (species, genetic) of large number of terrestrial and freshwater organisms (mammals, birds, fish, invertebrates, micro-organisms, vascular plants, mosses and lichens) along large geographic sectors in the Arctic.

Don Russell – Rangifer as an Indicator of Health and Change in the Circumpolar Arctic.

It is suggested that monitoring of Rangifer populations should follow the lead developed at the Rovaniemi workshop in 1999 (Human Role and Reindeer/caribou systems). That is, to sample populations within a 3 dimensional continuum – industrialisation (heavy development to pristine), institutional control (herding to hunting) and climatic trend (warming to cooling). Examples of herds that represented the extremes along this continuum were suggested.

We would suggest a 4 component monitoring program – herd assessment, remote sensing, community monitoring and communications. Herd assessment involves integrating the available data on selected herds and assessing impacts of change using computer simulation models. Using remote sensing the recent trends in early summer green-up and fall senescence will be determined and ongoing protocol for monitoring developed. Standard protocols need to be developed and implemented in a number of communities within the ranges of the herds. Communities are keenly interested and ideally positioned to monitoring the health and body condition of reindeer/caribou as well as environmental change in general. The fourth component, communications, is critical to ensure all partners are fully aware of the network and can provide constant feedback.

Present North American and international initiatives that would be useful in such a monitoring network were outlined and suggestions for where to begin were described.

Stephen Talbot and Donald D. Walker[2] - The Circumpolar Arctic Vegetation Mapping Project (CAVM) and the Pan Arctic Flora Initiative (PAF)

A new vegetation map is being prepared to provide a common legend and language for ecosystems of the Arctic region. Such a map is needed for a wide variety of purposes related to anticipated global changes, land-use planning, and biodiversity monitoring. The goals of CAVM are 1) develop a single 1:7,500,000-scale vegetation map of the circumpolar region, 2) develop a legend and method that can be used consistently in all the circumpolar countries, 3) unify information existing on a wide variety of maps at different scales, and 4) establish a model for mapping other global biomes such as the boreal forest. Some anticipated applications are 1) ecologically sound natural resource management, 2) models of trace-gas fluxes, and 3) ecoregions mapping. Continental syntheses for North America and Eurasia will be completed in 2001 and the final circumpolar synthesis will be competed in 2002. Four major products will be produced: 1) a photo-quality cloud-free and snow-free false-colour infrared image of the circumpolar region derived from satellite imagery; 2) a map of the relative vegetation greenness of the circumpolar region as portrayed by the maximum normalised difference vegetation index; 3) simple land cover map with eight classes; and 4) a geobotanical database and derived maps of the circumpolar arctic tundra and polar desert region. The database will consist of an integrated map coded with landscape and vegetation information.

To help develop an internationally accepted terminology related to arctic zonation and to understand vegetation patterns related to climate and substrate, the vegetation along an 1,800 mile transect was investigated in the eastern Canadian Arctic by members of the CAVM team. Preliminary observations show trends in plant functional types and dominant communities along latitudinal, substrate, and topographic gradients. Patterns are complex but recognisable in the Canadian Arctic; four subzones are delimited based on vegetation response to temperature along the north-south latitudinal gradient: 1) cushion-forb subzone, 2) prostrate-dwarf shrub subzone, 3) erect-dwarf shrub subzone, and 4) low shrub subzone.

The relevance to the CAFF/AMAP initiative is that CAVM is the first portrayal of the vegetation of the whole arctic in detail. This subdivision of the landscape into units that are relatively homogeneous will provide a framework for planning and sampling. The integrated mapping procedure incorporates climate, parent material, and topography into a unified legend approach that is ecologically meaningful. Global modelling efforts can use plant functional types to group the multitude of plant species into more manageable groups considered important to ecosystem function. Relative vegetation greenness products have been already prepared for the globe and North America and are extremely useful for examining spatial patterns of biomass production and for modelling the effects of climate change

The Pan-Arctic Flora (PAF) project began as a biodiversity project with the aim of a comprehensive inventory of the arctic flora. The goal of the project is unified view of the arctic vascular plant flora. PAF is a separate, independent project working in parallel with CAFF. PAF will provide a checklist as a standard source for plant names. It will also provide detailed data on the distribution of plants and a serve as a source for rare plant documentation. Long-term PAF aims are 1) production of a critical Panarctic Flora based on one or several consensus species concepts; 2) establishment of databases for information on

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[2] University of Alaska Fairbanks

arctic vascular plants; and 3) establishment of information exchange about the unified treatment of arctic plants.

B. DISCUSSIONS

Two breakout groups were formed to discuss monitoring of the terrestrial environment[3]. The group's main observations and conclusions are summarised below.

Criteria for Choosing the Elements in a Monitoring Program.

Based on the draft Conceptual Framework for a Circumpolar Biodiversity Monitoring Network, the following criteria were emphasised for guiding the selection of elements in the program:

Environmental criteria

- The biological components should have a circumpolar distribution/relevance.
- Components should be important to ecosystem structure/function.
- Components should be disposed to monitoring of phonological changes.
- Vulnerable species and habitats need special consideration.
- Regional expansion and contraction/extirpation of species (species moving in and out of an area) are good indicators of change.
- Peripheral species can be most sensitive to change and may serve as early warning systems.

Socio-economic criteria

- Some of the species and habitats included must be subject to human exploitation.
- The components/methods in the program should make it possible to include local inhabitants in a community-based program.
- The components in the program must be understandable and familiar to decision-makers.

Feasibility criteria

- Cost effective monitoring methods should be available or possible.
- To the extent possible work should build on existing networks in the Arctic countries.
- Data access and management must be a part of each of the components.
- The initial network should have a potential for expansion.

Potential Elements of the Network[4]

Potential biotic elements of a monitoring program were discussed, using Table 3 in the Report from the IASC Workshop on Climate Change (Tromsø, 1999), as a basis.

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[3] Moderators and rapporteurs: Snorri Baldursson, Kevin McCormick, Ivar Mycklebust and Don Russell

[4] Note: Most of the recommendations from the AMAP/CAFF Svanvik Workshop on Biological Methods (1995) and the AMAP/CAFF Rovaniemi Workshop on Climate Change (1998) are still valid, and provide important guidelines for further discussion on a circumpolar monitoring program for biodiversity

Species

	Vulnerability threat	***Socio-economic importance***	***Ecological importance***
Mammals:			
Reindeer/Caribou	Pasture change Parasites	Herders, hunting	Pasture grazer Prey source
Arctic fox	Prey shift endangered species	Cultural, tourism	Predator, scavenger
Small rodents	Food quality change	Indirect through food web	Key prey, vegetation impacts
Birds:			
Geese	Pasture/flyway change Climate signal	Hunting, tourism	Pasture grazer
Waders	Pray shift Endangered species	Cultural, tourism	Predator, scavenger
Passerines e.g. Snow bunting, Lapland bunting	Climate indicators Food change	Indirect through food web	Kay prey
Ptarmigans	Food change	Hunting	Shrub grazer
Gyrfalcon	Food shift, Endangered species	Cultural	Predator
Invertebrates:			
Ants	Habitat	Indirect through food web	Scavenger
Moths	Food quality	Indirect through food web	Climate indicator, defoliating species

Habitats/Ecosystems

	Vulnerability, threat	**Socio-economic importance**
Timberline forest	Climate change/dispersal	Subsistence/herding/logging
Wetlands	Permafrost	Conservation
Dry heaths	Reduced precipitation	Conservation
Riparian	Flooding	Conservation
Estuaries	Flooding, sea level	Conservation, fishing

Special Programs

In addition to specific species and habitats/ecosystems, the group discussed the following programs and opportunities: **ITEX** (International Tundra Experiment) as an ongoing and successful research network on vascular plants; **CPAN** (Circumpolar Protected Areas Network) as an existing circumpolar network supported by CAFF, and; **community based networks** as an opportunity for low-tech gathering of long-term data series, especially those related to phenology of plants and animals.

Genetic Diversity

Species diversity is low in the Arctic compared to more southern regions. However, this low species diversity may be partially compensated for by high genetic variety, as many Arctic species are widespread and composed of distinct populations or genetic morphs. The workshop agreed to highlight this fact. However, due to the fact that techniques/methods to monitor genetic diversity are still evolving, the workshop proposed that this type of monitoring should not, at present, be included in a circumpolar monitoring program.

Where to Monitor?

Not much time was left to discuss where to focus the monitoring efforts, but some points for further consideration can be mentioned:

- Choose areas subject to maximum change and pollution;
- Choose north-south transects;
- Choose migration gradients (reindeer, geese, waders etc.);
- AMAP map should be considered.

Group conclusions

Priorities – elements ready for networking:

Reindeer/caribou are of key ecological and socio-economical importance in the terrestrial Arctic environment. They are the only species monitored circumpolar today and should therefore be included in a Circumpolar Biodiversity Monitoring Program.

The International Tundra Experiment (ITEX) represents an existing circumpolar network focusing on impacts of climate change on Arctic vegetation. ITEX has already provided important information and time series. Hence ITEX should be included as the main vegetation element in the program.

International networks already exist for geese and waders and these networks should be consulted/approached with a proposal for a linkage to a circumpolar monitoring program.

Arctic protected areas (PAs) represent habitats/ecosystems/landscapes of special importance. They may be looked at as reference points in a changing environment. Long-term monitoring is/was carried out in many PAs in the circumpolar Arctic. The Circumpolar Protected Areas Network (CPAN) Strategy and Action Plan includes monitoring provisions for implementation by Arctic countries. Thus CPAN provides an excellent opportunity to implement harmonised monitoring activities on a circumpolar basis.

Community networks/volunteer programs are especially valuable for phonological observation e.g. of ground vegetation (flowering time etc.), migratory birds (arrival and nesting dates etc.), snow cover and sea-ice changes. Also the linkage between remote sensing and "traditional methods" should be encouraged and an arena for this could be the 6th circumpolar symposium on remote sensing, Yellowknife 12-14 June. Community networks provide an excellent opportunity to be further explored.

Elements where further development is needed – to early to include in a circumpolar program

Monitoring of arctic fox and rodents is done in some of the Arctic countries, although for quite different reasons – i.e. in Iceland Arctic fox is abundant and controlled through hunting; in northern Scandinavia it is red listed as rare species. The rodent cycle in the Arctic is still not fully understood and this might be a reason to exclude rodents from the circumpolar program at present.

Passerines as a group are good climate indicators, but only the Nordic countries have existing activities in Arctic areas. For the same reason as mentioned above for small rodents, ptarmigans might be difficult to include in a circumpolar program.

Careful thinking is needed before habitats/ecosystems are included in a circumpolar program, and this might be a subject for an expert group as for example the CAFF Flora Group. Among the ecosystems discussed wetlands should be given top priority due to status of knowledge, existing monitoring and networks.

Although monitoring of genetic diversity is not advanced enough to be incorporated into a circumpolar monitoring program, further research should be encouraged (e.g. through IASC).

V. MODULE 3: FRESHWATER ENVIRONMENT

A. PRESENTATIONS

The Module opened with three introductory presentations:

Erik Jeppesen - NORLAKE: Cross-system analysis of the variation in biological structure and dynamics of North Atlantic lakes related to variations and changes in climate and land use.

NORLAKE is a joint Nordic research project included in the North Atlantic research programme initiated by the Nordic Ministers' Council. The project includes 14 research groups from Denmark, Iceland, The Faroe Islands, Sweden and Norway. The primary objective of NORLAKE is to elucidate how variation and changes in climate and land use influence biological communities, trophic interactions and biodiversity of North Atlantic lakes - on a short-term and a long-term scale. We expect to establish conceptual and empirical models for forecasting the effects of climatic changes on arctic lake ecosystems. The approach includes comparative cross-system analyses of data from approx. 300 North Atlantic lakes covering a wide temperature gradient ranging from oceanically influenced lakes in the Faroe Islands and over sub-arctic lakes in Iceland, western Greenland and northern Norway to high Arctic lakes in Greenland and Svalbard. Additional data from lakes in Antarctica and eastern Arctic Canada are included.

During the first three years of the project (1999-2001) we focus on qualitative and quantitative changes of flora and fauna, trophic interactions and biodiversity in lakes along the selected climate gradient. As far as possible from the data available we also study how differences in land-use influence the lake ecosystems in the different geographical (climate) regions. We aim at identifying thresholds for changes in the lake ecosystem and to elucidate the time scale of such changes. We include contemporary data, palaeoecological data and results from studies using stable isotopes for identifying food web interactions. Further information: http://thule.oulu.fi.NARP/

Árni Einarsson - Monitoring the Lake Mývatn Ecosystem

Lake Mývatn is a biodiversity hotspot. It is a shallow eutrophic lake whose ecology is closely connected with the Mid-Atlantic rift volcanism in Iceland. Situated at biogeographical crossroads between the Nearctic and Palearctic and the Arctic and Boreal zones it has a unique species composition, waterfowl, especially ducks, being the most characteristic animals.

In 1974 the area was made a nature reserve after a controversy over a hydropower scheme. An ecological field station was established and among its main tasks has been the monitoring of the wildlife. The basic idea was to use waterfowl as indicators because they could be counted quite easily and all the different species have their special ecological requirements - they form an ecological spectrum. Furthermore we had a historical record of egg harvest and fishing going back to the turn of the century. The Arctic char was soon included in the programme. It was early realised that whatever changes would be recorded we would need to know if the changes were locally induced or perhaps because of something happening on the wintering grounds (most of the birds are migratory). So, in 1977 we started monitoring the food resources, that is the chironomid midges, using specially designed window traps to collect the insects. The main populations of chironomids showed dramatic and quite regular fluctuations. Simple regression models indicated that the duck populations responded to those fluctuations both in the production of young and in return rate between years. The next question was about the mechanism driving those fluctuations so in the late 19 eighties we started monitoring other compartments of the food web, like benthic Cladocera and the most abundant fish species the three-spined stickleback, also monitoring other lakes in the neighbourhood for comparison. We also took sediment cores to get a paleolimnological perspective, extending the record some 2000 years back in time. Parallel to the monitoring program we are running research projects in cooperation with the University of Iceland to test certain hypotheses about the causal relationship within the ecosystem. In the near future we will be entering an experimental phase where these hypotheses will be tested further.

Hilmar Malmquist - Monitoring Biodiversity in Nordic Rivers and Lakes

In 1996 the Working Group on Monitoring and Data (NMD), under the Nordic Ministers Council, asked for a joint Nordic project focusing on recommendations for biological monitoring in Nordic rivers and lakes. The result of this project is now in the form of a final draft, *„Biological Monitoring in Nordic rivers and lakes. (Skriver, J. ed.)"*, to be published this year (2000) in the Nordic report-series *„TemaNord"*. The purpose of the project has been firstly, as stated in the report, *„to develop strategies for biological monitoring expressed as general ecological quality, biodiversity, threatened species etc."* and secondly, *to give an input at the Nordic as well as the European level to common operational methods of sampling, data treatment and analysis by using a multivariate approach as well as an ecoregion approach."* The aim has not been to prepare and design one Nordic monitoring programme for ecological quality in rivers and lakes, but to reach general agreement on common approaches and methods which will make existing and future monitoring activities in the Nordic countries comparable. Standardised methods for instance will enhance inter- and intra-country comparisons. Finally the project will identify the needs for further research and development at a Nordic and at a European level.

B. DISCUSSIONS

Two breakout groups discussed monitoring of the freshwater environment[5]. The groups' main observations and conclusions are summarised below.

Why Monitor Arctic Lakes?

Arctic lake ecosystems are commonly closed systems. They can be considered as archives accumulating and storing historic as well as current information of environmental changes occurring in the surrounding landscape as well as from more distant sources at lower latitudes. Sediment core profiles provide indicators of paleoclimatic episodes. Because of the extreme sensitivity of many species of the current flora and fauna their responses to e.g. climate changes may be clearly observed, especially when specific key indicators with a narrow temperature range are monitored and studied in detail.

What to Monitor on a Circumpolar Basis?

The freshwater group identified 2 key elements:

- Arctic char, as a circumpolar and highly temperature sensitive freshwater fish. Its social, cultural, economic, ecological, and scientific significance is well documented. The Arctic char may be used as an indicator of a temperature change on both the species and allelic distribution level.

- Freshwater lake ecosystems as such, as they reflect an integrated response to various types of environmental stress, including acidification, increased nutrition loading, pollution, introductions of new species, climate change etc.

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[5] Moderators and Rapporteurs: Johan Hammar, Jarle I. Holten, Gunnar Steinn Jonsson and Aevar Petersen

Approach

The breakout groups discussed freshwater monitoring in some detail and observed that monitoring should be carried out at three levels: intensive selective sites (few sites, many observations); extensive sites (many sites, few observations); remote sensing.

Intensive level (Tier 1):

Monitoring should be carried out at an ecosystem level including various functional elements at community, species, and gene level in the:

- Pelagic habitat: Current composition of zooplankton, and phytoplankton, including algae pigmentation.
- Littoral zone: Current composition of chironomids and macrophytes.
- Sediments: Diatom and chironomid profiles.
- Fish: Arctic char; population structure and intra-specific variation at a protein locus documented to be associated with temperature (*EST-2** locus).

Extensive level (Tier 2):

The group identified 4-indicator species/genera:

- Oldsquaw duck (*Clangula hyemalis*) indicative of fish-empty lakes
- Loons (Gavia spp.) indicative of lakes with fish
- Arctic char (*Salvelinus alpinus* sp. complex)
- *Lepidurus arcticus* (Notostraca), narrow temperature range

Special attention should also be paid to invading new species, especially at species distribution borders

Remote sensing (Tier 3):

- Changes in terrestrial vegetation as early warning for changes in the aquatic ecosystems
    - o Sediment quality/quantity?
    - o Nutrient loading, DOC, DON?
- Some sensors may reach down to 10 meters. Actual variables to be measured by remote sensing may include
    - o Ice cover duration
    - o Chlorophyll – phytoplankton
    - o Macrophyte phenology

Where to Monitor?

The groups made the following observations on site selection principles and organisation:

- Integration and co-location of aquatic and terrestrial monitoring programme. Select landscapes including the elements of lakes, rivers and a closely interacting terrestrial environment. Stratify sample sites (intensive and extensive) by parent material/bedrock/geology – as key factors affecting response.

- Link to existing monitoring programmes, e.g.
    - ITEX (International Tundra Experiment)
    - NORLAKE (Nordic Lake Survey)
    - Biological Monitoring in Nordic Rivers and Lakes

- Link to existing long-term assessment programmes, e.g.
    - Counting fence operations by DFO in Canada.

- Link to existing programs of assessment and sustainable use of fishery resources by indigenous people in Alaska, Canada, Sweden etc.

Concluding Remarks

Most countries do not yet have existing monitoring schemes for freshwater habitats, but may list a number of assessment programs.

The Arctic countries are not yet ready to produce a fully-fledged monitoring program for freshwater key elements. There is a need to improve our understanding of how already ongoing monitoring networks address the issue of recording evidence of a climate change

Both groups focused on lakes, while rivers, estuaries and lagoons were only briefly discussed. Large rivers are permanent habitat to numerous organisms, and present means of transportation of both organisms and matter. Lagoons form transitional ecosystems between marine and limnic ecosystems, commonly demonstrating higher biodiversity than surrounding habitats.

Two key elements and a series of indicators on community, species and gene levels being sensitive to climate changes were identified and listed. Three levels of monitoring intensity were suggested.

It is important to include monitoring of other biotic and abiotic elements along with the indicator species, in order to understand the recorded response.

The concept of setting up a monitoring network and linking people of various origin and disciplines together is highly appreciated, although the group did not yet consider it feasible, due to lack of further guidelines.

VI. Module 4: Marine Environment

A. PRESENTATIONS

The Marine Environment Module began by four introductory presentations:

Petter Fossum - Marine Biodiversity in Relation to Climate and Water Masses

Marine biodiversity is phyletic diverse, however, there are much fewer known marine species than terrestrial. Especially in the Northern hemisphere there is a south-north gradient with highest biodiversity in the tropical areas. There is also a depth dependent variation in biodiversity with the highest biodiversity at intermediate depths. There is much higher benthic than pelagic biodiversity. At soft bottom the biodiversity is dependent on particle-size, at hard bottom the biodiversity is dependent on large structuring organisms. The pelagic biodiversity is dependent on key organisms.

Some benthic research is carried out by the Universities of Oslo, Bergen, Trondheim and Svalbard and some benthic investigations are also carried out by the oil industry. Scientists at Aquaplan NIVA are cooperating with Russian scientist regarding the benthic biodiversity in the Barents Sea region and NIVA is monitoring the benthic biodiversity at fixed station along the coast connected to the JAMP program (OSPAR).

In Norwegian waters physical parameters are monitored with regularity, on fixed stations, along transects and with area coverage. Zooplankton is monitored with regularity along four sections and with one area coverage in the whole Barents Sea each autumn. Several fish species are monitored regularly with combined acoustic and trawl surveys. In these surveys all boycott are identified and registered both from bottom and pelagic trawl catches. In the future it would be better to monitor the marine biodiversity in restricted water masses than in fixed section and stations along the coast.

David Irons - Seabird Monitoring in the Circumpolar Countries

Seabirds in Alaska are monitored at 12 sites annually and another 16 sites every three years. Murres (Common (*Uria aalge*) and Thick-billed (*Uria lomvia*) and Black-legged Kittiwakes (*Rissa tridactyla*) are monitored at most sites. Other species also monitored, but at fewer sites. At the annual sites we collect data on several reproductive parameters such as nesting phenology, clutch size, hatching success, fledging success and overall productivity. Data on diets and survival are collected at a few sites. Population levels are determined every one to three years at each site. The objective of this monitoring is to detect population changes and to collect data that may help in determining the cause of those changes.

CAFF, and the Circumpolar Seabird Working Group, have developed an International Murre Conservation Strategy and Action Plan. Part of the strategy was to bring together the existing monitoring data that had been collected by the CAFF nations. Already the results show promise as global patterns of changes in murre populations are becoming evident and appear to be related to climate change. Preliminary results suggest that murre populations in areas of warming have declined and murres in areas of cooling have increased in numbers. This serves as an example of the value of joining the data from the CAFF nations to help understand how and why populations fluctuate globally.

Norman W. Green - Benthic biodiversity monitoring in selected Norwegian programmes.

Example results from marine benthos investigations are presented. Species structural patterns are the basis for distinguishing spatial or temporal gradients. The environmental monitoring of petroleum activities on the Norwegian shelf reveal that biodiversity indices alone are not enough to determine the extent of influences. Multivariate techniques are more sensitive. The Coastal Monitoring Programme - Long term monitoring of environmental quality in the coastal regions of Norway – have no clear gradient or effect to relate changes to but multivariate techniques have shown that for soft bottom stations along the southern coast of Norway there are distinct influences of location (east/west aspect) and sample depth.

Coastal Monitoring Programme for hard bottom benthos (0-30m depth) using multivariate techniques has indicated influences of temperature changes (winter minimum). Correspondence analyses such as Canonical (CCA) has been found to be a useful tool for determining which external factors (or combination thereof) most influence species groupings. Though these techniques may be more complicated they may be valuable to determine "key" monitoring variables and provide a sensitive means of early warning. The importance of harmonisation of programmes/data is stressed. There is also considerable work within the OSPAR, ICES and EEA that should be taken into account when evaluating and developing biodiversity-related programmes in the Arctic region.

Jörundur Svavarsson – BIOICE (Benthic Invertebrates of Icelandic Waters).

One of the largest international scientific efforts in the North Atlantic and the Nordic Seas (Greenland, Iceland and Norwegian Seas) during this decade is the BIOICE (Benthic Invertebrates of Icelandic Waters) project. Starting already in 1991 (formally in 1992), the BIOICE project is a base-line study focusing on the distribution and abundance of benthic invertebrates in Icelandic waters. Its objectives are to provide general information on the benthos, allowing evaluation of patterns of species diversity, interactions between benthos and fish, life habits of individual species, etc.

Though dealing with Icelandic marine benthic invertebrates, the project is more than just a local inventory. The waters around Iceland can be regarded as the boundary between the Arctic and the North Atlantic Oceans. Much of the exchange of water between the Arctic and the North Atlantic Ocean occurs in Icelandic waters and the fauna in this area ranges from truly boreal forms to high-arctic species. Solid knowledge of the distribution and diversity of benthic animals in this area is important for further understanding of the origin of the Arctic fauna and Atlantic-Arctic interactions.

As a part of BIOICE, samples have been collected in 13 cruises and sampling will continue at least until the end of the year 2002. To date 1118 samples have been taken with a variety of sampling gear at 465 stations at depths between around 20 and 2500 metres. The samples are sorted at the Sandgerði Marine Centre, Sandgerði, Iceland, and distributed to around 110 specialists participating in the project, located in 20 countries.

The BIOICE project has already increased considerably the knowledge of distribution of benthic invertebrates in an area where the Arctic meets the North Atlantic Ocean. These studies have shown that most of the species in Icelandic waters are restricted to either the Nordic Seas or to the North Atlantic Ocean. The results obtained from the BIOICE project are fully comparable to results obtained from other studies in the Arctic and adjacent waters (BIOFAR and other studies) due to the same methodology being used.

B. DISCUSSIONS

One breakout group[6] discussed monitoring opportunities for the marine environment:

[6] Moderators/Rapporteurs: Kit Kovacs and Helgi Jensson

Opportunities

The focus of this workshop is on the monitoring of biotic elements to detect change as a first step towards the monitoring of circumpolar biodiversity, building on existing programs. What existing programs should CAFF build upon?

Marine Mammals:

The Polar Bear Agreement organises regular international workshops, which produce excellent summaries of the status of polar bears on a circumpolar scale.

The workshop supports the CAFF/AMAP Ringed Seal Monitoring Initiative that has been proposed by the US.

Harbour seals are a highly temperature-sensitive species, which exist in the Arctic at the edge of their range. Therefore, their distribution is likely to be sensitive to climate change.

Seabirds

The Murre Monitoring Program, which has been developed by the CAFF Circumpolar Seabird Working Group (CSWG) to implement provisions of the International Murre Conservation Strategy and Action Plan, is seen as a carefully planned program and a model to follow for other types of biota.

A monitoring program for eiders should be developed as a part of CAFF's Circumpolar Eider Conservation Strategy.

The group recognises the importance of monitoring assemblages of marine seabirds rather than relying on single-species databases wherever possible, especially where those species occupy different parts of the food web. This approach may provide information about broader marine ecosystem responses to change.

Marine Fish

The group recognises that commercial fish stocks and bycatch are monitored closely be respective governments, and that this information could be part of a biodiversity monitoring program.

However, important Arctic species such as polar cod and sand lance are not monitored. They nevertheless remain key species in the food web, and the possibility of monitoring them in the future should be considered.

Benthos

A number of studies of soft- and hard-bottom benthic communities have been done in the boreal Arctic. Only a few of these are long-term studies. As an example, the group recognises the value of international projects such as the BIOICE project.

The workshop encourages creation of a communication network among scientists studying soft- and hard- bottom benthic communities so that, through international workshops, they can explore the potential offered by benthos as a monitoring tool, and develop standard methods for benthic community measurement and assessment.

In this regard, the workshop requests CAFF/AMAP participants to scope out the existence of benthic (soft and rocky bottom) studies via a network, and determine what international bodies are relevant to their work.

VII. Module 5: General Conclusions and Recommendations

A. WORKSHOP CONCLUSIONS

Approach and Main Initial Focus of Work

The workshop noted that the biodiversity concept is extremely broad and complex and that the design and implementation of a fully-fledged Circumpolar Biodiversity Monitoring Program might be a too ambitious task, at the present time, for providing any practical results. Hence the initial focus should be on making use of existing programs and scientific interests, through a networking strategy focusing on few key elements of the Arctic biota.

While considerable uncertainty still exists about the exact nature of the future impacts of global climate change, there can no longer be any doubt that major changes in the climate have occurred in recent decades in the Arctic, with visible and measurable impacts following the climate changes. Greater impacts are likely in the future and while some of them will be positive, others will be detrimental to biodiversity and to human activities. The need for documentation of change in biological elements and assessment of both biological and socio-economic impacts is growing, and monitoring of biodiversity is one of the tools that must be developed in a circumpolar context. Hence the workshop agreed that biological impacts of climate change should be the main initial focus of work towards establishing a circumpolar monitoring program.

Networking and Community Involvement

The workshop recognises the potential benefits of community observations in contributing to the understanding of change in habitats and ecosystems. There are clear efficiencies and advantages to having people who live on the land participating in the monitoring process. Similarly, indigenous and local knowledge can provide insights and observations that may be difficult to obtain by other means. The workshop therefore, encourages further work on ensuring incorporation of indigenous and local people in monitoring programs.

The workshop recognises the importance of networking, i.e. the coming together of or communication among experts to provide solutions to biodiversity issues, and encourages networking as fundamental to the successful synergy and development of a biodiversity monitoring program. Such networks are also a cost effective way to explore the “need” for and or “interest” in multilateral collaboration.

Remote Sensing

The workshop recognises the importance of remote sensing in habitat mapping and its potential importance as a useful tool in monitoring certain aspects of terrestrial, freshwater, and marine habitats. Issues of the limitation of current technology, such as resolution, are also recognised.

Further Work and the Way Ahead.

The workshop agreed to focus initially on creating voluntary networks of experts dealing with the following key species/elements:

Media/environment	Species/program	Co-ordinator/netmaster	
Terrestrial	Reindeer/caribou	Don Russell	russell@ec.gc.ca
	ITEX	Ingibjörg S. Jónsdóttir	isj@systbot.gu.se
	Geese	To be identified	
	Waders	Hans Meltofte/Ellen Pierce	MEL@dmu.dk
	Wetlands	To be identified	
Freshwater	Arctic char	Johan Hammar	johan.hammar@ fiskeriverket.se
Marine	Ringed seal	Kit Kovacs	kit.kovacs@npolar.no
	Polar bear	To be identified	
	Murre	David Irons	david_irons@fws.gov

The mandate of the networks is initially to explore the "need" for and "interest" in a circumpolar collaboration in relation to the wider Framework for a Circumpolar Biodiversity Monitoring Network. The Drafting Team will develop formal Terms of References for the networks and identify a few initial questions for them to explore. The co-ordinators should report progress to CAFF VIII in fall 2000 (Trondheim, September 6-8).

It was pointed out that use of the CAFF/AMAP websites would facilitate the flow of information and should therefore be an important part of the networks.

The workshop emphasised that although only a few species/items were selected and prioritised as a starting point, the importance of including other species/trophies in the programme should not be forgotten or overlooked. Therefore the species/item chosen for the different media have to be looked at in connection with the reports from the different sessions (terrestrial, freshwater and marine) with the view to expand when such becomes feasible or necessary.

The "single topic" approach adopted as a practical way of initiating the work on building a circumpolar biodiversity monitoring program should not overlook the importance of species interactions or connections between different media. An example is the influence of land use on freshwater lake systems and the processes in estuaries.

B. WORKSHOP RECOMMENDATIONS

1. The workshop recommends a pragmatic approach to establishing a Circumpolar Biodiversity Monitoring Program, i.e. through the initial creation of voluntary expert networks for reindeer/caribou, ITEX, Arctic char, waders, ringed seals and seabirds.

2. The workshop recommends that networks be also established for geese, wetlands and polar bears, once coordinators have been identified, and that CAFF/AMAP explore the feasibility of including also Arctic fox, rodents and passerine birds.

3. The workshop recommends that protected areas be included in a circumpolar monitoring program and that CAFF harmonises on a circumpolar level and implements monitoring provisions of the CPAN Strategy and Action Plan.

4. The workshop recommends that community networks/volunteer programs be established for phenological observations of ground vegetation migratory birds, snow cover and sea-ice changes, and other simple indicators for change.

6. The workshop recommends that CAFF/AMAP work to establish a drafting committee on the incorporation of local and indigenous people in community based monitoring programs based *inter alia* on local and indigenous knowledge.

3. The workshop recommends that CAFF/AMAP consider the monitoring of harbour seals in relation to climate change.

5. The workshop recommends that CAFF implement an eider monitoring initiative as soon as possible.

7. The workshop requests CAFF/AMAP to scope out the existence of benthic (soft and rocky bottom) studies via a network, and determine what international bodies are relevant to their work.

8. The workshop recommends that CAFF/AMAP organise more topic-related meetings and workshops in order to increase the knowledge of what is currently being done, consolidate information on what monitoring studies are on-going, and where to change or add to existing programs.

9. The workshop recommends CAFF/AMAP to help fund and revitalise relevant existing regional and circumpolar programs (e.g. ITEX) holding long term datasets. CAFF/AMAP should more carefully "scope" such programs assist with their implementation.

10. The workshop encourages IASC to develop methodology and research directed at circumpolar monitoring of genetic diversity.

Appendix 1

CAFF/AMAP Workshop on a Circumpolar Biodiversity Monitoring Program

Revised Agenda

Sunday 6 February

Arrival at Hotel Loftleidir, registration

Evening – informal get-together

Monday 7 February

09:00-12:00, SESSION I: INTRODUCTORY PRESENTATIONS (15 min each)

1. Welcoming Address – Ingimar Sigurdsson, Ministry for the Environment, Iceland
2. Biological monitoring – Work under Pan-European Biodiversity and Landscape Strategy – Ulla Pinborg
3. Remote sensing – possibilities and opportunities for biodiversity monitoring - Brad Griffith, USA.
4. Community networks and indigenous knowledge: possibilities and opportunities for biodiversity monitoring - Struan Simpson
5. Implementation of an Integrated Monitoring Program for Svalbard and Jan Mayen - Christopher Brodersen, Norway
6. CAFF/AMAP climate change and biodiversity – Bill Heal, UK.
7. Framework for a Circumpolar Biodiversity Monitoring Network: work of drafting committee - Kevin McCormick, Canada.

13:30 – 17:00, SESSION II: MONITORING TERRESTRIAL BIODIVERSITY (Moderators: Kevin McCormick and Snorri Baldursson)

- Short introductions (10 min presentations)
- Inga Svala Jonsdottir – ITEX and Tundra Northwest 1999
- Don Russell – Caribou
- Steve Talbot and Skip Walker– CAVM/Pan Arctic Flora

- Discussions:
  - 2-3 key species/communities
  - biological methods, remote sensing, TEK
  - opportunities (ongoing programs)
  - recommendations/conclusions and next steps

Tuesday, 8 February

09-12:00, SESSION III: MONITORING FRESHWATER BIODIVERSITY (Johan Hammar and Gunnar Steinn Jonsson)

- Short introductions
- Erik Jeppesen – NORLAKE
- Arni Einarsson – Lake Myvatn
- Hilmar Malmquist – Monitoring Biodiversity in Nordic Rivers and Lakes

- Discussions:
  - 2-3 key species/communities
  - biological methods, remote sensing, TEK
  - opportunities (ongoing programs)
  - recommendations/conclusions and next steps

13:30 – 17:00, SESSION IV: MONITORING MARINE BIODIVERSITY (Kit Kovacs and Helgi Jensson)

- Short Introductions (10 min):
- Petter Fossum – Marine Biodiversity in Relation to Climate and Water Masses
- David Irons – Seabird Monitoring
- Norman Green - Benthic biodiversity Monitoring in Selected Norwegian Programmes
- Jorundur Svavarsson - BIOICE

- Discussions:
  - 2-3 key species/communities
  - biological methods, remote sensing, TEK
  - opportunities (ongoing programs)
  - recommendations/conclusions and next steps

Evening: Official Dinner at Naustið, A bus will leave Hotel Loftleidir at 19:30.

Wednesday, 9 February

09:00-12:00: SESSION V: SYNTHESIS (Moderators from sessions II-IV) and Workshop Close

Appendix 2

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Appendix 3

Word Presentations

Ulla Pinborg, Project manager for Biodiversity
The European Environment Agency

Biological monitoring – current approach by the EEA

The European Environment Agency (EEA) mission is to deliver timely, targeted, relevant and reliable information to policy-makers and to the public for the development of sound environmental policies in the European Union and other EEA member countries.

EEA does not perform data collection and monitoring, but relies completely on data and information already collected in national or international monitoring activities as well as on statistics and reports produced by the wide range of environmental institutions. EEA uses this information as the necessary background for performing more and more integrated analyses and reports. In doing so, EEA works closely with the European Commission and other Community institutions as well as with member countries. The reports shall be used to understand what happens to the environment and whether the political instruments are effective in improving the environment.

The working framework for collecting data, for analysis and reporting is called the DPSIR-chain ; from understanding the socio-economic Driving forces and the Pressures on the environment caused by these to assessing the Status and Impact on the environment to the effectiveness of political and societal Responses adopted and used. This entails access to a wide range of data and information on the main topics such as water, air, land use, soil, waste and naturally also on biodiversity. In all work it is necessary to use an approach which is targeted towards those environmental issues, which are most basic and need most attention. These issues change over time and thus the priorities of work have to be adjusted accordingly over time.

As EEA is dependent on data collected by member countries and other bodies, it is equally dependent on the access, quality, reliability and coverage in topic, space and time of those data. Since the analyses and the reports are to be used to support decisions and policies at Community level and to assist member countries, data must be comparable and harmonized and must also be of a character which allow integrated assessments.
In using information to consider policy decisions, decision makers cannot deal with the overwhelming amounts of data in existence. The data needs to be analysed and given meaningful interpretations in such a way that the resulting data will function as indicators of the main problems and their causes and directions.

EEA as a user of data has a basic interest in how data are being collected and in ascertaining the coverage of data. In some fields there is a long history for precisely defined data collection based on equally well defined monitoring. This is the case for some of the international environmental conventions and EU directives and concerns for instance climate, air conditions, forest and to some extent also water conditions. For biodiversity the case is different.

The term biodiversity as it is defined under the global Convention for Biological diversity (CBD) is a very broad and variegated term, encompassing both wildlife and domesticated organisms as well as natural and cultivated habitats and genes. Indicators for biodiversity as such need to be developed with careful consideration as to level and component elements as well to representativity. The higher and more general the aggregation, the lower the information content and direct application on individual cases. The higher the detail, the lower the wide usefulness. From the elements and processes monitored there is a direct line to which indicators can in the end be developed. The discussions on indicators and monitoring are interlinked.

At the global and European level, several institutions are developing and producing indicators and data for indicators; OECD, Eurostat, EEA. In January 2000 the biodiversity indicators to be suggested used under the CBD were discussed at the SBSTTA meeting in Montreal. These naturally will have to be seen in the light of other already existing initiatives and a thorough coordination will be necessary in the next few years.

There are many other indicator initiatives for biodiversity. Nearly all European countries are developing their own official indicator concepts and data collections, and they base much data on species and habitats on data collection on field monitoring schemes, done by national authorities or performed by NGOs or scientists. But there are also a wide range of other initiatives dealing with both monitoring and indicator development, which are central to aspects of biodiversity directly or indirectly.

At this workshop we will be presented with information on several such initiatives. In January EEA held a small workshop on Biodiversity Monitoring, involving some of the large site based environmental monitoring systems. In December of last year a workshop was held in Stockholm on cost effective indicators for biodiversity, looking at the same time into what should be monitoried to obtain the data. And the project NoLimits has spent much time investigating monitoring activities in more general.

When EEA looks into activities in monitoring and indicator development, the aim is not scientific analysis, but as indicated above a pragmatic approach in order to identify and if possible secure access to information targeted at supporting decision making and in doing so to avoid overlaps, but assisting initiatives in coming closer to each other, benefiting from collaboration.

The EEA work in the next years is foreseen to consist of steps on parallel, interlinked tracks:

Reporting obligations
Overview of reporting obligations for EU Member States and the Community

- The STAR and ROD Databases (biodiversity part)

Indicators

- Follow up and assistance to the Commission on indicators for CBD. Which data sets exist, how are they collected, are they available and how can they be analysed for indicators
- Assistance on the EU Headline indicators
- Assistance to Joint Questionnaire OECD/Eurostat (wildlife, agriculture, forestry, land use, landscape etc)
- Assistance to Joint Questionnaire FAO/Eurostat (forests)
- Development of EEA Environmental Signal indicator based report
- Development of EEA broad integrated reports, based on indicators

Monitoring overview, discussion and assistance to coordination

- Identification and assistance to development of monitoring for implementation and management under the EU Directives for Birds and for Flora, Fauna and Habitats (collaboration with the Commission and Member States)
- General background monitoring (CBD and directive relevant, general status and trend relevant)
- Possibilities for coordination and development between large monitoring networks (NatureNet thinking)

Access to information

- Development of access to the EUNIS database
- Development for the Commission of the European Community Clearing House Mechanism for Biodiversity (EC CHM). To be launched April 2000.

In the spring 2000 a report will be published by EEA on the findings and analysis from the January workshop on Biodiversity Monitoring and early 2001 a report on Europe's Biodiversity will be published. For this report an overview of monitoring initiatives and programmes is foreseen.

Indicators

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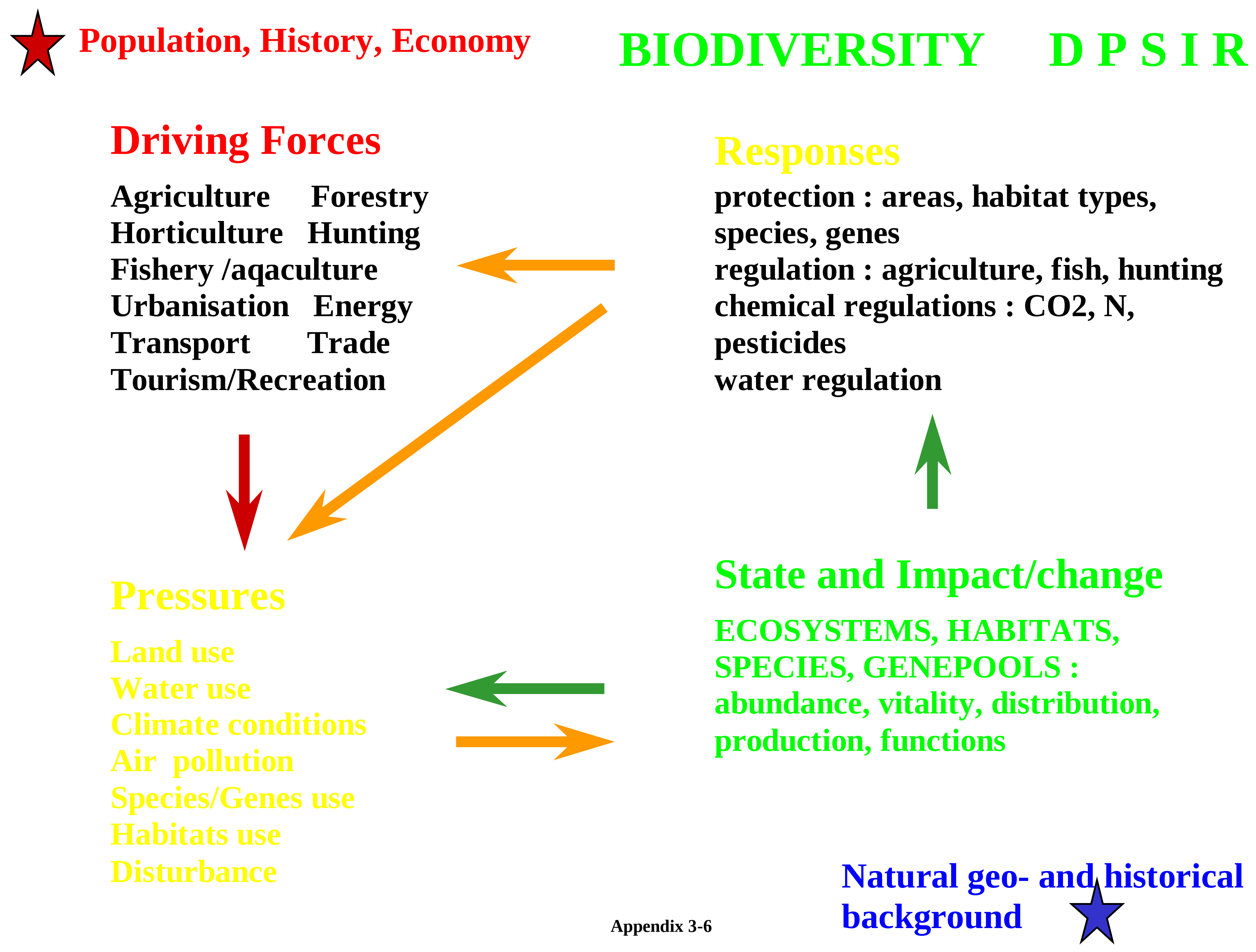
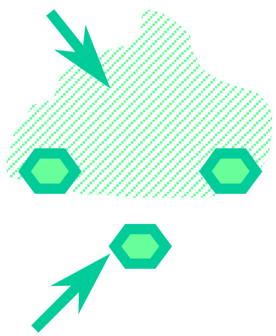

Population, History, Economy
BIODIVERSITY D P S I R
Driving Forces
Agriculture Forestry
Horticulture Hunting
Fishery /aqaculture
Urbanisation Energy
Transport Trade
Tourism/Recreation
Responses
protection : areas, habitat types, species, genes
regulation : agriculture, fish, hunting
chemical regulations : CO2, N, pesticides
water regulation
Pressures
Land use
Water use
Climate conditions
Air pollution
Species/Genes use
Habitats use
Disturbance
State and Impact/change
ECOSYSTEMS, HABITATS, SPECIES, GENEPOOLS :
abundance, vitality, distribution, production, functions
Natural geo- and historical background

BIO-DIVERSITY MONITORING : Species/Genes, Habitat types, Sites

Monitoring Type 1	Monitoring Type 2	Monitoring Type 3
Specific Monitoring for NATURA 2000	General Monitoring for Understanding and Analysis	Special Monitoring in Reference Sites - NATURE NET

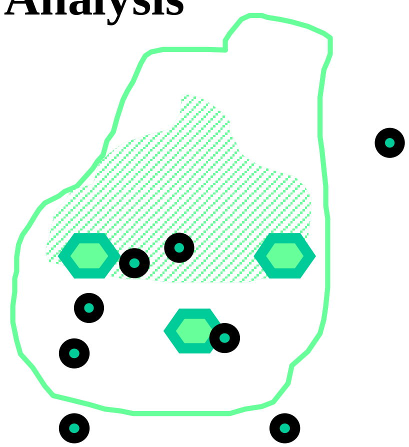
Monitoring Type 1

Protected Species



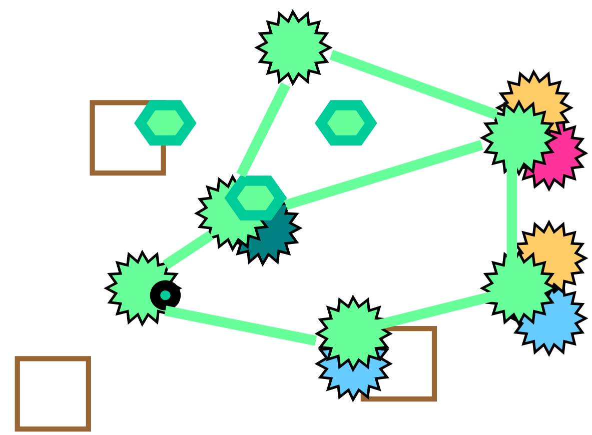
NATURA 2000 Sites

Monitoring Type 2



Monitoring Type 3

integrated when possible with : water, air, soil, agriculture, forest



DATA

Monitoring Type 1	Monitoring Type 2	Monitoring Type 3
Status, Trends Management, Plans, Problems	Status, Trends, Distribution, Functions	Status, Trends, Functions

Designated or special Areas/Sites — Species/Habitat type distribution — Monitoring

Circumpolar Biodiversity Monitoring Programme

Monitoring Biodiversity and Change in the Russian Arctic

Possibilities and opportunities for biodiversity monitoring using community networks and indigenous knowledge

Presentation to CAFF Workshop, 7-9 February 2000
by Struan Simpson, Conservation Foundation, London

1. Introduction

Inter-governmental concern for the status of indigenous peoples is recognised in Agenda 21 and incorporated in the terms of the Arctic Environmental Protection Strategy (AEPS).

A circumpolar environmental monitoring scheme envisaged by CAFF/AMAP acknowledges the potential value of traditional ecological knowledge (TEK) and local expertise to combat pollution, conserve biodiversity and monitor climate change.

Concurrently, UNEP-Grid Arendal refers to a Nordic programme for capacity building & participation of Russia's indigenous peoples in sustainable development of the Arctic, highlighting the need for funding which can co-ordinate complementary programmes and encourage complementary initiatives.

CAFF is considering a three-layered approach to monitoring, i.e.:

1. Conventional biological plot-based approach;
2. Remote sensing;
3. Community-based initiatives (TEK) on a circumpolar scale

RAIPON (Russian Association of Indigenous Peoples of the North) represents Russian indigenous minorities, estimated at 210,000 people, 67,000 of whom comprise approximately 3.35% of the two million inhabitants of Arctic Russia.

RAIPON has made an overall assessment of common problems relating to environment and natural resources. In March 1999, it determined the following order of priority for project development:

1. Networking
2. Communications
3. Environmental Impact Assessments (EIA)
4. Legal Regime
5. Regional Environmental Information
6. Small Business Development

Enhancing the capacity of the RAIPON network to conduct EIA could be of considerable added value to Russian biodiversity endeavors, to the work of

CAFF/AMAP and relevant institutions among the international scientific community.

A partnership is envisaged between RAIPON, the Conservation Foundation's London Initiative on the Russian Environment (LIRE) and the World Conservation Monitoring Centre (WCMC, Cambridge), expanding on the excellent relationships that already exist between RAIPON and the Arctic scientific community.

Funding, inevitably, is required and it is proposed to apply to a number of agencies for support in assisting RAIPON explore the potential of the indigenous peoples whom it represents, to influence the management of biodiversity conservation, pollution prevention and control, environmental health and livelihood alternatives.

2. Approach

The project's objective is to assist the integration of indigenous knowledge of biodiversity and changing landscape into policymaking and managing environmental and health issues in the Russian Arctic.

Indigenous peoples probably would best be left to their own devices were it not for the life stresses imposed upon them by natural resource exploitation, pollution and changing patterns of land tenure, as well as the pressures upon them to integrate with Russian society.

But at the same time, scientists need data to measure and interpret the impact of these and other factors on fragile Arctic ecosystems (in which landscapes have been traditionally managed in order to sustain ecological balance and support livelihood activities). Indigenous peoples need information that will define and re-enforce their status and needs in a changing and uncertain secular environment.

Distribution of Minority Ethnic Groups in the Russian Arctic

Russian Arctic	**Okrug/Region**	**Predominant Ethnic Groups**	**All groups as % of total pop.**
East Siberian Highlands	Chukotka AO Eastern Sakha	Chukchi	9.75
Central Siberian Plateau	Sakha Republic	Even & Evenk	5.98
West Siberian Lowland	Taimyr AO Yamalo-Nenets AO	Dolgan Nenets Khanty	15.64 6.08
Ural Mountains	Nenets AO	Nenets	12.00
East European Plain	Murmansk Oblast	Saami	0.16
		ALL	3.36

AO=Autonomous Okrug

The total population of indigenous peoples is approximately 210,000, dispersed across an area of about 7.0m. km² (more than twice the area of India). This representing about 40 percent of Russian territory, in five republics, ten administrative areas (*oblast*) and eight autonomous regions (*okrug*).

The entire population of this area, native, settlers and others (around 2.0m. people) has a density of 0.28 people per km². India, by contrast (but typical of tropical Asia and indeed some African countries) has a population density upwards of 175 people per km². Population distribution in Siberia, outside the urban townships, can thus be said to be sparse.

Population density clearly is one of important factors in designing approach and method, especially in the distinctions between settled and nomadic groups.

However, whatever methods may be adopted, an approach to indigenous peoples has to be based upon the principles of partnership and equity. While the scientific community is driven by the imperative for valid, objective data, subsistence peoples are concerned more with subjective matters and how these might affect their daily lives.

Thus, method has to be designed in such a way as to yield information of value to all participants, to the scientists and to the people who would be recruited for fieldwork. This suggests an alignment of natural and social sciences, whatever the focus of study might be.

Some of the factors that need to be taken into consideration in determining approach, method and desired outcomes are as follows:

Socio-economic:

- Disruption of indigenous livestock economy (reindeer herding, hunting, fishing)
- Adjustments to changes in land tenure (from collectivisation to private ownership)
- Loss of livelihood, high morbidity and mortality, erosion of social and family structure
- Lack of indigenous influence in local bureaucracies and administrations
- Lack of a coherent state policy towards these regions. (Taking land use and resource management as central arenas of negotiation between indigenous peoples and government, there is a complex web of separate and conflicting state agencies whose legal status is uncertain. Moreover, conflicting interest groups include various factions among indigenous people themselves).

Ecological:

- Air, land and water pollution by industry and the military. Of all global biomes, the Arctic is the most affected, according to all global circulation models (GCM)
- Contamination of the food web (by heavy metals, POPs and radioactivity) via national and trans-national pathways (atmospheric, riverine and marine)
- Loss of biodiversity (species reduction from habitat degradation, pollution and disturbance).

It is widely accepted that indigenous peoples' relationship with their environment is unique, productive and basically sustainable. Yet there is considerable bureaucratic reluctance to admit of the value of their ecological knowledge and opposition to demands for native self-government, their aspirations for land ownership and community life.

There is however, a growing public appreciation of indigenous survival and subsistence skills, in keeping the environment free of pollution, and in upholding traditional spiritual and family values (Krupnik, 1996).

Specific objectives are therefore to:

- Equip the indigenous peoples of the Arctic with the practical tools and mechanisms (skills) which can integrate their knowledge within environmental monitoring and reporting and reporting systems;
- Enable trained indigenous individuals to become multipliers of these skills in their own communities;
- Create a structure of mutually beneficial cooperation between indigenous communities, the scientific community, NGOs and relevant regional and Federal governmental institutions of the Arctic Council countries in programmes designed to protect the environment.

3. Method

Adopted methodologies not only need to be suitable to the scientific purpose, but also matched to the skills, commitment and expectations of the participants. These methodologies must be simple enough to be used by everybody and be efficiently applied to cover critical aspects of biodiversity that are valid within scientific programmes (e.g., CAFF and AMAP). Moreover, the output must provide either tangible benefits or at least be perceived as leading to amelioration of some of the negative aspects of people's lives.

Changes in the human environment (social, political, ideological, demographic and economic) are taking place much faster than climate change (Vitebsky, 1996), and it is of course these changes that are more apparent and more worrying to the people experiencing them.

AMAP cites the rights of Arctic residents to good information about their environment at the same time recognising that they also have knowledge that can assist in an overall understanding of environmental damage. By these tokens, the methodologies adopted by this project should amalgamate the efforts of both social and natural scientists.

In principle therefore, it is suggested that the mechanics of c**ommunity mapping** are developed as the basic monitoring method in the Russian Arctic, both for nomadic and non-nomadic groups.

The method has several advantages and has been used in a number of developing countries as a prelude to devising resource management strategies. Community

mapping allows communities to be both the originators and owners of their vital (ecological) knowledge, which furnishes them with an empowerment tool in both scientific and political circles.
Essentially, community groups would devise their own maps to plot ecological, biological and sociologically significant characteristics of the landscapes in which they function, which would be subject to scientific validation.
It is proposed therefore:

- Though discussions between RAIPON and LIRE/WCMC in May 2000, to establish the protocols for integrating the knowledge of Russian indigenous communities in biodiversity monitoring;
- Determine which scientific and civil society organisations are working in these areas, and which aspects of their programmes would be mutually complementary to this project and how they could re-enforce other initiatives on biodiversity monitoring;
- At a workshop planned for September/October 2000, decide approach and design methodologies;
- At a later workshop/seminar, possibly Spring 2001, establish a programme to train indigenous people to train indigenous communities in monitoring and reporting on their environment as a critical input to presently established Arctic initiatives (Circumpolar Biodiversity Monitoring Programme);
- Agreements need to be reached on the regions and sites that should be involved the first stages of the project;
- Particular attention will be paid to the mechanics of developing community networks and how best these can be managed;
- Also the manner in which information and data should be collected, as “ground truth” for digitising in remote sensing and GIS.

4. Training Workshops

Two workshops in Russia would seek to assess the potential for utilising indigenous peoples’ skills and experience in order better to manage environmental change and reach consensus on a common set of monitoring targets throughout the Arctic, based upon community mapping principles. The first workshop would aim to construct a template for the Russian Arctic focusing on specific sites, as the basis for formulating a 'training the trainers' approach in the organisation of environmental monitoring, and covering five major areas.

- An introduction to Arctic biodiversity: the characteristic features of biodiversity on a circumpolar scale, addressing phenology of climate change, pollution and biodiversity in general. Topics to be covered should include how to construct a greening index, based, for example, on larch trees, dwarf birch or first flowering of Caltha spp. Lichen can be recruited for measuring air pollution and radiation, and selected fish spp. for the state of freshwater systems. Selected bird spp., among others, could serve to monitor biodiversity in managed and unmanaged areas;
- Review monitoring schemes currently used by indigenous peoples and local communities throughout the Arctic;
- Explore a common basic strategy and methodologies for monitoring

biodiversity in the Russian Arctic, focusing upon community mapping techniques;

- Devise a common database structure suitable for scientific analysis and to enable information sharing and communication between indigenous groups;
- Define and expand local needs for supplementary data on, for example, environmental health topics.

Priority areas for indigenous involvement in biodiversity monitoring, suggesting some key elements of community mapping

MAMMALS	**THREATS**	**REMARKS**	
Rare & vulnerable marine	Over hunting	Politically sensitive	
Terrestrial	Over hunting		
BIRDS			
Economic	As migrant	Changes in food source	
INSECTS			
Attractive/keystone species	Habitat loss, local pollution		
HIGHER PLANTS			
Rare species	Land use management		
Exotic species			
Terrestrial vegetation			
Aquatic flora			

Analysis and discussion of the factors listed in these two tables should take account of settlement characteristics, traditional cultures and institutions, gender issues, health care and disease vectors, education, employment and commerce, water management, pollution, regulatory frameworks and inter-community relationships.

We are seeking to develop methods which can monitor change and set the priorities for in-puts and interventions in biodiversity management and for the desired improvement of the social status of indigenous peoples.

Priority areas for environmental health monitoring

DIET	**Resource**	**Trophic level**	
Hunting			
Fishing			
Cultivation			
Gathering			
Imported foods			
RENEWABLE RESOURCES			

NON-RENEWABLE RESOURCES			
WATER QUALITY			
SANITATION			
MEDICINAL PLANTS			

5. Outputs from September 2000 workshop

Expected results:

- Priorities for biodiversity, environment and health monitoring according to the knowledge and perceptions of indigenous peoples' community groups.
- An agenda for a follow-up workshop(s) to train the trainers.
- Long-term commitment of indigenous communities to biodiversity, environmental and health monitoring.
- Closer co-operation between scientific community, local and federal administrations, and indigenous peoples, each learning to understand and work with the other.
- **A** method is suggested which could permit indigenous people to own their data and apply them to political and/or scientific ends as appropriate to their needs.

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CAFF/AMAP Workshop
on
Circumpolar Biodiversity Monitoring Program.

February 7-9, 2000
Hótel Loftleiðir, Reykjavík, Iceland.

Session III. Monitoring Freshwater Biodiversity

„BIOLOGICAL MONITORING IN
NORDIC RIVERS AND LAKES.“

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Biological Monitoring in Nordic Rivers and Lakes.
Co-ordinator in the Icelandic project:
Ecological Survey of Icelandic lakes: A Standardised Database.
Participant in the Nordic project:
NORLAKE.

In 1996 the Working Group on Monitoring and Data (NMD), under the Nordic Ministers Council, asked for a joint Nordic project focusing on recommendations for biological monitoring in Nordic rivers and lakes. The result of this project is now in the form of a final draft, *„Biological Monitoring in Nordic rivers and lakes. (Skriver, J. ed.)“*, to be published this year (2000) in the Nordic report-series *„TemaNord“*.

The purpose of the project has been firstly, as stated in the report, *„to develop strategies for biological monitoring expressed as general ecological quality, biodiversity, threatened species etc.“* and secondly, *to give an input at the Nordic as well as the European level to common operational methods of sampling, data treatment and analysis by using a multivariate approach as well as an ecoregion approach.“* The aim has not been to prepare and design one Nordic monitoring programme for ecological quality in rivers and lakes, but to reach general agreement on common approaches and methods which will make existing and future monitoring activities in the Nordic countries comparable. Standardised methods for instance will enhance inter- and intra-country comparisons. Finally the project will identify the needs for further research and development at a Nordic and at a European level.

There are several sensible and urgent arguments for a project of this kind. The Nordic countries have vast water resources and a tradition for monitoring environmental conditions in freshwater. Impacts of acidificaton, eutrophicationa and physical alterations have been monitored in both national and inter-Nordic programs during the last decades. Due to close cultural relations, methodological approach is quite similar among the Nordic countries. However, general ecological quality, biodiversity included, has received limited attention until now. Generally, past monitoring programs have dealt with single species or very few animals or populations, isolated from the rest of the living and abiotic environment. Therefore, since changes in populations may be due to a number of simultaneously occuring pressures, both natural and anthropogenic, cause-effect data are missing, hence the tool for management is also missing. This drawback calls for a more ecologically oriented biological monitoring in the future. There are also international obligations calling for such an approach. The Convention of Biological Diversity from Rio being a prominent example. All the Nordic countries have signed the CBD and hence they have obligations to implement it. Similarly, the Nordic countries, as other nations party to the European Union or the European Economic Zone, must comply with EU-directives relating to the freshwater environment, especially the Water Directive.

In the report, major threats to the freshwater environment are identified and summary given of ongoing monitoring programs at a national scale. It is recommended to focus on three indicator groups; macrophytes, macroinvertbrates and fish. The latter two, but not macroinvertebrates, have since long been monitored in the Nordic countries. It is emphasised that future biological monitoring should be based upon existing monitoring programs as much as possible. Also, to enhance explanatory power of the data, monitoring of the three indicator groups should preferably be carried out at the same site. The need of collecting supplementary abiotic, environmental parameters is stressed. Further, stratification at various levels are recommended in order both to cover natural heterogeneity in freshwater ecosystems and to reduce counfounding effects of variability on the monitoring data. It is e.g. recommended to adopt the ecoregion approach, developed by the Nordic countries.

Whithin each indicator group, several indicator species, sensitive for different impacts, are identified. In general, however, a community approach is favored in the monitoring programs. Also, within each indicator group, recommendations for using particular indicator metrics for assessing ecological quality are put forth. These range from single species and diversity indicies to more combined integrity metrics, reflecting various bilogical functions and human impacts. In order to be operational, indicator metrics of ecological quality should ideally be compared with an undisturbed situation. The importance of identifying reference or pristine conditions is addressed and suggestions put forth as how to establish them. Suggestions for predictive modelling are presented in the report and so are recommendations on sampling methods in detail for each indicator group.

Appendix 4

Power Point Presentations