Conservation of Arctic Flora and Fauna

CBMP

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Terrestrial Expert Monitoring Group

Designing an Arctic Terrestrial Biodiversity Monitoring Plan: 1st Workshop
Hvalsø, Denmark, October 11-13, 2011

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- Directorate for Nature Management, Trondheim, Norway
- Environment Canada, Ottawa, Canada
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- Russian Federation Ministry of Natural Resources, Moscow, Russia
- Swedish Environmental Protection Agency, Stockholm, Sweden
- United States Department of the Interior, Fish and Wildlife Service, Anchorage, Alaska

CAFF Permanent Participant Organizations:

- Aleut International Association (AIA)
- Arctic Athabaskan Council (AAC)
- Gwich'in Council International (GCI)
- Inuit Circumpolar Council (ICC) – Greenland, Alaska and Canada
- Russian Indigenous Peoples of the North (RAIPON)
- Saami Council

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CAFF Designated Area

CAFF Conservation of Arctic Flora and Fauna

CBMP

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Background

United States and Greenland/Denmark agreed in 2010 to act as lead countries for the initial development of the Terrestrial Expert Monitoring Group (TEMG) of CAFF's Circumpolar Biodiversity Monitoring Program (CBMP).

Prior to the first meeting of the Terrestrial Expert Monitoring Group (TEMG) in April 2011, the two lead countries developed the Draft Terms of Reference (see TEMG – Background paper) and an outline for the Terrestrial Expert Monitoring Group – Background Paper. Before summer 2011, the TEMG had members from all eight Arctic countries.

The overall goal of the TEMG is to develop a multidisciplinary, integrated, pan-Arctic, long-term terrestrial biodiversity monitoring plan. In addition to the monitoring plan, the Arctic Council has asked the CBMP and thus the TEMG to develop an implementation plan for the monitoring plan that identifies timelines, costs, organizational structure and partners.

The need to measure and understand change in Arctic biodiversity is increasing given the evidence that Arctic ecosystems are already rapidly responding, in some cases quite dramatically, to climatic changes. Substantial shifts in the Arctic environment are predicted for the near future (e.g., encroachment of more southerly species and ecosystems) and recent changes in physical processes such as sea ice loss have outpaced predicted changes. Limited functional redundancy in Arctic ecosystems poses a particular risk as the loss of a single species could have dramatic and cascading effects on an ecosystem's state and function.

Members of the the Terrestrial Expert Monitoring Group at their inaugural workshop in Denmark October, 2011. Photo: Michael Svoboda

Based on these change scenarios the Arctic has experienced a dramatic increase in research and monitoring activities both in terms of scientific disciplines and geographical coverage. International, regional, national and local actors has initiated projects and programmes to improve our ability to detect

changes that allow us to deal with some of the challenging issues that the biodiversity of the Arctic is facing today. There are however still gaps in the knowledge and capacity to fully understand and monitor changes in Biodiversity and predict impacts of a changing climate as well as natural and human induced stressors.

This document provides an overview of the first workshop in a series of two. Experts with broad expertise (both scientific and community-based) on various aspects of Arctic terrestrial ecosystems and monitoring was brought together to initiate the design of a monitoring plan that will be able to identify trends in biodiversity; and possible causal links to stressors. The two workshops will together contribute towards the design of the integrated Arctic Terrestrial Biodiversity Monitoring Plan and will identify the networks to be involved.

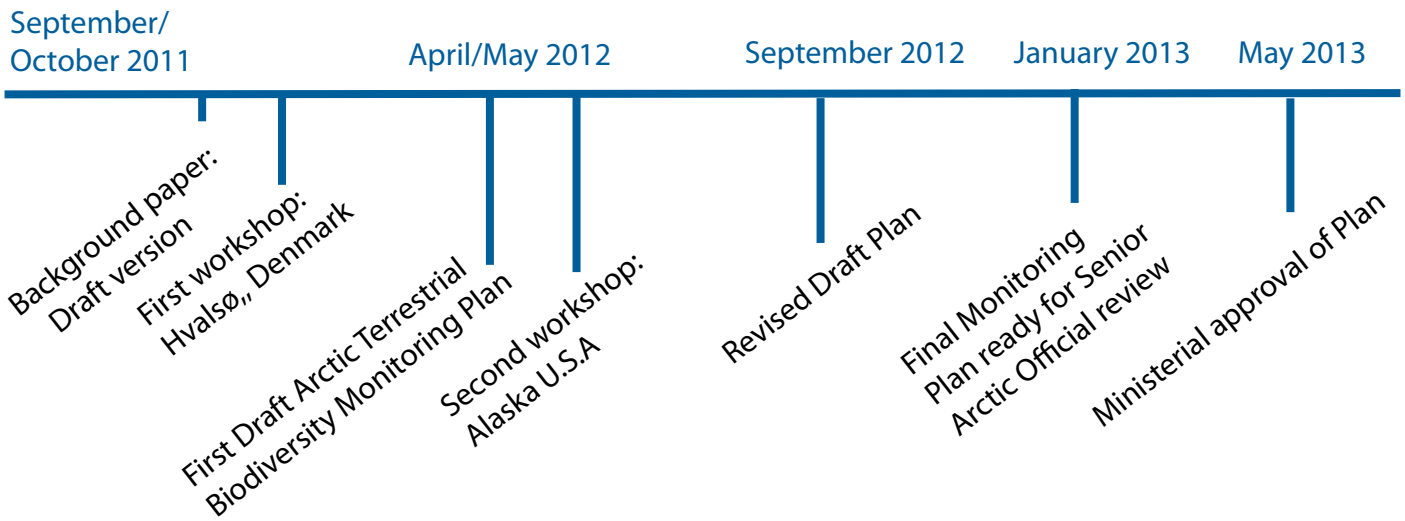
The workshop was arranged in conjunction with the IASC terrestrial Working group and an Arctic Field Station Managers Meeting - part of the INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic) project. A one day common meeting was held October 12 to coordinate objectives, ongoing work, and to draw synergies between the three groups. This one day workshop was called "Understanding Biodiversity Changes and Causes – Synergies in Arctic Terrestrial Biodiversity Research and Monitoring" and is included in this report.

Session 1. Introduction and context
(Chair Tom Christensen)

Opening Remarks

Tom Christensen provided opening remarks and welcomed the 37 member group to Hvalsø, Denmark. After the introductions, Tom provided the overview and context and information about the TEMG. Key messages included (i) an overview of TEMG steering committee; (ii) reviewed the purpose and need developing a pan-Arctic, integrated terrestrial biodiversity monitoring plan that serves as an umbrella monitoring framework; and an (iii) overview of process timelines (figure 1.). The timeline describes the process until ministerial approval of the final monitoring plan in 2013. After the approval there will be an implementation period. The plan will provide guidance on how the eight Arctic countries can implement the plan into their effort in the future.

Figure 1: Timeline for the development of the monitoring and implementation plan.



Agenda review

Tom Christensen reviewed the agenda in detail and outlined how the various sessions related to each other in order to achieve the workshop objectives. See appendix 1 for a copy of the workshop agenda and appendix 2 for participation list..

Nordic Council of Ministers

Jannica Pitkänen-Brunnsberg shared some perspectives from the Nordic Council of Ministers. In addition to identifying the key role and vision of the Council, Jannica specifically highlighted the information and data needs that the Council sees as a key objective of the CBMP's TEMG process. She also highlighted upcoming funding opportunities including the Arctic cooperation program that is being tabled for renewal/ approval in November 2011 by the Council, and will flow to the Senior Arctic Official (SAO) for consideration/ presentation (total of 6 Million DKK), related to priorities in the program.

Conservation of Arctic Flora and Fauna (CAFF)

Tom Barry provided an introduction and overview of CAFF. In addition to highlighting some of the challenges related to linking Arctic data to policy direction/ action, Tom highlighted some of the opportunities that CAFF is seeking to achieve often highlighting the need to shortening the time it takes monitoring to inform decision making.

Tom concluded with some questions/topics that CAFF may be seeking to answer including how they will impact the Arctic including (i) greening of the Arctic; (ii) treeline moving north; (iii) species declines; (iv) ecosystem trends.

Circumpolar Biodiversity Monitoring Program

After reviewing the monitoring challenges in the Arctic, Mike Gill reviewed the CBMP's purpose, vision, and goals. Mike highlighted the opportunities that the TEMG and indeed the larger CBMP partners are seeking to achieve related to harmonizing biodiversity monitoring in the Arctic. The presentation also identified key components of an integrated monitoring plan for the group to consider. The presentation concluded with a reminder of why monitoring at the circumpolar scale is strategic and adds value.

Discussion:

- There is a challenge to linking climatologist to what is happening on the ground (biodiversity changes).
- This first workshop is a balance between engaging the right people, and not everyone, to keep the workshop 'manageable'

Arctic Biodiversity Assessment (ABA)

Hans Meltofte provided an overview of the ABA process to date. The presentation reviewed the purpose, scope, and key components of the assessment. The project timeline to April 2013 was shared, and the detailed sections were summarized. Hans noted that the terrestrial biodiversity section is still in preparation. The discussion concluded by highlighting that the ABA process is focusing on accessible and peer reviewed data only while the TEMG will be focussed on a broader scope of monitoring programs.

Discussion:

- It was stated that there should be very high focus in the TEMG work to secure synergy between the ongoing ABA and the TEMG monitoring and implementation plan, especially in the development of element to monitor on.

Session 2. Key considerations:
Draft Backgroundpaper
(Chair Tom Christensen and John Payne)

The TEMG meeting was framed by a series of talks based on a background paper previously developed by the TEMG to affirm the monitoring approach, indicator selection methodology and criteria and proposed data management strategy.

TEMG Focal Areas, Stressors, and Indicators criteria
Jesper Madsen reviewed the TEMG focal areas, stressors, and indicator criteria. Questions for the group to consider in the afternoon breakout sessions were raised. The following is a list of criteria that were used when considering various indicators in the breakout sessions.

- Indicators for consideration will be SMART:
  - Specific, Measurable, Achievable, Results oriented & Temporally defined
- Criteria used to select the indicators will include:
  - Sensitivity to natural or anthropogenic drivers
  - Scientific validity
  - Relevance to and resonance with diverse audiences (e.g., local communities, decision makers, global public)
  - Ecological relevance
  - Availability and sustainability of monitoring capacity and expertise
  - Subjection to targets and thresholds; and
  - Practicality
- The indicators shall represent and incorporate the following:
  - Major Arctic biomes at various scales
  - Identified Arctic stressors
  - Major trophic levels, major Arctic biodiversity components (e.g., genes, species, habitat)
  - Critical ecosystem functions (for ecosystem resilience)
  - Critical ecosystem services

Discussion:
There were discussions about how to use the indicator criteria in the TEMG work. It was agreed that the TEMG group in the future work should focus on the development of "key ecosystem components" instead of "indicators". It was decided that the TEMG group will use the concept "key ecosystem component" instead of indicator, since the TEMG group will be very focused on the ecosystem approach in the development of the monitoring plan.

Data management
Michael Svoboda provided a highlight of the data management approach that CBMP is following. In addition to highlighting the strategic nature of the distributed data infrastructure, he provided examples from established data nodes.

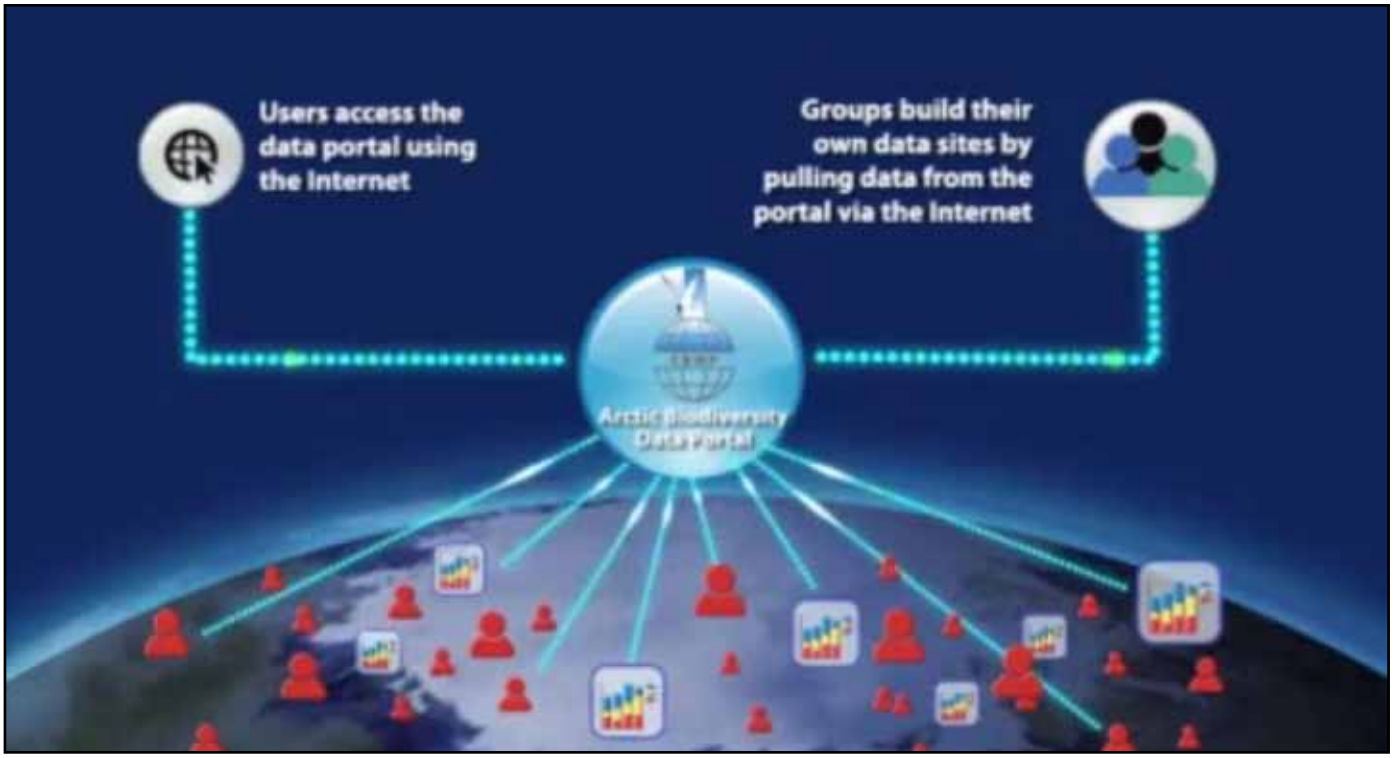
Discussion included topics of

- The metadata components needed to facilitate assessing database usefulness in analysis (eg. statistical sampling regimes etc.)
- Building on a number of existing discovery portals and networks (eg. CADIS etc). Ensuring that the process is inclusive and metadata sites are included.
- How current 'relational database infrastructure' is applied in the data management cycle. Some have indicated that there is a move away from relational databases for larger datasets.

Table 1. Data management table life cycle

Phase	Description	Key players
Data collection	Monitoring activities and data gathering.	Individuals, networks, countries
Discovery	Identify what datasets exist	EMG (ongoing) Networks (ongoing), CBMP Polar Data Catalogue
Distributed nodes operational	Established databases are available for aggregation to support analysis etc.	Data holders CBMP (standards)
Aggregation	Ensuring linkages between datasets (past = interoperable/ compatible)	Networks EMG CBMP 'support'
Analysis and synthesis	Analyzing aggregated data and identifying key findings and recommendations	Networks EMG CBMP (customized tools)

Figure 2. Data portal figure



Monitoring approach and methods

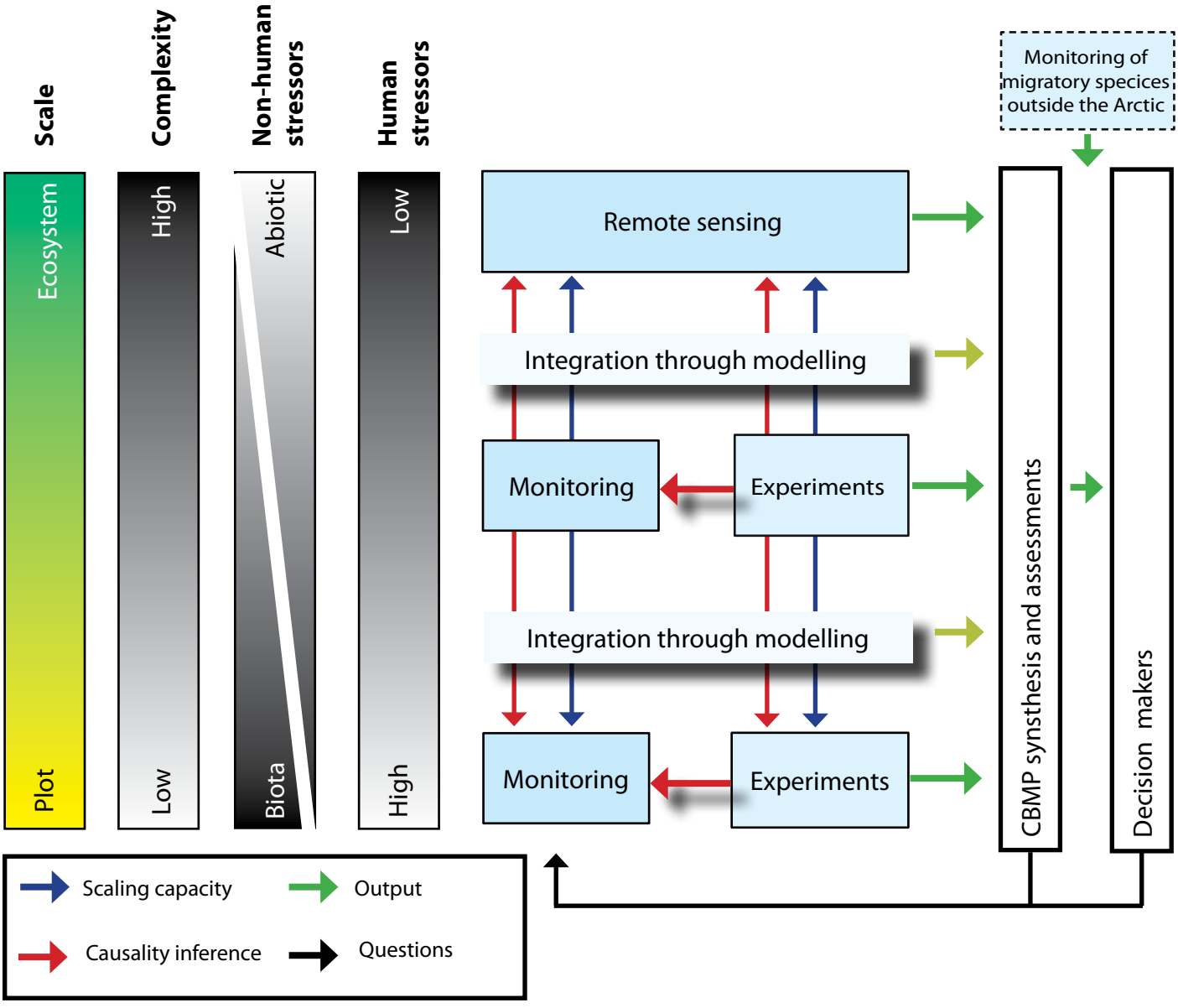
Marlene Doyle provided an overview of site-based, key ecosystem species-based, multi-species and remote sensing monitoring approaches. Her presentation touched on considerations for spatial and temporal resolution, geographic coverage and cost. Niels Martin Schmidt reviewed the conceptual model of monitoring ecosystem components (figure 3). The model included linkages to 'experimental process inputs' to enhance monitoring programs.

Jason Taylor discussed the challenges related to standardization and harmonization of robust, biodiversity monitoring methods. Specifically, he reviewed the challenges of combining information to result in meaningful results. Although consistent methods provide ease for combining data, there are opportunities to develop or calibrate 'less compatible data' for meaningful conclusions.

Discussion included:

- Is there a monitoring program that exists that meets the program criteria presented? Response identified some large national programs that are able integrate data over a large area.
- Biological data monitors are an important factor, as an impact on how data is interpreted and can be analyzed. This should be considered when developing a monitoring design. May also want to engage statisticians.
- Some concern related to focusing on statistical questions at a large scale. Dealing with the Arctic scale, this has challenged monitoring in both Europe (investigator driven) and North America (statistical design). There is a balance that needs to ensure that biological / ecological realities should help design the monitoring programs. However, in the US the courts are driving the rigour needed to be defendable in a court of law.
- Discussion between standardization and harmonization. There may be different methods, results can be comparable, and may be scaled up also.

Figure 3. Conceptual model of monitoring ecosystem components.



Inventory of existing monitoring capacity

Niels Martin Schmidt presented a summary of the metadata tables describing long-term Arctic terrestrial biodiversity monitoring submitted by countries prior to the workshop. See Background paper.

Figure 4. Scale of monitoring

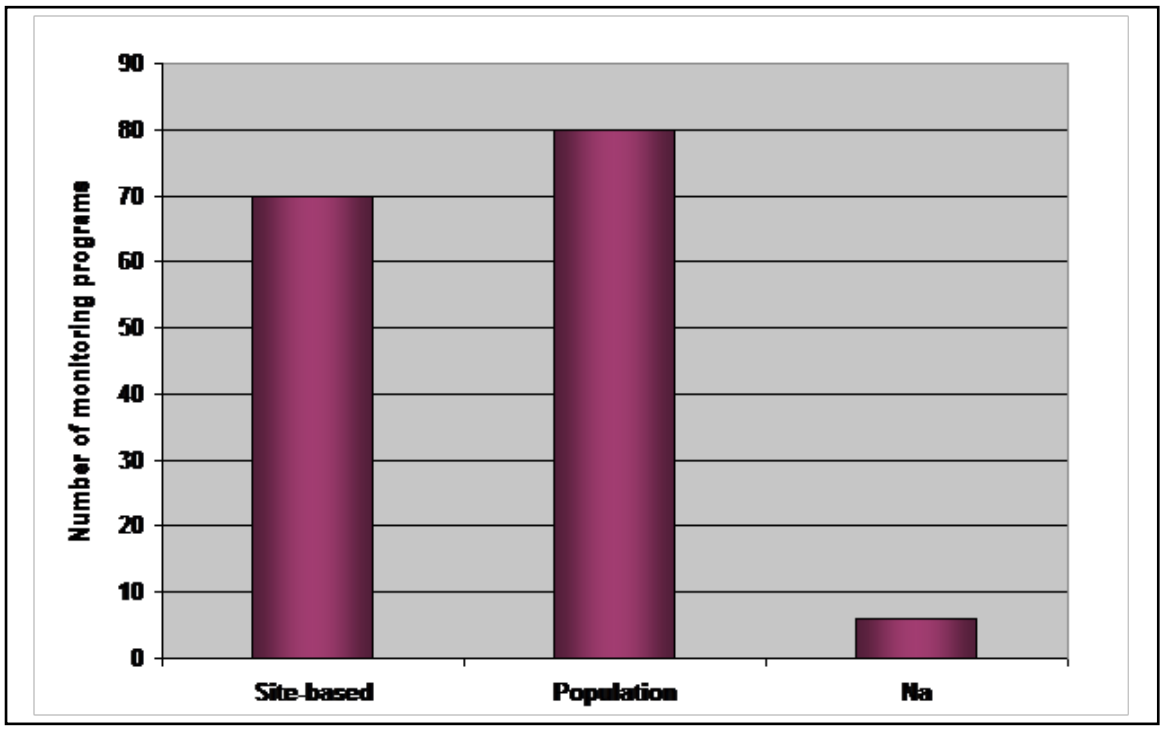


Figure 5. Monitoring of organism groups

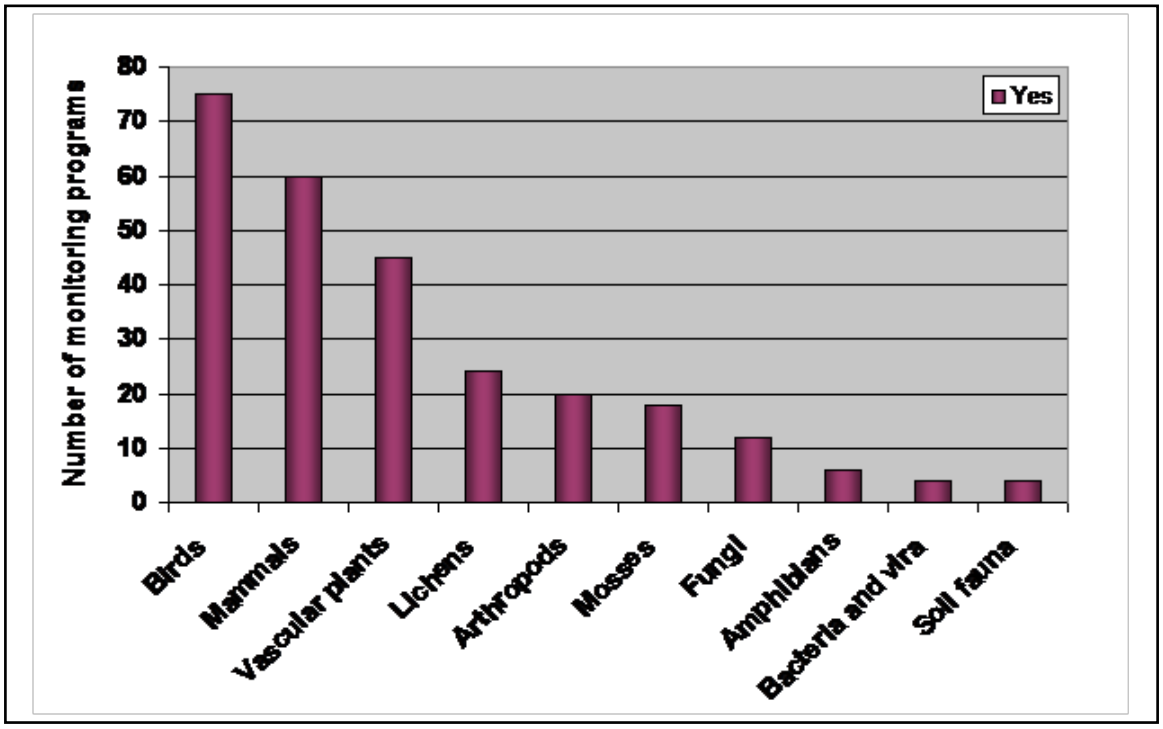


Figure 6. Monitoring of themes

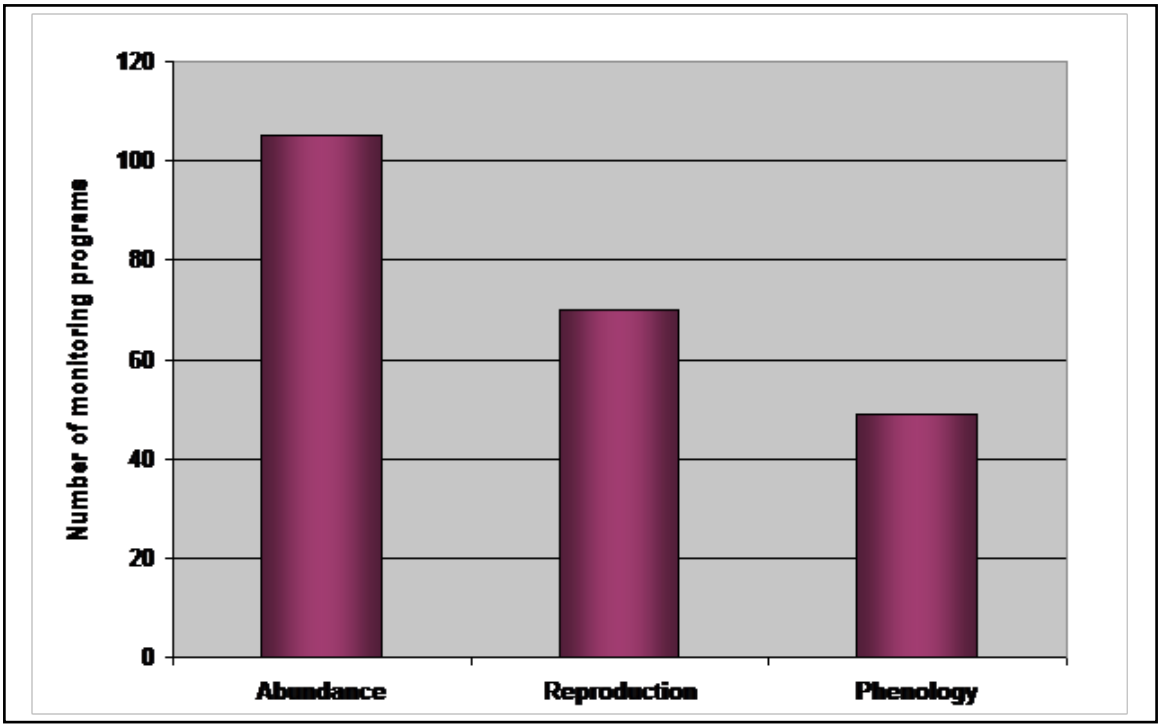
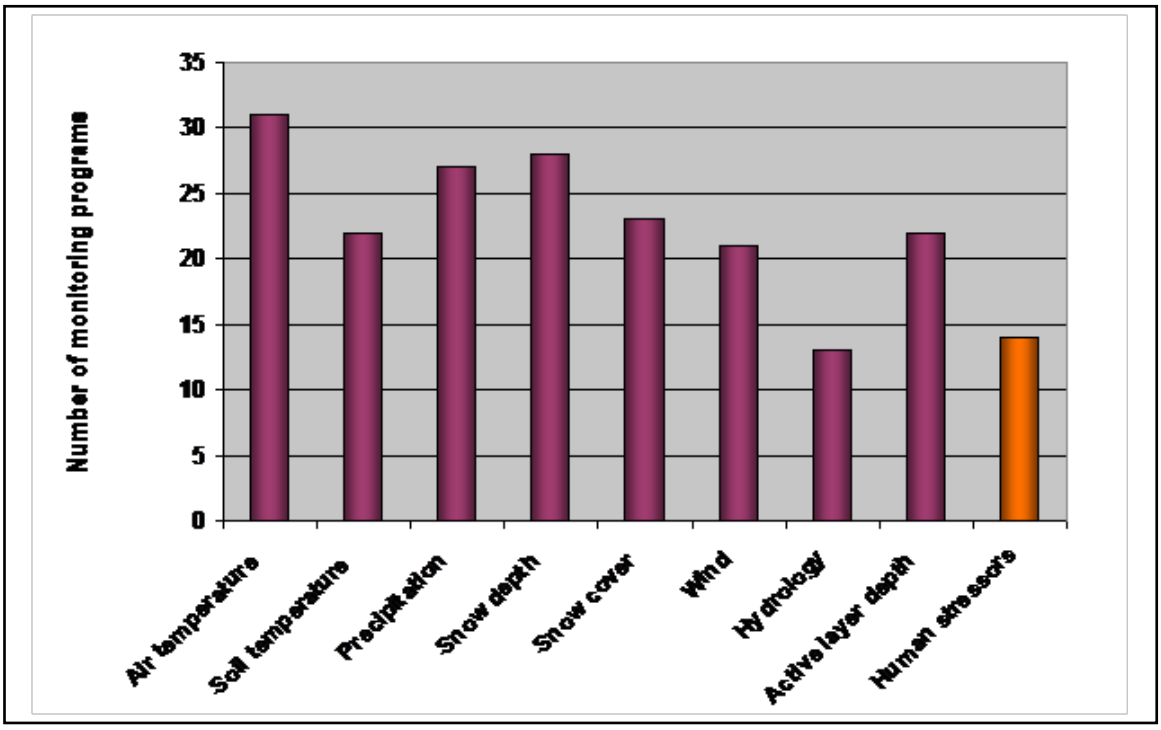


Figure 7. Monitoring of stressors



Preliminary conclusions that can be drawn:

Examples on circumpolar programs using common protocols:

- International Tundra Experiments (ITEX)
- CircumArctic Rangifer Monitoring and Assessment Network (CARMA)
- Arctic Breeding Birds Condition Survey (ABBCS)
- Global Observation Research Initiative in Alpine Environments(GLORIA)

Photo: Wild Arctic Pictures

Gaps in existing monitoring

- Geographical coverage
  - Current monitoring effort varies between regions
  - Elements and stressors
    - » Most monitoring effort currently put on few organism groups
  - Stressors are not consistently monitored
  - Only few examples of biodiversity monitoring in a true ecosystem framework
- Modeling capacity
  - Lack of geographical coverage, standardized protocols, and solid statistical set-up limits (large-scale) modeling capacity

Session 3. Indicator coverage for monitoring Arctic Terrestrial Biodiversity

(Chair Jason Taylor)

Ecosystem based monitoring of Arctic biodiversity: How to adhere to principles of adaptive monitoring

Rolf Ims presented an overview of monitoring theories related to biodiversity. He presented the Lindenmayer and Likens (2009) adaptive monitoring conceptual model vis a vis the other monitoring paradigms (eg. passive monitoring models; mandated monitoring, large number of monitoring parameters). A benefit of the adaptive monitoring approach is the identification of causal factors explaining monitoring trends and results.

Key remarks that should be taken into account when TEMG is developing its conceptual models:

- Describes key species functions, interactions and processes
- Links to stressors and management options and their impact
- Are simple and effective
- Status of knowledge
- Are tailored to focal ecosystem (one size will not fit all).
- Should be continuously improved
- May be in the end transformed to quantitative statistical models.

Adaptive monitoring focus on direct measurements rather that proxy indicators unless necessary. Rolf clarified that adaptive monitoring and adaptive management are considered different and that adaptive monitoring requires a focus on both change and state.

Discussion:
There was some concern expressed related to the scope of the CBMP monitoring plan if we are trying to address processes of the model. The level of details for the causal links will need to be carefully balanced with targeted monitoring, but also including future changes that we don't know the questions to.

Selecting Key Ecosystem Components (indicators in CBD) and parameters that meet the goals for an IMP

Mike Gill presented experiences from CBMP, and what should be taken into account if the plan should contribute to the Convention on Biodiversity, Aichi Biodiversity Targets and to the CBD/ UNEP/ COP/ DEC etc. Mike highlighted the importance of the IMP serving data needs of decision makers and the 'need' if the program is to be sustainable.

Breakout sessions and poster session

Focused discussion on monitoring plan components was structured through five concurrent breakout groups: avian, mammals, arthropods, vegetation (in situ), and remote sensing. Groups were instructed to identify the management goals and questions for which the monitoring strategy should deliver integrated information related to their topic. Groups were also asked to describe drivers of change and what we would want to be able to say about Arctic terrestrial biodiversity in 5 years and 10 years within their focal area (see also session 4 – 5)

Photo: Peter Krejzl/Shutterstock.com

Each group produced a list of management questions. These questions are categorized and summarized below:

Status and Trends:

- What is the status of a given system?
- What are Status and Trends for Birds and other species?
    - Global perspective: Conventions like CBD and Ramsar
    - Regional/ National: For legislation
- What can we do about negative trends? (Food security)
- For those of unfavourable conservation status, are the factors affecting phenology, distribution and abundance acting inside or outside of the Arctic?
- How many birds, reindeers (and other species) can be harvested?
- Can we distinguish between human and natural causes of population change
- Are the protected site networks living up to the criteria's?
- What is the Status and Trends in (red listed) habitats/ species? Why?
- What are the effects of protection?
- Are there spots in the landscape that should get special focus?
- What is the Status, Trends and Distribution of important (cultural, economic etc.) species?
- What is the impact of human activity on habitats and species?
- What will be the effect of vegetation change on reindeer / Caribou and vice versa?
- What is the effect on species/ habitat/ system of extreme events?

Invasive species

- What are the effects of invasive species – will they destroy natural habitats?
- What is the location and abundance of invasive (non native) species, related to anthropogenic introductions?

Infrastructure and human disturbances:

- What are the impacts of humans?
    - Site development for birds, reindeer and other "important" (for human use) species
- Are these stressors being more frequent?
- Can we distinguish between natural and human induced change?
- How is vegetation affected by infrastructure?
- What are the effects of human "traffic" on the vegetation?

Plenary session. Photo: Michael Svoboda

Break out session. Photo: Michael Svoboda

Break out session. Photo: Michael Svoboda

Break our group. Photo: Michael Svoboda

Human dimension:

- What are the risks for human populations of bird-transported pathogens?
- How will climate change impact social structures of indigenous communities?

Ecosystems and productivity:

- What are the impacts of overabundant populations for Arctic Ecosystems?
- Are there ecosystem types disappearing?
- How will the tundra productivity change?
- How will the distribution of ecosystem / habitat types change?
- What are the anticipated changes to habitat because of climate change?
    - What implications will this give for other species? (phenology, structure, productivity)
- What are the primary indicators that can be used in relation to remote sensing?
    - NDVI and other vegetation indices, including productivity.
    - Changes in land cover
- What are the drivers that we can detect using Remote Sensing?
    - Land temperature
    - Snow extend
    - Snow water equivalent
    - Phenology of snow, vegetation, sea ice, land temperature
    - Surface water extend
    - Infrastructure extend
- What data will we need?
    - Satellite data at multitude scales of all the above using visible IR, SAR, telemetry

Plant communities:

- What are the landscape level location, abundance and pattern of vegetation communities?
    - How are they changing?
- Is there change in the treeline?
- Diversity in plant communities? Where are the species rich sites? And how is it varying – causes?

Genetic diversity:

- To what extent is genetic diversity changing?

Break out session. Photo: Michael Svoboda

Break out session. Photo: Michael Svoboda

Presentation. Photo: Michael Svoboda

Presentation. Photo: Michael Svoboda

Session 4. Linkage of networks – How do we embed the CBMP-Terrestrial Plan into broader initiatives and identification of priority parameters
(Chair Mora Aronsson)

Summary of breakout sessions and instruction for next break out session

Jason summarized the outcomes of the breakout session leads. The group also revisited and discussed why the geographic scope of the TEMG was limited to high and low Arctic. However, there was understanding that there will be a need for flexibility in the monitoring program (i.e. to accommodate flyways, or migrating caribou etc.). Niels Martin Schmidt highlighted the conceptual model and how it should be 'used' to assist in the selection its key elements. His presentation also outlined the common language that this group will use, as described below.

- **Key elements**: The target ecosystem component to be monitored. Key elements are critical to the functioning and resiliency of Arctic ecosystems and/or reflect the vital importance to the subsistence and economies of northern communities.
- **Attributes**: Aspects or characteristics of the key element to be tracked.
- **Parameters**: the metric measured in the field to track the attribute

Breakout groups were asked to develop conceptual models to describe the system and use the model to propose key elements, attributes and parameters for the CBMP TEMG monitoring plan. The workshop participants lacked the expertise to tackle arthropods and other soil fauna so participants in this breakout joined the other sessions. The in situ vegetation and the remote sensing group joined together. Breakout groups were also asked if the system can handle

- How issues of community structure for example can be reported on
- Trophic balance
- Diversity indices
- Harvest
- Drivers need more attention, how to use in the concept/ future.

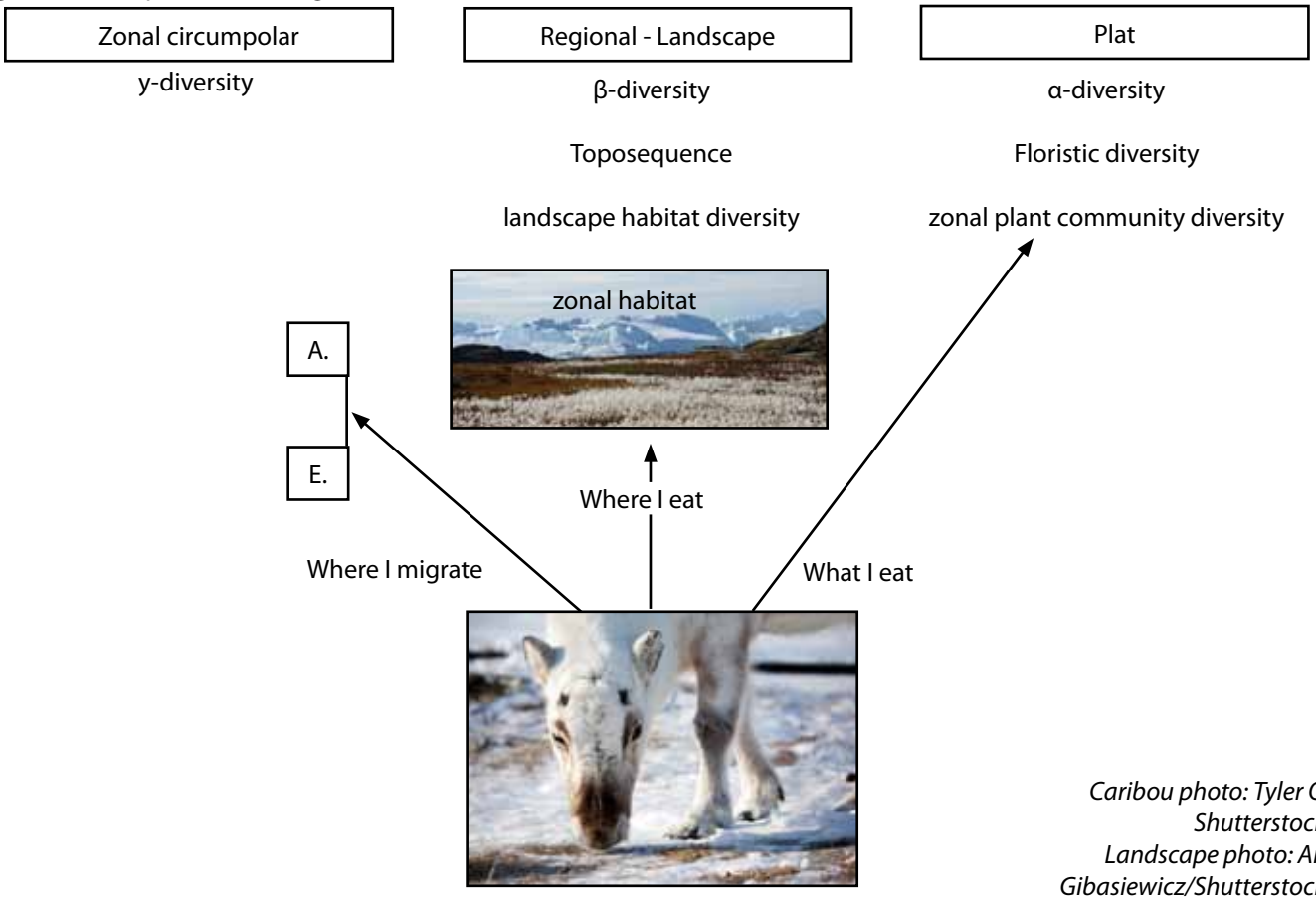
Pale Arctic clouded yellow (summer colour). Photo: Heiti Paves/Shutterstock.com

Breakout session

Conceptual models were developed by each group, with the exception of the remote sensing vegetation group.

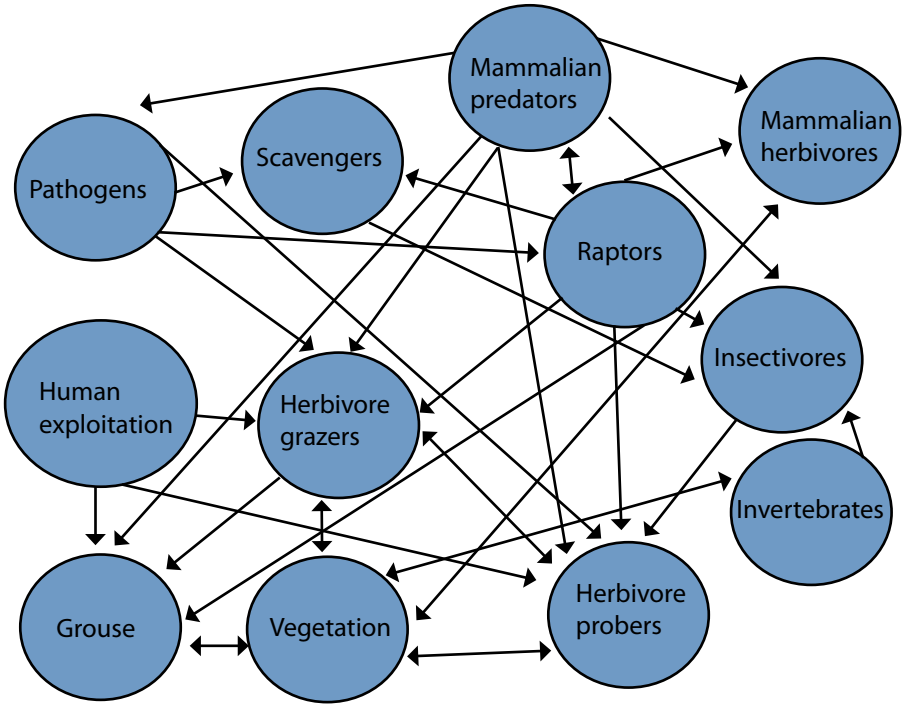
These are presented below.

Figure 8. Conceptual model vegetation.



Caribou photo: Tyler Olson/ Shutterstock.com
Landscape photo: Andrezj Gibasiewicz/Shutterstock.com

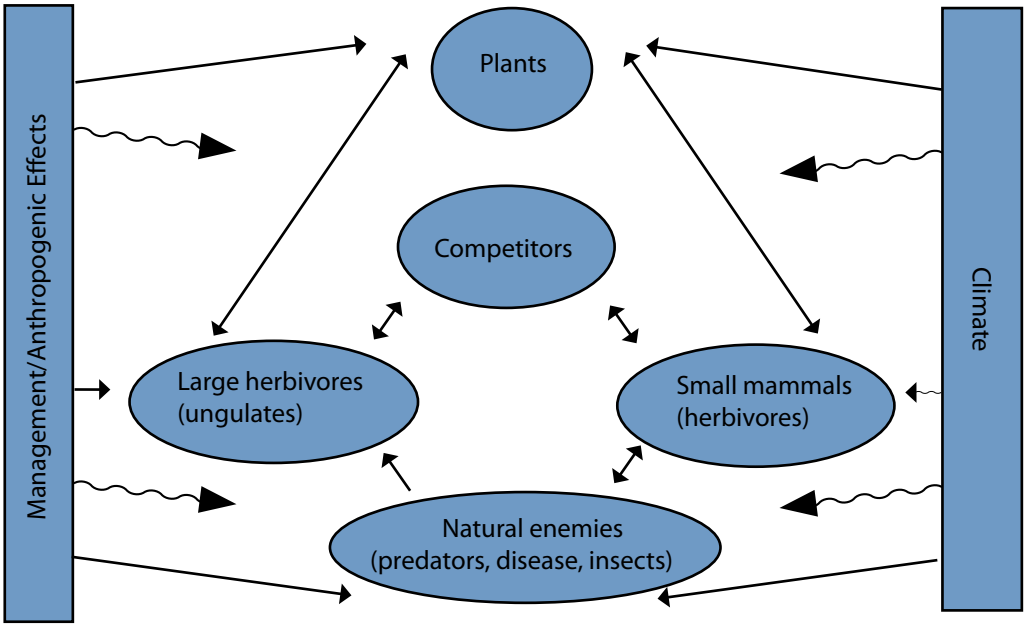
Figure 9. Conceptual model Birds



Stressors

Climate
Snow cover
Timing of snow melt
Temperature
Precipitation (flooding)
Wind/patterns
Contaminants
Harvest
Physical development
Habitat loss: disturbance
tourism, industry, etc.
Stressors outside the Arctic

Figure 10. Conceptual model Mammals



Session 5. Towards an Integrated Terrestrial Monitoring Plan

Groups returned to share the results of populating the Key Elements, Attributes, and Parameter Table.

Table 2: Parameter table - Mammals. Discussion – can make comment as to what the links are to stressor or driver (e.g. do not have climate yet in table).

Key elements	Justification	Attribute	Parameter
Large Ungulate (caribou/ musk ox)	key ecosystem element/ service	population dynamics	abundance (periodicity, amplitude, measure of variance)
		spatial use	distribution
			migratory patterns
		demographics	age structure
			mortality
			calf: cow
			bull: cow
		health/body condition	jaw bone/tooth wear
			body size
			bone marrow
			rump fat
			immunocompetence
			prevalence and virulence of pathogens (abundance diversity)
		adaptive capacity/ evolutionary potential	genetics
		community structure	number
		diet	rumen content
			feces
		behaviour	migratory patterns
			activity budget

Key elements	Justification	Attribute	Parameter
		harvest	number of animals killed
		competitors	Including invasive sp: abundance and spatial use (geese, insects, etc.)
		predators (wolf/bear)	abundance, spatial use
		Food resources (winter/ summer specific spp.)	biomass, phenology, resource-specific NDVI
Small herbivores (lemming/ vole)	key ecosystem element/ service	population dynamics	abundance (periodicity, amplitude, measure of variance)
		spatial use	distribution
		demographics	age structure
			mortality
		health	prevalence and virulence of pathogens (abundance diversity)
		adaptive capacity/ evolutionary potential	genetics
		community structure	number:
		diet	
		behaviour	activity budget
		predators (wolf, mustelids, fox, predatory birds)	abundance, spatial use
		competitors	including invasives: abundance and spatial use
		Food resources (winter/ summer specific spp.)	biomass, phenology, resource-specific NDVI

Photo: Wild Arctic Pictures/Shutterstock.com

Photo: Arnd Drifte/Shutterstock.com

Table 3. Avian – Pathogens have not been added yet. It may be included as some sort of health or driver measure. Also, the group felt that this was a first level of monitoring, like if there was a disease outbreak, or if there was a negative trend, one could expand the monitoring to get more details as to why (like a triggered monitoring program).

Key elements	Justification	Attribute	Parameter	Related elements
Herbivores	Key ecosystem function	Abundance	Population size; numbers	mammalian predation pressure
	Harvested	Distribution	Local density; presence/ absence	vegetation
	Unfavourable conservation status	Demography	propensity; clutch size; brood size; age ratio; nest success; age specific survival	mammalian herbivore abundance
	Overabundant	Harvest	Hunting bag (+ effort)	
		Community structure	Diversity index	
Insectivores	Key ecosystem function	Abundance	Population size; numbers	mammalian predation pressure
	Harvested	Distribution	Local density; presence/ absence	invertebrates
	Unfavourable conservation status	Demography	propensity; clutch size; brood size; age ratio; nest success; age specific survival	
		Harvest	Hunting bag (+ effort)	
		Community structure	Diversity index	

Key elements	Justification	Attribute	Parameter	Related elements
Raptors	Key ecosystem function	Abundance	Population size; numbers	rodent abundance
	Unfavourable conservation status	Distribution	Local density; presence/ absence	
		Demography	propensity; clutch size; brood size; age ratio; nest success; age specific survival	
		Community structure	Diversity index	

Table 4. Vegetation: The group followed a scaled approach (i.e. at landscape level vs. site level monitoring.

Key elements	Justification	Attribute	Parameter
Plant Community	Fundamental element of habitat	• Greening • Productivity • Composition • Area-location • Change-spatial distribution	• NDVI • Biomass • LAI • IPAR • Alpha Diversity (total species diversity) • Plant functional types (diversity) • Maps/spatial distribution metrics
Habitat Types (complex of plant communities)	Fundamental groups of communities defining landscapes or Repeating assemblages of plant communities in typical landscapes	• Greening • Productivity • Composition • Area-location- • Change-spatial distribution	• NDVI • Biomass • LAI • IPAR • Beta Diversity (total habitat diversity) • Plant functional types (diversity) • Maps/spatial distribution metrics
Bioclimate sub zones	Large groups of plant communities occurring within zonal climatic subdivisions	• Greening • Productivity • Composition • Area-location • Change-spatial distribution	• NDVI • Biomass • LAI • IPAR • Gamma Diversity (total biographical diversity) • Plant functional types (diversity) • Maps/spatial distribution metrics
System Drivers		• Climate (precipitation/snow cover, temperature) • Permafrost (controls soil temp, moisture, micro-topography) • Topography (Micro-, Meso-, Macro-scale) • Hydrology • Disturbance (Natural [e.g., fire, landslides, animals] and Anthropogenic) • Land Use	

In summary, the pieces of a biodiversity monitoring plan are starting to come together. However there is a need to identify key element, attributes and parameters for some themes that was not covered at the Hvalsø workshop. For these thematic gaps there is also a need to identify further gaps. First of all major thematic gaps not covered at the Hvalsø workshop include invertebrates (Arthropods / soil fauna) and non vascular plants. The plan is to consult relevant experts on these thematic gaps before the Anchorage workshop. The overall purpose will be to have the five themes (Plants, mammals, vegetation, invertebrates (Arthropods/ soil fauna) and non vascular plants) covered with relevant parameters tables (like table 2-4) and conceptual models (like figure 9-11) before the workshop in Anchorage and have relevant experts to present these tables and figures at the Anchorage meeting as a platform for the meeting.

There is also a general need to conduct an assessment of the proposed elements, attributes and parameters against current monitoring capacity, as identified by the monitoring inventory, to assess the ability to deliver data on the proposed measures within current investment levels.

The next steps in the development of the monitoring plan will include identifying sampling approaches, where, and who is involved and engaging their participation in plan development. There is a need to spend some time discussing CBMP data management approach and the details, as well as the reporting cycles (identify other products, scientific publications, live data serving); and finally, how and when we implement, who is involved, and how do we work as a group, what are the timelines and what are the costs.

Closing remarks

Tom and John provided closing remarks and adjourned the workshop.

Joint Workshop with IASC and INTERACT.

On the second day between session 3 and 4 a joined workshop where held with representatives from CBMP, IASC, INTERACT and ISAC.

Background for the joint workshop

The need to measure and understand change in Arctic biodiversity is increasing given the evidence that Arctic ecosystems are already rapidly responding, in some cases quite dramatically, to climatic changes. Substantial shifts in the Arctic environment are predicted for the near future (e.g. encroachment of more southerly species and ecosystems) and recent changes in physical processes such as sea ice loss have outpaced predicted changes. Limited functional redundancy in Arctic ecosystems poses a particular risk as the loss of a single species could have dramatic and cascading effects on an ecosystem's state and function.

Based on these change scenarios the Arctic has experienced a dramatic increase in research and monitoring activities both in terms of scientific disciplines and geographical coverage. International, regional, national and local actors have initiated projects and programmes, to improve our ability to detect changes that allow us to deal with some of the challenging issues that the biodiversity of the Arctic is facing today. There are however still gaps in our knowledge and capacity to fully understand and monitor changes in biodiversity and to predict the impacts of a changing climate as well as natural and human induced stressors.

There is some coordination between some biodiversity related projects and programmes in the Arctic, but there is still overlap between different initiatives and possibilities for improved coordination and sharing of knowledge and experiences. There is therefore a need to combine resources and jointly work together to improve our understanding of Arctic terrestrial biodiversity and ecosystem processes, status and trends and to disseminate the relevant information in both the public and policy arena.

A workshop on "Understanding Biodiversity Changes and Causes – Synergies in Arctic Terrestrial Biodiversity Research and Monitoring" was held 12 October 2011 at Sonnerupgaard Gods in Denmark. This workshop was organized jointly by INTERACT, The Circumpolar Biodiversity Monitoring Programme's Terrestrial Expert Monitoring Group (CBMP TEMG) and the International Arctic Science Committee's Terrestrial Working Group (ISAC TWG).

The workshop was funded by the organising organisations with support from the Nordic Council of Ministers.

Purpose and programme of the joint workshop

Several international organisations and networks work with Arctic ecosystems and biodiversity research and monitoring. Some main stakeholders such as the two monitoring programmes under Arctic Council, Circumpolar Biodiversity Monitoring Programme (under CAFF) and the Arctic Monitoring and Assessment Programme (AMAP) focus on the status and trends of biodiversity/ecosystems and their drivers. Others such as the International Study of Arctic Change (ISAC) and International Arctic Science Committee (IASC) focus on the understanding of the processes driving the systems and their organisms. Some existing research networks already employ consistent, repeatable and standardized measures also in relation to biodiversity monitoring. The INTERACT network of circumarctic field stations host a number of these networks, and thus contributes to major environmental assessments based on site based monitoring and research. This infrastructure network is therefore a key platform for Arctic ecosystem and biodiversity research and monitoring. Furthermore, INTERACT sites host and initiate summer schools that could help build capacity for field identification of difficult taxa and sampling.

The overall goal of the workshop was to identify possible synergies between organisations and networks working with Arctic terrestrial biodiversity, and to agree on common actions to improve the collaboration and communication (see appendix 3 and 4 for further information about agenda and participants).
To reach the goal, the participants where provided with an overview of stakeholders in Arctic Terrestrial Biodiversity Research and Monitoring, including decision makers, the science community, Indigenous Peoples Organisation, and NGOs.

The following presentations were given:

Setting the scene

- Terry V. Callaghan - Setting the scene and expected outputs
- Hans Meltofte - Arctic Biodiversity Assessment (key speaker)

Stakeholders

- Inge Thaulow - Government of Greenland, National Authority of Arctic Council member state
- Anne Brunk - Indigenous Peoples Organisation
- Martin Sommerkorn - NGO representative - WWF

Inspirational presentations

- Terry V. Callaghan - International Tundra Experiment (ITEX) / Back to the Future (BTF) – examples of circumarctic research and monitoring programmes
- Finn Danielsen - Community-based monitoring - Opening doors to native knowledge
- Morten Rasch - Greenland Ecosystem Monitoring (GEM) - Designing an ecosystem/Site based research and monitoring programme
- Bob Shuchman - Remote sensing
- Skip Walker - Scaling

Major Arctic initiatives related to biodiversity research and monitoring

- Mike Gill - CAFF/CBMP Terrestrial Expert Monitoring Group
- Margareta Johansson - INTERACT
- Skip Walker - IASC Terrestrial Working Group
- Gus Shaver - ISAC
- Jesper Madsen - SAON

Presentations from the workshop can be found on the INTERACT website: http://www.eu-interact.org/station-managers-forum/meetings/international-workshop/.

After each presentation, time was set aside for brief discussions where participants were asked to focus on the following points:

- Map the opportunities for collaboration within the field of Arctic terrestrial biodiversity
- Identify knowledge gaps and capacity constraints
- Produce a list of recommended activities and
- Identify topics with potential for collaboration within the field of biodiversity research and monitoring including identification of relevant stakeholders.

The Synergy Group

A Synergy Group consisting of representatives of the major initiatives related to monitoring and research of Arctic terrestrial biodiversity, was asked to identify gaps, synergies and areas of potential collaboration and to produce a report based on the workshop (see Synergy Group Conclusions and Recommendations). After presentations and discussions, the Synergy Group had time to prepare a conclusion and draft recommendations for a final plenary discussion. The Synergy Group consisted of:

- Jesper Madsen, Aarhus University, Denmark (CBMP)
- Terry Callaghan, Royal Swedish Academy of Science and University of Sheffield (INTERACT and IASC)
- John Payne, North Slope Science Initiative, USA (CBMP)
- Gus Shaver, Ecosystem Centre Massachusetts, USA (ISAC)
- Mike Gill, CBMP-office, Canada (CBMP)
- Mads C. Forchhammer, Aarhus University, Denmark (IASC)

Synergy Group conclusions and recommendations

This section presents the recommendations and conclusions finalised by the Synergy Group after the workshop:

The goal of the workshop was to identify possible synergies between organisations and networks working with Arctic terrestrial biodiversity and to agree on common actions to improve the collaboration and communication.

Several international organisations and networks work with Arctic ecosystems and biodiversity research and monitoring. Some organisations focus on the status and trends of biodiversity/ecosystems and their drivers, while others focus on the understanding of the processes driving the systems and their organisms. However, they all share the common goal of improving our understanding about what causes the observed changes and what impacts the multiple natural and human-induced drivers of change will have on terrestrial biodiversity and ecosystem functioning. The various organisations and networks also share an interest in the dissemination of timely and science-based advice to the Arctic people and political-administrative systems about causes and consequences of changes in support of possible adaptation and mitigation strategies.

The endeavour to fully understand biodiversity changes and underlying causes is challenged with incomplete knowledge, ranging from limited spatial and temporal observational coverage, small skill pools (e.g. taxonomic), slow take-up of new technologies, lack of coordination and harmonisation of sampling protocols over understanding system responses, species invasiveness and effects of extreme events to predictive capabilities and lack of concepts on how to preserve and manage biodiversity. None of the organisations have the capacity to fill these gaps on their own, but by working together, the actors can at least fill some of the critical gaps. Provided that there is a willingness to buy-in, collaborate and communicate, there is much synergy to be gained by setting up a coalition between the partners.

When seeking to identify areas of potential collaboration, the Synergy Group wanted to focus on obvious areas for collaboration within ongoing activities and joint efforts to fill important knowledge gaps to ensure that the collaboration is initiated with realistic achievable targets.

The following actions were discussed at the workshop:

A) Mechanism for communication and collaboration: Arctic Biodiversity Coalition - Terrestrial
It was agreed that organisations and networks should work together via a Memorandum of Understanding (MoU) and not create a new administrative unit. The MoU signatories will be partners in the Arctic Biodiversity Coalition – Terrestrial (ABC – Terrestrial) within which an informal forum will be established to:

- Inform about activities
- Make joint activities
- Avoid duplication of efforts
- Evaluate causalities
- Make joint outreach campaigns and deliver fast products to decision makers
- Develop ways of involving local communities in biodiversity research and monitoring

The members of the Synergy Group will in the nearest future form a basis for post-meeting formulation of an agreed mechanism for communicating and refining proposed joint actions. The members of the Synergy Group will continue to discuss:

- Who are the partners of the ABC – Terrestrial? (see figure 1)
- How the partners within ABC - Terrestrial should communicate (frequency and form) to ensure regular updates on joint activities and identify new synergies and proposed actions
- A refinement of proposed joint actions and identification of future synergies

Based on this a Memorandum of Understanding should be developed by the Synergy Group and distributed to relevant organisations and networks.

Photo: Skip Walker

B) Synergies in ongoing activities

Synergy 1

Activity	Lead organisation:	Description:	Partners:
Terrestrial Biodiversity Monitoring Plan	Circumpolar Biodiversity Monitoring Programme (CBMP), Arctic Council/ CAFF	The CBMP Terrestrial Expert Monitoring Group (TEMG) is developing a monitoring plan for Arctic terrestrial biodiversity. In order to identify indicators it is essential to understand the processes shaping Arctic biodiversity and ecosystems. INTERACT provides a unique network of field stations in the Arctic that could act as a site based component of the CBMP TEMG biodiversity monitoring plan. Therefore, CBMP TEMG will involve relevant organisations and networks in the development of the plan. The CBMP biodiversity monitoring plan also includes a community-based monitoring component. Similarly, the INTERACT project also includes a component on involvement of local communities in monitoring and discussion of changes and adaptation strategies. CBMP TEMG and INTERACT should therefore explore opportunities to coordinate the programmes and jointly develop community-based monitoring.	CAFF/CBMP, INTERACT, others to be identified.

Synergy 2

Activity	Lead organisation:	Description:	Partners:
IPY Back to the Future project (BTF 2) – revisiting old assessment sites to assess change	INTERACT, CBMP	The core work of the IPY - Back to the Future (BTF) project was to identify old datasets/research sites and repeat the old assessments to quantify change. More specifically : a) To assess multi-decadal past changes in the structure and function of polar terrestrial and freshwater ecosystems and environments in relation to diverse drivers of change. b) To assess the current status of polar ecosystems and their biodiversity. c) To permanently record precise locations of old sites. BTF 1 has been very successful: many papers have been published and a special issue of the international science journal "Ambio" was published at the end of last year. Partners of BTF 2 are interested in ensuring that additional old assessment sites and data are identified, stored and used to assess changes and ensure the IPY legacy. At the workshop, it was therefore decided to look at possibilities for hosting the project within one of the ABC – Terrestrial partner organisations or networks.	INTERACT, CBMP, others to be identified.

C) Recommended new actions

Action 1

Activity	Lead organisation:	Description:	Partners:
Joint efforts to develop training/ courses/ education.	IASC, INTERACT.	Capacity building is needed within a number of scientific fields. A priority in this context is taxonomy and early career scientists. It is therefore proposed that ABC – Terrestrial partners arrange common practical taxonomy training courses and capacity building of young scientists via summer schools.	IASC, ISAC, CBMP, INTERACT, others to be identified.

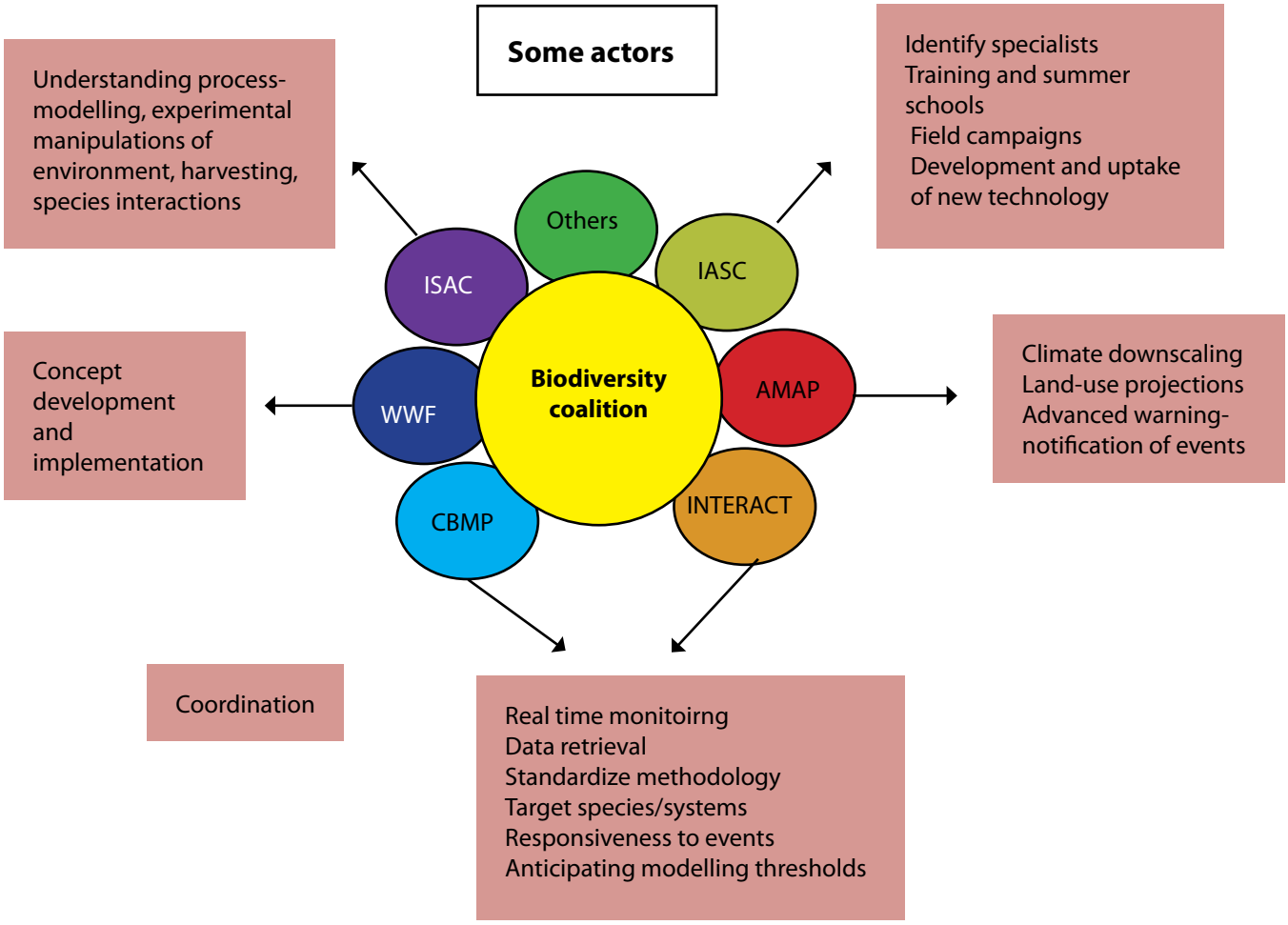
Action 2

Activity	Lead organisation:	Description:	Partners:
Joint workshops to increase understanding of biodiversity changes and causes	Synergy Group Members	In order to fill in some of the gaps in our knowledge and understanding of factors shaping Arctic biodiversity and ecosystem functioning, there is a need to bring experts together. Therefore, it is proposed that the ABC – Terrestrial partners jointly arrange workshops with specific scientific scopes. The Synergy Group proposed the following activities as a starting point: • Joint workshop on fundamental biodiversity concepts • Joint workshop on ecosystem resilience/thresholds • Joint workshop on species redistribution/dispersal capabilities	Synergy Group members, WWF (resilience), others to be identified.

D) Other areas of potential collaboration noted by the Synergy Group during presentations and discussions

- Standardisation of methodologies.
- Categorisation and definition of biodiversity components; e.g. develop standardised approaches for describing and mapping vegetation and plant communities at multiple scales.
- Develop ideas for joint efforts to inform decision makers and provide rapid response to acute information needs.

Figure 12. Key partners in the Arctic Biodiversity Coalition - Terrestrial and their possible focal areas.



Immediate post developments from the joined workshop

1. ABC
ABC - Terrestrial was immediately proposed by CBMP, IASC and INTERACT as a task within SAON. The proposal was discussed at a recent meeting of the SAON Board and the outcome is pending. Membership is currently being discussed by several organisations such as ISAC and ITEX.

2. BTF 2
INTERACT has accepted the task to coordinate BTF 2 and will collaborate closely with the CBMP TEG. INTERACT and CBMP TEG now needs to discuss operational aspects. Leaders of BTF 1 (Terry Callaghan and Craig Tweedie) agree to this development and continue to contribute to a leading role in a new organisational context.

3. Project on Ecosystem Resilience
Following recommendations from the workshop, a project led by Jesper Madsen and Mads C. Forchhammer, Aarhus University, Denmark has been proposed with the aim to provide the first Arctic Ecosystem Resilience Assessment (AERA) across terrestrial, limnic and marine ecosystems in the Arctic. A circumpolar workshop will be held, with the aim to produce an assessment report, a series of scientific papers and a policy-guiding document on the resilience of Arctic species and ecosystems. Applications for funding have been sent to The Nordic Ministers Council and Danish funding agencies (response awaited in March 2012). This is a joint project between ABC - Terrestrial partners.

Appendix 1. Agenda

Designing an Integrated Arctic Terrestrial Biodiversity Monitoring Plan: 1st workshop of 2 arranged by the Circumpolar Biodiversity Monitoring Group (CBMP) - Terrestrial Expert Monitoring Group (TEMG). October 11-13, 2011, Hvalsø, Denmark

Tuesday October 11

Session 1. Introduction and context (Chairs; John Payne and Tom Christensen)

9:00 Welcome by TEMG co-leads (John Payne and Tom Christensen)
9:10 Introduction, presentations and Background – Setting the stage (Tom Christensen / John Payne)
9:30 CAFF (Tom Barry) – Arctic Council
9:50 CBMP (Mike Gill)
10:10 Arctic Biodiversity Assessment
10:30 Coffee Break

Session 2. Key considerations: Draft Background paper (Chairs; John Payne and Tom Christensen)

11:00 Introduction (John Payne / Tom Christensen).
11:10 TEMG Focal Areas, Stressors and Indicator criteria + questions (Jesper Madsen)
11:30 Data management (Michael Svoboda)
11:45 Monitoring Approach and Methods + questions (Marlene Doyle/ Jason Taylor/ Niels Martin Schmidt)
12:10 Inventory of existing monitoring capacity (Niels Martin Schmidt / Michael Svoboda. (explain appendix, explain what the eight countries has been asked to do – if possible conclude and discuss the inputs – can we se any possibilities/ platforms for coordinated circumpolar - examples)
12:30 Lunch

Session 3. Indicator coverage for monitoring Arctic Terrestrial Biodiversity (Chair: Jason Taylor)

13:30 Indicators coverage and linkage to stressors (keystone function, ecosystem coverage, flagship indicators, indicators for ecosystem goods and services etc) (Rolf Ims)
13:50 Selecting indicators and parameters that meets the goals for an IMP – experiences done in CBMP (and what should be taken into account if the plan should contribute to the Convention on Biodiversity, Aichi Biodiversity Targets and to the CBD UNEP/CBD/COP-/DEC/X/13 decision including (Mike Gill)
14:00 Instructions to breakout groups (Chairs)
14:05 Break out session – including coffee break

Break out session:
6 - 8 thematic groups (≤6 in each) discus management goals and relevant:
We break into trophic groups and have each group identify the priority indicators that should be created to serve our key information needs.

Each Breakout Group will produce one poster to hang up in the room.

Key questions to be addressed on one poster from each group:

- What management goals and questions do we need to answer?
- What would we want to say about Arctic terrestrial ecosystems in 5 years, 10 years?
- What drivers do we have to consider?
- Can causal links between trends and stressors be identified
- What is the conceptual framework we will use

- What indicators do we need to develop (or already exist – for instance in the ABA) to allow us to report on this?
- Based on this, what indicators do we need to choose? Priority indicators (critieria – critical answers as well as doable ones with existing data)
- Based on the indicators, what parameters do we need to populate these indicators?

16:30 Poster session – one person from each group will stand at the poster – others can walk around. Two or more TEMG members will be responsible for selecting information and make a summary of break out session on day 3.
17:00 Final remarks day one and short presentation of day two (John Payne & Tom Christensen).
17:10 End of day one

Day 2 – With IASC and INTERACT (se separate agenda)
Two TEMG members join second day synergy group.

Day 3

Session 4. Linkage of networks – How do we embed the CBMP – Terrestrial Plan into broader initiatives and identification of priority parameters (Chairs; TEMG members).

9:00 Introduction (Chairs)
9:05 Summarise results of day 1 (TEMG members – see day one program)
9:25 Messages from day two – relevance for the development of an integrated terrestrial monitoring plan (Jesper Madsen and John Payne)
9:45 Comments in plenary
10:00 Instruction to break out session (Chairs)
10:05 Break out session including coffee break

Break out session:
We break into groups (same groups as day one) and have each group to Identify the Priority Parameters that need to be measured at a circumpolar scale that would generate the information needed to populate the indicators that the group has identified.

Key questions to be addressed on one poster from each group:

- What existing data and networks do we have that can help us begin to report.
- What priority parameters should be measured at a circumpolar scale?
- What trends may the plan be unable to detect?
- What new networks and data (filling gaps) would we need?

The discussion and new questions that may arise should lead us to the 2012 workshop.

12:00 Lunch

Session 5. Towards an Integrated Terrestrial Monitoring Plan (TEMG members).

13:00 Summarise results of 2nd breakout session and discuss next steps (Facilitated by TEMG members).
14:30 Final remarks and next steps to develop an integrated Monitoring plan (John Payne & Tom Christensen).
14:45 End of workshop.

Appendix 2: Participation list – TEMG workshop

List of participants to the Circumpolar Biodiversity Monitoring Group (CBMP) - Terrestrial Expert Monitoring Group (TEMG) workshop:

Participant	Organization	Email contact
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Appendix 3. Agenda – joined workshop day

Understanding Biodiversity Changes and Causes: Synergies in Arctic Terrestrial Biodiversity Research and Monitoring

Sonnerupgaard Gods, Hvalsø, Denmark
12 October 2011

Purpose
The purpose of the joint workshop is:

- to provide participants with an overview of stakeholders in Arctic Terrestrial Biodiversity Research and Monitoring, including decision makers, science community, Indigenous Peoples Organisation and NGOs.
- to ensure that workshop participants have a clear and full understanding of programme goals and outputs of Arctic Council initiatives (SAON, CBMP-Terrestrial Expert Monitoring Group, AMAP), IASC Terrestrial Working Group, ISAC and INTERACT, and opportunities for collaboration within the field of biodiversity.
- to identify knowledge gaps and capacity constraints, and produce a list of recommended activities and topics with potential for collaboration within the field of biodiversity research and monitoring including identification of relevant participants.

Output
A report presenting gaps and recommended collaborative actions in relation to biodiversity research and monitoring in the Arctic. The report will describe gaps and recommended activities that will help fill the gaps and improve our understanding of biodiversity changes and causes. The report will also include an initial list of networks, organisations, programmes and projects that are interested in participating in suggested activities (e.g. in the form joint research and monitoring efforts, developing courses and training programmes, joint workshops or reports on specific topics, etc.).

Agenda

8:30 Welcome, agenda and practicalities (Elmer Topp Jørgensen, INTERACT, Tom Christensen, CBMP)
8:35 Setting the scene and expected outputs (Terry V. Callaghan INTERACT /IASC TWG)
8:50 Key note speaker 1: Arctic Biodiversity Assessment (Hans Meltofte, Aarhus University)

Session 1: Stakeholders in Arctic Biodiversity
9:15 National Authority of Arctic Council member state (Inge Thaulow, Greenland/Denmark)
9:30 Indigenous Peoples Organisation (Anna Brunk, Indigenous Peoples Secretariat)

9:45 NGO representative (Martin Sommerkorn, WWF)
10.00-10.25 Coffee

Session 2: Inspirational presentations

10:25 Introduction to session 2 (Chair Margareta Johansson, INTERACT)
10:30 International Tundra Experiment (ITEX)/ Back to the Future (BTF) - Circumarctic research and monitoring programmes (Terry V. Callaghan)
10:50 Community-based monitoring - Opening doors to native knowledge (Finn Danielsen, MOMA/ Nordeco)
11:10 Greenland Ecosystem Monitoring (GEM) - Designing a ecosystem/site based research and monitoring programme (Morten Rasch)
11:30 Remote sensing (Bob Shuchman)
11:45 Scaling (Skip Walker)
12:00-13:00 Lunch

Session 3: Circumarctic Terrestrial Biodiversity Research and Monitoring initiatives

13.00 Introduction to session 3 (Chair John Payne, CBMP TEMG)
13.05 CAFF/CBMP Terrestrial Expert Monitoring Group (Mike Gill)
13.40 INTERACT (Margareta Johansson)
14.15-14.45 Coffee
14.45 IASC Terrestrial Working Group (Skip Walker)
15.20 ISAC (Gus Shaver)
15.55 SAON (Jesper Madsen)

16:15-17:15 Break (except for Synergies Group members)
16:15-17:15 Synergy Group meeting (Synergy Group members only)

The Synergy Group consists of representatives of major initiatives within the field of Arctic Biodiversity. The Group discuss and identifies gaps and areas of potential collaboration based on workshop presentations and discussions. These are presented theme by theme immediately hereafter.

Session 4: Identification of gaps, recommended activities and potential synergies

17:15 – 18.45 Synergy Group presentation of gaps, recommended activities and areas of potential collaboration, followed by plenum discussion
18:45 Concluding reflections by the Synergy Group
19:00 Closing remarks and the way ahead – the process of turning gaps and areas of collaboration into synergy action (Mike Gill and Terry Callaghan)
19:30 Dinner

Appendix 4: Participation list – joint workshop day

Participant	Country	Institute/Organization	Email contact
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