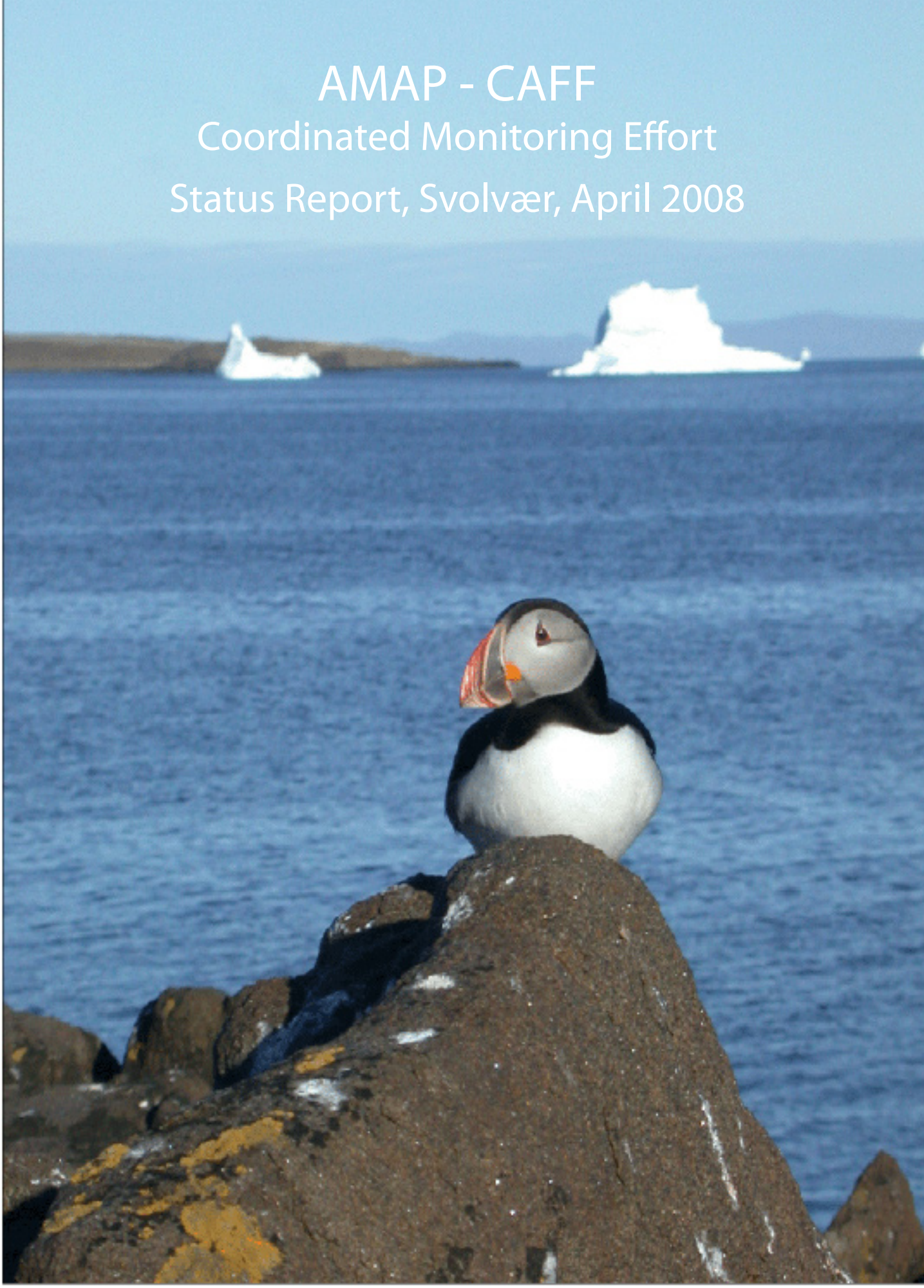
AMAP - CAFF

Coordinated Monitoring Effort

Status Report, Svolvær, April 2008



CAFF
Conservation of Arctic Flora and Fauna

AMAP
Arctic Monitoring and Assessment Programme

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Introduction

Cooperation between the Arctic Monitoring and Assessment Programme (AMAP) and the Conservation of Arctic Fauna and Flora (CAFF) continues to develop. A joint meeting was held in Copenhagen on the 18th September 2007. At this meeting a Green Paper entitled AMAP/CAFF Coordinated Monitoring Effort (CME) was accepted by both Working Groups (Appendix I). This paper has helped to facilitate the integration and harmonizing of monitoring between CAFF and AMAP.

The next step involved determining the projects that were to be included as part of the CME. To this end each country submitted a national list of current monitoring activities that might be suitable for inclusion in the CME. At the joint meeting in Copenhagen, each delegation determined the most relevant projects that could be considered as pilot projects for the CME. As part of the discussion regarding determination of pilot projects, it was agreed that projects included in the CME are required to:

- Fulfill the mandates of both CAFF and AMAP
- Have a data management strategy in place
- Have funding for the project in place, and to have existing results from the project
- Have a long-term perspective (not just three or five years)

At the previous SAO meeting in Narvík in November 2007 CAFF and AMAP introduced the list of monitoring activities which were submitted under the CME. These projects are to present annual reports at SAO meetings and this Report contains the first such annual reports which provide an overview of the current status of those projects listed under the CME

The CME is considered as a contribution by the Arctic Council to the Sustaining Arctic Observing Network (SAON) process.

The Arctic as defined by CAFF

Arctic Biodiversity of Char

Broad objectives of project

Wide diversity both latitudinally and longitudinally exists in the aquatic ecosystems of the circumpolar Arctic. Widespread fish species, particularly salmonids of the genus Salvelinus (chars), are key elements of freshwater (lakes, rivers), estuarine, and nearshore marine ecosystems throughout the Arctic. Moreover, chars and related salmonids sustain fisheries and aquaculture, thus are integral to lifestyles of northern peoples. Chars are also keystone ecosystem components occupying many trophic (feeding) levels as secondary, tertiary and higher predators in Arctic ecosystems. Both local and widespread stressors present in the Arctic (e.g., climate change, contaminant loading, hydrocarbon development, exploitation) combine to significantly directly affect chars or their ecosystems (these latter usually with follow-on additional indirect effects on chars). Accordingly, monitoring of char populations provides understanding of change and its causes for both the char populations themselves as well as the aquatic ecosystems they occupy.

This project has three over-arching long-term objectives:

- Conduct research projects locally and throughout the Arctic to understand char biodiversity, roles of that diversity in aquatic ecosystem structure, function and sustainability, and the effects of stressors, particularly climate change and contaminants, on chars and their ecosystems
- Using activities within Canada as an example, develop national summaries of the present char biodiversity and status, link these with understanding of local and pervasive stressors, and establish trends in change of char biodiversity through appropriate long-term monitoring programmes
- Establish an international network linking research and monitoring activities on chars and their ecosystems throughout the Arctic

Specific species and ecosystems included

Salmonid fishes of the genus Salvelinus are the focus of this project. Although additional char species occur in some areas, throughout the Arctic, two closely related species complexes (Arctic char, S. alpinus complex; Dolly Varden, S. malma complex) [Figure 1] are primarily found in lacustrine and riverine habitats respectively. Arctic char occur throughout the Arctic to the northernmost extent of land (where they are the only fish species present in freshwater), whereas, Dolly Varden occur primarily in eastern Asia and western North America [Figure 1].

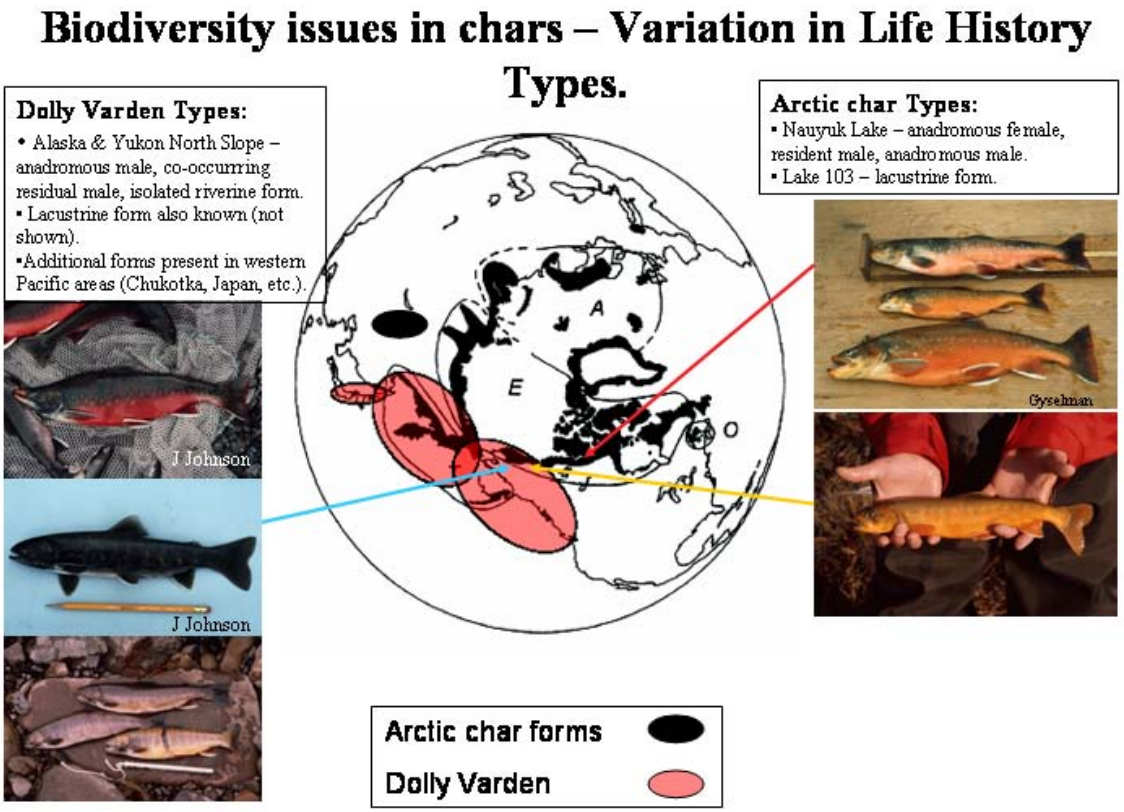

Figure 1: Chars of the Arctic (Dolly Varden and Arctic Char) showing various life history types. Map illustrates the distribution of Arctic char species complex (black shading) and Dolly Varden complex (red shading).

Both species complexes are comprised of many taxonomically distinct species, may co-occur, and within some may exhibit multiple ecologically and phenotypically distinguishable forms [e.g., three ecophenotypes in Lake Hazen, Figure 2].

Figure 2. Ecophenotypes of Arctic char from Lake Hazen, QNP, Nunavut, Canada (photos by J. Reist): A) Three individuals of Large Form, B) Small Form, C) Benthic Dwarf Form, and D) Lake Hazen. Note that the scale in each photo is very different.

For freshwater ecosystems connected to nearby marine areas for which no barriers such as waterfalls exist, chars may also be migratory to and from nearshore marine ecosystems thus exhibit various life history types. Migratory (sea-run or anadromous) char typically co-occur with resident non-migratory char while in freshwaters in such systems. This char diversity within and among ecosystems adds structural stability and functionality to those ecosystems, thus providing for long-term sustainable services from them. These aspects, however, also result in the cumulation of stressor effects within char populations (e.g., biomagnification of persistent contaminants with increasing tropic level). Individual and cumulative effects of Arctic stressors thus threaten both chars and the stability of their aquatic ecosystems. This, in turn, ultimately affects derived services from those ecosystems such as sustainability of fisheries.

Geographic coverage

The overall project focus is pan-Arctic, particularly high Arctic areas, however, individual project activities include areas throughout the geographic range of chars. In Canada there are a number of ongoing projects linked to this CME project:

- High Arctic Char Biodiversity: This work has focused upon northern areas of Ellesmere Island (Quttinirpaaq National Park, QNP) particularly Lake Hazen (84oN), Resolute Bay area of the central Archipelago, Bathurst Inlet area of the central coastal mainland, northern Quebec and Labrador. Focal activities include understanding local char diversity and placing such in the pan-Arctic context, understanding trophic patterns within the aquatic ecosystem, and placing contaminant burdens in both these contexts.
- Geographical surveys of contaminants (particularly bioaccumulated heavy metals) for both sea-run and lacustrine (landlocked) chars include areas from Holman (western Canadian Arctic) east to Pond Inlet (Baffin Island) and south to Nain (Labrador), Kangiqsualujjuaq (northern Quebec) and Sanikiluaq

(southern Hudson Bay).

- Additional activities are occurring in most Arctic countries, particularly with respect to documenting local char diversity. For example, recent work in Russia has focused upon isolated char populations in Transbaikalia (Northeast Siberia). Liaison is also occurring regarding projects conducted in several sub-Arctic nations where chars occur in high altitude ecosystems.

Recent Progress

Selected recent activities associated with the Canadian components of this project include the following.:Funding for research, monitoring and synthesis activities on chars focused within Canada was secured through a successful proposal to the Canadian International Polar Year (IPY) fund (http://www.api-ipy.gc.ca/intl/fs/cvc_e.html), and a companion International IPY project developed and approved (http://classic.ipy.org/development/eoi/proposal-details.php?id=300).

Field research (summer 2007) at Lake Hazen documented three co-occurring ecophenotypes of Arctic char [Figure 2].

Sampling in Lake Hazen and other lakes in QNP, Resolute Bay area, Bathurst Inlet area, and Labrador documented char populations, investigated trophic (foodweb) structure and mercury bioaccumulation, and collected young char to investigate thermal ecology. A manuscript documenting temporal trends (1990-2006) in heavy metals including mercury in Lake Hazen chars was submitted for publication [Figure 3. Gantner, N., G. Koeck, J.A. Babaluk, J.D. Reist, W.L. Lockhart, M. Power, K.R. Solomon and D.C.G. Muir. Temporal trends of mercury, cesium, potassium, selenium, and thallium in Arctic char (Salvelinus alpinus) from Lake Hazen (Nunavut): Effects of trophic position, size and age. Submitted to Environmental Toxicology and Chemistry, February 2008].

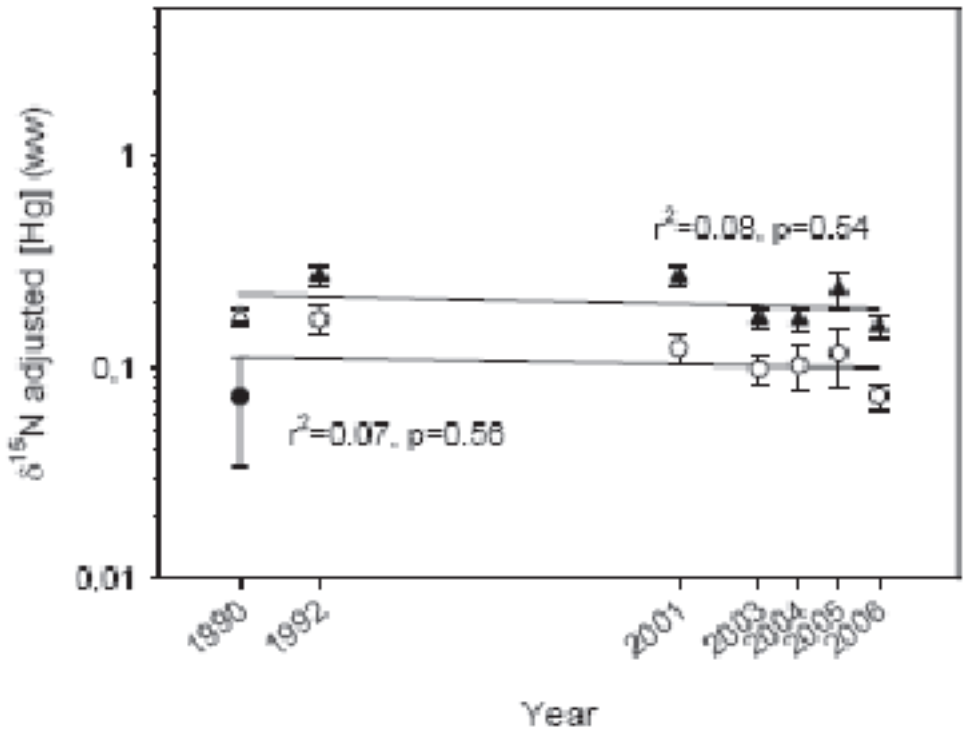

Figure 3. Temporal trends for mercury concentrations adjusted by trophic position (nitrogen stable isotopes) of all chars (filled triangles) and small form chars (open circles) from Lake Hazen (1990-2006) (N. Gantner unpublished data; manuscript submitted 2008).

Since 2004 sea-run char from six widespread Canadian Arctic communities have been surveyed for mercury and organochlorine concentrations with the finding that levels are very low in comparison to landlocked chars (including lake trout). There is no evidence of declining mercury concentrations with time, however, current organochlorine concentrations are lower than in the 1980s. Results are annually reported through the Canadian Northern Contaminants Programme (NCP).

Genetic relationships within and among chars from Transbaikalia (northeastern Siberia) were investigated and placed into the global context, and a manuscript submitted for publication [Alekseyev, S.S., R. Bajno,

N.V. Gordeeva, J.D. Reist, M. Power, A.F. Kirillov, V.P. Samusenok, and A.N. Matveev. Phylogeographic patterns and sympatric speciation in the Arctic charr Salvelinus alpinus (L) complex from Siberia as revealed by mitochondrial DNA sequence analysis, with special reference to Transbaikalia. Submitted to Journal Fish Biology, February, 2008].

Network development was initiated – concept developed and presented at International Char Conference (Reykjavik, 2006), poster presentations at International Conference on Arctic Research Planning (ICARP II, Copenhagen, 2005, http://arcticportal.org/extras/portal/iasc/icarp/Posters/7-27.jpg), Sustained Arctic Observing Network (SAON I, Stockholm, 2007), and SAON II (Edmonton, 2008) (http://www.arcticobserving.org/). Continued network development will be facilitated through ongoing IPY and related follow-on activities, development of aquatic monitoring programmes for northern Canada, and direct liaison with the Circumpolar Biodiversity Monitoring Programme (CBMP) of Conservation of Arctic Flora and Fauna (CAFF) Working Group of the Arctic Council (char is one of the underpinning species networks for this programme). Reporting of progress is through regular IPY updates, national reporting activities (e.g., NCP), scientific literature, and via CBMP and related venues.

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Beluga

Broad objectives of project

Examining beluga ecology and contaminant uptake in the Beaufort Sea, where there is a relatively long time series of beluga data, going back to the 1980s. Recently an Ecosystem-Approach was used to better understand mercury sources to this beluga population. The approach incorporated the analysis of food web sources, beluga behaviour and habitat use to determine the mercury dietary sources. Specific species and ecosystems included

Specific species and ecosystems included

Beluga: Beaufort Sea beluga population

Geographic coverage

- Summer (late May to October): Beaufort Sea, including Amundsen Gulf, Mackenzie Delta (estuary zone of importance), M'Clure Strait, Viscount Melville Sound
- Fall Migration (September to November): Beaufort Sea (nearshore/offshore – size/sex dependant), Chukchi Sea, Wrangel Island Russia
- Winter (December to April): Bering Sea, most southerly extent – St. Matthews Island.
- Spring Migration (April/May): follow open lead along Alaskan coastline to Beaufort Sea Contact People

Recent Progress

Over the last decade there has been concern over the high levels of mercury (Hg) in the Beaufort Sea beluga (Delphinapterus leucas) whale population that summers in the eastern Beaufort Sea and Mackenzie Delta region in the western Canadian Arctic. In the 1990's, liver Hg levels in this beluga population tripled in comparison to 1980 levels , and were the highest relative to other Canadian Arctic beluga populations. Although still higher than 1980 levels, Hg concentrations have dropped and are now comparable to other Arctic populations .

Population Status

The most recent aerial survey estimated just under 20,000 individuals (Harwood et al., 1996). Approximately 100 to 200 are landed each summer by the Inuvialiut subsistence harvesters in western Canada. They are also landed by Inupiat in Alaska.

Beluga Summer Habitat Use

During the summer, habitat selection of sea ice and bathymetry among differs with length, sex and reproductive status likely reflecting differences in energy requirements and survival strategies (Loseto et al., 2006). Three beluga habitat groups were defined: 1) shallow open-water near the mainland was selected by females with and without calves and by small males (< 4 m); 2) the sea ice edge was selected by medium length males (3.8 - 4.3 m) and a few females (>3.4 m) without neonates; and 3) heavy sea ice concentrations in deep, offshore waters were selected by the largest males (4 - 4.6 m). Beaufort Sea beluga are size dimorphic; males reach a mean asymptotic length of 4.2 metres and the female asymptotic length is approximately 0.5 metres less Thus, variation in habitat selection as it relates to size, sex and reproductive status may support different feeding strategies and dietary composition.

Beluga Mercury Relationships

Mercury levels in beluga tissues remain lower than those measured in the 1990's. Beluga muscle tissue was found to be a better indicator of dietary Hg sources than liver which accumulates Hg over time bound to selenium as a method of detoxification (Loseto et al., accepted). The process of Hg biomagnification driven by food web structure, better predicted muscle levels than bioaccumulation over time. Because almost all of the Hg present in beluga muscle is in the form of methyl mercury it reflects dietary sources of Hg.

Beluga Diet

The diet of Beaufort Sea belugas is not well known because harvested animals usually have empty stomachs; yet, local hunters have observed beluga feeding in the Mackenzie River estuary (Harwood and Smith 2002). Through the use of fatty acid signature analysis and stable isotopes of beluga tissues along with potential prey items, the diet composition of beluga was estimated (Loseto et al., submitted). Overall, the Arctic cod (Boreogadus saida) appeared to be the most important prey item for adult Beaufort Sea beluga, whereas

bottom-feeding fish did not appear to be as significant. Similar results have been found for beluga diets estimated from fatty acid near Svalbard (Dahl et al., 2000). The fatty acid and stable isotope analysis revealed a gradient in diet composition that varied with beluga size (Loseto et al., accepted). The diet of larger beluga consisted predominantly of offshore Arctic cod, whereas the diet composition of medium and small beluga included Arctic cod from shallow waters and other fish from the nearshore regions, demonstrating a more diverse diet composition than larger whales.

Mercury in Beaufort Food web and Beluga

The Mackenzie River is a large source of Hg (Leitch et al., 2006); however, fish sampled in the Mackenzie estuarine-shelf region the lowest Hg levels, ranging from 0.1 to 0.27 ug/g dry weight (dw) in arctic cisco (Coregonus autumnalis) and saffron cod (Eleginus gracilis) respectively (Loseto et al., In Press). This matched well with lower Hg levels found in smaller sized males that use nearshore habitats. Arctic cod collected nearshore had lower Hg and 15N levels than those collected offshore. Thus belugas feeding on arctic cod in the offshore regions are exposed to higher Hg levels relative to those feeding in the nearshore habitat. Highest Hg levels occurred in fourhorn sculpin (Myoxocephalus quadricornis) (0.5 ug/g dw) from the epibenthic food web (Loseto et al., In Press). Although, the epibenthic fauna may not currently be important to beluga diet this may change with alterations in food web dynamics and shifts in available prey that may occur in association with sea ice reduction.

Current Monitoring Program

The Beaufort Sea Beluga population is harvested by the Inuvialuit subsistence harvesters in the Western Arctic during the summer months. A long term beluga monitoring program in partnership with Fisheries & Oceans Canada (G. Stern) and the community Tuktoyaktuk NT has enabled the collection of tissues for contaminant monitoring. Recently new projects were initiated to examine contaminant toxicity effects and nutritional stress.

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CircumArctic Rangifer Monitoring and Assessment Network (CARMA)

Broad objectives of project

Mission Statement: To monitor and assess the impacts of global change on Human-Rangifer (reindeer, caribou) systems across the circumarctic through cooperation, both geographically and across disciplines,

Goal: CARMA's goal is to learn more about wild reindeer and caribou so that we will all be better able to understand and respond to the impact of changes on our human/Rangifer systems in the north. CARMA is achieving this goal by:

- Taking a circumpolar perspective to capture the diversity of environments and outside pressures
- Making the best use of data that already exists – looking into the past to learn about the future
- Collecting new data in a standard way so that we can monitor and assess impacts of change across herds
- Focusing on herds that have good baseline information and partnering with institutes, agencies, councils and boards committed to cooperate and to collect more information in the future
- Involving experts in remote sensing, population ecology, caribou body condition and health, traditional and local knowledge, data analysis and modeling and communication and education

Specific species and ecosystems included

CARMA Reference herds

- Porcupine – Canada/US
- Bluenose West - Canada
- Bathurst - Canada
- Qamaniurjuaq - Canada
- Southampton - Canada
- Leaf/George - Canada
- Akia- Maniitsoq - Greenland
- Iceland - Iceland
- Hardangervidda - Norway
- Teshekpuk - US
- Taimyr - Russia
- Lena-Olenek - Russia
- Chokotka - Russia

Geographic coverage

Canada, US, Greenland, Norway, Russia, Iceland

Recent Progress

- Synthesis questions and 'matrix" drafted and ready for review
- CARMA data management structure proposed, initial data archiving completed
- Final draft and field testing of body condition and health manual – Russian translation completed
- Draft of demography manual ready for CARMA review
- Habitat monitoring component initiating cooperative projects
- Number of contacts with community groups and representatives
- Actively working with reference herd contacts on mutual projects
- Further development and testing of synthesis and decision support tools

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International Tundra Experiment (ITEX)

Broad objectives of project

The International Tundra Experiment (ITEX) was established to monitor changes in arctic tundra ecosystems in relation to climate variability and change. Studies are based on long-term monitoring and experiments that are intended to simulate expected changes in climate, including warming and snow depth manipulations.

Specific species and ecosystems included

Arctic (and alpine) tundra ecosystems throughout the tundra biome. Within ITEX sites, studies are arranged along moisture and exposure gradients. A wide range of tundra plant species are monitored at each site, with a focus on species or species groups with circumpolar distribution. The ITEX Manual describes monitoring methods for a number of circumpolar and other widely distributed plant species (www.geog.ubc.ca/itex/library/).

Geographic coverage

Circumpolar. ITEX sites are located in all Arctic countries and cover areas from sub-arctic mountains to the high Arctic. However, sites in Russia have been inactive for many years. ITEX sites involved in the four major syntheses are found at www.geog.ubc.ca./itex and in the publications listed below.

Recent Progress

ITEX was established in 1990, with research beginning at sites in 1992. A core number of sites (ca. 15) have maintained studies since the mid 1990s. Annual ITEX Workshops are held to discuss results and plan syntheses. The major products from the research are four syntheses involving results from across the ITEX sites: 1) species specific responses to short-term experimental warming are described in 15 papers in Henry (1997); 2) a meta-analysis of the species responses in Arft et al. (1999); a meta-analysis of plant community responses to experimental warming in Walker et al. 2006; and a synthesis of responses of carbon dioxide flux conducted at the major North American ITEX sites in Oberbauer et al. (2007).

Current research is linked to the International Polar Year (IPY), in which ITEX is a core project. Researchers at all sites are invited to participate in new syntheses of species-level variables (phenology, growth and reproductive) and plant community changes. The focus will be on changes in the control plots, some of which have been monitored since 1992. In addition, there have been increases in studies of the effects of experimental warming on soil processes, including nitrogen fixation and mineralization. Recent studies at a High Arctic tundra site in Canada have found changes in the diversity of microorganisms involved in these soil processes.

ITEX synthesis publications:

- Henry, G.H.R. (ed.) 1997. The International Tundra Experiment (ITEX): Short-term Responses of Tundra Plants to Experimental Warming. Global Change Biology 3 Suppl. 1 (16 papers).
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Polar Bears

Broad objectives of project

The monitoring of population levels and contaminant levels in polar bear from seven polar bear management zones. A National Contaminants Programme (NCP) project (led by Rob Letcher of Environment Canada) monitors contaminant levels in polar bear from seven polar bear management zones throughout the Canadian Arctic. This work is carried out in cooperation with other existing programs and includes collaboration from Mitch Taylor and John Nagy in Nunavut and North Western Territories (NWT) respectively, as well as Ian Stirling and Nick Lunn (Environment Canada), and Andrew Derocher (University of Alberta). This work also contributes to a Canadian IPY project which is assessing the effects of climate change and contaminants on the ecology of polar bears and is linked into a circumpolar IPY initiative (BEARHEALTH).

Specific species and ecosystems included

Polar bears

Geographic coverage

Seven polar bear management zones throughout the Canadian Arctic

Recent Progress

Update pending

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Ringed Seal Populations

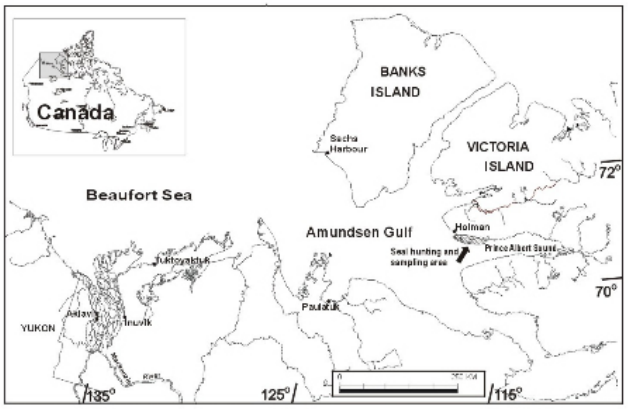
Broad objectives of project

Ongoing studies of ringed seal population demographics (body condition and reproduction, age structure, health) and relationship to sea ice, climate change impacts, key habitats, diet and contaminant loads since 1992. Cooperates with other Fisheries and Oceans (DFO) Scientists (Gary Stern, Ole Nielsen) and Northern Contaminants program (NCP) project (Derek Muir) by providing samples from specimens for determilnation of disease and contaminant loads in individuals. At some locations the time series for body condition, reproduction and contaminants goes back to the 1970s.

Specific species and ecosystems included

Ringed Seal (Phoca hispida)

Geographic coverage



Recent Progress

This harvest-based program involves measuring and sampling ringed seals taken in the annual harvest in the Ulukhaktok area, using reproductive status and body condition as indicators of ecosystem productivity and fluctuations in the seal population.

These aspects are evaluated in the context of regional ice conditions. The fatness of the seals appears linked to the severity of ice conditions, with years of heaviest ice (1996, 2000, 2002) being years of poorest condition, while years of lightest ice (1998, 2006, 2007) being years of highest seal body condition. Results from 2005 showed seals in poorest body condition since the study started in 1992, and an apparent failure of reproduction in adult female ringed seals in the Mashooyak sample. There was also an apparent downturn in the proportion of pups in the sample from 2000-2005. With lighter ice years in 2006 and 2007, trends in pup production, reproduction and seal fatness all increased once again. The link between severity of ice conditions in eastern Amundsen Gulf in spring, climate change and seal productivity is evident in this long-term data series, and is being analysed with the assistance of Dr. Humfrey Melling of the Institute of Ocean Sciences, Sidney, BC Canada.

The project provides the mechanism for the collection of samples for "stock health" studies such as disease and contaminants. The project also includes funds for the continuation of youth going to the camp with the seal monitor for exposure/training to the project. This was recommended by the HTC in 2003 and added annually since that time.

This project is unique in that it builds on a consistent and long-term data base that is not available for other marine mammal consumers high in the food chain in the ISR. The Ulukhaktok work has been conducted by the same monitor and the consistencies in the data are testament to the care that is taken with the sampling

and labelling. The link between seal body condition and timing of break up of the land fast ice is indisputable and similar trends are found in other species such as Dolly Varden charr. Recent significant decreases in sea ice (2006, 2007) raise the question of the impact of light ice conditions on ringed seal condition, survival and reproduction, and it is a prudent time to be continuing to monitor these aspects.

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Ringed Seals

Broad objectives of project

Ringed seals are also monitored at 15 sites throughout the Arctic. Cooperates with Lois Harwood project in the collection of specimens and data from the Western Arctic. At some locations the time series for contaminants goes back to the 1970s

Specific species and ecosystems included

Ringed Seals

Geographic coverage

The Canadian Arctic

Recent Progress

Update pending

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Seabird: Contaminants in Arctic Seabird Eggs

Broad objectives of project

Seabirds are good integrators of contamination in the marine ecosystem. Egg collections provide a non-intrusive means of obtaining contaminant information. Eggs of seabirds representing different feeding strategies from Prince Leopold Island in the Canadian High Arctic have been monitored for contaminants since 1975 in order to determine if levels of contaminants in seabird eggs, as representative of the marine environment of the Canadian Arctic, are changing. Contaminants monitored include the legacy persistent organic pollutants (POPs), dioxins, furans, total mercury (Hg), perfluorinated compounds (PFCs), brominated flame retardants (BFRs) as well as stable isotopes of nitrogen (15N) and carbon (13C) as indicators of trophic status and diet.

The data provide an index of contamination of the arctic marine ecosystem and possible implications for seabird health. As well, many Northerners harvest seabirds and their eggs for consumption. Due to the high costs and logistical difficulties of accessing arctic seabird colonies, collections of eggs for arctic seabirds have been opportunistic in the past but, with the support of the Northern Contaminants Program (NCP), the collections have been standardized to every five years since 1988. In an effort to examine the inter-year variation in contaminant data and to improve the statistical power of the temporal trend data series for Canadian Arctic seabirds, eggs from each of two species of seabirds (northern fulmar, thick-billed murre) from Prince Leopold Island are being collected annually for five years starting in 2005.

For comparative purposes, we are also making annual collections of thick-billed murre eggs from Coats Island in northern Hudson Bay (our Low Arctic monitoring colony since 1993) in parallel with the High Arctic collections. The Coats Island colony may also be a good choice for monitoring the impact of climate change on contaminant cycling in the Arctic since there is already evidence of the effects of climate change on the breeding ecology of thick-billed murres at that colony.

Specific species and ecosystems included

Five seabird species from the Canadian Arctic are the focus of this monitoring program. Eggs of thick-billed murres (Uria lomvia), northern fulmars (Fulmarus glacialis) and black-legged kittiwakes (Rissa tridactyla) from Prince Leopold Island in the Canadian High Arctic have been monitored for contaminants since 1975 to provide an index of contamination of the arctic marine ecosystem and possible implications for seabird health. Starting in 1993, black guillemots (Cepphus grylle) and glaucous gulls (Larus hyperboreus) were added as monitoring species to make the Canadian program more compatible with other monitoring activities under the Arctic Monitoring and Assessment Program (AMAP). As well, collections of thick-billed murre eggs from Coats Island in northern Hudson Bay were initiated in 1993 to provide data from a Low Arctic monitoring colony for comparison with the High Arctic collections.

Geographic coverage

Seabird Monitoring Locations

The seabird egg monitoring program focusses on two locations in the Canadian Arctic: Prince Leopold Island (74°02'N, 90°05'W) in Lancaster Sound is the High Arctic colony and Coats Island (62°30'N, 83°00'W) in northern Hudson Bay is the Low Arctic monitoring colony (Figure 1). As already mentioned, two additional seabird species were added to the monitoring program in 1993 to make the Canadian program more compatible with other monitoring activities under AMAP. The data are also comparable with data generated by the U.S. program recently initiated to monitor contaminants in seabird eggs in the Bering Sea and Gulf of Alaska. A spatial survey of contaminants in the Canadian Arctic was conducted in 1993 using seabird eggs which covered a number of colonies in Hudson Bay, the eastern High Arctic and a few mainland colonies in the western Arctic. However, the birds at the mainland colonies did not reflect contaminants in the marine ecosystem.

Recent Progress

- Eggs of two species (thick-billed murre, northern fulmar) have been monitored for contaminants (e.g. legacy POPs, dioxins, furans, BFRs, PFCs, total Hg, stable isotopes) annually starting in 2005 and continuing until 2009.
- Temporal trend results from 1975-2003 for the legacy POPs and Hg in seabird eggs were recently published showing that most of the legacy POPs have shown decreases or no change (except -HCH) whereas Hg continues to increase: Braune, B.M. 2007. Temporal trends of organochlorines and mercury in seabird eggs from the Canadian Arctic, 1975 to 2003. Environ. Pollut. 148:599-613.
- Temporal trend data for the perfluorinated compounds (PFCs) were also recently published: Butt, C.M., Mabury, S.A., Muir, D.C.G., Braune, B.M. 2007. Prevalence of long-chained perfluorinated carboxylates in seabirds from the Canadian Arctic between 1975 and 2004. Environ. Sci. Technol. 41:3521-3528.
- Results for the 2006 collections can be found in: Braune, B. 2007. Temporal trends of contaminants in arctic seabird eggs: inter-year variability. pp. 89-97, In: Synopsis of research conducted under the 2006-2007 Northern Contaminants Program, Smith, S. and Stow, J, eds. Indian and Northern Affairs Canada.
- Data were included in both the National Contaminants Programmes Canadian Arctic Contaminants Assessment Report II 2003 and the AMAP Assessment 2002.
- Data are also being contributed to the AMAP POPs and Hg assessments currently underway.

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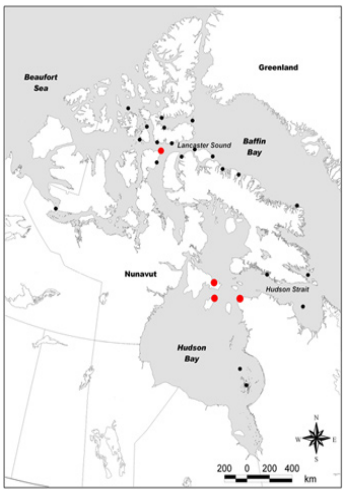
Seabirds: Colony Monitoring

Broad objectives of project

The Canadian Arctic supports more than 10 million seabirds through different stages of their annual cycle. Seabird colonies in this region are relatively large, widely separated from one another, and generally clustered around productive marine features such as ice edges and polynyas. Certain seabirds continue to be harvested by local indigenous peoples, or are harvested by sport or commercial hunters during their migration. Seabirds are also excellent indicators of the condition of marine environments, with years of poor marine production or shifts in food supplies typically manifested as altered behaviour or reduced reproductive success at nearby seabird colonies. For these reasons, the Canadian Wildlife Service has been monitoring seabird population size, diet, health and movements at selected colonies in both the Low and High Arctic. Because the logistics and cost of working in the Canadian Arctic are challenging, efforts have been focused on four colonies, but opportunistic monitoring has occurred at other sites, and where possible has linked to other programs (e.g. contaminants monitoring). Population monitoring was initiated at Prince Leopold Island (in Lancaster Sound, High Arctic) in 1975, at Coats Island in 1984, at Digges Sound (northern Hudson Bay, Low Arctic) in 1980, and at East Bay (Foxe Channel, Low Arctic) in 1995.

The overall objectives of this monitoring work are: (1) assess long term trends in populations of various seabird species by counting numbers of birds on established plots; (2) conduct whole colony censuses opportunistically; (3) record phenology and success of reproduction for selected species; (4) monitor diet of breeding birds and determine if this is changing through time; (5) use new technological developments to determine foraging behaviour and habitat use during breeding, migration and wintering of seabirds from the Canadian Arctic; and (6) evaluate health of Arctic seabirds, linking to the contaminants monitoring program.

Specific species and ecosystems included



Five species form the focus of the Canadian Arctic seabird monitoring program. In the High Arctic, the key species monitored are northern fulmar (Fulmarus glacialis), thick-billed murre (Uria lomvia), black-legged kittiwake (Rissa tridactyla), and glaucous gull (Larus hyperboreus). In the Low Arctic, focal species are thick-billed murre, glaucous gull, and common eider (Somateria mollissima borealis). Recently, a project was initiated to determine the population status of ivory gulls (Pagophila eburnea), a High Arctic Species which has experienced a dramatic decline in population size since the early 1980s. This species has been added to the annual population monitoring program.

Where possible, we have conducted censuses, health examinations, or localized population monitoring of other species including Arctic tern (Sterna paradisaea), Sabine's gull (Xema sabini), Ross's gull (Rhodostethia rosea), black guillemot (Cepphus grylle), Herring gull (Larus argentatus), and Thayer's/Iceland gull (Larus glaucoides/ L. thayeri complex).

Geographic coverage

The principle monitoring sites are one High Arctic colony (Prince Leopold Island: 74°N, 90°W) and three Low Arctic colonies (Coats Island: 62°30'N, 83°W; Digges Sound: 62°33'N, 77°35'W; East Bay: 64°N, 81°50'W). These are highlighted in red in the Figure. However, various types of census and monitoring work have been undertaken at colonies situated between 56°N and 77°N.

Recent Progress

- Most northern fulmar colonies have been censused since 2000, and a paper describing the status and population trends in fulmars was produced (Gaston et al. 2006. Arctic 59: 165-178)
- Relationships between sea-ice, counts of birds at colonies and reproductive success were evaluated in the Low and High Arctic (Gaston et al. 2005. Journal of Animal Ecology 74: 832-841; Gaston et al. 2006. Ecography 28: 336-344)
- Changes in the marine food web in northern Hudson Bay were detected by monitoring diets of thick-billed murres (Gaston et al. 2003. Arctic 56: 227-233)
- Summary of thick-billed murre monitoring in the Canadian Arctic was produced (Gaston. 2002. Canadian Wildlife Service Occasional Paper 106)

- Dramatic declines in ivory gull populations in Arctic Canada were reported, and a population viability analysis conducted; species uplisted to Endangered in Canada (Gilchrist and Mallory. 2005. Biological Conservation 121: 303-309; Robertson et al. 2007. Avian Conservation and Ecology 2: 8)
- Summary of key habitat sites for marine birds in the Canadian Arctic was produced (Mallory and Fontaine. 2004. Canadian Wildlife Service Occasional Paper 109)
- International implications of movements and migration by Canadian nesting eiders was assessed (Mosbech et al. 2006. Ardea 94: 651-665)
- Current projects underway include: (a) examining health in various seabird species, (b) comparing current diet of most species to similar data collected in the 1970s, to assess possible climate-induced changes in the Arctic marine ecosystem, (c) developing a model of sustainable harvest levels for common eider populations shared with Greenland, (d) examining the ecology of avian cholera on common eiders, a disease which has appeared in the eastern Canadian Arctic since 2002, and (e) determining population trends for kittiwakes.

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Environmental Monitoring Data on the Faroe Islands Ecosystem (ENVOFAR)

Broad objectives of project

To provide a more direct and user friendly access to the environmental data gathered in the Faroese region

Specific species and ecosystems included

ENVOFAR is intended to have an open framework, which can expand as new parameters or problems enter. Most data can, however, be grouped into one of three categories: - Biodiversity, Climate, Contaminants

Geographic coverage

The cooperation is centered around the Faroe Island ecosystem including the terrestrial environment and the marine ecosystem and ocean currents passing through these systems

Recent Progress

Update pending

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Nuuk Basic

Broad objectives of project

The Nuuk Basic monitoring program focuses on providing long time series of data on the dynamics of a low arctic ecosystem. Focus is on climate change effects and feedbacks in both the marine and the terrestrial compartments of the ecosystem. The program consists of four sub-programs, i.e. Climate Basic (monitoring of climate and water balance), Geo Basic (monitoring of physical landscape processes, solute fluxes and carbon balance in the terrestrial part of the ecosystem), Bio Basic (monitoring of biological processes in the terrestrial part of the ecosystem) and Marine Basic (monitoring of physical and biological processes in the marine part of the ecosystem). The program is coordinated with a similar monitoring program, Zackenberg Basic, in high-arctic Northeast Greenland. Both programs measure each year c. 1,500 different ecosystem parameters including both climatic/physical parameters and biological parameters.

The overall purpose of Nuuk Basic is to collect long-term data quantifying seasonal and inter-annual variations and long-term changes in the biological and geophysical properties of the terrestrial, freshwater and marine ecosystem compartments in relation to local, regional and global climate variability and change. The overall aim of Nuuk Basic is to establish a data platform which enables

1. A thorough description and analysis of climatic effects on the structure, function and feedback dynamics of a low arctic ecosystem
2. Together with its exiting high arctic counterpart, Zackenberg Basic, a more complete spatial coverage of the general climate–ecosystems interactions across the Arctic
3. An understanding of the interactions between human utilization of natural resources and climate effects

The programme is addressing questions and providing data in accordance with the recommendations given by Arctic Climate Impact Assessment (Table 1).

Specific species and ecosystems included

Each subprogram in Nuuk Basic monitors a broad variety of abiotic parameters and organisms and processes (Table 1 and 3). Most abiotic and some biotic parameters are monitored year- round, whereas other abiotic parameters and most biological parameters are monitored intensively in early May through October. Nuuk Basic provides data for a large number of international monitoring programs and networks (Table 4). The program does not include monitoring of contaminants.

Geographic coverage

The Nuuk Basic monitoring is conducted in and around Kobbefjord and Godthåbsfjord in Southwest Greenland. The major part of the terrestrial component of the program focuses on ecosystem processes in a 25 km2 study area comprising a well-defined drainage basin at the bottom of the fiord, Kobbefjord, only c. 20 km from Nuuk.

Recent Progress

The program is very young. The marine component of the program was fully established in 2006. The terrestrial component of the program received its first funding in 2006 and was partly established in the field in 2007. The establishment of the program will be fully accomplished in 2008. The establishment of the necessary infrastructure, including a small field laboratory in Kobbefjord will also be completed in 2008.

Table 1. ACIA recommendations of relevance to Nuuk Basic

Recommendations	Programme	Action
Cryosphere and hydrology		
Sea ice: Fine resolution studies of sea ice cover in coastal waters	M	Satellite and photosurveillance
Sea ice: Seasonal, interannual and interdecadal measurements of sea surface albedo	M	Satellite surveillance (optional)
Snow cover: In situ measurements of snow water equivalents in high latitude areas	CG	Manual snowdepth and density measurements
Snow cover: Measurements of snow albedo over northern terrestrial regions	CG	Point measurements, satellite surveillance (optional)
Snow cover: Establishment of models to simulate snow melt process	CG	Point and spatial through camera and satellite surveillance
Glaciers and ice sheets: Mass balance studies from regions where data are sparse	M/GEUS	None in programmes. Link to GEUS ice margin monitoring
Permafrost: Long-term field data on permafrost-climate interactions and on permafrost-hydrology interactions	G	CALM
River and lake ice: Improve understanding of hydrological and meteorological control of freeze-up and breakup	CBG	Hydrological monitoring, camera surveillance
Freshwater discharge: Increase the network of gauge stations for monitoring discharge rates	C	Hydrological monitoring
Freshwater discharge: Better estimation of subsurface flow		None
Arctic Tundra and Polar Desert ecosystems		
Biodiversity changes: Monitor currently widespread species that are likely to decline under climate change	B	Systematic monitoring of species
Relocation of species: Measure and project rates of species migration	B	Systematic transect monitoring (local/regional)
Vegetation zone redistribution: Improve information about current boundaries of vegetation zones	BG	NDVI monitoring (cameras, satellite)
Carbon sinks and sources: Long-term, annual C monitoring throughout the Arctic	G	Not whole year but summer and 'shoulder' periods (CO2 and CH4)
Carbon sinks and sources: Models capable of scaling ecosystem processes from plot experiments to landscape scale	BG	Spatial modelling
Carbon sinks and sources: Develop observatories to relate disturbance to C dynamics	BCG	Monitoring platform and database
Carbon sinks and sources: Combine ecosystem carbon flux estimates with C flux from thawing permafrost	G	Irrelevant to Nuuk Basic. No permafrost
Ultraviolet-B radiation and CO2 impacts: Long-term impact on ecosystem of increased CO2 concentrations and UV-B radiation	BCG	UV-B and CO2 monitoring
Increasing and extending the use of indigneous knowledge: Expand use of indignous knowledge	G	None
Monitoring: More networks of standardised, long-term monitoring are required	BCG	It is the ambition that Nuuk Basic participate in all such networks
Monitoring: Integrated cross-disciplinary monitoring of co-varying environmental variables	BCG	The concept for this is developed in Zackenberg- and NuukBasic
Monitoring: Long-term and year-round eddy covariance sites and other long-term flux sites for C flux measurements	G	Seasonal, CO2 by eddy correlation, CH4 by chamber measurements
Long-term and year-round approach: Long-term observations are required	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal
Long-term and year-round approach: Year-round observations are necessary to understand importance of winter processes	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal

Table 1. ACIA recommendations of relevance to Nuuk Basic

Recommendations	Programme	Action
Cryosphere and hydrology		
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Glaciers and ice sheets: Mass balance studies from regions where data are sparse	M/GEUS	None in programmes. Link to GEUS ice margin monitoring
Permafrost: Long-term field data on permafrost-climate interactions and on permafrost-hydrology interactions	G	CALM
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Freshwater discharge: Better estimation of subsurface flow		None
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Biodiversity changes: Monitor currently widespread species that are likely to decline under climate change	B	Systematic monitoring of species
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Carbon sinks and sources: Combine ecosystem carbon flux estimates with C flux from thawing permafrost	G	Irrelevant to Nuuk Basic. No permafrost
Ultraviolet-B radiation and CO2 impacts: Long-term impact on ecosystem of increased CO2 concentrations and UV-B radiation	BCG	UV-B and CO2 monitoring
Increasing and extending the use of indigneous knowledge: Expand use of indignous knowledge	G	None
Monitoring: More networks of standardised, long-term monitoring are required	BCG	It is the ambition that Nuuk Basic participate in all such networks
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Monitoring: Long-term and year-round eddy covariance sites and other long-term flux sites for C flux measurements	G	Seasonal, CO2 by eddy correlation, CH4 by chamber measurements
Long-term and year-round approach: Long-term observations are required	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal
Long-term and year-round approach: Year-round observations are necessary to understand importance of winter processes	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal

Table 2. The specific aims of the four basis monitoring of *Zackenberg Basic* and *Nuuk Basic*: ClimateBasis, GeoBasis, BioBasis and MarineBasis. Adopted from Rasch et al. (2003).

Basis Programme	Aim
ClimateBasis and GeoBasis	Provide long-term data that are: • Necessary for describing all aspects of the regional climate at Zackenberg and Nuuk. • To be used to quantify and model the variation in snow cover at Zackenberg and Nuuk. • To quantify the freshwater, sediment and nutrient transport from the terrestrial system to the marine system. • To quantify, together with BioBasis and MarineBasis, the carbon balance of the terrestrial part of low and high arctic ecosystems. • To improve current understanding of the effect of climate variability on the physical landscape dynamics.
BioBasis	Provide long-term data: • To establish ecological base-line data for evaluating and modelling how climatic changes, directly and indirectly, sum up and affect an entire low and high arctic ecosystem, respectively. • For the fundamental knowledge of the spatio-temporal dynamics of a low and high arctic ecosystem in a changing climate. • To describe and quantify intra- and intertrophic processes. • To describe and quantify short- and long-term changes in UV radiation effects, species composition and the communities in which they are embedded. • To describe and quantify short- and long-term changes in individual life history of central floral and faunal species.
MarineBasis	Provide long-term data: • Necessary for modelling the coupling between physical oceanography and biological production and consumption. • For use in modelling the regulation of pelagic-benthic coupling (vertical flux). • To quantify and improve understanding of the lateral coupling (land/fiord/sea). • To quantify the effect of changing freshwater input, sea ice cover and deepwater formation on biological production and consumption. • To improve current understanding of the effect of climatic changes on selected species composition and adaptation in the arctic marine environment.

Table 3. Summary of the central scientific themes embraced by the four basis programmes in *Zackenberg Basic* and *Nuuk Basic*.

Scientific theme	Description
Climate	Temperature (air, surface and soil), wind, humidity, precipitation
Snow	Cover, thickness, distribution
Hydrology	Water balance, nutrient cycling
Glacier ice	Iceberg export to Godthåbsfjorden
Sea ice	Cover, thickness, distribution
UV radiation	Strength, seasonal,interannual variations and ecosystem effects
Soil	Water balance, chemistry, soil arthropods, decomposition
Vegetation	Species diversity, growth, reproduction, phenology, parasitism, distribution of vegetation types, UV radiation effects
Gas flux	Carbon dioxide, methane, interactions with structure and function of herbivore-plant interactions
Lakes	Chemistry, Carbon balance, abundance and production of plankton and fish
Athropods	Insect abundance, reproduction and phenology
Mammals & Birds	Selected terrestrial, freshwater and marine species, species diversity, Abundance, distribution, reproduction, phenology
Water phase	Temperature, salinity, currents, chemistry, carbon balance, plankton, crustacean, fish.
Sea bottom	Chemistry, carbon balance, growth, abundance and distribution of benthic animals

Table 4. Projects, programmes and networks in which *Zackenberg Basic* is and *Nuuk Basic* will be involved. More information is given by the attached reference or web site.

Acronym	Name	Reference / Web page
ABBCS	Arctic Birds Breeding Conditions Survey	http://www.arcticbirds.ru/
ACD	Arctic Coastal Dynamics	http://www.awi-potsdam.de/acd/
CALM	Circumpolar Active Layer Monitoring Programme	http://www.geography.uc.edu/~kenhinke/CALM/
CEON	Circumpolar Environmental Observatories Network	http://www.ceoninfo.org/
ENVINET	European Network of Arctic-Alpine Environmental Research	http://envinet.npolar.no/
GRDC	Global Runoff Data Center	http://grdc.bafg.de/servlet/is/Entry.987.Display/
ITEX	International Tundra Experiment	http://www.geog.ubc.ca/itex/
SCANNET	Scandinavian / North European Network of Terrestrial Field Basses	http://www.scannet.nu

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Zackenberg Basic

Broad objectives of project

The Zackenberg Basic monitoring program focuses on providing long time series of data on the dynamics of a high arctic ecosystem. Focus is on climate change effects and feedbacks in both the marine and the terrestrial compartments of the ecosystem. The program consists of four sub-programs, i.e. Climate Basic (monitoring of climate and water balance), Geo Basic (monitoring of physical landscape processes, solute fluxes and carbon balance in the terrestrial part of the ecosystem), Bio Basic (monitoring of biological processes in the terrestrial part of the ecosystem) and Marine Basic (monitoring of physical and biological processes in the marine part of the ecosystem). The program is coordinated with a similar monitoring program, Nuuk Basic, in low-arctic West Greenland. Both programs measure each year c. 1,500 different ecosystem parameters including both climatic/physical parameters and biological parameters.

The overall purpose of Zackenberg Basic is to collect long-term data quantifying seasonal and inter-annual variations and long-term changes in the biological and geophysical properties of the terrestrial, freshwater and marine ecosystem compartments in relation to local, regional and global climate variability and change. The overall aim of Zackenberg Basic is to establish a data platform which enables (i) a thorough description and analysis of climatic effects on the structure, function and feedback dynamics of a high arctic ecosystem, (ii) together with its exiting low arctic counterpart, Nuuk Basic, a more complete spatial coverage of the general climate–ecosystems interactions across the Arctic, and (iii) an understanding of the interactions between human utilization of natural resources and climate effects. The programme is addressing questions and providing data in accordance with the reccommendations given by Arctic Climate Impact Assessment (Table 1).

Specific species and ecosystems included

Each subprogram in Zackenberg Basic monitors a broad variety of abiotic parameters and organisms and processes (Table 1 and 3). Most abiotic and some biotic parameters are monitored year- round, whereas other abiotic parameters and most biological parameters are monitored intensively in early May through October. Zackenberg Basic provides data for a large number of international monitoring programs and networks (Table 4). The program does not include monitoring of contaminants.

Geographic coverage

Zackenbergdalen and the adjacent fjord, Young Sound/Tyrolerfjord, in Northeast Greenland (74°30'N / 21°00'W). The study area for the terrestrial part of the program comprises the drainage basin of Zackenberg River with an area of app. 500 km2, while the marine component focus on the fiord system, Young Sund/ Tyrolerfjord, with a drainage area of c. 3,016 km2 .

Recent Progress

A new glaciological monitoring, Glacio Basic will be established in 2008. The Glacio Basic programme will study the mass balance of the glaciers within the study area to quantify among other things the contribution of the glaciers to the water balance of Zackenberg River. A book reporting the first ten years of monitoring and research in the marine part of the ecosystem at Zackenberg was published in 2007 (Rysgaard, S. & Glud, R.N. (eds.) 2007: Carbon Cycling in Arctic marine ecosystems: Case study Young Sound. Meddelelser om Grønland, Bioscience 58, 214 p.). A similar reporting of reporting the first ten years of monitoring and research in the terrestrial part of the ecosystem will be published in 2008 (Meltofte, H., Christensen, T.R., Elberling, B., Forchhammer, M. & Rasch, M. In press: High-Arctic Ecosystem Dynamics in a Changing Climate. Ten years of monitoring and research at Zackenberg Research Station, Northeast Greenland. Advances in Ecological Research 40. 556 p.

Table 1. ACIA recommendations of relevance to Zackenberg Basic

Recommendations	Programme	Action
Cryosphere and hydrology		
Sea ice: Fine resolution studies of sea ice cover in coastal waters	M	Satellite and photosurveillance
Sea ice: Seasonal, interannual and interdecadal measurements of sea surface albedo	M	Satellite surveillance (optional)
Snow cover: In situ measurements of snow water equivalents in high latitude areas	CG	Manual snowdepth and density measurements
Snow cover: Measurements of snow albedo over northern terrestrial regions	CG	Point measurements, satellite surveillance (optional)
Snow cover: Establishment of models to simulate snow melt process	CG	Point and spatial through camera and satellite surveillance
Glaciers and ice sheets: Mass balance studies from regions where data are sparse	M/GEUS	None in programmes. Link to GEUS ice margin monitoring
Permafrost: Long-term field data on permafrost-climate interactions and on permafrost-hydrology interactions	G	CALM
River and lake ice: Improve understanding of hydrological and meteorological control of freeze-up and breakup	CBG	Hydrological monitoring, camera surveillance
Freshwater discharge: Increase the network of gauge stations for monitoring discharge rates	C	Hydrological monitoring
Freshwater discharge: Better estimation of subsurface flow		None
Arctic Tundra and Polar Desert ecosystems		
Biodiversity changes: Monitor currently widespread species that are likely to decline under climate change	B	Systematic monitoring of species
Relocation of species: Measure and project rates of species migration	B	Systematic transect monitoring (local/regional)
Vegetation zone redistribution: Improve information about current boundaries of vegetation zones	BG	NDVI monitoring (cameras, satellite)
Carbon sinks and sources: Long-term, annual C monitoring throughout the Arctic	G	Not whole year but summer and 'shoulder' periods (CO2 and CH4)
Carbon sinks and sources: Models capable of scaling ecosystem processes from plot experiments to landscape scale	BG	Spatial modelling
Carbon sinks and sources: Develop observatories to relate disturbance to C dynamics	BCG	Monitoring platform and database
Carbon sinks and sources: Combine ecosystem carbon flux estimates with C flux from thawing permafrost	G	Irrelevant to Nuuk Basic. No permafrost
Ultraviolet-B radiation and CO2 impacts: Long-term impact on ecosystem of increased CO2 concentrations and UV-B radiation	BCG	UV-B and CO2 monitoring
Increasing and extending the use of indigneous knowledge: Expand use of indignous knowledge	G	None
Monitoring: More networks of standardised, long-term monitoring are required	BCG	It is the ambition that Nuuk Basic participate in all such networks
Monitoring: Integrated cross-disciplinary monitoring of co-varying environmental variables	BCG	The concept for this is developed in Zackenberg- and NuukBasic
Monitoring: Long-term and year-round eddy covariance sites and other long-term flux sites for C flux measurements	G	Seasonal, CO2 by eddy correlation, CH4 by chamber measurements
Long-term and year-round approach: Long-term observations are required	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal
Long-term and year-round approach: Year-round observations are necessary to understand importance of winter processes	BCG	ClimateBasic year round, Bio- and GeoBasic seasonal

Table 1, continued. ACIA recommendations of relevance to Zackenberg Basic

Recommendations	Programme	Action
Freshwater Ecosystems and fisheries		
Freshwater ecosystems: Increase knowledge on long-term changes in physical, chemical and biological attributes	BCG	Physical, chemical, biological monitoring
Freshwater ecosystems: Establish integrated, comprehensive monitoring programs at regional, national and circumpolar scales	BCG	It is the ambition that Nuuk Basic shall participate in all such networks
Freshwater ecosystems: Standardise internationally approach for monitoring	BCG	Standardised procedures developed for Nuuk Basic
Freshwater ecosystems: Improve knowledge of synergistic impacts of climate on aquatic organisms	BCG	Possible with existing data
Freshwater ecosystems: Increase understanding of cumulative impacts of multiple environmental stressors on fresh water ecosystems	B	Nuuk Basic mainly addresses undisturbed ecosystems in relation to climate
Freshwater ecosystems: Increase knowledge of effects of UV radiation - temperature interactions on aquatic biota	B	None
Freshwater ecosystems: Increase knowledge of linkages between structure and function of aquatic biota	BCG	Included in existing programmes
Freshwater ecosystems: Increase knowledge on coupling among physical/chemical and biotic processes	BCG	Included in existing programmes
Marine Systems		
Observational techniques: Increase application of recently developed techniques	M	Yes, state-of-the-art equipment and techniques in use
Surveying and monitoring: Undertake surveys that are poorly mapped and whose resident biota has not been surveyed	M	No investigations like this before the Zackenberg and Nuuk Basic
Surveying and monitoring: Continue and expand existing monitoring programs	M	It is the ambition that Nuuk Basic shall participate in international cooperation
Surveying and monitoring: Evaluate monitoring data through data analysis and modeling	M	Included
Data analysis and reconstruction: Reconstruct twentieth century forcing field		None
Data analysis and reconstruction: Establish database with all available physical and biological data	M	Included - data can easily be provided to other databases
Data analysis and reconstruction: Recover past physical and biological data	M	Included
Data analysis and reconstruction: Past climate events to understand physical and biological responses to climate forcing	M	Included
Field programs: Undertake field studies to quantify climate-related processes	M	Major purpose
Modelling: Develop reliable regional models	MB	Included
Approaches: Prioritize ecosystem based research by integrating multiple ecosystem components in models concerning climate effects	MB	The concept in both Nuuk and Zackenberg Basic
Ozone and Ultraviolet Radiation		
Ultraviolet radiation: Address the impact of increased UV irradiance	BCG	Included

B: *BioBasic,* ***G:*** *GeoBasic,* ***C:*** *ClimateBasic,* ***M:*** *MarineBasic,* ***GEUS:*** *Geological Survey of Denmark and Greenland*

Table 2. The specific aims of the four basis monitoring of *Zackenberg Basic* and *Nuuk Basic*: ClimateBasis, GeoBasis, BioBasis and MarineBasis. Adopted from Rasch et al. (2003).

Basis Programme	**Aim**
ClimateBasis and GeoBasis	Provide long-term data that are: • Necessary for describing all aspects of the regional climate at Zackenberg and Nuuk. • To be used to quantify and model the variation in snow cover at Zackenberg and Nuuk. • To quantify the freshwater, sediment and nutrient transport from the terrestrial system to the marine system. • To quantify, together with BioBasis and MarineBasis, the carbon balance of the terrestrial part of low and high arctic ecosystems. • To improve current understanding of the effect of climate variability on the physical landscape dynamics.
BioBasis	Provide long-term data: • To establish ecological base-line data for evaluating and modelling how climatic changes, directly and indirectly, sum up and affect an entire low and high arctic ecosystem, respectively. • For the fundamental knowledge of the spatio-temporal dynamics of a low and high arctic ecosystem in a changing climate. • To describe and quantify intra- and intertrophic processes. • To describe and quantify short- and long-term changes in UV radiation effects, species composition and the communities in which they are embedded. • To describe and quantify short- and long-term changes in individual life history of central floral and faunal species.
MarineBasis	Provide long-term data: • Necessary for modelling the coupling between physical oceanography and biological production and consumption. • For use in modelling the regulation of pelagic-benthic coupling (vertical flux). • To quantify and improve understanding of the lateral coupling (land/fiord/sea). • To quantify the effect of changing freshwater input, sea ice cover and deepwater formation on biological production and consumption. • To improve current understanding of the effect of climatic changes on selected species composition and adaptation in the arctic marine environment.

Table 3. Summary of the central scientific themes embraced by the four basis programmes in *Zackenberg Basic* and *Nuuk Basic*.

Scientific theme	Description
Climate	Temperature (air, surface and soil), wind, humidity, precipitation
Snow	Cover, thickness, distribution
Hydrology	Water balance, nutrient cycling
Glacier ice	Iceberg export to Godthåbsfjorden
Sea ice	Cover, thickness, distribution
UV radiation	Strength, seasonal,interannual variations and ecosystem effects
Soil	Water balance, chemistry, soil arthropods, decomposition
Vegetation	Species diversity, growth, reproduction, phenology, parasitism, distribution of vegetation types, UV radiation effects
Gas flux	Carbon dioxide, methane, interactions with structure and function of herbivore-plant interactions
Lakes	Chemistry, Carbon balance, abundance and production of plankton and fish
Athropods	Insect abundance, reproduction and phenology
Mammals & Birds	Selected terrestrial, freshwater and marine species, species diversity, Abundance, distribution, reproduction, phenology
Water phase	Temperature, salinity, currents, chemistry, carbon balance, plankton, crustacean, fish.
Sea bottom	Chemistry, carbon balance, growth, abundance and distribution of benthic animals

Table 4. Projects, programmes and networks in which *Zackenberg Basic* is and *Nuuk Basic* will be involved. More information is given by the attached reference or web site.

Acronym	Name	Reference / Web page
ABBCS	Arctic Birds Breeding Conditions Survey	http://www.arcticbirds.ru/
ACD	Arctic Coastal Dynamics	http://www.awi-potsdam.de/acd/
CALM	Circumpolar Active Layer Monitoring Programme	http://www.geography.uc.edu/~kenhinke/CALM/
CEON	Circumpolar Environmental Observatories Network	http://www.ceoninfo.org/
ENVINET	European Network of Arctic-Alpine Environmental Research	http://envinet.npolar.no/
GRDC	Global Runoff Data Center	http://grdc.bafg.de/servlet/is/Entry.987.Display/
ITEX	International Tundra Experiment	http://www.geog.ubc.ca/itex/
SCANNET	Scandinavian / North European Network of Terrestrial Field Basses	http://www.scannet.nu
CHASM	The Committee for Holarctic Shorebird Monitoring	http://www.caff.is/sidur/uploads/Shorebirds.pdf

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Big Deep Oilgotrophic Lakes

Broad objectives of project

Monitoring of bio-accumulation compounds in inland and coastal waters, and Fish resources

Specific species and ecosystems included

Inland and coastal waters and fish resources

Geographic coverage

Finland

Recent Progress

Update pending

Contact people

Update pending

Pallas Soldankylä

Broad objectives of project

To obtain a comprehensive picture of the physical, chemical and ecological state of the atmosphere and the biosphere and their trends in the boreal forest zone.

Specific species and ecosystems included

The data sets available from the Pallas-Sodankylä area include a variety of atmospheric, geophysical, hydrological, limnological, and ecological parameters that are briefly described below.

Atmospheric sciences

The first meteorological observations at Sodankylä were made during the First International Polar Year in 1882-1883. Regular aerological observations at the site have been conducted already over 60 years constituting one of the longest upper atmosphere meteorological observation series north of the Arctic circle. Since 1994 the Pallas-Sodankylä site has been one of the 22 global stations of the World Meteorological Organization's Global Atmosphere Watch (GAW) programme. This is globally the most important international network to monitor greenhouse gas and aerosol concentrations, ozone, ultraviolet radiation, certain reactive gases and precipitation chemistry which are the priority species of the GAW programme.

The long-term observations made at Pallas-Sodankylä area include, for example, upper-air weather, ozone, aerosol and radioactivity soundings, and total column measurements of ozone, aerosol optical depth, and spectral UV radiation. Ground-level measurements include, e.g. airborne natural radionuclides (e.g. beryllium-7 and lead-210), various meteorological parameters, reactive gases (ozone, sulphur dioxide, carbon monoxide and nitrogen oxides), greenhouse gases (carbon dioxide, methane, nitrous oxide and sulphur hexafluoride), aerosol particle number concentration and size distribution, PM10 particle mass concentration, aerosol scattering coefficient, black carbon, volatile organic compounds (ethane, propane etc.), and inorganic compounds (e.g. sulphate, nitrate, gaseous ammonia and particle-bound ammonium, sodium, calcium etc.). Fluxes across the surface/atmosphere interface are also measured, e.g. deposition of acidifying compounds (e.g. sulphate), carbon dioxide flux between pine and spruce forests and the atmosphere, and methane and carbon dioxide fluxes between a wetland and the atmosphere. Stable isotopes (carbon-13, deuterium and oxygen-18 in water vapour and carbon dioxide) are monitored too. The northernmost weather radar in Finland is situated on the top of Luosto fell 25 km south of Sodankylä. The range of the radar covers most of the Finnish Lapland.

Surface waters

The Pallas-Sodankylä area is included in many national and international research and monitoring projects as a background area for air pollution and climate change impact estimations. The quality of the surface waters is monitored and the effects of air pollutants to aquatic ecosystems are evaluated. The sampling is carried out once a year during the fall overturn or six times a year, before snow melting, twice after breaking up of the ice, in the end of the summer and twice during the fall overturn. The water samples are analyzed for several chemical and physical properties: temperature, conductivity, pH, Gran alkalinity, O2, O2 %, turbidity, colour, CODMn , SiO2, SO4, Cl, F, TOC, tot.P, tot.N, NO3 -N, NH4 –N, K, Ca, Mg, Na, Fe, Mn, Hg, Cd, Cu, Pb, Zn, Ni, As, Cr, V, Pt, Pd.

Toxic compounds in the environment

The Pallas-Sodankylä area is used for atmospheric, aquatic and terrestrial monitoring of long-range transported contaminants like persistent organic pollutants (POPs, e.g. chlorinated pesticides [HCH], PAHs and PCBs), heavy metals (including lead, cadmium and mercury), and artificial radionuclides (e.g. cesium-137 and strontium-90). The atmospheric concentrations of these substances and their deposition are studied to find out their source areas. The seasonal variation of the deposition of these substances affects their transfer to terrestrial and aquatic ecosystems. Diverse biota, soil humus and aquatic samples are collected and the content of these harmful substances in them are analyzed. Samples are also stored in environmental specimen bank for future studies of as yet unknown contaminants (retrospective studies). To evaluate historical development of the atmospheric load of the harmful substances sediment stratigraphy studies are performed.

Terrestrial ecosystems

Long-term forest experiments are focused on the regeneration of different types of forest, the performance of different tree species, natural forest dynamics, the stand dynamics of northern boreal forests, the flow-

ering and seed crops of forest trees, and the impacts of thinnings on growth and yield. The research and monitoring activities include the dynamics of oro-arctic forest and tree lines, game, small mammal and insect populations, forest tree breeding, plant phenology observations, etc. One of the intensive monitoring plots of the pan-European ICP Forests forest condition monitoring programme is located in a Norway spruce stand in the area. Crown condition, needle chemistry, stand growth, stem diameter growth, litterfall, soil condition, deposition and soil solution chemistry, ground vegetation and meteorology and phenology have been monitored continuously on the plot since 1996.

Geophysics and remote sensing technologies

Geophysical research at the Pallas-Sodankylä research infrastructure includes e.g. measurements of ionospheric properties, aurora borealis, geomagnetic observations, and ionospheric heating experiments using the EISCAT Heating facility. The long-term observations consist of e.g. geo-magnetic and seismic measurements, ionospheric soundings and tomography, riometer measurements, ELF-VLF measurements, all-sky camera pictures, and infrasound measurements. Data from several satellite instruments, for example ESA/Envisat GOMOS, Odin/OSIRIS, and EOS/Terra and Aqua – MODIS, EOS/Aura - OMI, are received, processed, delivered to users and archived. The in-situ measurements at Pallas-Sodankylä are utilized in the calibration and validation activities of the satellite observations.

Data utilization

The measurements at the Pallas-Sodankylä research infrastructure are used, for example, in

- Operational weather service
- Hydrological forecasts
- Tropospheric ozone limit value and UV radiation warnings
- Radioactivity surveillance
- Regional climate change modeling and forecasts
- Mass budget studies (main stores and fluxes) of carbon and nitrogen and their long-term changes, together with processes impacting decomposition of organic matter
- Studies on forest ecosystem carbon and nutrient budgets and fluxes
- Ecosystem effects research
- Satellite observation ground-truthing

Geographic coverage

The Pallas-Sodankylä site is located in northern Finland north of the Arctic Circle and it is a good representative of boreal and sub-arctic Eurasian environment in a transition zone from marine to continental climate (a transition from marine to continental in the west to east direction). The site provides in situ monitoring and high spatial resolution land cover data sets that are not available for other regions north of the 67th latitude. A special feature of the site is that it is the westernmost part of the Eurasian taiga forest belt that reaches close to the Pacific Ocean in its easternmost extent. As the Russian in-situ environmental and climate monitoring network declined after the collapse of the Soviet Union the Pallas-Sodankylä area provides data and a research infrastructure (available e.g. for measurement campaigns) that are hardly available elsewhere in that particular ecological and climate region. The site is particularly suitable for long-term ecological and atmospheric monitoring because the Pallas area has been a national park over seven decades and thus represents a relatively pristine nature. There are very few local sources of air pollutants. The site incorporates a variety of biotopes, e.g. boreal forests, bogs, aapa mires, mountain heaths, lakes and rivers.

The Pallas-Sodankylä research infrastructure consists of the Pallas-Yllästunturi national park, maintained by Metsähallitus, Natural Heritage Services, and the adjacent research forests, and the Finnish Meteorological Institute's Arctic Research Centre and the Geophysical Observatory of the University of Oulu at Sodankylä. In addition to these partners, a number of research institutes operate in the area, for example Finnish Forest Research Institute, Finnish Environment Institute, Lapland Regional Environment Centre, University of Helsinki, STUK – Radiation and Nuclear Safety Authority, and Geological Survey of Finland.

Recent Progress

1. A significant interaction between the atmosphere and the boreal forest was reported by Tunved et al. (2006), Science 312, 261-263. The boreal forests are able to maintain a high natural aerosol loading during the summer season (1000-2000 particles/cm3). The observed loading can be explained by the con-

version of 5-10% of the emitted terpenes into particulate matter.

2. Pallas-Sodankylä site was recently selected to the Finnish Long-term socio-ecological monitoring (LTER) programme
3. Pallas-Sodankylä site is incorporated in the preparatory phase of "LifeWatch", a Pan-european ecological research infrastructure programme.

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Black Guillemots and Contaminants

Broad objectives of project

Trends in and age-related effects of contaminants.

Specific species and ecosystems included

Black Guillemot Cepphus grylle; marine ecosystem

Geographic coverage

Breiðafjörður (W-Iceland)

Recent Progress

Population study annually since 1974. In early years constant increase in study population, while more or less decline since 1987. (Petersen, A. 1980. Population study of Black Guillemots (Cepphus grylle) in Iceland. Nordecol Newsletter no. 12: 16-17; Petersen, A. 1981. Breeding biology and feeding ecology of Black Guillemots. D.Phil. Thesis. University of Oxford, England. xiv + 378 p.; Frederiksen, M. & A. Petersen 1999. Adult survival of the Black Guillemot in Iceland. Condor 101(4): 589-597; Frederiksen, M. & A. Petersen 1999. Philopatry and dispersal within a Black Guillemot colony. Waterbirds 22(2): 274-281; Frederiksen, M. & A. Petersen 2000. The importance of natal dispersal in a colonial seabird, the Black Guillemot Cepphus grylle. Ibis 142(1): 48-57; Petersen, A. 2001. Black Guillemots in Iceland: A case-history of population changes (Box 70). Pp. 212-213 in: Arctic Flora and Fauna (Status and Conservation). CAFF/Edita, Helsinki. 272 pp.

Monitoring of organochlorine contamination since 1976 (PCB, DDT, HCB, HCH, oxychlordane, transnonachlor, toxaphene). First four compounds declined to 1996, others showed no changes. (Ólafsdóttir, K., A. Petersen, E.V. Magnúsdóttir, T. Björnsson & T. Jóhannesson 2005. Temporal trends of organochlorine contamination in Black Guillemots in Iceland from 1976-1996. Environmental Pollution 133: 509-515).

Study of prey of a top predator, Gyrfalcon Falco rusticolus, showed elements from the marine ecosystem, incl. Black Guillemots, showed highest organochlorine concentrations. Much less in members of the terrestrial and freshwater ecosystems. Higher concentrations in migratory prey compared to sedentary. (Ólafsdóttir, K., A. Petersen, E.V. Magnúsdóttir, T. Björnsson & T. Jóhannesson 2000. Persistent organochlorine levels in six prey species of the Gyrfalcon Falco rusticolus in Iceland. Environ. Poll. 112: 245-251).

The present study has shown that Black Guillemots only accumulate contaminants up to a certain concentration, which then does not change with increased age. Study in progress to find out the avenues by which Black Guillemots get rid of contaminants from their body.

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Black Legged Kittiwake Populations and Climate Change

Broad objectives of project

Trend and productivity data for Black-legged Kittiwake Rissa tridactyla in Iceland

Specific species and ecosystems included

Black-legged Kittiwake; marine ecosystem.

Geographic coverage

Mainly in Breidafjördur (W-Iceland), but also with data from other parts of Iceland; multiple colonies

Recent Progress

Icelandic work carried out in connection with the CAFF CBird Group. Comparable monitoring studies are carried out in the other Arctic countries. Cooperation also with Nordic countries.

Monitoring of several colonies (ground censuses), both annual and at irregular intervals, have taken place since 1975. Two complete censuses (nest counts) carried out, in 1993-94 and 2005-07, at around 60 colonies. Large decline took place between these two censuses, latter results only 45% of former. Review paper for total area in preparation. Decline related to changes in main prey Sandeel/Sandlance Ammodytes spp., possibly related to increased sea temperature and climate change. Part data for this region published in Petersen, A. 1979. [Breeding birds of Flatey island in Breidafjördur and adjacent islets.] Náttúrufraedingurinn 49(3-4): 229-256 (Icel., with English summary) and in Petersen, A. 1989. [The natural history of the Breidafjördur islands.] Pp. 17-52 in: [The Breidafjördur islands. Árbók Ferðafélags Íslands 1989. 260 pp.] (Icel.).

A. Gardarsson (University of Iceland) has carried out aerial censuses of Kittiwake colonies, including those in the Breidafjördur region, in 1983-84 (Gardarsson, A. 1996. [Numbers and distribution of breeding Kittiwake Rissa tridactyla in Iceland.] Bliki 17: 1-16 (Icel., with English summary).

Two international papers in preparation, one by the CBird Group, dealing with population changes in relation to climate change (lead by G. Robertson (Canada) and R. Barrett (Norway), with participation from other Arctic countries). The other paper deals with the NE-Atlantic (lead M. Frederiksen, Denmark, in cooperation with country experts), analyzing productivity results from the countries in this region, in relation to oceanographic and biological (esp. zooplankton and Sandeel) changes, and possible climate change.

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Eiders and Climate Change

Broad objectives of project

Population trends related to climate change models; Linked to CAFF CBird Work Plan and the International Eider Conservation Strategy

The project started in 2007. We are exploring the effects of weather and climate variables on large-scale habitat selection and population regulation in a long-lived arctic-nesting bird, the Common Eider. We address novel questions in population ecology, which also have sociological relevance, as eider farming is a principal livelihood of many rural families in Iceland. Long-term data on colony sizes are available from eider-down farms around the country. We use these data to investigate a century of population dynamics on large temporal and spatial scales. Specifically, we assess whether 1. eider population increases have resulted in expansion into habitats that differ from traditionally occupied locations, 2. breeding habitat type is related to population stability in response to climatic variation, and 3. population trajectories following severe weather events vary with habitat and the season in which the severe weather occurs. This will allow us to assess how weather has affected eider colonies throughout the 20th century, to predict the likely impacts of future climate change on eider populations and to explore how habitat selection, population fluctuations and anthropogenic impacts have driven changes in eider distribution over time. These issues link important questions in population ecology to the economic stability and future development of eider-farming. We will use our findings to advise farmers on how to maintain and enhance eider populations in a changing world.

Specific species and ecosystems included

Common Eider Somateria mollissima; marine, coastal, island ecosystem

Geographic coverage

Iceland, nationwide: multiple colonies. Common Eider nest along most of the Icelandic coast (Figure 1).

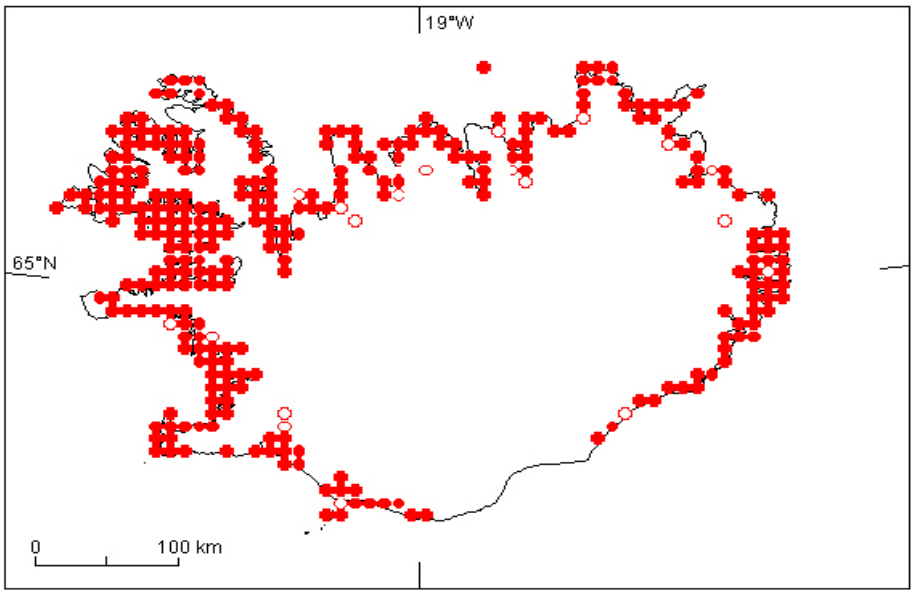

Figure 1: Breeding distribution of the Common Eider in Iceland. Red dots indicate regular breeding, open circles indicate pas breeding and suspected breeding. Most of population data collected to date (see Recent Progress) originates from the north-west part of the country (upper left on map). Map provided by the Icelandic Natural History Institute.

Recent Progress

- Data was obtained from eider farmers in 2007 and such efforts continue in 2008. Data series on colony size, ranging 10-100 years, have been obtained for 14 Common Eider colonies (4 March 2008).
- The project also uses the Icelandic Seabird Colony Registry, which is nationwide but includes variable details for individual seabird colonies, including those of Common Eider (contact A. Petersen).
- Two peer-reviewed publications are anticipated in 2008.

- Preliminary findings (using time-series analysis) indicate significant relationships between winter and spring weather and numbers of breeding females, arrival date, and clutch size. Mild winters seem favorable for breeding numbers and unfavorable springs can delay arrival dates and may reduce clutch size.

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Gyrfalcon and Contaminants

Broad objectives of project

Trends in contaminants

Specific species and ecosystems included

Gyrfalcon Falco rusticolus; terrestrial ecosystem

Geographic coverage

Iceland

Recent Progress

Update pending

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International Tundra Experiment

Broad objectives of project

A New Associated Highland Ecosystem Project. Update Pending

Specific species and ecosystems included

Terrestrial ecosystem

Geographic coverage

Iceland: Two sites

Recent Progress

Update pending

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Lake Þingvallavatn

Broad objectives of project

In 2005 the Icelandic parliament (Alþingi) passed a law on the protection of Lake Þingvallavatn and the watershed. The protection of biota, habitats and spawning sites, discharge and water level control are addressed especially. A monitoring programme was launched in 2007 with focuses on chemistry and the pelagic food web. The programme is funded by Þingvellir National Park, Ministry for the Environment, Orkuveita Reykjavíkur (Reykjavik Energy) and Landsvirkjun (National Power Plant).

Specific species and ecosystems included

Plankton, Arctic Char, Nutrients and Contaminants. It has been estimated that as much as 90% of the water flowing into the lake enters as groundwater springs from fissures at the north end of the lake. The chemistry of this inflow is monitored as well as the chemistry of the outflowing water. Three monitoring stations are located in the lake (see map). In 2007 the following parameters were monitored four times over the period May–October: temperature, secchi depth, pH, conductivity, chlorophyll-a, phytoplankton (species composition, number and volume) and zooplankton (species and biomass).

The Arctic char (Salvelinus alpinus), the pelagic morph, has been monitored (cpue and life history traits) for a long period, and this monitoring continues. Similarily, the dwarf morph of Arctic charr along with sediment, plants and invertebrates, are monitored for heavy metals once a year on a five year basis.

Geographic coverage

Þingvallavatn is situated in SW Iceland in the neovolcanic zone, with an area of 83 km3 and maximum depth 114 m. The lake has been subject to intensive ecological studies for the past decades (for further details see: Ecology of oligotrophic, subarctic Thingvallavatn. Ed: Pétur M. Jónasson, 1992, OIKOS 64, 437 pp.). See Figure 1 for map of Lake Þingvallavatn showing monitoring sites

Recent Progress

Results from the monitoring programme are to be made public and accessible as soon as possible and the latest within a year from data collection. Presentation of results will be in written reports and on the web. Information in Icelandic about the programme can now be accessed on the web at: http://www.natkop.is/page5.asp?ID=5

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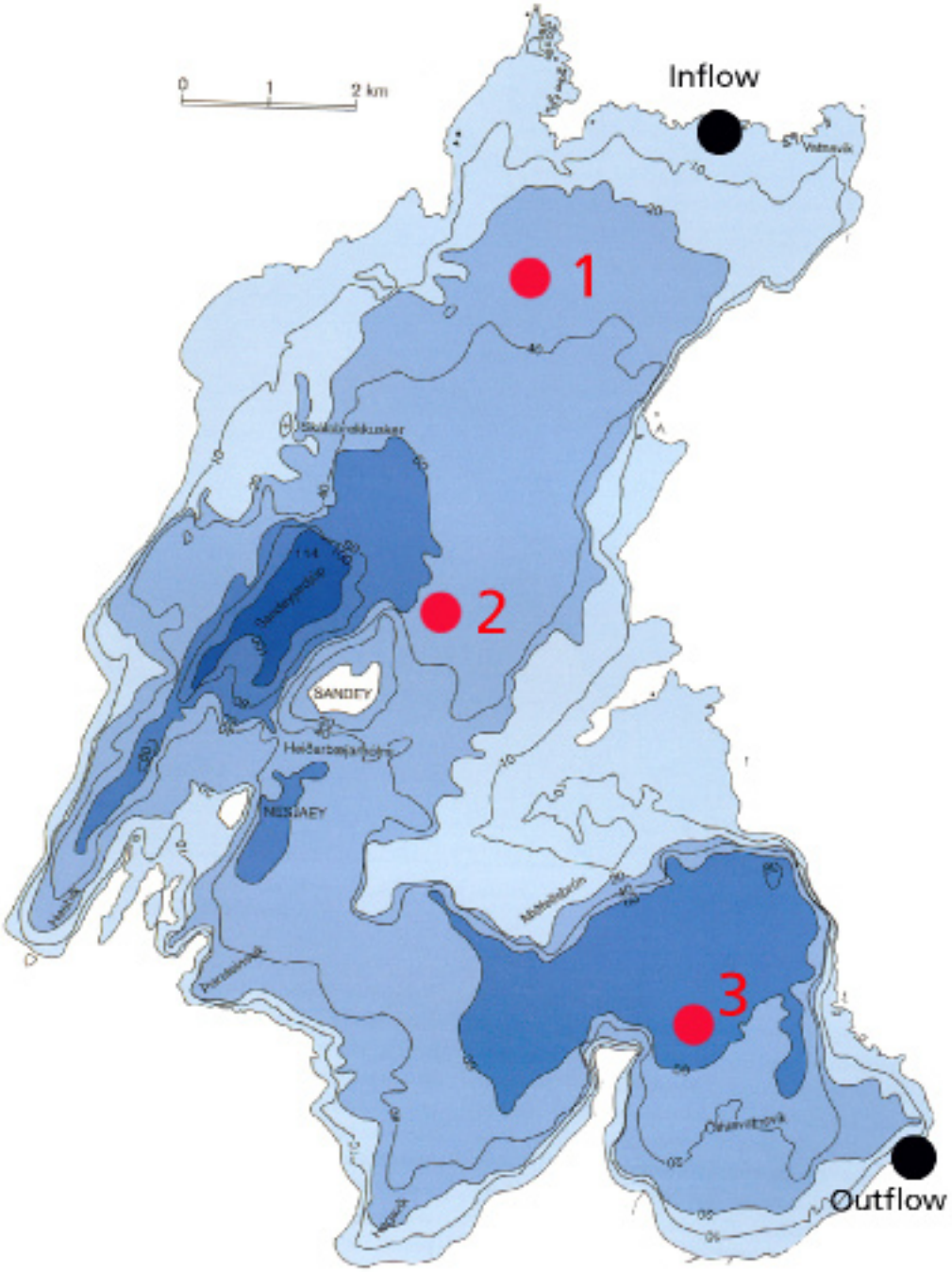

map of

Figure 1: Map of Lake Þingvallavatn showing monitoring sites

Murre Populations and Climate Change

Broad objectives of project

Trends in murre populations (Alcidae)

Specific species and ecosystems included

Thick-billed Murre Uria lomvia; Common Murre U. aalge; marine ecosystem

Geographic coverage

Iceland but similar data collected at most Arctic countries, in relation to the CAFF CBird Group. At present monitoring data in Iceland available for three colonies (Langanes NE-Iceland), and (Krísuvíkurbjarg and Hafnaberg SW-Iceland), but shorter series for some other colonies. Monitoring work organized by A. Gardarsson (University of Iceland). Censuses started in 1982-85, at variable intervals. Publications: Gardarsson, A. 1995. [Numbers and distribution of Common Murre Uria aalge, Thick-billed Murre U. lomvia and Razorbill Alca torda in Iceland.] Bliki 16: 47-65. (Icel., with English summary). Gardarsson, A. 2006. [Recent changes in numbers of cliff-breeding seabirds in Iceland.] Bliki 27: 13-22. (Icel., with English summary). Bornaechea, P.G. & Arnþór Garðarsson 2006. [A survey of the bird cliffs of Snaæfellsnes, W-Iceland, in 2005.] Bliki 27: 51-54. (Icel., with English summary).

Recent Progress

Results mostly published (see above). Long-term decline in lomvia (see also Náttúrufræðistofnun Íslands 2000. [Redlist 2. Birds.] Náttúrufræðistofnun Íslands. 103 pp. [authors: K.H. Skarphéðinsson, A. Petersen & Á. Ingadóttir]. Icel., with English summary) while algae was increasing until recently when all species show decline, presumably due to changes in main prey (Sandeel/Sandlance Ammodytes spp. and Capelin Mallotus villosus).

A cooperative project of the CBird Group has recently been finalized in a paper published in Global Change Biology (accepted), dealing with changes in Arctic murre populations in relation to climate fluctuations (lead D. Irons chair CBird Group).

Current project, using aerial surveys, aims at comparing 1982-86 results with current situation, a cooperative project between University of Iceland, Icelandic Institute of Natural History, and Marine Research Institute.

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White Tailed Eagles and Contaminants

Broad objectives of project

Trends in contaminants and effects on population

Specific species and ecosystems included

White-tailed Eagle Haliaetus albicilla; marine ecosystem

Geographic coverage

Iceland

Recent Progress

Update Pending

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Contaminants in Polar Bears in the Svalbard Area

Broad objectives of project

Update Pending

Specific species and ecosystems included

Ursus maritimus

Geographic coverage

Svalbard

Recent Progress

Update Pending

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Joint Assessment and Monitoring Programme (JAMP)

Broad objectives of project

Analyses of contaminants in sediments and organisms. This falls under OSPAR including contaminants and biodiveristy elements

Specific species and ecosystems included

Sediments and benthic organisms

Geographic coverage

Norwegian coastal waters

Recent Progress

Update Pending

Contact people

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National Coastal Monitoring

Broad objectives of project

Monitoring of the state of environment related to nutrients and biodiversity

Specific species and ecosystems included

Hydrology/-chemistry and plankton, soft and hard bottom ecology.

Monitoring Parametres

Water samples for measurements of physio-chemical key elements (salinity, temperature, nutrients, oxygen) and of the biological key element phytoplankton, have been collected about twice a month at 4 stations. The basic parameters include: total phosphorus, phosphate, total nitrogen, nitrate, ammonium, silicate, chlorophyll a, particulate nitrogen, phosphorus and carbon, oxygen, salinity, temperature and Secchi-depth.

Standard sampling depths are: 0, 5, 10, 20, 30, 50, 75, 100, 125, 150, 200 and 300 m depth, depending on maximum depth at the station. (Not all parameters are analyzed for all depths.) In addition, phytoplankton and zooplankton are sampled (plankton net) 22 times a year from one station in Skagerrak and abundance of species and biomass is calculated.

Soft bottom fauna and chemical characteristic of the sediment is sampled once a year (spring) regularly at 8 stations, covering soft-bottom communities from 50m to 460m depths. The measurements include species composition and abundance, and supplementary measurements of sediment particle size and silt fraction, and analyses of organic carbon and nitrogen in the sediment. The communities in Skagerrak are composed of more than 300 species.

Hard bottom communities are monitored regularly at 16 stations with 4 stations within each of the 4 regions. The sites are surveyed annually in June. The monitoring include annual registrations of semi-quantitative transect of algae and animals from the littoral zone to about 30m depth, qualitative and quantitative analyses of stereo photographs of fixed areas of rocky bottom, measurements of the kelp forest and under water video documentation. The method is in accordance with the Norwegian Standard NS-9424 (1996), except for minor deviations due to the necessity to maintain the long data series established already in 1990.

Table 1. Standard sampling depths and parameters

	Hydrology/ -chemistry	Plankton	Soft bottom	Hard bottom
Standard sampling depth in meter(m):	0, 5, 10, 20, 30, 50, 75, 100, 125, 150, 200, 300, + maximum depth	Water samples from 0, 5, 10, 20, 30 meter. Plankton sampling net 0 m and vertikal sampling from 50m	8 parallel grab samples pr. station	0, 1, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30m
Standard analyzing parameter*:	Tot.P, PO4, Tot.N, NO3, NO2, NH4, SiO3, Chl.a, POC, PON, POP, TSM, O2, salinity, Temperature, Secchi-depth	Abundance of species of phytoplankton and zooplankton (cells/L), Biomass (gC)	species composition and abundance (number/ 0,1m^2) sediment particle size and silt fraction, POC and PON	Semi-quantitative transect of algae and animals from the littoral zone to about 30m depth measurements of the kelp forest, CNP in kelp Stereo photographs/video

* Not all chemical parameters are analyzed in all depths, see earlier detailed programs.

Geographic coverage

Coastal areas in Norway – but no father north than about 60° north - see Figure 1 and table 2.

Table 2. Sampling stations and frequency.
Hydrologi/-clemestry, *plankton– stations in 2006. (EUREF89-WGS84).

Region	Station	Longitude	Latitude	Depth (m)	Frequency
A	Fjørder – F	10.5000	59.0000	0-150	9 ggr. pr. year *
B	Jomfruland – J	9.6667	58.8500	0-125	14 ggr. pr. year
B	Arendal St. 2 - A2 *	8.8167	58.3833	0-75	22 ggr. pr. year
B	Arendal St. 3 - A3	8.9000	58.3333	100-300	12 ggr pr. year
C	Lista -L	6.5333	58.0167	0-300	12 ggr pr. year
D	Utsira - U	4.9000	59.3100	0-240	12 ggr. pr. year

* Replaced from 2008 – with stasion Torbjørnskjær

Soft bottom – stations in 2006. One yearly sampling in may. (EUREF89-WGS84).

Region	Station	Longitude	Latitude	Depth (m)	Frequency
A	A05	10.3717	59.0123	50	1 g. pr. year
A	A30	10.6392	58.9467	300	1 g. pr. year
B	B05	8.6295	58.3253	50	1 g. pr. year
B	B35	9.0312	58.4038	350	1 g. pr. year
C	C15	7.0480	58.0358	150	1 g. pr. year
C	C30	6.5747	58.0188	300	1 g. pr. year
D	D60	5.4667	60.1042	600	1 g. pr. year
D	D20	4.8778	60.2280	200	1 g. pr. year

Hard bottom - stations in 2006. One yearly sampling in june. (E=eksposed. M=moderat eksposed.) (EUREF89-WGS84).

Region	Station	Longi-tude	Latitude	Depth (m)	Direction (°)	Eksposure	Period (year)
A	a02 Fjørder fyr	10.5268	59.0267	0-28	88	E	90, 94-2006
A	a03 Lynghlm.	10.2963	59.0432	0-30	180	E	1990-2006
A	a02 Kongshlm	10.4548	58.1218	0-30	80	M	2002-2006
A	a03 Vakerhlm	10.3754	58.1168	0-30	100	M	2002-2006
B	b07 Tromøy N.	8.9443	58.5132	0-30	360	M	1990-2006
B	b10 Presthlm.	8.5372	58.2732	0-30	140	E	1990-2006
B	b11 Hunnøy	8.4289	58.2382	0-30	85	M	1990-2006
B	b12 Meholmen	8.1980	58.0961	0-30	10	E	90-91,95-2006
C	c05 Launes	7.0406	58.0239	0-30	270	M	2002-2006
C	c15 Revø	6.7980	58.0480	0-25	190	E	1990-2006
C	c17 Skiden	6.7147	58.2218	0-30	240	M	1990-2006
C	c18 Rosø	6.5011	58.2280	0-28	170	E	1990-2006
D	d22 Mauhlm	5.14428	59.5805	0-30	116	M	1990-99+2005-06
D	d23 Yhvesøy	5.08530	59.8800	0-30	340	E	1990-99+2005-06
D	d25 Arebrot	4.90818	60.4210	0-30	25	M	1990-99+2005-06
D	d27 Mageøy	4.88393	60.7965	0-30	30	E	1990-99+2005-06

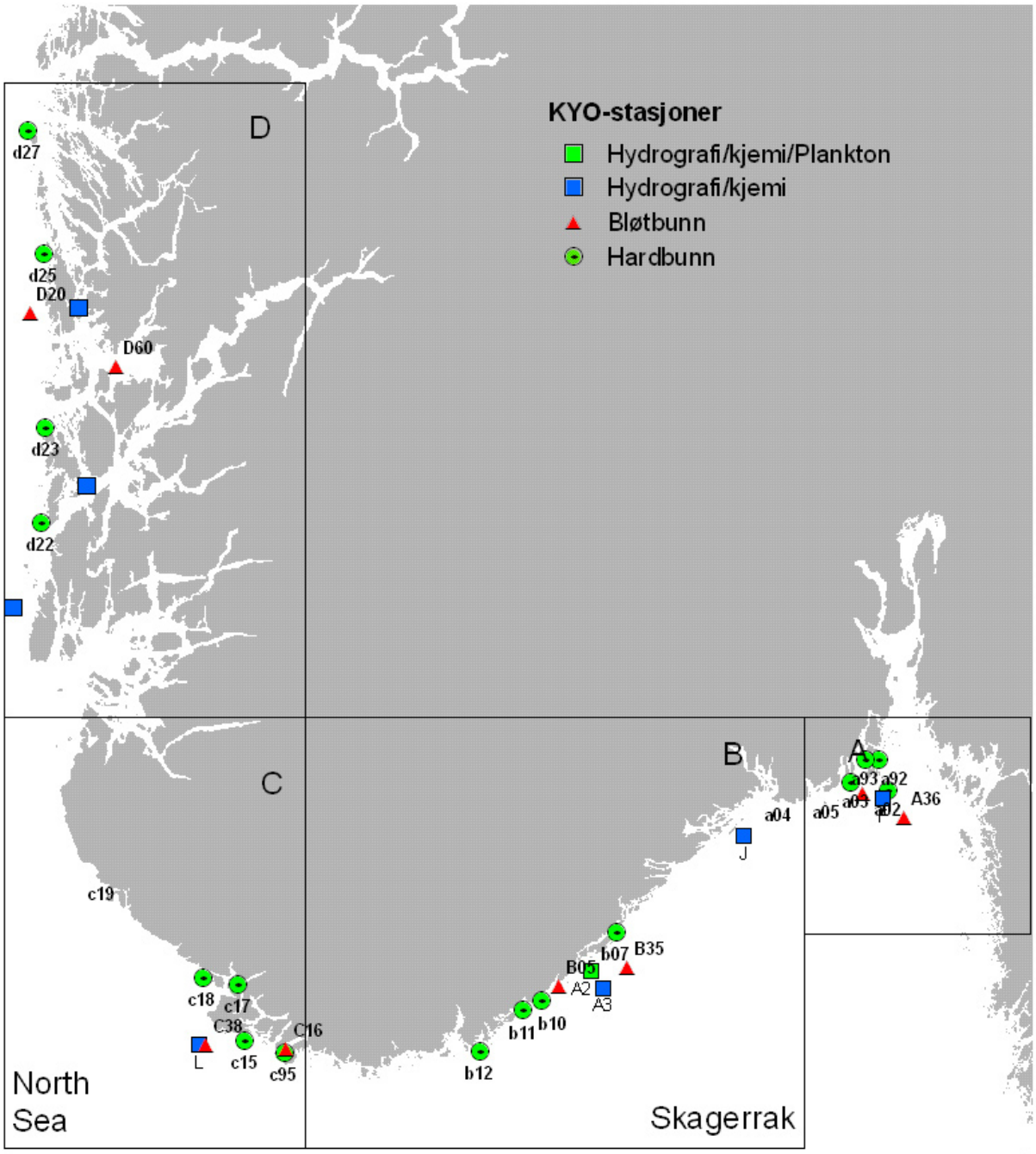
See map – Figure 1.

Recent Progress

A report is due on the 2007 data by the 9th of may 2008.

Kjell Magnus Norderhaug - Kjell.Norderhaug@niva.no – administrator of the management of the program

Figur 1. Map over coastal monitoring regions A, B, C og D. (Station number without marking symbol are not



in the program in 2007).

Hydrografi/kjemi/plankton - Hydrology/-chemistry, plankton - Hydrografi/kjemi - Hydrology/-chemistry
Bløtbunn – Soft bottom / Hardbunn – Hard bottom

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Norwegian International Research Site

Broad objectives of project

A comprehensive research site that includes several research stations established by other nations. It will be necessary to prepare and coordinate the required outputs

Specific species and ecosystems included

Multiple monitoring activities

Geographic coverage

Ny Ålesund at Spitsbergen, Svalbard

Recent Progress

Update Pending

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National Monitoring of the Marine Environment and Living Resources

Broad objectives of project

Monitoring of sea environment with special focus on sustainable fisheries management

Specific species and ecosystems included

Physical and chemical parameters, zooplankton, phytoplankton, fish eggs and larvae, several fish species, prawn, lobster, benthic ecosystems

Geographic coverage

Barents Sea and Norwegian Sea

Recent Progress

Update Pending

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Offshore Monitoring of Norwegian Petroleum Activities

Broad objectives of project

The environmental monitoring of petroleum activities offshore includes both monitoring of bottom sediments and monitoring of the water column. Environmental monitoring is a requirement posed by The Norwegian Pollution Control Authority (SFT), which is laid down in the Norwegian Regulations relating to the Execution of Activities in Petroleum Enterprises (the Activity Regulations). This is a part of the Regulations relating to health, environment and safety in petroleum enterprises.

Monitoring of pollutants and species diversity in sediments in the vicinity of offshore installations.

Sea bed monitoring is intended to show the scope and extent of pollution from oil and gas enterprises on the Norwegian continental shelf. The monitoring also reveals existing trends as well as providing projections for anticipated trends, and it has been adapted to the pollution risks that are being faced. Environmental monitoring in sediments has been in operation since the 1980s in connection with the individual oil fields. In 1996 the continental shelf was divided up into 11 regions for sea bed monitoring. Studies are performed in an individual region every third year, and these alternate between the regions. The scope of the monitoring is related to the offshore activity in the individual regions.

Monitoring of uptake and effects of pollutants in mussels and fish

In order to see the effects of the emissions on the organisms that live in the water, fish and mussels in strategically placed cages are monitored in connection with oil platforms and oil fields. In addition "wild fish" are sampled in different regions to measure the levels of different selected components. Methods for water column monitoring are still under development.

Monitoring of the water column has been operative since 1999.

Specific species and ecosystems included

Sea bed fauna/ biodiversity/ ecosystems.

The monitoring consists of taking samples of the sea bed, analysing the sediment for various heavy metals and oil compounds, as well as looking at the biodiversity in the zoobenthos (sea bed animals) community. Data from the monitoring is also used in connection with reporting for OSPAR (the Oslo-Paris Convention).

Water column/impact monitoring/condition monitoring

The impact monitoring consists of measuring the effect/levels of heavy metals and selected organic compounds in cod (Gadhus morhua) and blue mussels (Mytilus edulis) downstream platforms. Biological Effect Monitoring (BEM) is also performed on these animals, and different methods are tested. The condition monitoring includes measurement of the levels of selected components in fish cod and haddock (Melanogrammus aeglefinus) from 4 regions (including 2 reference areas) – every three years

Geographic coverage

The whole Norwegian shelf where there is oil and gas activities. The 11 regions which are defined for sediment monitoring are to be found on the sft homepage. At the time being there are activities in 7 of these regions. The regions for condition monitoring are the North Sea (Ling /Egersund Bank and Tampen area), the Norwegian Sea –Halten Bank and the Barents Sea (see figure 1)

Recent Progress

In 2008 sediment monitoring are performed in the regions I (Ekofisk) and IV (Tampen) . Impact monitoring of the water column are done at Ekofisk (I) and Gullfaks (IV) and condition monitoring in all regions are due this year. Testing out of some new BEMs are included in the water column programmes and measuring of radioactivity in water are includes this year (Ekofisk and Gullfaks). Some new fish species are taken on board in the condition monitoring programme for 2008.

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Figure 1: The regions for condition monitoring are the North Sea (Ling /Egersund Bank and Tampen area), the Norwegian Sea –Halten Bank and the Barents Sea

Polar Bear Population in the Barents Sea

Broad objectives of project

Long term monitoring of population size by aerial line transect surveys

Specific species and ecosystems included

Ursus maritimus

Geographic coverage

Barents Sea, Svalbard, Frantz Josef Land, sea ice north of these areas, from the ice edge.

Recent Progress

A survey was done in August 2004 where the Barents Sea population size was estimated. A paper has been written based on this study, and is at the moment in review for the journal Marine Mammal Science. A method paper on measuring distances to bears from line transects based on the study is already published (Marques et al. 2006). The plan is to conduct a survey each fifth year to look for trends in numbers, and to provide a baseline for future comparisons. Thus, the next survey is planned for August 2009.

Introduction

The Barents Sea polar bears belong to one out of 19 different populations in the Arctic. In total, it is suggested there are about 20 000 – 25 000 polar bears in the world (Aars et al. 2006). No meaningful estimate of the size of the Barents Sea population based on any study that covers the whole area in question has been available before 2004. In the beginning of the 1980's, Larsen (1986) suggested that the Barents Sea polar bear population size was between 3000 and 6700 (dependent on subpopulation definition). This was based on data from multiple sources including den counts and spatially restricted, non-random air surveys, and extrapolation to larger areas. The importance of using scientifically derived population estimates in the management of polar bears has recently been stressed (Wiig 2005, Aars et al. 2006).

The Barents Sea polar bear population, shared between Norway and Russia, has not been harvested since 1956 in Russia and since 1973 in Norway (Prestrud and Stirling 1994). Persistent pollutants (Andersen et al. 2001), climate change (Derocher 2005), and oil development are possible threats to the population. To be in a position to assess the effects of these or other threats to polar bears in the future, knowledge of the number of bears in the Barents region is essential. The northern Barents Sea population has its stronghold in the area from Svalbard in the west and to Franz Josef Land in the east. This population is thus managed jointly by Norwegian and Russian authorities. Management of the population has had a high political profile, and hunting is currently banned throughout the area.

Results from the first survey, in 2004

Densities of most bear habitats in Svalbard and Frans Josef land was estimated by line transects in August 2004. Most of the area from the ice edge and 50 nautical miles northward was also covered by line transects except a section in the Russian area, where weather conditions hindered flying. For both this section and for areas further north, assumed densities were estimated by assuming that data from telemetered bears sampled over several years reflected bear distribution during the study. The ratio of telemetry fixes within and outside areas covered was used to predict expected observations in the unsurveyed areas had they been covered. Based on these sources of data, it was estimated that there were approximately 2650 (95% CI appr. 1900 – 3550) polar bears in the Barents sea area in August 2004.

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Population Ecology of the Polar Bear in the Svalbard Area

Broad objectives of project

Population ecology of Polar bear in the Svalbard area (1967-) MOSJ (Miljøovervåkning Svalbard og Jan Mayen)

Specific species and ecosystems included

Ursus maritimus, long term trends in polar bear ecological parameters

Geographic coverage

Svalbard and the Barents Sea area

Recent Progress

Data available for MOSJ can be found at: (http://mosj.npolar.no/FaunaFlora%20Mappe/Isbjoern). Average ages and litter production from 1992 – 2002 has been analyzed. Estimated average ages have dropped over the period, although some of this seems to be due to methodological bias in age determination (Christensen-Dahlsgaard et al. unpublished data). Cub production per female has over the same period gone down. An extension to the time series will become available after a major analyses on demography for the more recent years have been conducted, and the work has been submitted. The Svalbard bears are part of the Barents Sea subpopulation. It was estimated to be between 1900 and 3550 animals in August 2004. The next survey to estimate the subpopulation size is planned for August 2009. It is planned to follow time trends in prevalence of different diseases in polar bears. In samples from the 1990s (mainly from the late part of this period), prevalence of Brucella sp. (3.6%), Morbillivirus (9.6%) and Calicivirus (1.5%) have been recorded. For the same samples, analyses on Trichinella and Toxoplasma is currently ongoing, and results will be available in near future. For Toxoplasma, analyses are also currently being performed for recent samples that will provide a second point for comparing temporal changes. Prevalences on some or all of the other disease agents will also be performed on the more recent samples for similar studies and included in MOSJ. For the lab analyses, blood from polar bears is used. The studies are done in cooperation with Veterinærhøyskolen in Tromsø. Between 50 and 100 polar bears are marked every year in the Svalbard area, and provide both the demographic data and the samples for the disease analyses. The most recent available demographic results on polar bear ecology in Svalbard can be found in Derocher 2005. Data on diseases can be found in Tryland et al. 2001, and Tryland et al. 2005.

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The Annals of Nature

Broad objectives of project

Circumpolar Biodiversity Monitoring Programme in State Nature Zapovednik Reserves of Russia based on "The Annals of Nature"

- To develop a biodiversity monitoring programme for each zapovednik reserve, keeping in mind main parameters of the Circumpolar Biodiversity Monitoring Programme (further referred to as CBMP)
- To establish biodiversity monitoring databases in zapovednik reserves and national parks of the Russian Federation, including in those that implement the CBMP;
- To develop research aimed at assessing possible impacts of climate change on Arctic ecosystems to be carried out in state nature zapovednik reserves

Specific species and ecosystems included

Subjects of observation and research are species playing key roles in the ecosystem functioning, as well as rare and endangered species. At the same time, observations over changes in individual ecosystem variables and abiotic factors (weather, topography, hydrological features etc.) are made. Work is carried out by staff of respective state agencies. The total of 55 scientists of various biological specializations have been working in the nature zapovednik reserves financed by the government. Additionally, Russian and international research institutions have been carrying out research there according to their programmes. Meteorological information has been collected at weather stations located on territories of the zapovednik reserves or in their immediate vicinity.

Geographic coverage

The network includes state nature zapovednik reserves located within CAFF designated area or in its immediate vicinity (Komandorsky).

The following list of state nature zapovednik reserves have been sanctioned by a Rosprirodnadzor instruction: Pasvik, Kandalakshsky, Laplandsky (Murmansk Oblast), Nenetsky (Nenets autonomous area), Gydansky (Yamalo-Nenets autonomous area), Bolshoi Arktichesky, Putoransky, Taimyrsky (Taimyr autonomous area), Ust-Lensky (Republic of Yakutia), Wrangel Island (Chukot autonomous area), Magadansky (Magadan Oblast), Komandorsky, Koryaksky (Kamchatka Krai).

Recent Progress

Currently, the Rosprirodnadzor Federal Supervisory Natural Resources Management Service is developing and planning the implementation of a programme to monitor populations of rare and endangered animal and plant species listed in the Red Data Book of the Russian Federation in zapovednik reserves and national parks (based on The Annals of Nature program) all over the Russian Federation. In 2008, the monitoring and research programme will be updated in accordance with CAFF recommendations on the CBMP for Arctic state nature zapovednik reserves of Russia.

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ECORA

Broad objectives of project

Development and implementation of the Integrated Ecosystem Management in three model areas in the Russian Arctic

Specific species and ecosystems included

Waterfowl (NAO, Sakha, ChAO), reindeer (NAO, Sakha), endangered bird species (ChAO), seabirds (ChAO), marine mammals (ChAO)

Geographic coverage

Three Model Areas: Kolguev Island (Nenets AO), Lower Kolyma River (Sakha Republic), Beringovsky region (Chukotka)

Recent Progress

Scientific studies of ecosystems and their resources supported by ECORA project in 2005-2007

1. After the collapse of the USSR, the majority of biodiversity studies in the most parts of the Russian North ceased to exist. No such studies have been conducted in any of the three ECORA MAs. ECORA has contributed substantially to environmental data collection in these territories and a better understanding of the overall biodiversity status of the Russian Arctic.

On Kolguev Island

2. Data collected in ECORA revealed the nesting sites for more than 335,000 pairs of three goose species – white-fronted goose, barnacle goose, and bean goose in Kolguev Island. The total population sizes of nesting white-fronted goose is assessed to be about 150,000-250,000 nesting pairs and of bean goose about 60,000-70,000 nesting pairs. In the spring, together with the arrival of the non-breeding population, the overall size of the white-fronted goose population is about 400,000–600,000 birds. This population size is about one-third of the population wintering in Europe. The overall size of the Western Palearctic population of tundra bean goose is in the range of 500,000 to 600,000 birds. The number of barnacle goose on Kolguev Island is about 65,000 nesting pairs. Together with non-breeding individuals, the number of barnacle geese arriving in the spring is about 170,000, or about 42% of the total Russian population of this species (ca. 400,000). ECORA specialists have conducted detailed

biological studies of this species. Furthermore, data on the nesting sites of peregrine falcon – a rare species in a number of Red Books - has been collected.

3. ECORA has developed a scheme for nature protection zoning on Kolguev Island in order to organize a protected area for the core population of nesting goose.
4. For the first time, detailed morphological and physiological studies, including a genetic analysis of Kolguev Island's domesticated reindeer, have been conducted. A number of technological processes (pastures and corralling) in local reindeer herding have been studied.
5. A range of maps has been produced for Kolguev Island. Most of these maps have not been updated since the mid-1980s. The maps compiled include : landscape, geobotanical, hunting area types, fragmented and destroyed habitats and industrial activities, fisheries, cost evaluation of biological resources, and reindeer pastures and their capacities. Descriptions of vascular plants and lichens were also compiled.

In Lower Kolyma MA

6. For the first time during the last 20 years, a complex assessment of fisheries of Kolyma River was conducted.
7. A special study of domestic reindeer herding after its conversion from large-scale to small community scale herding was conducted for the first time. This study allowed the development of specific recommendations for local communities on how to improve the efficiency and technological base of reindeer herding.
8. Assessment of the current state of Sundrun wild reindeer population. Data about this population were practically lost during the last 20 years.
9. Ecosystem studies supported by ECORA allowed the development of GIS-based maps showing the biodiversity status and ecosystems state in the region.

In Beringovsky District MA

10. Information on hunted and rare birds in Beringovsky District collected 30 years ago was updated and complemented with new data gathered in ECORA. Detailed biological data on spoonbilled sandpiper – an endemic species in Chukotka and included in IUCN Red Books - allowed the development of a protected areas scheme for this and other rare species. For the first time, ECORA supported detailed studies of sea birds in Beringovsky District, uncluding the biggest bazaar at Navarin Cape.
11. Sites of marine mammals have been thoroughly explored and special training on sustainable hunting practices and methods and meat processing were conducted with local people.
12. Ecosystem data collected in the framework of ECORA were used to develop recommendations for the establishment of a cluster-type protected areas network. Some of those areas will be included in the international biosphere national park "Beringia".
13. A number of maps have been produced for the Beringovsky District. Most of these maps have not been updated since mid-1980s. The maps compiled included the following: landscape, geobotanical, types of hunting areas, fragmented and destroyed habitats and industrial activities, fisheries, cost evaluation of biological resources, reindeer pastures and their capacities.

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The International Breeding Conditions Survey on Arctic Birds (ABBCS)

Broad objectives of project

The International Breeding Conditions Survey on Arctic Birds (ABBCS) is a project of the International Wader Study Group, aiming at collating information on environmental conditions on breeding grounds of Arctic nesting birds in a regularly updated database. The data are collected from a network of respondents on an annual basis, and published electronically to the project websites (http://www.arcticbirds.ru and http://www.arcticbirds.net). Most of the data can be accessed via interactive maps and using on-line queries to the database. Interactive maps on bird breeding success, rodent abundance, and weather parameters in the Arctic are available for the period from 1988-2007, but information is most complete starting from 1998. Interactive maps and information linked to them are updated approximately every 2 months. Breeding conditions reports of the network participants are published annually in the information bulletin, along with the analysis of information for the last season and occasional papers relevant to different aspects of dependence of bird breeding performance in the Arctic on climatic, predatory and other factors. Eight issues of the bulletin (in English and in Russian) are available electronically on the project websites. Hardcopies can be requested from the project coordinators free of charge; the bulletin issue #9 is in print in March 2008.

The database holds 1072 site-year reports on bird breeding conditions in the Arctic (March 2008), which can be accessed on the project websites via interactive maps. Information from the survey database was used in the analyses which results appeared in the following publication:

Soloviev, M.Y., Minton, C.D.T. & Tomkovich, P.S. 2007. Breeding performance of tundra waders in response to rodent abundance and weather from Taimyr to Chukotka, Siberia. pp. 131-137 in Boere, G.C., Galbraith, C.A. & Stroud, D.A. (eds). 2007. Waterbirds around the world. TSO Scotland Ltd., Edinburgh, UK. 940 pp. Available online at http://www.jncc.gov.uk/PDF/pub07_waterbirds_part3.3.1.2.pdf.

Specific species and ecosystems included

Searchable on-line database contains 17736 records on breeding status and abundance of 348 species of birds (March 2008). On-line queries return tabular data on breeding status and abundance of a bird species in requested years, with geographic coordinates and proper references, while a map returned by image map server allows visualizing localities provided in the table. Categorical information on rodent abundance (570 records on ca. 30 species or species groups) is currently available on the web via interactive maps, but not via on-line queries.

Geographic coverage

Circumpolar Arctic. Information is most complete and consistent for the Russian Arctic from 1998 and Alaska (USA) from 2001. Coverage in other regions is less complete, although there are long-term monitoring stations in Canada and Greenland participating in the project already for 7-10 years.

Recent Progress

In winter and spring 2008 information on bird breeding conditions in the Arctic in summer 2007 has been collected and published electronically. The project website in spring 2008 will be reconfigured to provide principal types of information also in the Russian language. Bulletin issue # 10 is planned for publication in autumn 2008. However, the financial support, available for the project from 1998 to 2005, was discontinued in 2006, which resulted in failure to publish bulletin issue # 8 as a hardcopy, and certain difficulties in maintaining and extending a network of respondents. The funding opened again in 2007 allowed to improve the situation and prepare bulletin issue # 9 for publication, but the support for further activities in 2008 is currently (March 2008) not available.

Year	Country								Total sites
	IC	NW	FI	SW	RU	US	CA	GR	
1988	0	0	0	0	11	1	0	1	**13**
1989	0	0	0	0	19	1	0	1	**21**
1990	0	0	0	0	23	1	0	1	**25**
1991	0	0	0	0	35	1	0	1	**37**
1992	0	0	0	0	35	1	0	1	**37**
1993	1	1	0	0	35	0	0	2	**39**
1994	0	1	0	0	66	0	2	2	**71**
1995	0	3	1	1	45	3	4	3	**60**
1996	1	2	0	0	33	0	3	2	**41**
1997	0	1	0	0	47	1	2	2	**53**
1998	0	1	0	0	40	2	2	2	**47**
1999	0	1	0	0	30	6	10	3	**50**
2000	0	1	0	0	39	6	7	3	**56**
2001	0	1	0	0	49	17	8	2	**77**
2002	0	2	1	1	55	17	9	3	**88**
2003	0	1	2	0	45	14	8	3	**73**
2004	0	2	3	0	54	18	9	2	**88**
2005	0	1	2	0	59	16	11	2	**91**
2006	0	1	0	0	47	15	13	3	**79**

Countries: IC – Iceland, NW – Norway, FI – Finland, SW – Sweden, RU – Russia, US – USA, CA – Canada, GR – Greenland.

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Information Cooperative Centre of Monitoring of Russian Arctic Biodiveristy

Arcady Tishkov

Broad objectives of project

Interdepartmental cooperation and the methodical help on gathering, processing and dissemination of information on biodiversity of the Russian sector of Arctic

Specific species and ecosystems included

Arctic species and ecosystems of Russia

Geographic coverage

Russian Arctic

Recent Progress

Update Pending

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Monitoring of Hunting Animals

Broad objectives of project

Regular counting of hunting mammals and birds

Specific species and ecosystems included

Some species of animals officially recognized as hunting ones

Geographic coverage

Territory of Russia

Recent Progress

Update Pending

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Freshwater Ecosystem Monitoring

Broad objectives of project

The overall objective of the Swedish national monitoring of freshwater is to describe the state and changes in the state of the environment. The sites of trend stations are selected for as little as possible of regional and local stressors. The national monitoring programme has a nation wide perspective, with an aim to generate a picture of the country as a whole, also to generate data for obligatory international reporting demands as well as non binding reporting. The station net shall also generate data for the six environmental quality objectives which are connected to water (Natural acidification only, Zero eutrophication, Flourishing lakes and streams, Good-quality groundwater, A non-toxic environment and a rich diversity of plant and animal life) which represents a common environmental goal for Sweden

In addition to the national program fresh water monitoring is also per-formed on a regional level by the County administrative boards and at the local level by the municipalities. The regional monitoring programme reflects the national system but with a focus on recipient control and different kinds pollutants and/or effects of measures in the water bodies.

Specific species and ecosystems included

The monitoring system covers' most of the lakes, rivers and ground water types. The program is designated as a trend programme and as such most of the monitoring activities are monitored annually. Monitoring of lakes is performed one, four or eight times a year depending of type of lake and parameters selected. Monitoring of rivers is done every month. The monitoring activities include chemistry and biology and the sampling sites are located at the same spot if possible. The biological parameters monitored are fish, zooplankton, phytoplankton, macrophytes, perifytic algae and benthic fauna. In 32 lakes there is a specimen banking program performed which consists of sampling of perch that is preparated and stored at –80°C freezers for future analyses on the content of metals and organic substances.

Geographic coverage

The monitoring program is nationwide with 110 trend stations for lakes, 63 trend stations for rivers with addition of 47 river mouths. This latter monitoring is performed on chemical parameters only and the aim of the program is to estimate the contribution from the Swedish inland to the surrounding seas. The 47 big rivers correspond to 87% of the total run off. Within CAFF area, 8 lakes and 9 rivers are monitored intensively.

The map on the left shows the 67 trend stations in rivers — and the 47 river mouths. The map on the right shows the 110 trend stations in lakes. On the maps the five Swedish water districts are shown

Recent Progress

During 2006 a revision of the national monitoring program was performed. The main focus on this revision was to adjust the monitoring to the demands in the Water Frame Work directive both concerning parameters monitored and types of water bodies included. Some additional water bodies were selected and mainly biological monitoring was enhanced. During 2008 a revision is taking place in the regional monitoring system with the same focus and the Water Frame Work directive. Finally more local monitoring systems will be revised.

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Marine Coastal Fish Populations

Broad objectives of project

Integrated studies of coastal fish with respect to population development, health status and concentrations of POPs and metals

Specific species and ecosystems included

Stationary coastal fish in the North Baltic Sea. Coastal brackish ecosystems

Geographic coverage

One area in the Northern Baltic Sea (plus three areas in non-arctic environments) for integrated studies of fish populations, hazardous substances concentrations and health status. In addition there are a number of areas where central and regional authorities study population development and composition of coastal fish in a coordinated manner.

White squares = Integrated studies. / Black squares = Population studies by different authorities.

Recent Progress

Yearly, long term studies. Recently, sampling methods have been changed in order to include fish of a broader size spectrum for improved ecological studies from small to large fishes.

The project includes measurements with standardized methods of population density and structure of stationary coastal fish of all species, age distribution of perch (Perca fluviatilis) and occurrence of external signs of diseases. In the viviparous blenny (Zoarces viviparous) a number of reproduction variables are measured. In parallel,studies of biochemistry and phusiological status are made on the two latter species, as well as concentrations of POPs and metals (see project "Metals and POPs of Marine Biota).

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Marine Macro Benthos

Broad objectives of project

To detect possible long-term changes of soft bottom macro benthos species distribution and abundance in relation to eutrophication and oxygen depletion

Specific species and ecosystems included

Marine soft bottom ecosystem

Geographic coverage

Swedish coastal and offshore waters

Recent Progress

According to the requirements of the EU Water Framework Directive (WFD), the status of the benthic fauna is used, in addition to other physical-chemical and biological quality elements, to classify the environmental conditions of the coastal zone. As a response the WFD requirements, the Swedish national benthos programme has been evaluated and changed accordingly. A number of regional station clusters were formed, each acontaning about ten individual monitoring sites. This sampling strategy allows an interpretation on different geographical scales. See enclosed map.

The status of soft bottom benthos is evaluated, based on a Benthic Quality Index (BQI). The index uses three variables: species composition (proportion of sensitive and tolerant species), abundance and number of species. These variables react to changes in organic load.

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Marine Top Predators

Broad objectives of project

To follow the population development of and health status of marine top predators, particularly with respect to impacts of POPs.

Specific species and ecosystems included

White-tailed eagle (Haliaeetus albicilla), grey seal (Halichoerus grypus), harbour seal (Phoca vitulina) and ringed seal (Phoca hispida).

Geographic coverage

Swedish coastal area

Recent Progress

Yearly studies of long term effects. The seals are photographed via aerial surveillance and later counted from the photographs, or counted from land or boat. All inhabited nests of the white-tailed eagles are localized during spring. They are visited later in the season, when the young birds in each nest can be counted.

In addition the health status of seals, which have been found dead from different causes, is determined by documentation and classification of injuries and abnormalities of different body organs.

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Metals and POPs of Marine Biota

Broad objectives of project

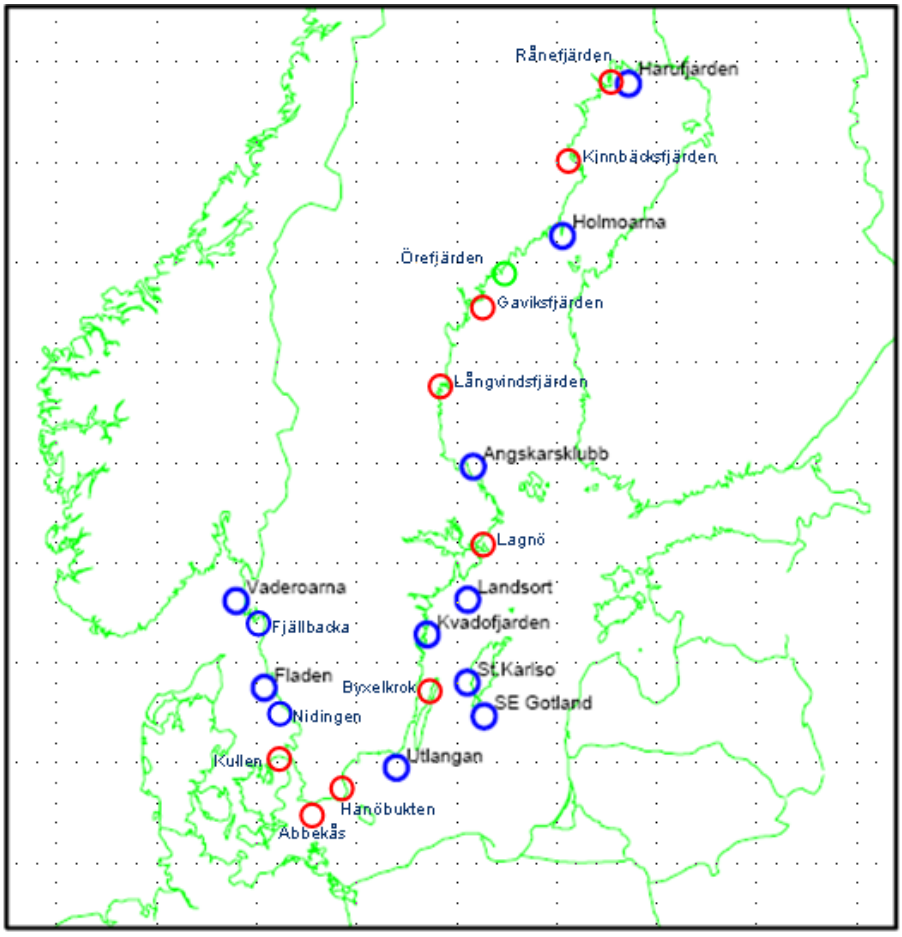
To follow long-term trends of concentrations of metals and POPs in marine organisms.

Specific species and ecosystems included

Fish, blue mussel (Mytilus edulis), guillemot.

Geographic coverage

Swedish coast including Arctic areas. Recently, the number of areas has been increased to around 20 along the Swedish coast.



Recent Progress

Yearly, long term studies, maily in reference areas. Main investigated species is herring (Clupea harengus), but also guillemot (eggs), blue mussels, cod, perch and viviparous blenny are studied.

Yearly analyses of metals (Hg, Pb, Cd, Cu, Zn, Cr, Ni. Ag and As planned), PCB (7), DDT (incl. DDD and DDE), HCH (α, β, γ), HCB, BDE:s, HBCD, PAH (in mussel, 3 areas only), dioxins, organic tin compounds and perfluorinated compounds. Less frequently analyses of relevant EU Water Framework Directive substances are made. Screening activities are regularly performed for additional relevant substances

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Monitoring of Predators

Broad objectives of project

The objective is to monitor five predator species to be able to manage their populations in a proper way.

Specific species and ecosystems included

The predators are Lynx, wolverine, wolf, brown-bear and golden eagle.

Geographic coverage

Nationwide. However, those species are all of great importance in the CAFF area and half of the budget is allocated to this area.

Recent Progress

Update Pending

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Monitoring of Small Animals

Broad objectives of project

The aim is to monitor trends in small mammal populations, both as an impact indicator for e.g. toxic pollutants and climatic change, and as cornerstone species for higher trophic levels(vertebrate predators).

Specific species and ecosystems included

Biyearly trapping of voles, lemmings, and shrews at 2 forest-dominated sites and 3 mountain (subalpine-alpine) sites.

Geographic coverage

South-central to northern Sweden. Two of the mountain site are within the CAFF area, and the third is near outside

Recent Progress

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National Inventory of Landscapes in Sweden (NILS)

Broad objectives of project

The aim of NILS is to monitor aspect of landscape composition, biodiversity, cultural heritage and N2000 biotopes. It is based on a systematic sample of 5 x 5km plots, which are mapped by interpretation of false colour air photos, and subsequently visited in the field. It is a yearly program, but each plot is mapped and visited every 5th year. The project has a website at http://nils.slu.se/, from which English translations of the manuals for the air photo interpretation and for the field work can be downloaded.

Specific species and ecosystems included

All terrestrial ecosystems are covered, including wetlands and shores. Monitored species include: all forest and bush species, a selection of vascular plants, lichens and mosses in the field and bottom layers. Two species of epiphytic cyanolichens are also monitored. In addition, capercaille, black grouse, hazel grouse and ptarmigans are observed.

Geographic coverage

Nationwide. Of 620 5 x 5 km plots, ~130 is in the CAFF area.

Recent Progress

Update Pending

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Swedish National Inventory of Forests (RIS)

Broad objectives of project

RIS is a yearly inventory of forest and forest soils, based on a systematic sample of field plots. It comprises the National Forest inventory (NFI), which focuses on the tree layer but also on other parts of the vegetation as well as general site and land use conditions, and the Swedish Forest Soil Inventory (MI), which acquires data on state and changes of forest soils. While the emphasis historically has been on forests from a timber production perspective, biodiversity aspects increasingly have been included during recent decades. Today, the Swedish National Inventory of Forests conducts a broad assessment of forests, including most aspects of relevance for sustainable forestry.

Some major objectives are to:

- Make annual contributions to Swedish official statistics on state and changes in Swedish forests
- Provide data for long-term scenario analyses regarding the potential future utilization of Swedish for ests
- Provide data for the Swedish environmental quality objectives regarding forests, acidification, etc.
- Annually deliver data to the Climate Convention and its Kyoto Protocol, regarding emissions and removals of greenhouse gases within the land use, land-use change, and forestry sector.
- Annually deliver data to the Convention on long-range trans boundary air pollutions, regarding state and changes of forest condition
- Contribute to general Swedish environmental monitoring of forests and forest-related land cover categories
- Provide data for research

Specific species and ecosystems included

All major species of trees and bushes are monitored, as well as more than 250 individual species or species groups from the field and bottom layers (dwarf shrubs, herbs, mosses, lichens); some epiphytic lichens also are included. Anthills, traces of woodpecker activities, dead wood, and fruiting bodies of some wood-inhabiting fungi are examples of other ecologically relevant recordings within the inventory. While the focus of the inventory is forests, all land use categories are included and the inventory provides representative sample data from the entire terrestrial landscape. However, in some cases (mainly in alpine regions and large agricultural areas) the assessment of the sample plots only is conducted in maps and/or aerial photographs.

Geographic coverage

The inventory has nationwide coverage. Annually, data from about 10 000 sample plots are collected; the plots are allocated in small clusters in order to make the field work more cost-efficient. In order to assess changes more efficiently, about 2/3 of the plots are permanent and re-assessed every 5 years. The remaining plots are temporary, and thus assessed only once. Each cluster of plots comprises 4-16 plots, depending on inventory stratum. The design is optimized so that it accounts for the lower spatial auto correlation of conditions in southern Sweden as compared to northern Sweden. The plots are concentric – vegetation related recordings are made on plots in the range 0.3 – 5.64 meters while tree related recordings are made on plots in the range 3-20 meters.

Recent Progress

The inventory started in 1923 and has undergone several development steps. A major transition occurred in the 1940s when the original strip sampling design was exchanged to a plot design, of the same kind as the one used today. In the 1980s permanent plots were introduced. Changes during the last decade has focused more on what variables are assessed in the inventory and inclusion of several new, ecologically relevant, variables has been made.

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Screening of Chemical Substances

Broad objectives of project

Screening mainly of POPs in all kinds of media including arctic and subarctic animals to identify substances which potentially can cause health and environmental problems

Specific species and ecosystems included

Marine ecosystems (fish, sediment, blue mussel), freshwater ecosystems (fish, sediment), air transport, terrestrial ecosystems (birds, terrestrial animals, soil), Human exposure (blood, urine, mothers milk), urban areas (air, sewage sludge, runoff water)

Geographic coverage

All over Sweden

Recent Progress

A number of chemicals and/or groups of chemicals are chosen for screening each year. The aim is to find out whether they are released into the environment into levels that can cause harm to man as well as to the environment. Screened substances include e.g. perfluorinated substances, different brominated flame retardants, a number of high volume chemicals, biocides, pharmaceuticals, additives like musk and pigment colors, metals like silver and platina, phenolic substances, substances prioritized by the EU and other international fora.

Different substances are found to different extent and it is not possible within the frame of this presentation to give a summary of all results obtained. For more detailed information see these reports published by the Swedish Environmental Protection Agency:

- http://www.naturvardsverket.se/Documents/bokhandeln/620-5744-8.htm
- http://www.naturvardsverket.se/Documents/publikationer/620-5524-0.pdf

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Circumpolar Monitoring Strategy for Ringed Seals and Beluga Whales

Broad objectives of project

The objective of this project is to develop comprehensive, integrated strategies for monitoring all aspects of the status of ringed seals (Phoca hispida) and beluga whales (Delphinapterus leucas) throughout their arctic ranges. In this context, it is important to recognize that the status of a marine mammal population reflects both the current dynamics of the populations as well as the population's resistance or resilience to current and projected threats. To effectively monitor status, it is necessary to monitor not only population dynamics but also the key intrinsic and extrinsic factors that drive those dynamics. These factors can be grouped into five categories: (1) behavior and (2) health status as intrinsic drivers and (3) trophic dynamics, (4) habitat, and (5) human activities/threats as extrinsic drivers. In many cases, population dynamics can be influenced by complex interactions of these drivers. For example, the impacts of human activities are often expressed through changes in health status, habitat, or trophic dynamics of a species, which in turn affect the species' population dynamics.

Specific species and ecosystems included

Species: Ringed seals and beluga whales, as well as key prey (e.g., arctic/polar cod, Boreogadus saida), competitor, and predator (e.g., killer whale) species.

Ecosystems: Marine and coastal ecosystems throughout the Arctic. Both ringed seals and beluga whales have circumpolar and broad distributions.

Geographic coverage

Circumpolar

Recent Progress

An international workshop was convened during 4-6 March 2007 at L'Oceanogràfic in Valencia, Spain to review current regional research and monitoring efforts and to develop integrated, circumpolar monitoring plans for ringed seals and beluga whales. Workshop participants reviewed previous and ongoing research and monitoring efforts, identified key efforts that should be continued or initiated, and provided recommendations regarding the geographic scale, frequency, and location of future efforts. In particular, participants discussed research and monitoring needs for each species with respect to population dynamics and the five categories of factors that influence population dynamics described above: behavior, habitat, health status, trophic dynamics, and human activities/threats. Information and recommendations provided at the workshop will be used to develop monitoring strategies for ringed seals and beluga whales.

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Circumpolar Seabird Monitoring and Contaminants

Broad objectives of project

Create a joint CAFF/AMAP program to concurrently monitor populations, productivity parameters and contaminants of selected seabirds at the circumpolar scale

The Seabird Tissue Archival and Monitoring Project (STAMP) is a long-term, collaborative effort by the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge (USFWS/AMNWR), the U.S. Geological Survey's Biological Resources Division (USGS/BRD), the National Institute of Standards and Technology (NIST), and the Bureau of Indian Affairs Alaska Regional Subsistence Branch (BIA/ARSB) to monitor long-term trends in environmental contaminants in Alaska seabirds using eggs and other tissues. STAMP began in 1999 with an emphasis on seabird colonies in the AMNWR. This is the largest National Wildlife Refuge in extent of geographic coverage in the U.S. It extends from the Chukchi Sea (Arctic Ocean) at Cape Lisburne south through the Bering Sea, west to the end of the Aleutian Chain in the Gulf of Alaska, and east through the Gulf of Alaska to Forrester Island near the southern most end of Southeast Alaska. Seabird colonies within this refuge are associated with a several arctic and sub-arctic marine ecosystems. More than 95% of the seabirds breeding in the continental U.S. nest at colonies in the Bering and Chukchi seas and in the Gulf of Alaska, and about 80% of these birds are found on Alaska Maritime National Wildlife Refuge (AMNWR) lands. Within the last three years the project has expanded to include colonies outside the Refuge, emphasizing colonies associated with Alaska Native subsistence use.

In addition to providing information on contaminant levels as related to the health of the birds, data generated by STAMP provide information on contaminants in a subsistence food resource (residents of many northern coastal communities harvest eggs from seabirds for local consumption), and are being used for geographic and temporal monitoring of marine and coastal environments. Seabird eggs, have played important roles in environmental monitoring in Europe and Canada where analyses of eggs have successfully documented temporal changes in PCBs, pesticides, and mercury. Many of these efforts have been ongoing since the 1970's in Canada, and in northern European countries such as Sweden, Norway, and Germany as part of a system to monitor the efficacy of environmental controls. The international Arctic Monitoring and Assessment Programme (AMAP) recommended using eggs from alcids (a family of seabirds) for circumpolar monitoring of persistent organic pollutants (POPs). Experiences of the European and Canadian programs indicate that one group of alcids, murres (Uria spp.), are particularly useful for monitoring contaminants. Murre eggs are also important subsistence foods in many parts of the world, including Alaska

Specific species and ecosystems included

Glaucous Gull, Black-legged Kittiwake, Common Murre, and Thick-billed Murre

Geographic coverage

Selected seabird colonies throughout the Arctic Region

Recent Progress

CBird (CAFFs Seabird Expert Group) is working on a Circumpolar Seabird Monitoring Plan which would identify potential colonies that could be used for the joint CAFF/AMAP monitoring.

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North-Pacific Climate Regimes and Ecosystem Productivity

Broad objectives of project

Two objectives 1) To monitor changes in coastal marine ecosystems through a network of in situ and remote observing systems; 2) To develop biophysical indicators and models that meet the needs of marine resource managers to adapt to predicted climate-induced changes in living marine resources

Specific species and ecosystems included

The North Pacific Climate Regimes and Ecosystem Productivity (NPCREP)

Geographic coverage

The eastern Bering Sea and the Gulf of Alaska

Recent Progress

Update Pending

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Russian-American Long-Term Census of the Arctic (RUSALCA)

Broad objectives of project

Gathering long-term observations to improve understanding of the causes and consequences of the reduction of sea ice cover in the Northern Bering Sea and Chukchi Sea., and further northward into the Arctic Ocean.

Specific species and ecosystems included

Zooplankton, fish larvae, fish, and benthos, phytoplankton, productivity, nutrients, variability of the above over space and time, co-monitored with the background physical and chemical oceanography. In 2008 a passive acoustic Whale monitor will be added to a RUSALCA mooring on the Southern Chukchi Plateau

Geographic coverage

From St. Lawrence Island in the Bering Sea northward into the Chukchi Sea and into the Makharov Basin. The region includes both U.S. and Russian territorial waters

Recent Progress

A complete chain of moorings from Alaska to Russia across the Bering Strait has been installed in 2007 to monitor the flux of heat, salt, and nutrients to and from the Pacific Ocean (Bering Sea) to the Arctic Ocean. This mooring chain is serviced on a yearly basis. In 2008 RUSALCA will revisit the stations sampled of 2004 to provide observations about changes in the ecosystem as well as changes in the physical and chemical oceanography of the region. RUSALCA hopes to expand to the west and north of Wrangle Island and north of the Herald Canyon into the Makharov Basin.

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Seabird Tissue Archival and Monitoring Project (STAMP)

Broad objectives of project

Using seabird eggs to investigate the geographic and temporal patterns in legacy contaminants, mercury, organotin compounds, and emerging contaminants of concern at Alaskan seabird colonies and in Alaskan marine ecosystems

Specific species and ecosystems included

Five seabird species were selected by STAMP: common murres (Uria aalge) and thick-billed murres (U. lomvia); black-legged kittiwakes (Rissa tridactyla); and glaucous gulls (Larus glaucescens) and glaucous-winged gulls (L. hyperboreus)

Geographic coverage

From the Chukchi Sea, southward throughout the Bering Sea to the end of the Aleutian chain (with efforts underway to include the Commander Islands in Russia), and throughout the Gulf of Alaska southward to Washington State (with plans to include colonies in California)

Recent Progress

Data from murre eggs collected previously by STAMP at colonies associated with deep oceanic habitats in the Bering and Chukchi seas and Gulf of Alaska have suggested that there are north-south and east-west geographical gradients in contaminant levels (see Christopher et al. 2002, Vander Pol et al. 2004, Day et al. 2006). To help verify the presence of these trends, STAMP added more sampling sites to the project, including murre colonies in coastal mainland habitats, e.g., Cape Pierce, Cape Denbigh (Fig. 1). Verifying geographic patterns is an important first step in identifying contaminant sources, transport routes, and pathways through marine food webs. Also, to determine if geographic differences in persistent organic pollutants (POPs) and mercury levels are also reflected in gull eggs, glaucous and glaucous-winged gull eggs obtained from one Chukchi Sea, four Bering Sea, and two Gulf of Alaska colonies were also analyzed for contaminants.

Through funding support from the North Pacific Research Board (NPRB Project 0534), murre and gull eggs collected in 2002-2005 were recently analyzed by the National Institute of Standards and Technology using state-of-the-art techniques. Analyses confirmed the presence of geographic contaminant patterns in the Gulf of Alaska and Bering Sea. They also verified that Gulf of Alaska POPs and mercury levels differed from Bering and Chukchi sea levels, and suggested that POPs patterns were similar in gull eggs (regional differences in mercury were not present in the gull eggs). Polybrominated diphenyl ethers (PBDEs) and organotins were documented in Alaskan seabird eggs for the first time. Evidence was found that some POPs (e.g., DDT) declined in murre eggs over the last 30 years and that others may also be declining (PCBs and HCBs at St. Lazaria Island in the Gulf of Alaska). Mercury levels in murre eggs were similar to values reported from other parts of the world. Geographic patterns in organotins in murre eggs differed from POPs and mercury patterns found in the same eggs. Levels were higher in the Gulf of Alaska and Chukchi Sea than in the Bering Sea. Organotin values in murre eggs were also about 2.5 times higher and less variable than the levels in gull eggs, a difference that probably reflects differences in foraging habitats and strategies.

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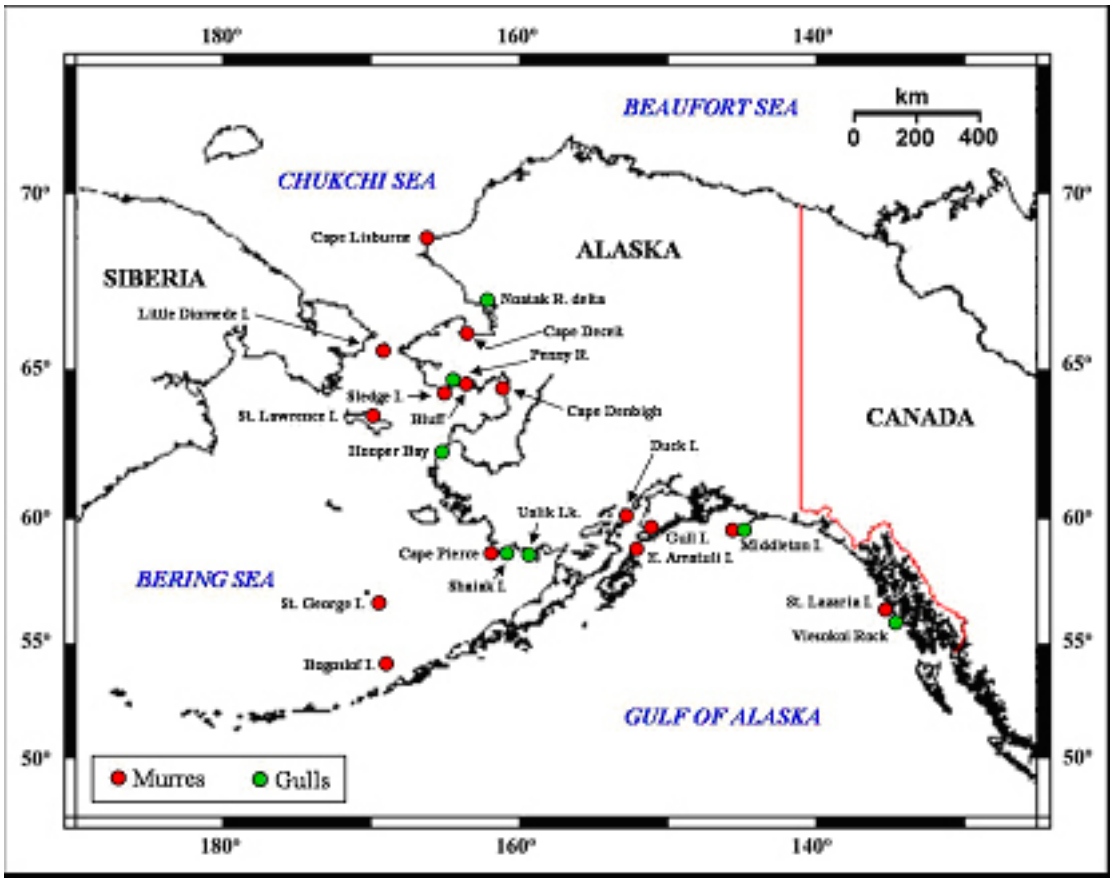

Figure 1. Murre and gull colonies where eggs have been collected and analyzed by STAMP for concentrations of contaminants.

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Appendix 1: Green Paper on AMAP-CAFF Coordinated Monitoring Effort

1.1 Introduction

Achieving sustainable development within the Arctic rests on the ability to maintain the integrity of Arctic ecosystems in light of rapidly increasing stressors such as climate change, contaminants, and economic development. In order to support science -based policy and decision-making for the sustainable use and conservation of the Arctic's living resources it is necessary to conduct sustained monitoring of key environmental variables. From it's beginning, the Arctic Council has identified monitoring as a key activity, coupled with assessments that address issues of importance to the Council. Two of the Working Groups of the Arctic Council have a monitoring mandate, the Arctic Monitoring and Assessment Program (AMAP) and the group on Conservation of Arctic Flora and Fauna (CAFF). AMAP's monitoring program is based on ongoing national and international monitoring activities. These are harmonized to the meet AMAP specifications for implementing a coordinated circumpolar monitoring program that is capable of delivering the data to meet AMAP's assessment needs.

CAFF's monitoring is implemented through the Circumpolar Biodiversity Monitoring Program (CBMP). The purpose of this paper, is to further explore how AMAP and CAFF can look for opportunities to coordinate their monitoring programs to further strengthen our understanding of the processes driving change across the Arctic and the effects of these changes on Arctic ecosystems, and to identify possible actions to compensate for, or reverse the effects of these changes, with sustainability and sustainable use of Arctic ecosystems as the ultimate goals. The main part of the AMAP – CAFF Coordinated Monitoring will be implemented through National Programs that fulfill AMAP and CAFF needs.

1.2 AMAP monitoring

Priority issues covered by AMAP monitoring activities include the levels, trends and effects (on biota and humans) of specific contaminants (persistent organic pollutants – POPs, heavy metals, radionuclides, etc.) that are present in the physical environment or carried in the tissues of organisms. AMAP monitoring priorities also include the environmental consequences and effects of global climate change, stratospheric ozone depletion, the effects of pollution on environment and human health, and the combined effects of pollutants and other stressors on ecosystem components and humans. 1

1 A Strategy for Coordination of Monitoring Activities between CAFF and AMAP. Submitted to AC Ministers, November 2004. This document began the process of coordination by outlining the general approach to be used.

1.3 CAFF monitoring

The priority for CAFF's monitoring activities is monitoring species, their habitats and ecosystems, including population sizes and distributions; reproductive health and survival; food web and ecosystem integrity - including marine, terrestrial, coastal and freshwater; migration patterns; and assessment of the effects of climate change and other impacts both natural and human-induced, on biodiversity. This type of monitoring provides an overall view on the status and trends of species that live and breed in the Arctic and their habitats, on different/various temporal and spatial scales, and ecosystem health at large.

1.4 An ecosystem -based approach to monitoring

If the monitoring strategies of the two Working Groups are viewed from the perspective of an integrated ecosystem-based approach (EBA), the manner in which the two monitoring programs fit together becomes clearer.

CAFF has the responsibility for monitoring ecosystems from the standpoint of species, their populations, habitats, and impacts on biodiversity resulting from a suite of stressors. AMAP is monitoring many of the relevant stressors, and their effects on Arctic ecosystems, e.g. climate change parameters, contaminants and Ultra Violet radiation.

By bringing data series for the two monitoring programs together, a strong approach that can forge to maintain ecosystem health and structural integrity, resiliency, and sustainability. AMAP assessments of 1997 and 2002 demonstrated the potential for linkages between contaminant transport pathways and fate, and changes in climate and UV radiation. The Arctic Climate Impact Assessment (ACIA) report demonstrated that

climate change will cause changes in biodiversity, but also noted that local human actions can be more influential on biodiversity in some cases than broad scale pressures of climate change. To most accurately assess the changing state of the Arctic environment, and evaluate the causes for change, simultaneous measurement of physical climate variables, contaminant loadings, and biodiversity are essential.

Ultimately, this type of ecosystem-based approach relates back to the Indigenous and other local people, and sustainability of Arctic communities where people depend on biodiversity and ecosystem health for food, economic sustenance, and preservation of culture. Human health depends in part on stressors such as contaminants (e.g. in food), and UV radiation. Through a better, more comprehensive understanding of species and their populations, and the stressors affecting change to these populations, we may also identifying the stressors affecting the economic, social and cultural fabric of Arctic communities.

1.5 Goals of the Coordinated Monitoring Efort

- Form a more complete picture of the overall state of Arctic ecosystems, and their extent of structural integrity, resiliency, and sustainability.
- Identify and/or quantify stressors affecting sustainability of Arctic ecosystems, and therefore the Arctic's living resources.
- Seek efficiencies of operation as directed by the Senior Arctic Officials (SAOs) To achieve these goals, the following objectives are proposed. 1.6 Objectives of the Coordinated Monitoring Effort
- As far as possible take advantage of approaches already accepted by the Arctic Council (e.g., integrated ecosystem-based approach, large marine ecosystems) bring the existing data of the two monitoring programs together where possible for analyses.
- To achieve a more cost efficient collection and storage of data, and a better use of the data collected in assessments and research.
- Identify areas of commonality (species and/or sites and/or ecosystems), where data from the two programs already exist within national monitoring programs and analyze how the data overlap, where the linkages are, what the data is signifying, and where the gaps lay.
- Based on the gap analysis, initiate projects to fill these gaps.
- Establish better linkages between the findings of this coordinated monitoring program with those of other programs, within and outside the Arctic, in order to broaden the scope of understanding of the potential impacts of Arctic and global change.
- Communicate the findings of this coordinated monitoring effort in published reports and maps, for use by policy-makers, environmental managers, indigenous people's organizations, international organizations, and the general public.

1.7 Proposed Approach to Initiating the Coordinated Monitoring Efort

For practical purposes, the coordinated effort will be based initially on activities already underway. Most of these activities are implemented at the national level. However, it may be necessary to propose relevant new components, e.g. if programs found in some Arctic countries are not found in some others. As the coordinated effort matures, there may be increased opportunity for bi- or multi-national components. Completion and acceptance of this Green Paper by both AMAP and CAFF are the first steps in initiating the coordinated effort.

Within each of the eight Arctic Council Member States, the AMAP Head of Delegation and the CAFF National Representative have identified examples of relevant on-going national monitoring activities. These activities are summarized in Table 1. Processing the information within Table 1, may require a joint meeting of the AMAP Head of Delegations (HoDs) and CAFF National Representatives (NRs), augmented as needed by relevant experts, where the on-going activities of greatest relevance to the coordinated effort will be decided and proposed as initial activities. Over the course of 2007, the coordinated will continue to evolve and produce its initial products.

1.8 Expected High Priority Activities for the Initial Coordinated Efort

At CAFF's CBMP meeting in November 2006, and at the AMAP Climate Workshop in June 2005, experts noted that use of "integrated monitoring sites" is one of the best approaches for implementing monitoring of the type suitable for the coordinated AMAP -CAFF effort. The definition of a "site" is flexible and should be left to the countries and scientists to define, as they need. It will be clarified how the work can be coordinated with the ongoing work to establish a Sustainable Arctic Observing Network (SAON). Another good approach is

a species network, for example projects on polar bears or reindeer, that evaluate the role of environmental factors, e.g. climate and contaminants, on their health and population trends in a way that allows data and information to come together and give a broader perspective.

It should be easy for the AMAP and CAFF representatives to identify relevant existing integrated monitoring sites or nodes in a species network that support the broad objectives of the coordinated effort. Once identified, these on-going activities would be considered as high priority candidates for inclusion in the coordinated effort.