

# Witness The ARCTIC

Arctic Research Consortium of the United States Member Institution

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## Arctic Research at the Norwegian Polar Institute

The Norwegian Polar Institute (NPI) is Norway's principal organization for research, environmental monitoring, and mapping in the polar regions of both hemispheres. The Institute also advises Norwegian authorities on matters concerning polar environmental management.

NPI is a directorate under the auspices of Norway's Ministry of Environment. It was established in 1928 on the heels of Norway's Svalbard and Arctic Ocean Survey. The esteemed oceanographer Harald Ulrik Sverdrup served as the Institute's first director. Sverdrup had taken part in several arctic expeditions and had been in charge of the scientific work during Roald Amundsen's *Maud* expedition (1918-25). From 1926-28, he was director of Scripps Institution of Oceanography in California and a professor of oceanography at the

University of California, San Diego. The Institute's current director is Olav Orheim. Orheim chairs the Committee for Environmental Protection under the Antarctic Treaty and is an executive of the European Polar Board.

NPI is comprised of three departments:

- Research (with a staff of 45),
- Environmental Management, and
- Administration and Logistics.

An Information Unit publishes the peer-reviewed, multidisciplinary journal *Polar Research*, and a Svalbard Unit based in Longyearbyen provides logistical support for fieldwork and conducts year-round environmental monitoring (see *Witness Autumn* 1998).

In 1998, after 70 years in Oslo, NPI moved north of the Arctic Circle to the coastal city of Tromsø, known as the Gateway to the Arctic. The site of the University of Tromsø, the city's well-developed infrastructure, extensive facilities, and local research community offer exceptional opportunities for arctic research.

The new Polar Environmental Centre houses NPI's headquarters and other institutions that offer polar research and advisory services; several of these institutions cooperate on projects with partner organizations in northwestern Russia. The Centre hosts many national and international scientific conferences and workshops.

NPI runs research stations in Ny-Ålesund, Svalbard (see page 4 and *Witness Autumn* 1998) and operates expeditions to Dronning Maud Land, Antarctica. The NPI's research vessel *Lance* has been



Stas Belikov (All-Russian Research Institute for Nature Conservation) and Andrew Derocher (Norwegian Polar Institute) deploy a satellite telemetry collar on a female polar bear. This work was part of the Norwegian-Russian polar bear project conducted in 1997 and 1998 to study population boundaries, habitat use, and contaminant loads of polar bears in the Barents Sea (photo by Stig Nilsen).

customized for navigation in icy conditions. Available for lease during portions of each year, *Lance* can accommodate up to 24 scientists and has laboratories and a helicopter landing platform.

### Research Programs

NPI research activities are organized in five interdisciplinary Research Programs. A brief presentation of these programs and some of the individual projects within them follows.



Spitsbergen is the largest island in the Svalbard Archipelago, which lies half-way between Tromsø and the North Pole. The Svalbard Treaty of 1920 gave sovereignty over the islands to Norway (map prepared by the Norwegian Polar Institute).

## The Polar Climate Program

The Polar Climate Program, led by Jan-Gunnar Winther, encompasses studies of:

- ocean fluxes of heat, mass, and salt in Fram Strait and the Barents Sea;
- atmosphere–sea-ice–ocean interactions in the marginal ice zone;
- sea-ice coverage and thickness;
- paleoclimatic archives (including marine sediment and ice cores in the Arctic and Antarctica); and
- research on radiation, glacier mass balance, and snow distribution in Svalbard.

With its interdisciplinary expertise in polar research, NPI also contributes to the development of regional climate models.

The overarching goals of the Polar Climate Program are:

- to contribute to the worldwide search for an understanding of climate change by considering climate variability and feedbacks in the sea-ice–land–ocean–atmosphere system in the polar regions;
- to assess the system’s sensitivity to disturbances; and
- to analyze the consequences of a changing climate.

### Nordic Sea-Ice Extent and Sea-Surface Temperatures

This project, led by Torgny Vinje, investigates changes in sea-ice extent and sea-surface temperature in the Nordic seas through analysis of March–September ship logs, mostly of sealers (1860–present) and Norwegian Meteorological Institute satellite images (1966–present).

The first survey shows that the extent of ice in April has decreased by approximately 33% during the past 135 years. Nearly half of this reduction took place

before 1900. While there is a strong negative correlation between the North Atlantic Oscillation (NAO; see *Witness Spring/Autumn 1999*) winter index and the extent of ice in the Nordic seas in April, the correlation is positive for the Newfoundland–Labrador Sea. Large-scale atmospheric circulation processes, which have a seesaw effect on sea-ice extent and temperatures east and west of Greenland, extend back at least 135 years.

### ENVISAT MERIS and ASAR for Snow and Glacier Ice Studies

The main objectives of this pilot study, conducted by Max König, are:

- to explore how the coming ENVISAT MERIS and ASAR satellite instruments can be used for cryosphere studies, including how snow and glaciers respond to climate change; and
- to develop algorithms that improve present environmental monitoring programs in the Arctic.

Project researchers are studying glacier characteristics, focusing on glacier mass balance estimation in Svalbard using satellite imagery and investigating how ENVISAT MERIS and ASAR sensors can be used to identify firn and equilibrium lines, superimposed ice zones, and glacier facies. Other topics under investigation concern the remote sensing of snow distribution and albedo in Svalbard.

### Ice Core Studies

Elisabeth Isaksson carries out research on ice cores taken from Svalbard glaciers. In collaboration with several European countries, a 120-m ice core was retrieved from Lomonosovfonna (1230 m above sea level [asl]) in 1997. The core dates back to AD 1100. Temporal variations in the ice core’s record seem to agree with 20th Century climate and environmental records on decadal scales; the cores are therefore believed to provide reliable data further

back in time. In 1998 and 1999, two ice cores were drilled from the top of Austfonna (740 m asl), in collaboration with Japan’s National Institute of Polar Research. The longest core is 299 m and dates back to approximately AD 1200.

All of these cores suggest that the 1900s have been the warmest century in the past 800 years. They also provide interesting records of anthropogenic pollution in this part of the Arctic.

### Mass Balance Measurements

Since 1966, NPI has been monitoring the mass balance of two glaciers in the Kongsfjorden area of northwestern Spitsbergen—Austre Brøggerbreen and Midtre Lovénbreen. Jack Kohler is currently responsible for collecting these data, which constitute the longest continuous mass balance series from the Arctic. The mass balance of both glaciers has decreased approximately 10% since the beginning of record keeping. While the winter balance has been stable, summer ablation has been widely variable. Neither winter precipitation or summer melting exhibit trends.

Kongsvegen, a larger, surge-type glacier in the same area, spans a higher elevation interval than the two other glaciers. Monitoring since 1986 indicates a small positive balance, attributable to the higher elevation.

### Reconstruction of Decadal-Scale Sea-Surface Temperature (SST) Variability During the Late Holocene

Project researchers headed by Nalân Koç are analyzing sediment cores retrieved during the International Marine Past Global Changes Study (IMAGES) cruise in August 1999, to elucidate the variability of the Nordic heat pump on a NAO time resolution during the late Holocene. Reconstructions of Holocene paleo-sea-surface temperatures are based on diatom assemblage studies of selected sediment cores. Results show that, during the past 3,000 years, SSTs varied 1–2° on time scales of less than 100 years. There is clear evidence of Holocene climatic events such as the Little Ice Age and the Medieval Warm Period.

### Polar Climate Monitoring Programs

NPI Polar Climate Monitoring Programs collect data in collaboration with national and international institutions under research initiatives such as the Arctic Ice Thickness Measurement Programme (AITMP), Arctic Climate System Study (ACSYS), Variability of Exchanges in the Northern Seas (VEINS), European Subpolar Ocean Programme 1 and 2 (ESOP 1-2), and the Filchner-Ronne Ice Shelf Programme (FRISP). ■

## The Marine Ecology Program

NPI's Marine Ecology Program is designed to provide sound scientific advice to Norwegian and international agencies responsible for resource management and conservation issues in the polar regions. The program is directed by Kit M. Kovacs. The research staff studies the population dynamics and ecology of a wide variety of arctic and Antarctic animals, with a strong emphasis on seabirds and sea mammals. The Marine Ecology group collaborates with other researchers to explore how factors such as sea-ice distribution, freshwater influxes, sedimentation rates, and water mass properties affect these animals *via* impacts on their prey.

### The White Whale Project

NPI research scientist Christian Lydersen initiated the first scientific study of white whales (belugas) in Norwegian waters in 1995. In collaboration with the United Kingdom's Sea Mammal Research Unit, satellite tags have been deployed to study distribution, seasonal movements, and diving behavior. White whales in the Svalbard Archipelago rarely travel offshore more than a few kilometers, spending most of their time in areas where glacier fronts meet the ocean. They appear to be year-round residents and may constitute a distinct local population.

Studies of pollution levels and diet indicate that contaminant loads in white whales from Svalbard are similar to those in the Canadian Arctic; PCBs and DDT compounds are the dominant organochlorines found in the blubber. Fatty-acid profiling suggests that the whales feed on many small, schooling fishes (*e.g.*, polar cod, capelin). Collaborative studies with scientists from the United States, Greenland, and Russia are addressing vocal behavior, molecular genetics, and the stock identities of white whale in the northeastern Atlantic.

### Population Studies and Feeding Ecology of Seabirds on Bjørnøya (Bear Island)

This long-term project, initiated in 1986 and currently conducted by Hallvard Strøm, monitors population size, survival rate, diet, and other parameters of selected seabird species (*i.e.*, thick-billed murre, common murre, black-legged kittiwake, northern fulmar, glaucous gull) on an annual basis.

Between 1986 and 1987, the common murre population declined approximately 85%. While there has been some recovery since then, numbers are still less than half of the 1986 level. Collapse of the capelin stock is thought to be the main reason for the decline. While adult survival rates for both murre species have been high during the 1990s, the survival rate of the thick-billed murre has been somewhat lower than that of the common murre; the difference is likely due to extensive winter hunting of thick-billed murre off the southwestern coast of Greenland. ■

## The Ecotoxicology Program

The overall objective of the Ecotoxicology Program is to gather knowledge that will improve understanding of sources and biological effects of contaminants in the European Arctic. The emphasis is on persistent organic pollutants (POPs). A central task is the establishment and development of a POP monitoring program in the Norwegian Arctic. The program is supervised by Geir W. Gabrielsen.

### Persistent Organic Pollutants in Marine Organisms in the Marginal Ice Zone in the Barents Sea: Bioconcentration and Biomagnification

Under Gabrielsen's direction, Katrine Borgå is investigating the occurrence of organochlorines in pelagic and ice-associated crustaceans in the marginal ice zone north of Svalbard and in Fram Strait. Analysis of amphipods collected during cruises in 1998 and 1999 showed that concentrations of polychlorinated biphenyls (PCBs), DDTs, chlordanes, hexachlorobenzene (HCB), and hexachlorocyclohexanes (HCHs) were generally low (1-300 ng/g lipid weight). Levels increased from the more herbivorous species (*Apherusa glacialis*) to the more carnivorous (*Gammarus wilkitzkii*) and necrophagous species (*Onisimus* spp.). Organochlorine occurrence, especially the

pesticide HCHs, also varied spatially, with higher levels found in organisms from Fram Strait and the Greenland Sea, and lower levels in those collected in the marginal ice zone north of Svalbard. Back trajectories indicate that the sea ice at the sampling stations has a different drift route, and that the elevated HCH concentrations in ice fauna in Fram Strait correspond to elevated HCH concentrations in the surface water of the central Arctic Ocean. Ongoing analysis of the samples relates organochlorine levels to the species' diet and position in the food chain, to their pelagic or ice habitats, and to the transport routes of toxins.

### Immune Response and Chlorinated Environmental Pollutants in Polar Bears

This interdisciplinary study, launched in 1997, is designed to provide definitive answers on the likelihood that persistent organic pollutants affect immune function in polar bears and the possible mechanisms by which this can occur. Under the direction of Andrew Derocher, researchers from Norway and Canada have developed a good methodology for:

- assessing immune function under field conditions;
- measuring cell-mediated immunity to microbes; and
- testing how environmental pollutants, infections, nutritional factors, hormone levels, starvation, and stress may influence lymphocyte function.

The study has demonstrated that high PCB exposure in polar bears can impair lymphocyte function, IgG concentration, and the ability to produce antibodies following vaccination of the bears with certain microbes. ■

## The Geological Mapping Program

NPI is the Norwegian national mapping authority, including noncommercial geological surveying, for the polar areas. Geological map data are collected during field expeditions and through cooperation with international research groups. Maps are stored in a Geographical Information System (GIS) for Svalbard and published with extensive area descrip-

tions. The program elucidates important gaps in regional geological knowledge and stimulates other research projects by addressing relevant scientific problems. Winfried Dallmann is the program leader.

Since 1994, work has concentrated on Precambrian and Devonian terrains of northern Spitsbergen. Projects address:

- post-Cambrian tectonic evolution;

- depositional development and stratigraphic correlation of the Devonian molasse sediment;
- petrology and tectonometamorphic development of the Precambrian basement; and
- a comprehensive isotopic age determination project of the basement rocks. ■

## The Terrestrial Ecology Program

NPI's Terrestrial Ecology Program focuses on Svalbard birds and mammals (e.g., Svalbard ptarmigan, arctic fox, reindeer), vegetation, and the causes of change in ecological systems. The program is led by Andrew Derocher.

### Environmental Stochasticity and Plant-Reindeer Interactions

The aim of this project, begun in 1998, is to evaluate the interaction between a Svalbard reindeer population and vegetation, and the potential impacts of climate change, including stochastic variability, on this interaction. Data collected by Elisabeth J. Cooper and Ph.D. student Ronny Aanes suggest that the observed regional climate change negatively affects the growth rate of the reindeer population through two mechanisms:

- warmer winters bring more snow (making it harder for reindeer to feed); and

- increased frequency of low atmospheric pressure during summer is associated with decreased temperatures during parts of the growing season, reducing plant growth in the area and, hence, reindeer food supply.

In collaboration with geophysicists at NPI, the project group aims to develop a model to predict the frequency of icing during warmer winters. The project is undertaken in cooperation with the Norwegian University of Science and Technology and Sweden's University of Uppsala. ■



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## Ny-Ålesund: A Far Northern Research Base

With many key arctic system components (e.g., permafrost, glaciers, human settlements), Svalbard has been the base of extensive research in the fields of snow hydrology, biology, glaciology, atmospheric science, and oceanography.

Located just shy of 79°N, Ny-Ålesund has evolved from a mining community to become a European center for year-round arctic environmental research, served by commercial air service and a modern harbor. The surrounding area includes a variety of marine and terrestrial environments.

Opened in 1999, the Sverdrup Research Station is NPI's base in Ny-Ålesund and is available to the international research community. A permanent

staff maintains equipment, provides logistic support, and equips and advises field parties. Sverdrup Research Station is one of approximately 20 member institutions and research facilities involved in the European Network for Arctic-Alpine Multi-disciplinary Environmental Research (ENVINET). Joint scientific and technical studies address climate change, ozone and UV radiation, long-range transport of pollutants, and biodiversity.

At the Institute's Zeppelin Station for Atmospheric Monitoring and Research, monitoring and research programs address climate change, arctic stratospheric ozone layer depletion, air pollution, and distribution of radioactive contaminants.

The Ny-Ålesund Large Scale Facility (LSF), financed by the European Union, is a collaboration between the NPI, the Norwegian Institute for Air Research, the Norwegian Mapping Authority, Germany's Alfred Wegener Institute, and the British Natural Environmental Research Council. Japan, France, and Italy also have research bases in the village.

A new arctic marine laboratory, to be established in Ny-Ålesund in 2001, will be the northernmost marine lab in the world and the most accessible marine lab in the Arctic. Participating institutions are represented by the Marine Lab Project Group, chaired by NPI research scientist Haakon Hop. ■