Witness The
ARCTIC

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Past Environmental Change in the Arctic: A PALE Contribution to Arctic System Science

by Konrad Hughen and the PALE high-resolution research group[1]

The Arctic, although at present one of the least disturbed regions on Earth, may also be one of the most susceptible to both natural and human-induced climatic changes. The effects of global climate change are likely to be amplified in the Arctic due to positive feedback mechanisms. Melting of ice and snow, for instance, reduces the total surface area that reflects sunlight; as more solar radiation is absorbed by rock, soil, and water, the earth warms. Other feedback mechanisms operating in arctic regions may include:

- temperature inversions resulting in stable atmospheric conditions, which can trap warm air near the earth's surface; and
- local or regional increases in cloud cover amplifying a warming trend, because in the Arctic, clouds, like greenhouse gases, absorb heat (infrared radiation) escaping from the earth's surface.

Because of this sensitivity, climate change may be evident in the Arctic before it is discernible in other parts of the world.

The Arctic, in turn, may be capable of influencing climate at lower latitudes, or even globally, through:

- impacts on temperature gradients in the northern hemisphere and on atmospheric circulation,
- modulation of atmospheric greenhouse gas (*e.g.*, CH_4) concentrations and, possibly,
- complex interactions involving high-latitude river runoff and subsequent effects on global oceanic circulation.

For these reasons, the Arctic is an important region for the study of patterns of natural climate variability.

The instrumental record of arctic climate change, though brief and geographically sparse, indicates that the Arctic warmed by about 1.2°C between 1910 and 1945. While some areas of the Arctic have cooled recently, the observed average temperature increase for the Arctic exceeds that of the Northern Hemisphere as a whole.

In order to extend the record of arctic environmental variability both spatially and further back in time, researchers depend upon indicators of past climatic

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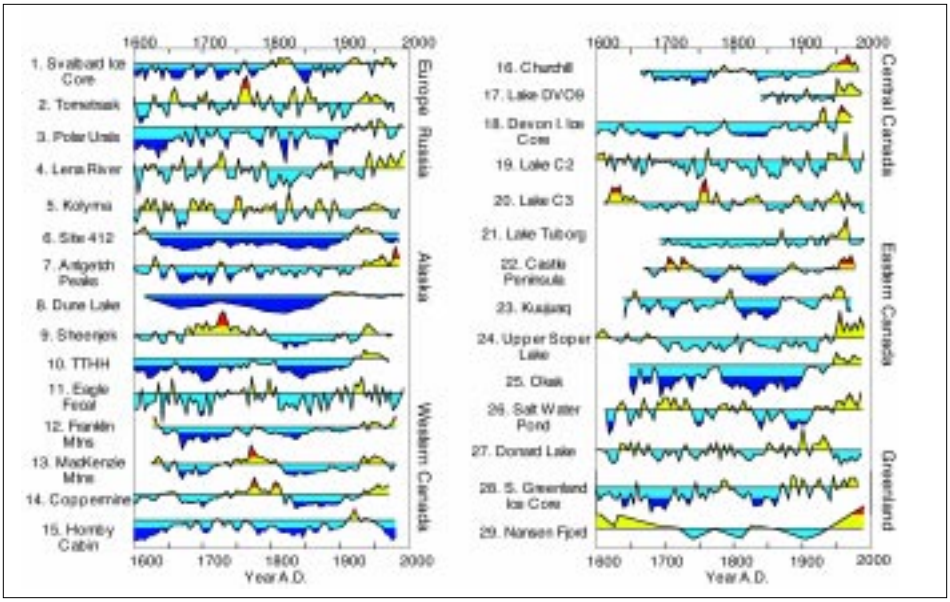

Standardized 400-year proxy climate records reflecting surface air temperature for sites from Arctic Europe east to Canada and Greenland. Red indicates temperatures greater than one standard deviation warmer than average for the reference period (1901-1960), whereas dark blue indicates at least one standard deviation colder than this average. All series presented as five-year averages, except for sites 8 and 29 which are plotted at their original, lower resolution. All time series represent surface air temperature, except site 29, which represents sea-surface temperature. These data are available at the NGDC Web site (http://www.ngdc.noaa.gov/paleo/paleo.html) (illustration by K. Hughen).

[1] J. Overpeck, K. Hughen, D. Hardy, R. Bradley, R. Case, M. Douglas, B. Finney, K. Gajewski, G. Jacoby, A. Jennings, S. Lamoureux, A. Lasca, G. MacDonald, J. Moore, M. Retelle, S. Smith, A. Wolfe, and G. Zielinski

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conditions that are preserved in ice; ocean, lake, and wetland sediments; and tree rings. Such paleorecords:

- permit the evaluation of recent climatic changes from the perspective of the past;
- help determine whether changes observed during this century are unique;
- allow the identification of interannual to century-scale climatic variability in the circumarctic region; and
- provide evidence for the role that natural forcing mechanisms play in driving arctic climate.

The Paleoclimates from Arctic Lakes and Estuaries (PALE) initiative within ARCSS (see page 8) has identified as one of its goals the recovery of high-resolution paleoclimate records from a network of sites throughout the Arctic. Here we present a brief summary of the results of a recent, PALE-sponsored study of past climate change in the Arctic (Overpeck *et al.* 1997).

The Paleoclimatic Perspective

Paleoclimate records are derived from indicators such as tree-ring widths, summer melt layers in ice cores, varve thicknesses in lake sediments (figure this page), and microfossils including foraminifera and diatoms. Such "proxy" data have demonstrated that the arctic environment underwent large changes during the Holocene (the last 10,000 years). During the early to middle Holocene, most of the Arctic experienced summers 1-2°C warmer than today. Local effects of topography, sea-surface temperatures, and land-ice cover resulted in variations in the timing of maximum warmth. In the late Holocene, decreasing summer temperatures culminated in the Little Ice Age, a period that began before AD 1500 and ended during the last century.

The new PALE paleoclimate compilation (figure page 1) is based on over 20 records of summer temperature from the North American Arctic and substantially fewer from the Eurasian Arctic. This compilation of annually resolved records provides a 400-year view of arctic variability superimposed on the Holocene trends described above. The most notable pattern of change seen in records throughout the Arctic is the transition from anomalously cold conditions of the 19th century to peak warm conditions in the 20th century (figure page 3). The 20th-century Arctic is warmer than during any period since 1600. The 19th-20th-century warming was 1-3°C locally and averaged approximately 1.5°C across the Arctic. The 20th-century warming observed in the instrumental record was, thus, only part of a larger circumarctic climatic event that began in the mid-19th century and marked the end of the Little Ice Age.

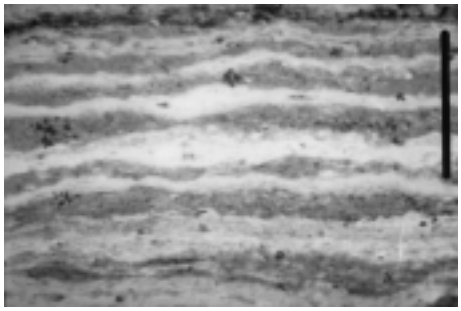
Another striking aspect of arctic temperature change over the last 400 years is that most of the Arctic experienced cooling in the first part of the 19th century, leading to the coldest period of the Little Ice Age. During parts of the 17th century, much of the Arctic was colder than today. Several of the records, however, show temperatures during the 18th century nearly as warm as today.

Arctic climatic change prior to 1800 was more regional in nature than after this time. For example, many sites around the Arctic were warmer at some time between 1700 and 1820 than they were later in the 19th century, but the timing and duration of this warmth varied significantly from region to region. This is also true of the preceding 17th-century period of generally colder conditions.

These records were combined to construct a spatially weighted record of average circumarctic summer temperatures for the past 400 years. The individual time series, together with the arctic average record and additional information on each site are available online from the National Geophysical Data Center (http://www.ngdc.noaa.gov/paleo/paleo.html).

Climate Forcing Mechanisms

The reconstruction of average paleotemperature for the circumarctic region reveals significant variability over all of the last 400 years. The record is dominated, however, by the dramatic warming trend from approximately 1840 to the 1950s. During this period, atmospheric concentrations of CO_2, CH_4, and other greenhouse gases increased rapidly as a result of human (anthropogenic) activity. Because greenhouse gases trap outgoing long-wave radiation in the atmosphere, rising concentrations are believed to cause increased global temperatures.



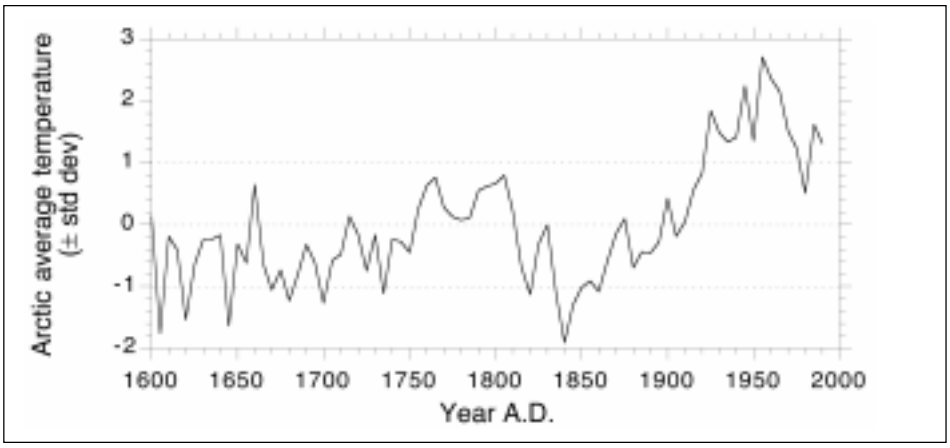
Photomicrograph of annually laminated sediments from Ogac Lake, near Upper Soper Lake, on southern Baffin Island. Light laminae result from diatoms blooming during the summer ice-free season. Dark laminae are mineral grains washed into the lake with runoff from early summer snowmelt. Many tidewater lakes in the Arctic contain similar varved sediments.

Half of the post-1840 warming (approximately 0.75°C), took place during the 80 years from 1840 to 1920, during which time atmospheric CO_2 and CH_4 increased by only 14 and 25% (20 ppm and 200 ppbv), respectively. The current best estimates of climate sensitivity to trace gases suggest that trace gases alone may be able to explain only 0.1-0.4°C of the pre-1920 warming. Therefore, the influence of other climate forcing mechanisms must be considered before attributing recent changes in the Arctic to human activity.

The possibility that the sun significantly influences climate is suggested by the fact that high inferred solar irradiance correlates with warm arctic temperatures during both the 18th and 20th centuries. In particular, the strong increase in temperatures after 1840 may have been a partial response to high solar irradiance. At least two factors, however, argue against a dominant role for solar forcing over the past 400 years:

- the absence of a distinct prolonged cold period associated with the late 17th-century Maunder sunspot minimum period (a period of low inferred solar irradiance); and
- the estimated low sensitivity of climate to reconstructed changes in solar irradiance (less than that for greenhouse gases).

With evidence mounting that human (trace gas) and solar activity may be responsible for only a fraction of variation



Spatially weighted average temperature record combining 29 paleotemperature time series from around the circum-arctic. The individual time series were standardized to the same reference interval (1901-1960) and binned into five-year averages using identical intervals. The average record shows that the entire Arctic experienced dramatic warming from the mid-1800s to the mid-1900s, culminating in the warmest temperatures of the last four centuries. To evaluate the magnitude of recent warming in the context of background variability, this average record was re-standardized using a mean and standard deviations that were calculated using the entire 400-year record. Average arctic temperatures during much of the 1900s are consistently greater than one standard deviation warmer than the rest of the record and cannot be explained as a result of natural patterns of variability (illustration by K. Hughen).

in climate, insight into the possibility that volcanic activity forces climate was gained through collaboration with a team working on the Greenland Ice Sheet Project Two (GISP2) ice core (see page 8). Comparison of the PALE temperature record with a volcanic sulfate record from GISP2 indicates that most decade-scale periods of average circumarctic cooling correspond to peaks in reconstructed volcanic activity. These findings agree with earlier evidence for significant volcanic forcing of arctic temperatures, in addition to a more regional 100-200-year record of volcano-climate linkages for subarctic North America. It is quite likely that the period of anomalously low volcanic activity from 1935 to 1960 may have contributed to the peak arctic summer temperatures at this time, reducing the implied sensitivity of the climate system to trace-gas and solar forcing during this same period. Renewed volcanic activity after 1960 likely contributed to the observed arctic cooling after peak mid-century warmth.

Thus, the first half of the unprecedented 19th-20th-century increase in arctic temperatures appears to be a natural readjustment as volcanic forcing weakens and irradiance (and, to a lesser extent, greenhouse gases) rise between 1840 and 1920. After 1920, both anomalously high solar irradiance and low volcanic aerosol loading likely continued to influence arctic climate, but exponentially increasing atmospheric trace-gas concentrations appear to have played an increasingly dominant role.

The Response to Arctic Climate Variability

An obvious impact of recent climate change is the observed retreat of glaciers throughout the Arctic during the past century. Although it has been suggested that climate warming may be accompanied by a sufficient increase in snowfall to expand ice sheets, it appears probable that most arctic glaciers will continue to melt if the Arctic continues to warm.

High-latitude permafrost conditions have also changed during the past 200 years. Ground temperature records support other evidence that dramatic warming has taken place since the 19th century. Further thawing of frozen ground will, in turn, affect hydrology, ecology, trace-gas fluxes, construction, and transportation in the Arctic.

The paleoenvironmental record of the past four centuries, together with recent ecological studies, indicates that potential future climatic warming is capable of driving changes in the arctic biosphere *that will likely rival any changes driven by non-climatic processes*, including human land use. For example, studies of recent seedling establishment and viability north of present treeline, together with evidence from annually dated fossil pollen records, suggest that those arctic plant species abundances and/or ranges have varied significantly in response to varying temperatures.

The limnology of arctic lakes is also likely to continue to respond to climatic change. Sediments from shallow ponds and lakes on Ellesmere Island show that warming since the mid-19th century caused dramatic shifts in diatom populations such as an increase in species diversity. These shifts are consistent with a longer growing season. Freshwater algae are sensitive recorders of environmental change; changes in their populations may influence the structures of higher trophic levels.

Implications for the Future

PALE reconstruction of past environmental change in the Arctic suggests that natural variability in this region is large and is working together with human activity to cause unprecedented arctic environmental change. Furthermore, the feedbacks that have amplified arctic temperature changes in the past have been nonlinear. For these reasons, linear extrapolations of observed patterns of change into the future will fail to predict arctic climatic change.

Reliable predictions of future change will require climate-system models that have proven to be effective in simulating past changes, including interactions and feedbacks, such as those reconstructed here. Even as these models are developed and tested, however, the arctic environment is likely to continue its pattern of rapid change. ■

Konrad Hughen is a NOAA postdoctoral fellow in the Department of Earth and Planetary Sciences at Harvard University, where he continues his research on arctic lakes.

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New Science Plan Guides ARCSS Research

The new ARCSS science plan, *Toward Prediction of the Arctic System*, published in March 1998 (see page 5), reviews progress over the past eight years of arctic system research and begins to define emerging questions and research priorities. Important findings, major accomplishments, and research priorities are outlined in the following pages (pages 6-9 this issue), as well as in the new science plan. The research conducted by the ARCSS program has contributed much to understanding the arctic system and leads now to the next stages of integration and synthesis.

Toward Prediction of the Arctic System sets out five questions that will form the basis of ARCSS planning over the next several years; the questions transcend the scope of any single component or project and offer opportunities for collaboration among the components. The questions are listed here with a brief description of some areas of inquiry that arise through this integrative approach. The extent of the research questions and their integration and synthesis possibilities are greater than can be described here:

1. *How will the climate of the Arctic change over the next 10 to 100 years?* Answering this question requires integration of information on land, shelf, and ocean climate feedbacks, common global and regional climate models, and testing models with paleoclimate data.
2. *How will future climate change interact with human activities to affect the sustainability of natural ecosystems and human societies?* Understanding the potential impacts of climate change requires the development of regional predictions of climate. Most of the arctic region's population live along the coast; better understanding of land-sea climate interactions is critical. Major questions include the interactions of climate change with petroleum development, hard-rock mining, long-range transport of contaminants and increased use of the Arctic by lower latitude residents.
3. *How will changes in arctic biogeochemical cycles and feedbacks affect arctic and global systems?* The synthesized understanding of arctic processes gained through ARCSS research could lead to development of the first integrated models of regional changes in arctic marine and terrestrial ecosystems, including changes in species of direct importance to people.
4. *How will changes in arctic hydrologic cycles and feedbacks affect arctic and global systems?* Research advancing understanding of small-scale hydrological processes that produce large-scale changes in river discharge could lead to prediction of changes in freshwater inputs to the shelf-basin system. In combination with the results of other ARCSS research, predictions could be made about the consequences of these changes to North Atlantic ocean circulation and, thereby, to environmental changes of substantial importance to people.
5. *Are predicted changes in the arctic system detectable?* Separating natural climate signals from human-induced climate change requires a context of past climate change on a regional basis as well as measurements of current indicators of change. In collaboration with other international efforts, a circumarctic view of past and current climate change and related changes in arctic ecosystems could be developed by systematically comparing current and past marine and terrestrial measurements.

The ARCSS Committee (AC)—the committee that provides community guidance to the ARCSS Program—will meet 29-30 October 1998 in Fairbanks, Alaska, to discuss research priorities and to continue developing the integrative and thematic aspects of ARCSS described here, as well as extrapolating ARCSS research across the circumarctic. The AC, chaired by Jack Kruse, plans to focus on:

- climate interactions and climate models—integrating terrestrial and marine processes; developing a better predictive capability;
- human/environment interactions—including building stronger connections to higher trophic level research; and
- hydrology—freshwater inputs to the marine system; interactions between the Arctic and the world oceans; predicting changes in sea ice, coastal marine productivity, and contaminant transport.

For more information, contact ARCSS Program Director Mike Ledbetter (703/306-1029; fax 703/306-0648; mledbett@nsf.gov) or Jack Kruse, AC Chair (413/367-2240; fax 413/367-0092; afjak@uaa.alaska.edu), or see the ARCSS Web site (http://arcss.colorado.edu) or the ARCUS Web site (http://www.arcus.org).

Ledbetter, Gilbert Awarded for Excellence

Two NSF Arctic Section staff members recently received the National Science Foundation Directors Award for Excellence. ARCSS Program Director Michael Ledbetter and Arctic Coordination Specialist Simona Gilbert were awarded this honor in June 1998 in recognition of their work at NSF. The awards stated:

...Gaining recognition for Administrative Excellence—Simona L. Gilbert for her knowledge and expertise in merit review and budget management in establishing a system for consistent review of the Arctic Sciences Section's research support requirements, liaison with logistics contractors, and coordination of Arctic logistics requests.

...Recognized for Program Management Excellence—Michael T. Ledbetter for his leadership, vision, and deep understanding of complex scientific issues associated with a multi-agency international project that is generating information about the surface heat budget of the Arctic Ocean to help assess global warming.

The NSF Directors Award is made annually and recognizes exceptional work by NSF staff. For more information see http://www.nsf.gov/.

Workshop Confirms Significant Arctic Change

Participants at a November 1997 workshop on the Study of Arctic Change presented research results corroborating earlier observations that the Arctic Ocean and atmosphere are in the midst of a significant physical change.

More than 70 oceanographers, sea-ice experts, and atmospheric scientists reported on manifestations of the change, discussed key questions, and deliberated how to further study the change.

By mid-1997, data from arctic expeditions and atmospheric studies suggested that the influence of Atlantic Water in the Arctic Ocean has become more widespread and intense in this decade than had previously been documented (see *Witness* Autumn 1997).

New observations include:

- There is a correlation between an increase in the temperature of Atlantic Water in the Arctic and the North Atlantic Oscillation index.
- Since 1990, there has been a marked decrease in heat and salinity input to the Arctic from the Pacific Ocean through Bering Strait.
- The cold halocline, which insulates the sea-ice cover from heat stored in Atlantic Water, has thinned and in some areas disappeared in the 1990s.
- There has been a trend in the 1990s toward decreasing ice extent, especially in the Siberian shelf seas.
- Spring and early summer air temperatures have increased. The melt season in the Arctic has gotten longer. In at least one Alaska location, permafrost temperatures have been increasing since approximately 1991.
- In atmospheric circulation within the North Pacific region in the 1990s, a Polar Pattern is increasingly important relative to the Pacific North American and North Pacific circulation patterns.
- Beaufort Sea mixed layer salinities measured in late 1997 during the SHEBA experiment (see page 7) are substantially lower than they were in the 1970s. This suggests that there has been increased melting of ice during summer. Heat (solar radiation) stored in the mixed layer is also greater.

Together, these and earlier observations suggest that arctic change is at least a decadal-scale phenomenon that has broad implications and relates to changes at lower latitudes. Workshop participants proposed that an international Study of Arctic Change should include:

- regular measurements of atmosphere, ocean, ice, and some terrestrial parameters for at least the next decade;
- examination of historical records for evidence of such change in the past; and
- a modeling effort to try to understand the causes of the change.

Some of the required observations are being carried out now as part of other programs. Prompt attention to the need for further data can close critical gaps.

The Arctic Change workshop was funded by the NSF ARCSS Program. A draft workshop report is available for review (http://psc.apl.washington.edu/Arctic_change/Report_5.html).

For more information, contact James Morison in Seattle, WA (206/543-1394; fax 206/543-3521; morison@crosby.apl.washington.edu). ■

All-Hands Workshop Report

Toward An Arctic System Synthesis: Results and Recommendations, the report from the first Arctic System Science (ARCSS) Program all-investigator workshop, which convened in May 1996 in Snowbird, Utah, is now available. More than 175 researchers who had been active in the first seven years of ARCSS research, investigators from other major national and international arctic research programs, and representatives of federal agencies conducting arctic research presented results, assessed the state of the ARCSS scientific enterprise and worked together to identify the following three research priorities related to the workshop theme, *Variability of the Arctic System: Manifestations and Mechanisms*:

- Temporal and Spatial Change;
- Environment, Resources, and People; and
- Global Change and the Arctic System.

Synthesis recommendations from the workshop were further developed in discussions with members of the arctic research community. These recommendations formed the basis for the new ARCSS science plan (see below).

The report is available from ARCUS (arcus@arcus.org). It is also available as a PDF file on the ARCUS Web site (http://www.arcus.org/ARCSS/AllHands/). ■

New ARCSS Science Plan Available

The new science plan for the ARCSS Program, *Toward Prediction of the Arctic System: predicting future states of the arctic system on seasonal-to-century time scales by integrating observations, process research, modeling, and assessment* was published in March 1998.

This plan examines the progress made in the last eight years, reviews significant research findings from each of the major programs of ARCSS, provides a basis for increased integration and synthesis, and begins to define the questions and research priorities that now arise based on increased understanding of the arctic system.

Copies of *Toward Prediction of the Arctic System* are available from ARCUS. The document also is available as a PDF file from the ARCUS Web site. ■

LAII Research Moves West

A new research program in the Western Arctic/Bering Sea region begins in 1998 under the Land-Atmosphere-Ice Interactions (LAII) component of the ARCSS Program. Arctic Transitions in the Land-Atmosphere System (ATLAS) examines transitions on arctic lands that are caused by climate change to develop scenarios of future change in the arctic system. Researchers aim to achieve this goal by quantifying geographic patterns and processes of climate-land surface exchanges of mass and energy.

ATLAS follows the LAII Flux Study, which examined CO_2 and CH_4 sources and sinks in the Kuparuk River basin of northern Alaska that could have feedback effects on the global climate (see *Witness* Autumn 1996). ATLAS is broader than the Flux Study in at least three respects:

- It will extrapolate climate, permafrost, vegetation, and fluxes at spatial scales from plots to the circumpolar Arctic.
- It will develop scenarios of future trajectories of these parameters over the next 10-200 years.
- The guiding motivation of the research is to improve understanding of the coupled nature of the land and atmosphere in the arctic system.

ATLAS supports eight multi-investigator projects ranging from climate to vegetation, trace-gas, and hydrology studies. The tightly integrated program includes field studies, remote sensing, and modeling. The new field studies will take place in a Western Arctic transect from Barrow to Atkasuk and Ivotuk on the North Slope, moving to the Seward Peninsula and, eventually, to Chukotka, Russia, over a five-year period.

Under-investigated issues that ATLAS studies will address include:

- spatial and temporal patterns of climate and soil moisture, and their relationship to energy exchange and runoff;
- modeling of hydrology at the regional scale (a finer scale than is afforded by global climate models),
- compiling and extrapolating data to fill in gaps in the climate data for large areas of the Arctic;
- patterns and controls of large-scale methane flux;
- socio-economic implications of global change in the region; and
- documentation of carbon, water, and energy fluxes in the high Arctic.

ATLAS research activities will contribute to other research programs, both within ARCSS and at other agencies (*e.g.*, the Bering Sea Impacts Study, see page 18). ATLAS projects will also advance international synthesis and monitoring programs (*e.g.*, Circumarctic Active Layer Monitoring network of the International Permafrost Association).

The *ATLAS Implementation Plan*, published in March 1998, is available on the LAII Web site (see address below).

The *Journal of Geophysical Research–Atmospheres* will publish a special issue on LAII Flux Study research in early 1999.

For more information, contact Patricia A. Anderson at the LAII Science Management Office in Fairbanks, AK (907/474-5698; fax 907/474-6722; patricia@gi.alaska.edu; http://www.laii.uaf.edu/).

Global Change Biology Publishes ITEX Results

In late 1997, a special issue of *Global Change Biology* published 16 papers developed from the 6th International Tundra Experiment (ITEX) workshop, held in April 1995 at the University of Ottawa, Canada. ITEX research is carried out in 11 countries; in the United States, studies are supported through the LAII component of the ARCSS Program.

Each paper compares the short-term responses of common species to climate variations and manipulations at ITEX sites (see *Witness* Autumn 1997). These manipulations include passive warming of tundra plots by open-top chambers and manipulation of snow depth. The open-top chambers increase mean near-surface temperatures by 1-3°C during the growing season, simulating predictions from global circulation models.

Editors of the compendium make the following qualitative observations:

- All vascular plant species investigated responded to the temperature increase, especially in variables related to timing (phenology) and reproduction.
- Short-term responses appear to be individualistic; there were no apparent patterns in responses noted for functional types.
- Responses were generally similar among sites, although the magnitude of response tended to be greater in high-arctic sites.
- Early snowmelt increased carbon: nutrient ratios in plants. Sustained growth and reproductive responses to warming will depend on nutrient supply; increased carbon:nutrient ratios in litter could buffer nutrient cycling and hence plant growth.
- Ongoing long-term research at ITEX sites, linked to other global change initiatives, will help elucidate probable effects of climate change at the ecosystem level in arctic and alpine tundra.

ITEX researchers gathered in Santa Barbara in December 1996 to conduct a quantitative analysis of the data that had been gathered from sites throughout the tundra biome (see *Witness* Autumn 1996). Marilyn Walker coordinated the workshop; a manuscript describing the first results from the meta-analysis is forthcoming.

For more information, contact Greg Henry in Vancouver, BC, Canada (604/822-2985; fax 604/822-6150; ghenry@unixg.ubc.ca) or Marilyn Walker in Boulder, CO (303/492-5276; fax 303/492-6388; mwalker@ taimyr.colorado.edu).

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OAII Receiving Data from Beaufort Sea Pack Ice

Ocean-Atmosphere-Ice Interactions (OAII) researchers are now retrieving data from the Surface Heat Budget of the Arctic Ocean (SHEBA) Phase II field efforts, and are moving forward on Phase I of the Western Arctic Shelf-Basin Interactions program.

Surface Heat Budget of the Arctic Ocean

The Canadian icebreaker *Des Groseilliers* has been drifting in arctic pack ice since October 1997. As of mid-June 1998, it was approximately 875 nautical miles from its original location. Interesting scientific results include evidence that the ice pack appears to be anomalously thin and that this is associated with variations in the temperature and salinity of upper water layers. A manuscript presenting these results (McPhee *et al.* 1998) is available on the SHEBA Web site (http://sheba.apl.washington.edu/).

SHEBA field work has received considerable media attention, including reports on ABC's *Good Morning America*, CBS' *Evening News with Dan Rather*, and National Public Radio's *Morning Edition*; and articles by the Associated Press, *Christian Science Monitor*, *USA Today*, and *The New York Times*.

As of 19 June 1998, the Canadian Icebreaker Des Groseilliers, *platform for the SHEBA research experiment, had drifted approximately 875 nautical miles since 2 October 1997, when it had been frozen into the Beaufort Sea pack ice.*

RAISE Prospectus Available

The Russian-American Initiative on Shelf-Land Environments (RAISE) Prospectus is now available. The objective of RAISE is to facilitate collaborative research between Russian and American scientists in order to understand processes and events in terrestrial, shelf, and ocean environments in northern Eurasia (see *Witness* Autumn 1997).

ARCSS strongly encourages submission of interdisciplinary proposals; the next due date is 1 August 1998. Proposals should demonstrate clear connections to both:

- the goals of RAISE and
- ARCSS themes as described in the program's long-range plan (see page 4).

For more information about the ARCSS Program, contact Michael Ledbetter (703/306-1029; fax 703/306-0648; mledbett@nsf.gov).

The Prospectus is available from ARCUS and can be downloaded as a PDF file from the ARCUS Web site (http://www.arcus.org/RAISE/). ■

Western Arctic Shelf Basin Interactions

The *Science Plan for the Western Arctic Shelf Basin Interactions* (SBI) program has been approved, and an Announcement of Opportunity solicited Phase I proposals due in June 1998. SBI will have a biological and biogeochemical focus. The *SBI Science Plan* is available from the OAII Science Management Office (SMO) and on the OAII Web site (http://arcss-oaii.ccpo.odu.edu/).

OAII Science Steering Committee (SSC)

The OAII SSC met in Knoxville, Tennessee in November 1997. Terry Whitledge, Chief Scientist on the 1997 U.S. Navy Submarine Arctic Science Cruise (see page 13), gave an overview of the experiment, which included data collection at the SHEBA site.

The SSC considered three research initiatives proposed by members of the arctic science community: 1) the Study of Arctic Change initiative (see page 5), 2) the Canadian Arctic Throughflow project, and 3) the Canadian Basin initiative. The SSC supports these projects for further consideration and has made recommendations for focusing the planning efforts.

Kelly Falkner, Dennis Darby, and Andrew Weaver succeed Knut Aagaard, Dave Clark, and Terry Whitledge on the SSC. OAII is grateful for the efforts of retiring members.

The *Planning Workshop Report* from the May 1997 ARCSS/OAII All-Hands Meeting in Virginia Beach (see *Witness* Autumn 1997) is now available from the OAII SMO.

For more information, access the OAII Web site (http://arcss-oaii.ccpo.odu.edu/), or contact Lou Codispoti at the OAII SMO in Norfolk, VA (757/683-5770; fax 757/683-5550; lou@ccpo.odu.edu) or OAII SSC Chair Jackie Grebmeier in Knoxville, TN (423/974-2592; fax 423/974-3067; jgreb@utkux.utk.edu). ■

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PALE PI Meeting Sets Direction for the Next Three Years

At the February 1998 Principal Investigators meeting in Boulder, Colorado, PALE researchers reviewed progress over the past three years:

- High-resolution climate records have been reconstructed using a wide range of climate proxies.
- A synthesis of current high-resolution data collected by numerous researchers was recently published in *Science* (see feature article).
- Regional heterogeneity in climate response across the Arctic is emerging as a pattern, as more data are gathered at both short (2,000-year) and longer (20,000- and 150,000-year) time scales.
- Several new climate-model simulations have been run, including a 10,000-year BP simulation using a low-resolution global climate model (GCM) (GENESIS 2.0) and a simulation of the North Atlantic region using a high-resolution limited area model (ARCSyM).

The group developed four themes to focus the next three years of research:

- What is the significance of the prominent 20th-century warming and coincident environmental changes in the context of changes that occurred through the Holocene?
- What is the sensitivity of arctic climate to altered forcing and potentially large feedbacks to the climate system (*e.g.*, snow and ice albedo, vegetation)?
- Where are the important links between land and ocean shelf (*e.g.*, extent and effects of changes in arctic sea ice)?
- What are sub-regional patterns and causes of climate variability, and how do these relate to biogeophysical processes (*e.g.*, carbon dynamics, permafrost) that may feed back to the climate system?

The latter two themes provide opportunity for coordination with other ARCSS programs; collaborative workshops are envisioned for the coming year.

PALE also plans to:

- further develop regional climate models in Beringia and the North Atlantic,
- further develop simulations with coupled atmosphere-ocean GCMs,
- expand its geographic focus in conjunction with its international counterpart, Circum-Arctic PaleoEnvironments (CAPE). In particular, the *PALE Atlas*, developed as a pilot project for the Beringian region (see *Witness* Autumn 1997), will be expanded to cover the Arctic and is expected to become the standard repository for arctic paleoenvironmental data. To view the *PALE Atlas*, visit http://www.ngdc.noaa.gov/paleo/pale/atlas.html.

The Beringian paleoenvironments workshop, co-sponsored by PALE in September 1997 and attended by well over 100 participants from North America and the Former Soviet Union, highlighted the breadth and depth of Beringian research and the large community of scientists who can potentially contribute to ARCSS goals. *Quaternary Science Reviews* will publish papers from this meeting in a special issue devoted to Beringia.

PALE and CAPE have initiated data-model comparisons in conjunction with the BIOME 6000 project, which aims to generate global maps of vegetation "biomes"—units defined on the basis of their dominant plant functional types—from pollen data for present, 6,000, and 18,000 ^{14}C years BP. These maps will then be used to assess GCM runs coupled to the BIOME vegetation model. PALE co-sponsored an international workshop in Germany in April 1998, with three goals:

- adapt an existing coupled biogeography-biogeochemistry model to simulate the major features (composition and function) of arctic vegetation,
- refine the present method for inferring biomes from paleoecological records in order to allow efficient discrimination among arctic vegetation types, and
- generate circumarctic paleovegetation maps.

For more information, contact Kim Marsella at the PALE Science Management Office (303/492-0246; fax 303/492-6388; pale@spot.colorado.edu), and see the PALE Web site (http://www.ngdc.noaa.gov/paleo/pale/index.html). ■

Journal of Geophysical Research Publishes GISP2 and GRIP Research

In November 1997, the *Journal of Geophysical Research* (JGR) published a Special Issue on the U.S. and European ice cores collected between 1989 and 1993 at Summit, Greenland (see *Witness* Spring 1997). This joint issue of JGR—*Oceans* and *Atmospheres*—contains 47 articles presenting research results from the cores (see Publications, page 23).

GISP2 investigators have been working closely with the World Data Centers for Glaciology and Paleoclimatology to produce a CD-ROM on the Greenland Summit Ice Cores. This CD-ROM is now available through the National Snow and Ice Data Center (303/492-6199). The data are also available from the ARCSS Data Coordination Center Web site (http://arcss.colorado.edu/).

Although the GISP2 initiative to collect the longest ice core available in the northern hemisphere is complete, GISP2 investigators continue to examine the core for clues on climate change. The international Ice-Core Circum-Arctic Paleoclimate Program (ICAPP; see page 17), has begun to collect and analyze other ice coring sites in the Arctic and compare them to the GISP2 record. This program and continued collaboration with other ARCSS initiatives will help to improve knowledge of the arctic climate system.

For more information, see the GISP2 Web site (http://www.gisp2.sr.unh.edu/GISP2/), or contact Mark Twickler at the GISP2 Science Management Office in Durham, NH (603/862-1991; fax 603/862-2124; gisp2.smo@unh.edu). ■

NSF Publishes Arctic Research Program Opportunities

In April 1998, NSF published *Arctic Research Program Opportunities (NSF 98-72)*, updating its 1995 document addressing proposals for research in all of the Arctic and for arctic research based at institutions in the United States.

The United States Arctic Research and Policy Act of 1984 defines the Arctic as:

- all areas north of the Arctic Circle;
- all United States territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim rivers; and
- all contiguous seas including the Arctic Ocean; the Beaufort, Bering, and Chukchi seas; and the Aleutian chain.

Field projects falling outside these boundaries but directly related to arctic science and engineering conditions or issues, such as laboratory and theoretical studies, are appropriate.

NSF is one of 12 federal agencies that sponsor or conduct arctic science, engineering, and related activities. As mandated by the Arctic Research and Policy Act of 1984, federal interagency research planning is coordinated through the Interagency Arctic Research Policy Committee (IARPC) which is chaired by NSF (see *Witness* Autumn 1996).

In fiscal year 1997, NSF provided $49.39 million for 362 arctic research projects. Of this, $30.71 million was from the OPP Arctic Research Program.

The goal of the Arctic Research Program is to gain a better understanding of the earth's biological, geological, chemical, and sociocultural processes, and the interactions of ocean, land, atmosphere, biological, and human systems. OPP offers focused multidisciplinary and interdisciplinary programs that emphasize the uniqueness of the Arctic for special scientific studies. OPP encourages the study of:

- long-term, human-environment interactions;
- contemporary socioeconomic, cultural, and demographic issues in the changing political environment of the post-Cold War world;
- bipolar research, especially glaciology, permafrost, sea ice, ecology, and aeronomy.

Increasing emphasis is being given to the integration of research and education. Scientific programs connected to students (K-12 and above), affected communities in the North, and the general public's improved understanding of basic research are strongly encouraged. Educational components are encouraged with proposed research in all disciplines and programs, but stand-alone proposals are also entertained.

Research Programs

Three integrated programs in OPP support arctic research:

Arctic Natural Sciences—glaciology; and atmospheric, biological, earth, and ocean sciences;

Arctic Social Sciences—anthropology, archeology, economics, geography, linguistics, political science, psychology, sociology, and related subjects, especially human/environment interactions, including issues related to subsistence and sustainable development; and

Arctic System Science (ARCSS)—interdisciplinary research to

- understand the physical, geological, chemical, biological, and sociocultural processes of the arctic system that interact with the total Earth system and thus contribute to or are influenced by global change, in order to
- advance the scientific basis for predicting environmental change on a seasonal-to-centuries time scale, and for formulating policy options in response to the anticipated impacts of global change on humans and societal support systems.

ARCSS places an emphasis on four scientific thrusts:

- understanding global and regional impacts of the arctic climate system and its variability;
- determining the role of the Arctic in global biogeochemical cycling;
- identifying global change impacts on the structure and stability of arctic ecosystems; and
- establishing the links between environmental change and human activity.

OPP also provides support for Arctic Research and Policy (management and integration of arctic data and information) and Arctic Logistics.

The Guide to Programs (NSF 97-150) describes special funding opportunities including international cooperative activities, human resources development, and other programs (see *Witness* Autumn 1997).

New announcements of research opportunities and the Foundation's Grant Proposal Guide (NSF 98-2) are available on the NSF Web site (http://www.nsf.gov). Copies of the Guide and the NSF Proposal Forms Kit (NSF 98-3) are available from the NSF Clearinghouse (301/947-2722; pubs@nsf.gov; http://www.nsf.gov/bfa/cpo/gpg/kit/start.htm).

A compilation of all NSF arctic and related research grants for each fiscal year is available (NSF 98-101 or http://www.nsf.gov/cgi-bin/getpub?nsf9778 for FY 1997. The current NSF Guide to Programs (NSF 97-150 or http://www.nsf.gov/cgi-bin/getpub?gp) should be consulted for additional program information.

For more information, see the OPP Web site (http://www.nsf.gov/od/opp/).

New Proposal Dates

Target dates for all NSF Arctic program proposals changed in 1998 to 15 February and 1 August. NSF proposal guidelines and other useful information, such as abstracts of projects funded, can be found at the NSF Web site (http://www.nsf.gov/).

Arctic Science is Benefitting From Broad Collaboration

by Garrett Brass

As this goes to press in mid-June 1998, the Senate Appropriations Subcommittee, which decides on the budget for NSF, has added $24 million for arctic logistics to the FY 1999 appropriation for the Office of Polar Programs. While this substantial increase has yet to be adopted by the full Appropriations Committee and reconciled with the House version of the bill, it can be interpreted only as a recognition of the needs of the arctic research community.

At least a part of this recognition is due to the outstanding report on *Logistics Recommendations for an Improved U.S. Arctic Research Capability* (see *Witness* Autumn 1997), produced for the U.S. Arctic Research Commission (see page 12) by ARCUS. While segments of the arctic research community had approached Congress in the past for logistics support for individual platforms and services, the broad cooperation in which we have been engaged during the past three years—to consider the needs of arctic science as whole and to identify short- and long-term priorities—is unprecedented and has been rewarded accordingly.

Many individuals throughout the arctic community of researchers, institutions, agencies, and policymakers deserve credit and appreciation for their willingness and ability to collaborate in this way. ARCUS has earned our appreciation for the vision and skill with which it has provided leadership throughout the process.

Now that there is finally new money for logistics, what are the next steps for the arctic research community?

Logistics facilities are going to continue to be scarce resources. In order to use them fully and to their best advantage, arctic researchers will need to continue to participate in community planning efforts. Perhaps the most obvious need will be to plan the use of the Coast Guard's newest ship. The *USCGC Healy* is already in the water and will commence its sea trials and test cruises within a year (see page 14). The Arctic Icebreaker Coordinating Committee (AICC) (see page 14) will be responsible for expeditionary planning of *Healy*'s operations, scheduling cruises and ship time to accommodate proposals that are submitted to multiple funding agencies in response to various announcements of opportunity. The AICC will soon consider how to plan for *Healy*'s science and will need your input.

A comparable planning system is already in place for the Submarine Arctic Science (SCICEX) program, which began in 1993 (see page 13). The fourth of five scheduled cruises is underway aboard the *USS Hawkbill*. Researchers who would like to conduct experimental work using a SCICEX submarine should watch for the Broad Area Announcement. Scientific input into the SCICEX cruise planning process is provided by the SCICEX Science Working Group. For more information, contact Working Group Chair Robin Muench in Seattle, WA (206/726-0522; fax 206/726-0524; rmuench@esr.org).

The SCICEX program will end by the year 2000, when the last of the Sturgeon Class submarines will be retired. A major workshop entitled SCICEX 2000 will be held in October 1998 to gather the results of the program, assess its impact on arctic research, and consider the possibilities for the future (see Calendar, page 23). Both researchers and Navy personnel will attend. Decisions about subsequent submarine research opportunities will depend largely upon the level of scientific progress achieved to date, the vision for the future, and the enthusiasm of the community. Here too, your input can help make the difference.

The arrival on-scene of the *Healy* and major imminent changes in the SCICEX program represent rapid and significant change in the scope of marine facilities.

Comparable but more evolutionary opportunities are foreseeable for terrestrial science. The facilities at Summit and Kangerlussuaq in Greenland (see *Witness* Spring and Autumn 1997), and Toolik Lake (see page 20) and Barrow (see *Witness* Autumn 1997) in Alaska, are *de facto* bases for substantial efforts in understanding solar-terrestrial interactions, terrestrial ecosystems, atmospheric processes, and the effects of global climate change. They also offer excellent opportunities for interaction with the Native peoples of the Arctic and the integration of traditional knowledge into research.

Upgrades and expansions of these facilities may now be possible but will require careful consideration by the research community and clear, science-based recommendations for upgrades. The community has made a good start toward improving terrestrial facilities with the recommendations in *Toolik Field Station: The Second 20 Years* (see *Witness* Spring 1995).

In the arena of international collaboration in arctic logistics (see page 11), some opportunities are growing, others are threatened. Keep your eye on the operations of ARCUS' Committee on International Collaboration, and support expansion of international efforts. For more information, contact Skip Walker, Chair of the Committee, in Boulder, CO (303/492-7303; fax 303/492-6388; swalker@taimyr.colorado.edu).

When the USARC, ARCUS, and the arctic research community began the process that resulted in *Logistics Recommendations for an Improved U.S. Arctic Research Capability* many, including myself, were aware that the number of existing reports on arctic research facilities, the size of those reports, and the number of plans for new endeavors were enormous—and that, collectively, they had had only modest effects. If there is a lesson to be learned from the recent, exciting developments, it is that it pays to work together, put the needs of arctic science first, and persist.

Thomas Jefferson is reported to have said that "the price of liberty is eternal vigilance." Well, arctic researchers, the price of progress is eternal effort. Keep up the good work.

Garrett W. Brass is Executive Director of the U.S. Arctic Research Commission.

International Collaboration for Arctic Logistics: Canada's Polar Continental Shelf Project

For 40 years, Canada's Polar Continental Shelf Project (PCSP) has provided one-stop shopping for most of the logistics for research conducted in the Canadian Arctic. On occasion, the organization has crossed the borders into Alaska and Greenland and has picked up scientists at the North Pole returning home from work in the Russian North. Today, PCSP goes to both ends of the earth to help scientists do their work.

During the 1997 field season (March-September), PCSP, operating from its bases at Resolute Bay and Tuktoyaktuk, coordinated logistics for approximately 1,000 scientists from 40 different entities in Canadian federal and territorial governments, Canadian universities, and foreign agencies. These scientists worked on more than 170 terrestrial, atmospheric, and marine research programs throughout the Canadian Arctic.

Plans for 1998 include approximately 140 projects, of which eight are U.S. research programs. "We encourage U.S. scientists in such efficient use of existing infrastructure," says Tom Pyle, Head of Arctic Sciences at NSF, "especially at sites with a long record of complementary data."

Science priorities are set within each Canadian government agency and funded accordingly; PCSP works with science managers to determine their arctic program priorities so that it can allocate logistics support to the top priority research programs. All non-government applications for support are assessed by a Scientific Screening Committee which ranks each proposal based on its scientific merit and, in the case of university programs, on the involvement of students. The final decisions depend upon logistical feasibility and cost considerations.

In the late 1970s, as demand outstripped PCSP's ability to supply services, the Project began to charge non-Canadian users for services and began increasingly to share logistics costs with Canadian research groups. On average, PCSP recovers 35-45% of total logistics expenditures from its clients.

PCSP contributes significantly to the northern economy. In 1997 alone, it spent $1.7 million (Cdn) contracting services and purchasing supplies from northern companies, the majority aboriginal-owned or -operated. In addition, PCSP serves arctic community groups engaged in traditional knowledge studies, and joint research programs that include northern community and aboriginal land claims organizations.

"Funding for northern science is increasingly challenging," says PCSP Director Bonni Hrycyk. "PCSP's budget has been cut by 46% in the past three years, and science budgets are under considerable stress. This has given all of us a huge push to work more closely, to share all costs, and increasingly to coordinate delivery of logistics services. For example, PCSP and the Canadian Coast Guard are working together more; the Coast Guard can provide ship-based support, while PCSP can provide virtually all other required logistics services."

Bilateral and Multilateral Joint Ventures

Bilateral and multilateral scientific and logistics joint ventures are also increasingly common and have been encouraged by recent discussions between President Clinton and Prime Minister Chrétien. One success story is the Surface Heat Budget of the Arctic Ocean (SHEBA), a U.S.-led program to address the interaction of the surface energy balance, atmospheric radiation, and clouds over the Arctic Ocean (see page 7).

The Canadian Coast Guard ship *Des Groseilliers* was set adrift in October 1997 in international waters for one year as a research platform for scientists to conduct a wide range of environmental studies (see *Witness* Autumn 1997). The ship is currently approximately 350 miles north of Barrow and drifting west from its original position. Sponsors of the project are the U.S. Office of Polar Programs and Division of Ocean Sciences, NSF, and the High Latitude Program, Office of Naval Research. Field support is provided by the Canadian Department of Fisheries and Oceans. The U.S. Department of Energy and NASA support other coordinated programs at the SHEBA site. Research scientists predominantly from the United States but also from a number of other countries are participating in the research programs conducted from the ship; PCSP has provided field equipment, advice, and some aircraft support for scientists involved in the program.

The Canadian Arctic-Antarctic Exchange Program

In 1997, PCSP and the Canadian Antarctic Research Program initiated the Canadian Arctic-Antarctic Exchange Program to encourage closer ties among arctic and antarctic research scientists who would like to carry out studies in both polar regions. Under the program, PCSP will waive recovery of some costs from non-Canadians working with Canadian research colleagues in the Arctic. In turn, the Canadian research scientist receives similar sponsorship to conduct work in Antarctica within a two-year period.

"This program will likely remain quite modest because we are strapped for funds," says Hrycyk, "but in a small way, it helps Canada to demonstrate its commitment to the Antarctic Treaty and particularly to the value of bipolar research."

PCSP is actively encouraging new research programs to work in the Canadian Arctic either in partnership with Canadian research scientists or colleagues from other countries. The infrastructure and services are readily available, and costs can be held in check. PCSP is open for business and U.S. scientists are encouraged by NSF to consider this opportunity when planning their arctic research.

For more information, contact Bonni Hrycyk in Ottawa, ON, Canada (613/947-1601; fax 613/947-1611; bhrycyk@nrcan. gc.ca; http://www.nrcan.gc.ca/ess/pcsp/pcsp.htm) or Tom Pyle in Arlington, VA (703/306-1029; fax 703/306-0648; tpyle@nsf.gov). ■

PRB Evaluates Arctic Natural Sciences Program

In the Fall of 1997, the Polar Research Board formed a special committee to evaluate NSF's Arctic Natural Sciences (ANS) program. The request for the study came from NSF's Office of Polar Programs and ANS program staff who wanted to be sure the relatively new program was on the right track and operating effectively.

The ANS program was established in 1996 to fund research in disciplines ranging from atmospheric and space science to geology, glaciology, biology, and oceanography.

The PRB committee was charged to study the program's operation and research priorities and to provide input on how the program should set research priorities given its diverse portfolio. The committee is considering the program's management strategy and suggesting how to judge which proposals are best suited for the ANS program *versus* related NSF programs (see page 9).

Committee members are John Andrews, Chair, and Susan Avery (University of Colorado, Boulder); Marianne Douglas (University of Toronto); Bernard Hallet and Jamie Morison (University of Washington, Seattle); Paul A. Mayewski (University of New Hampshire); Kim Peterson (University of Alaska Anchorage); Don Siniff (University of Minnesota); and Roger Smith (University of Alaska Fairbanks).

Input from the arctic science community has been sought through town meetings at the December 1997 American Geophysical Union (AGU) meeting in San Francisco and at the February 1998 AGU Ocean Sciences meeting in San Diego. In addition, a survey has been added to the PRB Web site (http://www2.nas.edu/prb/) asking researchers about their experiences with the ANS program and their ideas for improving it.

The final report, expected to be released early this summer, will address:

- the mission of the ANS program,
- maintenance of a portfolio that exhibits balance among the disciplines while retaining the flexibility necessary to meet the community's needs,
- guidance on what types of proposals are best suited for the ANS program, and
- steps to strengthen the ANS program's management strategy.

In other activities, the PRB's April-May 1998 meeting in Washington, DC included a special tribute to Charles Bentley recognizing his many years of service to the polar science community. Board discussions addressed the following topics related to arctic science:

- the International Arctic Science Committee's April 1998 meeting,
- project oversight, and
- new project planning.

A special session focused on polar aspects of global climate change, and a seminar was given on abrupt climate change.

Four new members joined the PRB at this meeting: Anthony Gow (U.S. Army Cold Regions Research and Engineering Laboratory), David Hofmann (NOAA's Climate Monitoring and Diagnostics Laboratory), Carole Seyfrit (Old Dominion University), and Robert Wharton (Desert Research Institute).

For more information, contact PRB Director Chris Elfring in Washington, DC (202/334-3479; fax 202/334-1477; celfring@nas.edu; http://www2.nas.edu/prb/). ■

USARC Prepares Report to Guide Arctic Research Policy

Advisors to the U.S. Arctic Research Commission (USARC) met in February 1998 to discuss priorities for the biennial *USARC Goals and Opportunities Report*. This report gives basic policy guidance to the Interagency Arctic Research Policy Committee (see *Witness* Autumn 1996), as it revises the plan that coordinates the 12 federal agencies engaged in arctic research. The USARC is drafting its report at this time and welcomes guidance from the arctic research community. Publication of both the USARC and IARPC reports is scheduled for January 1999.

The November 1997 meeting of the USARC in Washington, DC included:

- a briefing by Bob Corell, Assistant Director of Geosciences at NSF and Chair of the U.S. Committee on Global Change, regarding the Global Change Research Program and changes it is undergoing to focus more on effects in the United States;
- a briefing from the U.S. Minerals Management Service and PRB;
- discussion of the Arctic Monitoring and Assessment Program (see *Witness* Autumn 1997); and
- discussion of issues related to oil in ice-laden water.

The 50th meeting of the Commission convened at the Smithsonian Institution in February 1998. Commissioners were briefed on SCICEX '97 by Steve Kramer, Commanding Officer of the *USS Archerfish*, and Terry Whitledge, Chief Scientist for the cruise. The USARC also participated in a series of planning meetings for the SCICEX '98 cruise, which is currently underway (see page 13).

Commissioners also discussed the role of research in the preparation of environmental impact statements and resolved to schedule a meeting in FY 1999 to pursue this discussion.

The USARC will meet next in August 1998 in Seward, Alaska. For more information, contact Garry Brass in Arlington, VA (800/AURORAB or 703/525-0111; fax 703/525-0114; g.brass@arctic.gov). ■

SCICEX Launches Its Fourth Year of Arctic Ocean Studies

The last Submarine Arctic Science Cruise (SCICEX) missions of the century will take place in June-August 1998 and April-June 1999. Each cruise will last approximately 75 days, of which approximately 45 days will be under ice.

SCICEX is a five-year program that makes use of U.S. Navy nuclear submarines as a research platform. It aims to increase fundamental understanding of processes in the Arctic Ocean. The Office of Naval Research (ONR) and the NSF co-fund this unclassified basic research mission (see *Witness* Spring 1996).

As on all previous SCICEX cruises, researchers on the *USS Hawkbill* will conduct a wide variety of experiments. The major focus is to examine the physical, chemical, and biological properties of the Arctic Ocean. This involves continuous measurements using externally mounted instruments, collection of water samples from inside the submarine and from several surface stations, and gathering biological specimens.

Another major experiment will make use of a new geophysical instrumentation package to map the poorly charted floor of the Arctic Ocean.

The third major area of inquiry will use the submarine's unique capacity to survey the underside of the arctic ice pack to learn more about trends and mechanisms that determine ice thickness.

Following a pilot cruise in 1993, the first SCICEX cruise, on board the *USS Cavalla*, took place in the spring of 1995 during the annual period of maximum arctic ice cover (see *Witness* Spring 1996). The cruise covered 10,800 nautical miles within the Arctic Ocean basin over the course of 44 days in April and May. Four civilian scientists, assisted by three from the Arctic Submarine Laboratory, collected data for 26 investigators from 12 institutions.

The second cruise took place August-November 1996 on board the *USS Pogy*. Ten teams of investigators participated. The 45-day mission included transits along the Chukchi Borderland, a transect from the Pole to the Beaufort Sea during which 14 surfacings were performed, and a transit along the Lomonosov ridge.

The third cruise took place August-October 1997 on board the *USS Archerfish*. Approximately 30 days of data collection were devoted to ten science projects. Underway water samples were taken to investigate bacteria, viruses, zooplankton, and dissolved carbon. Chemical tracers in water samples were used to determine water motion and mixing. Temperature, salinity, and velocity were measured along cruise tracks spanning the Arctic basin.

For information about the 1998 SCICEX cruise aboard the *USS Hawkbill*, which is currently underway, visit the SCICEX 98 Web site (http://www.csp.navy.mil/scicex.htm).

The ARCSS Data Coordination Center at the National Snow and Ice Data Center (NSIDC) has been asked to be the long-term archive for SCICEX. For more information about the data archives, contact Matt Cross in Boulder, CO (303/492-5532; fax 303/492-2468; cross@kryos.colorado.edu).

A workshop to evaluate accomplishments of SCICEX and to outline the rationale and objectives for scientific cruises beyond 1999 will be held 6-8 October 1998 (see Calendar, page 23).

For more information about SCICEX, contact Dennis Conlon at ONR in Arlington, VA (703/696-4720; fax 703/696-2007; conlond@onr.navy.mil), or Jeff Gossett at the Arctic Submarine Laboratory in San Diego, CA (619/553-7446; fax 619/553-0972; gossett@manta.nosc.mil). Information is also available from the SCICEX Science Working Group (http://www.ldeo.columbia.edu/SCICEX/). ■

Newly Declassified Submarine Data Now Available

Formerly classified data on the thickness of sea ice in the Arctic, gathered by the U.S. Navy over several decades, is now being released. Data from an April 1992 trans-Arctic Ocean track is available; information from 19 other tracks, or maps of the submarine routes, will be analyzed and released over the next 18 months. The National Snow and Ice Data Center (NSIDC) is handling the data release.

The Arctic Submarine Laboratory, on behalf of the Chief of Naval Operations (CNO), approved declassifying the sea-ice data within a specific swath of the Arctic Ocean, roughly between Alaska and the North Pole. The area is known as the "Gore Box" for Vice President Gore's initiative to declassify arctic military data for scientific use.

During routine operations in the Arctic since 1957, the Navy has collected data on ice thickness, which was important for navigation and defense. This information is now valuable baseline data on the history of sea-ice thickness in the arctic basin. Climate modelers differ over the fate of the great expanse of arctic sea ice, which is about the size of the United States. More than half the ice melts and refreezes each year.

The data will also provide a historical context for current, more intensive studies of arctic ice by the Surface Heat Budget of the Arctic Ocean (SHEBA) project, in which NSF has frozen a ship into the ice to serve as a floating science platform for 13 months. SHEBA's aim is to chart the fate of the pack ice, ultimately improving predictions of global change (see page 7).

Walter Tucker and Stephan Ackley of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) are supported by NSF to process and analyze the digital ice-draft data collected since 1986.

For more information, contact Walter Tucker or Stephan Ackley (603/646-4268; fax 603/646-4644; wtucker@hanover-crrel.army. mil) at CRREL in Hanover, NH, or Florence Fetterer at NSIDC in Boulder, CO (303/492-4421; fax 303/492-2468; fetterer@kryos.colorado.edu; http://www-nsidc.colorado.edu/). ■

Healy and the Arctic Icebreaker Coordinating Committee

The Arctic Icebreaker Coordinating Committee (AICC) of the University-National Oceanographic Laboratory System (UNOLS) was created in 1996 to provide scientific oversight of arctic marine science support on U.S. vessels. The committee's primary focus is on U.S. Coast Guard Cutters *Polar Star*, *Polar Sea*, and the new *Healy*.

In January 1998, the AICC toured the active *USCGC Healy* construction site in New Orleans, Louisiana. In an earlier review of *Healy* science systems, the AICC requested 13 high-priority changes to improve the ship's suitability for scientific use. Nine of the 13 requests are being accommodated now; the remaining four will be considered at a later time.

Eight institutions have been selected to participate in the testing of 11 *Healy* science systems. The ship is scheduled for delivery in February 1999; for sea trials in June 1999; for ice trials that summer and fall; and for science operations early in 2000. Seattle has been designated as the *Healy* home port.

The USCGC Healy *is a modern polar research vessel designed to be operated by the U.S. Coast Guard for the U.S. polar science community: 420' length, 28' draft, 30,000 HP, 4.5' ice at 3 knots; 4,000 sq. ft. of lab space including climate-controlled main lab and bio-chem lab, dry assembly area, wet lab, science refrigerator/freezers; electronics/ computer lab, 4-season capability, science conning station, crew of 75 (14 in helo group), 4 sheltered lab/container vans; 35 science berths (surge capacity 50); 2 large out-of-weather 'garage' staging areas, diving support, uncontaminated seawater system, fiber-optic computer/video/data net, and multi-beam sonar (illustration courtesy of Guy Tapper).*

The AICC and the Coast Guard are collaborating to ensure close ties with the UNOLS technical and scientific communities. Training for Coast Guard marine science technicians now includes participation on short UNOLS cruises, and the Coast Guard is aligning many of its arctic science operations with those of major UNOLS vessels. The AICC is charged with assessing proposals for logistic and overall compatibility with each USCG Science-of-Opportunity mission. Other suggestions include establishing a liaison for oceanography technical support at a UNOLS operator institution.

Background

The U.S. Coast Guard, NSF, UNOLS, and the AICC aim to promote the best utilization of remote, high-latitude facilities. The AICC provides the scheduling and communications services in support of arctic marine science. It also promotes the use of cutting-edge technology and the advancement of international programs to enhance multidisciplinary polar science.

The next scheduled meeting of the AICC will be in New Orleans in late 1998 or early 1999. A tour of the completed *Healy* will be central to the meeting.

For more information, contact AICC Chair Jim Swift in La Jolla, CA (619/534-3387; fax 619/534-7383; jswift@ucsd.edu) or the UNOLS Office (unols@gsosun1.gso.uri.edu). ■

International Code of Safety for Ships in Polar Waters

In October l997, nearly 60 representatives from nine nations including the United States met in Hamburg, Germany, to continue discussions on harmonization of polar shipping rules. Their objective was to provide the International Maritime Organization (IMO) with a draft set of international rules for ship construction and navigation standards for use by all non-naval ships operating in the Arctic Ocean and around Antarctica.

The key tenets of the draft Polar Code—*The International Code of Safety for Ships in Polar Waters*—emphasize:

- the safety of life at sea, and
- the environmental protection of circumpolar seas and oceans.

The Code harmonizes many incompatible national systems that encompass rules for polar ship construction, equipment requirements, crew standards, and navigation. Bipolar application is the ultimate goal.

In March 1998, Canada (on behalf of the working group) submitted the draft Polar Code to the Design and Equipment Subcommittee of IMO. IMO review and acceptance may take several years.

For more information, contact Victor Santos-Pedro at Transport Canada in Ottawa, ON, Canada (fax 613/991-4818; santosv@ tc.gc.ca) or Lawson Brigham at the Scott Polar Research Institute in Cambridge, UK (fax +44/1 223 336 549; lwb20@ cam.ac.uk). ■

Strategic Plan for Arctic Marine Science Underway

During the past decade, scientific activity in the marine Arctic has grown significantly. In part, this growth stems from increased recognition that the region offers important insights into global issues and concerns including:

- the details of past climate,
- the role of continental shelves in biogeochemical cycling,
- the planetary heat budget, atmospheric chemistry, and radiative transfer,
- the overturning of the world ocean, and
- the global water cycle.

Arctic scientific activity has also been driven by an interest in specific processes that are important and well displayed in the marine Arctic, such as:

- mixing in a low-energy ocean,
- the maintenance of ecosystems in extreme environments, and
- the means by which sea ice mediates atmospheric and oceanic fluxes and structures.

Throughout this growth phase, there has been an increasing emphasis on examining how components and processes in the larger system are interrelated. This has, in turn, stimulated further growth, and innovative approaches and syntheses.

Developments that have significantly altered the nature and potential of arctic marine research in this decade include:

- expanded logistics and improved technology, including better access to ice-breakers, improved satellite coverage, the availability of submarines for research purposes, autonomous instrumentation, new capabilities in detection and measurement, and rapid progress in numerical simulation techniques;
- a changing geopolitical environment that has opened up areas of the Arctic that were previously inaccessible and has made new data sets available to the research community;
- recognition that environmental change, whether natural or anthropogenic, may have major consequences for human activity in the Arctic, making clear a need for better predictive capabilities;
- increased funding within NSF;
- several announcements of opportunity with the Office of Naval Research;
- programmatic changes at NSF—the Office of Polar Programs now has a separate Arctic Sciences Section, within which a large global change program, the Arctic System Science (ARCSS) Program, parallels the more process-oriented Arctic Natural Sciences program (see page 12). The Arctic Sciences Section also includes an Arctic Social Sciences Program (see page 19), as well as an arctic logistics component;
- the nation's first dedicated scientific ice breaker, the *USCGC Healy*, which is due to be available by the turn of the century (see page 14);
- access to decades of naval submarine data, the availability of naval submarines as research platforms, and discussion about making a submarine available for research purposes into the next century.

Taken together, these changes suggest both significant long-term opportunities and a need for the research community to examine its direction and priorities. To that end, NSF has charged the community with developing a scientific strategic plan for arctic marine research, and to do so within a broad and inclusive context that extends from marine geology and geophysics; through the biology, chemistry, and physics of the sediments, water column, and sea ice cover; to the sciences of the overlying atmosphere.

The objectives of the present planning effort are to:

- identify principal research issues in the marine Arctic, including opportunities for significantly advancing knowledge of regionally and globally important processes;
- develop an appropriate overall research strategy;
- consider the balance between large system-based studies and smaller process-oriented studies;
- assess the optimal use of existing and projected resources (*e.g.*, *Healy*); and
- consider means of coordination with international activities.

A six-member working group, appointed through ARCUS, is soliciting broad participation. A community survey and draft materials are posted on the ARCUS Web site (http://www.arcus.org/Marine_Science/Marine_Science.html). Comments on drafts will be solicited in August and October 1998. The strategic plan is due to be delivered to NSF in January 1999.

For more information, contact Knut Aagaard, Working Group chair, in Seattle, WA (206/543-8942; fax 206/543-3521; aagaard@apl.washington.edu). ■

New Permafrost and Ground Ice Map of the Arctic

The U.S. Geological Survey (USGS) has released a full-color polar projection of permafrost and ground ice covering most of the northern hemisphere including the Tibet Plateau and the European mountains. *The Circum-Arctic Map of Permafrost and Ground Ice Conditions* is a polar projection (scale 1:10,000,000) (see Publications, page 23). An international team led by the USGS, the Geological Survey of Canada, and the Committee of Geology of the Russian Federation compiled the data. The map was prepared under the direction of Jerry Brown of the International Permafrost Association, in cooperation with the Circum-Pacific Council for Energy and Mineral Resources. The National Snow and Ice Data Center is preparing to release a digital (CD-ROM) version of the map in June 1998.

According to USGS Associate Director Bonnie McGregor, "this is the first time that data on the entire North Polar region and adjacent lands has been compiled into a single map." ■

Nansen Arctic Drilling Program Defines Targets

The Nansen Arctic Drilling Program (NAD) is an international research effort designed to study the Arctic's geological evolution and past environmental change in order to better predict the future of the Arctic Basin and its effect on global processes. In 1995, NAD began seeking closer links to the international Ocean Drilling Program (ODP), which has sampled in all the world's oceans except the Arctic.

In 1997, following an October 1996 workshop in St. Petersburg, Russia (see *Witness* Spring 1997), NAD published an implementation plan. The plan is available from the NAD Secretariat at Joint Oceanographic Institutions (JOI) in Washington, DC (202/232-3900; fax 202/232-8203; joi@brook.edu; http://www.joi-odp.org/joi/PDFs/NADImplPlan.pdf).

Regional Planning Groups have formed to define the scientific objectives and required technology, to conduct site surveys, and to submit proposals. The initial targets are:

- Bering Sea Land Bridge,
- Laptev Sea on the continental shelf,
- the Yermak and Chukchi Plateaus, and
- in the deep Arctic, the Lomonosov and Alpha ridges.

The Bering Sea Land Bridge program seeks to develop a comprehensive understanding of past environmental variability in the Bering Strait's role as a Pacific gateway through documentation of past change and assessment of the possible responsible mechanisms. The program will explore the links between ocean and continents (*e.g.*, sea level, sea-ice cover, glacial history, marine/terrestrial paleoecology). A multidisciplinary approach will be required, in part because the Bering Land Bridge has been exposed above sea level at times; at least part of the sedimentary record is likely to include terrestrial peats, lake sediments, loess, permafrost, periglacial features, and glacial deposits. Researchers hope to encounter alternating sequences of terrestrial and marine sediments in the Land Bridge sediments, documenting perhaps dozens of sea-level changes that occurred through the Pleistocene, as continental ice sheets waxed and waned in response to changes in climate.

Because volcanism has been important on and around the margin of the Bering Land Bridge through the Quaternary (the past 1.6 million years), tephras and other volcanic deposits will form part of the marine sedimentary record.

Furthermore, recent tectonic features are likely to be recorded in the core, as the Bering Land Bridge is believed to form an active plate margin between Asia and North America.

Jim Begét (University of Alaska Geophysical Institute) is the scientific leader for the Bering Sea Land Bridge component of NAD.

Plans are also moving forward for the other NAD target sites. In summer 1998, the *Polarstern* will investigate potential drill sites on Alpha Ridge and perform a site survey in the Laptev Sea (Russia's permission is pending at press time). NAD plans to select the Laptev Sea drill site(s) in 1999 and to drill in 2000.

The 1998 Submarine Arctic Science Cruise (SCICEX, see page 13) will conduct a refraction/reflection program on the Chukchi Plateau which may yield potential NAD drilling sites.

A Lomonosov Ridge drilling proposal has been submitted to ODP. (A 1996 attempt to drill on Lomonosov Ridge from the Swedish icebreaker *Oden* was aborted.) A team of scientists led by Yngve Kristoffersen (University of Bergen) has been identified to determine best sites and platforms.

For more information, contact Andrea Johnson in Washington, DC (202/232-3900, x213 or 202/939-1623; fax 202/232-8203; ajohnson@brook.edu), or visit the JOI Web site (http://www.joi-odp.org/). ■

The Future of Scientific Ocean Drilling

The Ocean Drilling Program (ODP) is an international partnership of scientists and research institutions organized to explore the evolution and structure of the Earth. Since January 1985, ODP has used the drill ship *JOIDES Resolution* to recover more than 160,000 meters of core, providing researchers with access to a vast repository of sediments and rocks. Scientists from partner countries submit and review drilling proposals via ODP's scientific advisory structure, the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), which guides the program.

Although it has been successful, ODP is scheduled to end on 1 October 2003. In order to promote further collaboration, an international conference is planned for May 1999 in Vancouver, Canada.

The conference will define the scientific objectives for a future, multi-platform ocean drilling program with two major vessels. This conference will focus on the scientific goals of non-riser drilling; it will complement the July 1997 Conference for Cooperative Ocean Riser Drilling (CONCORD), which defined the scientific initiatives for use of a riser-equipped drilling vessel. (That report is available at http://mstip1.jamstec.go.jp/jamstec/OD21/CONCORD/result.html).

As a basis for guiding and structuring the Spring 1999 conference, the JOIDES Office is soliciting brief (approximately 1-page) statements of interest that describe a scientific objective, its importance, and the necessity for drilling. Technical details are not necessary. This is an opportunity for interested researchers to influence the scientific direction of the new program; input from the arctic research community is encouraged. Statements of interest should be submitted to the JOIDES Office by 1 September 1998.

For more information, contact JOIDES in Woods Hole, MA (508/289-3481; fax 508/457-2187; joides@whoi.edu; http://www.whoi.edu/joides). ■

Program Coordinates Arctic Ice-Core Research and Data

Reconstruction of past climatic change in the Arctic as a measure of natural variability in the system requires data most suitably obtained from ice cores. The Greenland Ice Core Project (see page 8) has demonstrated the wealth of data available in polar glaciers. No single ice core from the Northern Hemisphere, however, is able to provide a complete picture of past climatic change, particularly during warm climatic modes, like the Holocene, when arctic climate is more regionalized than during glacial times. Ice cores are needed from the many smaller ice caps in the circumarctic region as well as from subarctic alpine sites.

Because international cooperation is increasingly important in this field, the multi-national Ice-Core Circum-Arctic Paleoclimate Program (ICAPP) was formally established in 1996 as part of the Past Global Changes Project (PAGES) of the International Geosphere-Biosphere Program (IGBP). ICAPP will use paleoclimatic records from ice cores and snow and ice sampling to evaluate variability in past climate change and the magnitude and spatial variability of natural and anthropogenic pollutants reaching the Arctic. ICAPP will also encourage the compilation of these records to place the Arctic in the context of the global climate system.

The initial ICAPP project was a drilling program on the Penny Ice Cap, Baffin Island, jointly undertaken by the Geological Survey of Canada, Climate Change Research Center (University of New Hampshire), and the Nagaoka Institute of Snow and Ice Studies, Japan. A 334-meter core was collected from the summit region in 1995; a second core was collected on a smaller dome in 1996 as part of IGBP-PAGES and the Mass Balance of Arctic Glaciers and Ice Sheets in relation to Climate and Sea-Level Changes (MAGICS) Project of the International Arctic Science Committee (IASC).

The IASC Glaciology Working Group discussed future ICAPP ice-coring projects at its January 1998 meeting in Wales. Of particular interest is a proposed coring project on the glacier Akademii Nauk, on Severnaya Zemlya in Russia, probably in 1999. Researchers also plan to collect cores from Lomonosov, Vestfonna, Svalbard, and Franz Josef Land within two years.

For more information—and to contribute information on proposed and ongoing ice-coring projects in the Arctic—contact Gregory Zielinski in Durham, NH (603/862-1012; fax 603/862-2124; greg.zielinski@unh.edu) or Roy Koerner in Ottawa, ON Canada (613/996-7623; fax 613/996-5448; rkoerner@nrcan. gc.ca).

Second ACSYS Science Meeting Held

The Arctic Climate System Study (ACSYS) of the World Climate Research Programme (WCRP) held a conference on Polar Processes and Global Climate on Orcas Island, Washington, in November 1997. This second ACSYS Scientific Conference examined climatic processes in both polar regions, explored the connection between these processes and the global climate system, and addressed the need for global climate investigations to account realistically for polar processes.

The conference focused on three subthemes on the Polar Climate System:

- New Observational Insights;
- Sources, Sinks, and Budgets;
- Processes and their Modeling;

and a fourth on Polar and Global Climate:

- Variability and Feedbacks.

Approximately 150 participants took part. The conference demonstrated the extensive progress in understanding and determining the dynamic nature of the arctic climate system and its links to the wider global climate system since the first ACSYS Conference held in 1994. WCRP and ACSYS have fostered multidisciplinary activities including international coordination of observations and data sets and model intercomparisons.

Conference proceedings and a list of abstract titles are available on the Internet (http://www.npolar.no/acsys/rosarioweb/procedur.htm) and (http://www.npolar.no/acsys/rosarioweb/abstractlist.htm). The final proceedings and abstracts are being published by WCRP.

In early August 1998, ACSYS will convene two consecutive meetings in Seattle, Washington on the Arctic Buoy Program and Sea-Ice Charts of the Arctic (see Calendar, page 23).

For more information, contact Tordis Villinger at the ACSYS Program Office in Oslo, Norway (+47/22 95 95 73; fax +47/22 95 96 01; tvilling@npolar.no; http://www.caroline.npolar.no/acsys/).

IASC Meeting Engages Policymakers

The International Arctic Science Committee (IASC) held its annual meeting in Fairbanks, Alaska, in April 1998. One focus of the meeting was impacts and effects of global change. Speakers reviewed:

- current studies of global change (*e.g.*, the regional Bering Sea Impact Study, see page 18; terrestrial ecosystem studies);
- specific effects (*e.g.*, effects of increased UV-B exposure); and
- societal concerns.

A second focus, setting arctic priorities, provided an opportunity for a panel of stakeholders and policymakers to identify priority problems in the Arctic. A panel of scientists then commented on the information that would be necessary to solve those problems. IASC encourages others to foster comparable dialogues at national and international levels.

For more information, contact Odd Rogne in Oslo, Norway (+47/22-95-96-00; fax +47/22-95-96-01; iasc@npolar.no) or visit the IASC Web site (http://www.npolar.no/iasc/).

Bering Sea Ecosystem Research Underway

The Bering Sea is one of the richest marine ecosystems in the U.S. In the last decade, at least ten agencies and institutions have expressed concern about environmental changes observed in the Bering Sea and have developed science plans addressing diverse questions about the region (see Table;*Witness* Spring and Autumn 1997, Autumn 1996). According to the 1996 National Research Council report on the Bering Sea ecosystem, the combined effects of variability in climate forcing, structure and function of food webs, commercial harvest levels, and other anthropogenic disturbances are causing changes in the ecosystem.

Understanding the complex biophysical system interactions that structure the ecosystem, including direct and indirect effects of fishery removals, is critical to determining and monitoring its health. This understanding can help mitigate human-induced changes and aid in designing management strategies incorporating natural variability.

Research coordination and data sharing among the organizations that study and utilize resources of the Bering Sea are critical to this process. To this end, a scientific workshop on the Bering Sea ecosystem, sponsored by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior, and the Alaska Department of Fish and Game, was held 4-5 December 1997 in Anchorage, Alaska. Workshop recommendations included:

- continue building a Bering Sea metadatabase (see *Witness* Autumn 1997; http://www.pmel.noaa.gov/bering/mdb/); and
- identify mechanisms for Alaskan Natives and coastal communities to communicate traditional and local knowledge and to participate in research.

Initial results include:

- a dedicated Web site at NOAA's Pacific Marine Environmental Laboratory for research planning and information sharing on the Bering Sea (http://www.pmel.noaa.gov/bering/); and
- a draft Bering Sea Ecosystem Research Plan based on previous planning reports (See Table; http://www.pmel.noaa.gov/bering/), recommending research on 1) impacts of human activities on ecosystem health, production, and composition; and 2) effects of climate on individual species and productivity of the Bering Sea.

A June 1998 workshop in Anchorage, Alaska gathered feedback on the draft plan; a revised draft will be available soon. The plan ultimately will guide research efforts to be undertaken through the North Pacific Research Board, recently created by federal legislation. Contact Pat Livingston at the Alaska Fisheries Science Center in Seattle, WA (206/526-4242; fax 206/526-6723; pat.livingston@noaa.gov).

Cooperative Research Effort	Research Focus	Products and Funding Status
Fisheries-Oceanography Coordinated Investigations (FOCI-NOAA)	Physical and biological factors affecting commercial fisheries	Research funded since 1991 on commercial fisheries in Alaskan waters.
Alaska Regional Marine Research Program–Alaska Research Plan (ARMRP–ARP)	Safeguarding water quality and ecosystem health–effects of natural and human factors	1993 Science Plan
Marine Mammals Protection Act (MMPA)–Bering Sea Ecosystem Study Plan	Monitor the health and stability of the Bering Sea ecosystem with marine mammal and seabird emphasis	1995 Science Plan
Seabird, Marine Mammal, and Oceanography Coordinated Investigations (SMMOCI). Cooperative effort by USFWS, NMFS, USGS, and UAF.	Characterize foraging habitat for seabirds and Steller sea lions in the Gulf of Alaska and Bering Sea to understand the response of top level predators to fluctuations in prey base	Preliminary data collected in 1995. Investigators bring resources from their respective organizations.
National Research Council Report on the Bering Sea Ecosystem	Ecosystem dynamics–climate and human-induced change	1996 Report. Program does not fund research.
North Pacific Marine Science Organization (PICES) Bering Sea Working Group and Climate Change and Carrying Capacity Program	Effects of climate variability and fishing on ecosystems	1996, 1997 Science Plans
Southeast Bering Sea Carrying Capacity (SEBSCC-NOAA) Project	Effects of climate variability on pelagic ecosystem	15 projects funded 1996-98. Phase II awards expected October 1998. Project will phase out in 2002.
U.S. Global Ecosystem Dynamics (GLOBEC)	Effects of climate variability on marine animals	1996 Science Plan
Arctic Monitoring and Assessment Program (AMAP) under the Arctic Environmental Protection Strategy	Amount and effects of pollutants	1997 Report. Program does not fund research.
Arctic Research Initiative (ARI-NOAA)	Natural variability of the ecosystem and contaminant inputs, fate, and effects	15 projects funded in 1997; 23 funded in 1998. Future funding uncertain.
Bering Sea Impact Study (BESIS)	Regional impacts of global change–from climate to all trophic levels	1998 Report. Program does not fund research.
Bering Sea Ecosystem Management Project (BSEMP-NOAA)	Increase coordination and communication among those interested in Bering Sea ecosystem research and management	Draft Report. Some funding anticipated for FY99.

Opportunities in Arctic Social Sciences

Numerous scientists and educators contributed to a statement of opportunities now being prepared for the NSF Arctic Social Sciences Program (ASSP). ASSP encompasses all social sciences supported by NSF, including anthropology, archeology, economics, geography, linguistics, political science, sociology, and related subjects. While proposals in any of these fields are welcome, arctic social scientists have identified research areas of particular interest. Under current program guidelines, areas of particular interest include:

- rapid social change,
- community viability, and
- human/environment interactions.

These three areas were identified in the 1989 report, *Arctic Social Science: Agenda for Action*, as priorities for all federal agencies represented on the Interagency Arctic Research Policy Committee (see *Witness* Autumn 1996).

The new statement of opportunities, directed specifically toward ASSP, builds upon the 1989 report and incorporates post-Cold War developments in the Arctic. The document draws upon the research that has been supported by ASSP, contributions of arctic social scientists who met in Seattle, Washington, in October 1997 (see *Witness* Autumn 1997), and the many researchers and representatives of arctic indigenous peoples who commented on the first draft. These recommendations expand the original research areas into five topics:

- culture and environment,
- resources and economic change,
- development of social and political institutions,
- ethnic and regional identities, and
- knowledge systems.

The statement encourages interdisciplinary, international, and community partnerships and offers useful guidelines while retaining the flexibility and creativity characteristic of ASSP. The final version is expected to be published this fall and will be available on the ARCUS Web site (http://www.arcus.org/arcsocsci/) as well as in published form.

In the meantime, prospective applicants may consult the current ASSP program announcement on the NSF Web site (http://www.nsf.gov/od/opp/arctic/start.htm). The Arctic Social Sciences Program welcomes small, single-investigator proposals, dissertation-improvement proposals, as well as multi-institution, multi-investigator projects.

For more information, contact Program Manager Fae Korsmo in Arlington, VA (703/306-1029; fax 703/306-0648; fkorsmo@nsf.gov).

Arctic Social Sciences Conference—ICASS III

Social scientists from throughout the circumpolar North participated in the 3rd International Congress of Arctic Social Sciences (ICASS III) in May 1998, in Copenhagen, Denmark. ICASS III is sponsored by the International Arctic Social Sciences Association (IASSA), which was formed in 1990 to represent arctic social scientists in international contexts and to provide a network for social scientists working and/or living in the North.

Keynote presentations at the ICASS III meeting *Changes in the Circumpolar North: Culture, Ethics, and Self-Determination* were made by Carol Geddes (Canada) and Susanne Dybbroe (Denmark) on the topic of indigenous and local knowledge; Aqqaluk Petersen (Greenland) and Eldon Yellowhorn (Canada) on social viability and cultural continuity; and Nils Oskal (Saami/Norway) and Nikolai Vakhtin (Russian Federation) on political dynamics, governance, and self-determination.

Conference sessions included the topics of arctic economies, living conditions in the North, oral history and cultural revival, globalization and the North, indigenous peoples and ecosystem management, education and social change, rapid social and cultural change, land rights and self-government in the Russian North, sustainable development, and research ethics.

The IASSA General Assembly met during the conference and formally adopted a set of ethical guidelines for research in the Arctic that will be forwarded to the International Arctic Science Committee (IASC), indigenous peoples organizations, and professional associations. IASSA's continuing goal is to promote the conduct of research in the North that is in accordance with the highest standards of professional responsibility and accountability.

IASSA members elected a new seven-member governing council, which chose Professor Gerard Duhaime (Université Laval/Canada) as the organization's new chair. Other council members are: Noel Broadbent (USA/Sweden), Oscar Kawagley (USA), Ludger Muller-Wille (Canada), Marit Myrvoll (Norway), Frank Sejersen (Denmark), and Nikolai Vakhtin (Russian Federation). Ex-officio members of the council are Jens Dahl, IASSA's previous chair, and Murielle Nagy (Canada), IASSA's new secretary.

IASSA agreed to move its secretariat from the University of Copenhagen to Université Laval in Quebec, Canada. ICASS IV will be held in 2001 in Quebec.

The Secretariat's new address is: IASSA c/o GETIC, Pavillon Ernst-Lemieux, Université Laval, Quebec, G1K 7P4, Canada (418/656-7596; fax 418/656-3023; murielle.nagy@fss.ulaval.ca).

Following ICASS III, a number of social scientists participated in an IASC working group on *Rapid Cultural and Social Change in the Circumpolar North*. The purpose of this group is to facilitate international comparative and inter-disciplinary research in the social sciences within the IASC research program. For more information about this effort, contact Ludger Muller-Wille in Montreal, PQ, Canada (514/398-4960; fax 514/398-7437; inmw@musicb.mcgill.ca).

Toolik Field Station Expands to Year-Round Capabilities

NSF is funding the Institute of Arctic Biology (IAB) at the University of Alaska Fairbanks (UAF) to support the design and construction of a winter residence facility for the Toolik Field Station (TFS). The winter residence will complement the winter-use lab, funded by the Office of Polar Programs, which became operational in 1994 and will allow researchers to access the station's field sites during the arctic winter. Design of the winter residence facility has been completed, and construction is expected to be finished this summer.

During the past two field seasons, upgrades at the field station have included:

- a 12' x 60' meeting room/library;
- studies of electrical, water, waste water, and drainage needs;
- a site survey and mapping for planning purposes;
- a drainage project that upgraded the station road, installed 24-inch gravel pads under laboratories and the proposed winter facilities;
- an antenna mast to support two new phone lines; and
- purchase of chairs for the new laboratories and meeting room.

During the 1997 field season, the station provided accommodations for 216 science project members who stayed 3,974 days. Users and staff were in residence 1 May-9 September 1997. The station provided logistic support for 31 funded projects, four artists/writers-in-residence, and the 11th International Northern Research Basins Symposium and Workshop.

The TFS Steering Committee and Science Users Group held its annual meeting in December 1997 in Fairbanks, Alaska. Representatives from institutions including the University of Kansas, University of California-Irvine, Bureau of Land Management, ARCUS, and UAF participated in reviewing the 1997 field season and making recommendations for 1998.

The Steering Committee requested that ARCUS survey the arctic research community about future uses of the station, particularly to assess support for arctic science education programs based there. ARCUS distributed the survey in March 1998; many respondents expressed strong interest in the proposed education programs.

For more information, see the TFS Web site (http://www.uafbio.alaska.edu/toolik/toolik.html), or contact Michael Abels in Fairbanks, AK (907/474-5063; fax 907/474-5513; fnmaa@uaf.edu).

Arctic Science Has Rich Opportunities to Engage Students

Research-education partnerships in polar science education must serve students living in the Arctic—and those who live far from the Arctic. Most students and members of the public outside the Arctic have a limited and often inaccurate understanding of the region and its peoples. Young arctic residents may feel remote from modern scientific researchers, even though they inhabit an under-investigated region that attracts talented researchers who are tantalized by important questions.

Scientists, educators, and related professionals met in April 1997 in New Orleans, Louisiana, to address the value and potential of research-education partnerships in polar science education. The report developed on the basis of that workshop, *Building Partnerships in Polar Research and Education*, endorses the introduction of polar science curricula into K-12 classrooms within and beyond the Arctic, and states that such curricula must reflect:

- the constructive use of emerging communication technologies,
- contributions of local indigenous peoples to science, and
- collaboration of researchers with educators.

The report addresses three main topics:

Media-based arctic science education—Participants strongly recommended development of a media-oriented education program to focus the attention of educators and the public on research in the Arctic. Participants also recommended development of a longer term educational program that would feature curricula on the Web (*e.g.*, virtual arctic field trips) and structured classroom projects with mentors or guides from the arctic community.

Curriculum development—Participants agreed on the need for a broad-based educational effort to introduce polar research into K-12 curricula. Wherever possible, the learning programs should include hands-on research experience for students and teachers. Because of the geographic challenges posed by the polar regions, the use of information technology (*e.g.*, the Internet, CD-ROMs) is key to quick information access and a sense of the dynamic nature of science. Supplements to curricula could include access to current research data, online mentoring, and a system for matching researchers and teachers for collaboration.

Partnerships in research and education—Participants formed partnerships to plan specific interdisciplinary research-education projects. Work on the projects synthesized diverse expertise and developed connections among academic, agency, arctic community, and education participants. Several projects planned at the workshop have been implemented and show promising early results.

For more information, contact workshop co-chairs Peter Sommerville in Christchurch, New Zealand (+64/3 358 4450, fax +64/3 358 4480; psommerv@icair.iac.org.nz) and Elena Sparrow in Fairbanks, AK (907/474-7699; fax 907/474-6184; ffebs@uaf.edu). For a copy of *Building Partnerships in Polar Research and Education*, contact ARCUS or check the ARCUS Web site for a downloadable PDF file.

Science Teachers Gain Arctic Research Experience

Four high school science teachers from across the U.S. will join arctic research projects during the 1998 field season. They are sponsored by NSF's Teachers Experiencing the Arctic and Antarctic (TEA) program, which has been placing teachers, teamed with one or two high school students, with research teams in the Arctic since 1996. TEAntarctic has been sending teachers to Antarctica since 1992. TEA is jointly funded by the Office of Polar Programs and the Education and Human Resources Directorate.

The goals of the TEA program include:

- immersing teachers in a research experience as a component of their continuing professional development;
- infusing polar research experiences into classrooms in rich, engaging, and innovative ways that underscore the relevance of science and the scientific process to society and individuals; and
- establishing collaborations among teachers, students, school districts, researchers, and the community to build on the TEA experience.

Each of the four teachers will join one of the following projects this summer:

- Collecting and analyzing water and ice samples on an arctic cruise with Cold Regions Research and Engineering Laboratory (CRREL) scientists;
- Assisting researchers from Ukpeagvik Inupiat Corporation with an archeological dig of an Ipiutak culture site in the northwest Alaska village of Deering;
- Validating measures of oil contamination in otters with investigators from the University of Alaska at the new SeaLife Center in Seward, Alaska, to better understand the effects of oil spills on animals; and
- Mapping the depth of the soil active layer on the North Slope of Alaska with scientists from the University of Delaware, as a contribution to estimates of carbon flux in response to climate change in the region.

From their field sites, TEA teachers post daily journals and answer questions on a Web site; after the field season, they share their experience with other teachers, students, and their community. In particular, they develop related classroom materials and mentor two science teachers for 100 hours each over a three-year period. The teachers may also continue to collaborate with the field research team.

Qaiyaan Opie, Avaiyak Panigeo, and Wayne Danjin, students at Barrow High School in Barrow, Alaska, drill an ice core from Elson Lagoon for a winter sample (photo by Tim Buckley).

In Barrow, Alaska, a TEA research experience has already significantly enriched the science curriculum. Tim Buckley, a science teacher at Barrow High School, worked with CRREL scientists on a research cruise in the Arctic Ocean in the summer of 1996 (see *Witness* Autumn 1996). He learned how to collect ice and water samples and how to analyze them for structural features, pH, chlorophyll content, and conductivity. Buckley and his students now collect ice cores in the winter for CRREL researchers who had lacked such samples. Some analysis of the winter cores is done by the students in Barrow; some is done at CRREL. Both research and education benefit from this partnership.

For more information, contact Wayne Sukow at NSF (703/306-1613; fax 703/306-0412; wsukow@nsf.gov), see the TEA Web site (http://www.glacier.rice.edu/chapters/tea/tea_introduction.html), or contact ARCUS. ■

Curriculum Resources on the Internet

Indigenous curriculum resources are now available in the Culturally-Based Curriculum Resources database maintained at the Alaska Native Knowledge Network (ANKN) Web site (http://www.ankn.uaf.edu/).

Materials in the database illustrate ways in which indigenous and Western knowledge systems can be applied in schools through a balanced, comprehensive, and culturally aligned framework adaptable to local circumstances. The resources will help teachers and students connect the knowledge, skills, and ways of knowing necessary for a village livelihood with those reflected in the school curriculum.

The database is a project of the Alaska Rural Systemic Initiative (AKRSI), ANKN, and ARCUS to improve access to locally produced curriculum resources for rural schools in Alaska (see *Witness* Autumn 1997).

For more information, contact Sean Topkok, Indigenous Curriculum Specialist, in Fairbanks, AK (907/474-5897; fax 907/474-5615; fncst@uaf.edu). ■

Museums Can Be Educational Catalysts in the Arctic

by I. Michael Heyman

Museums contribute to research and education in all disciplines by protecting and displaying treasures of nature and of humankind. They illuminate forces that generate, shape, and sustain natural and cultural diversity. Arctic collections may be particularly important in research and education because of the Arctic's vast size, relative inaccessibility, geographic complexity, and cultural vitality. Not everyone who is interested in the Arctic can visit the region; most of the general public learns about the Arctic from museum exhibitions, and researchers rely on collections for many purposes.

The pre-eminent arctic collection in an American museum is at the Smithsonian's National Museum of Natural History (NMNH). More than a century of careful collecting and research by scientists has resulted in an unsurpassed repository of natural and cultural objects. Today, the Smithsonian's role in Alaska and throughout the North is taking a dynamic turn, moving rapidly beyond an earlier mandate as collector, repository, and interpreter of arctic science and culture into an era of active information exchange and partnership in research and education.

None of this would have been possible without the collections that had been gathered by scientists who worked almost continuously in the North ever since Spencer Baird, the second Secretary of the Smithsonian, sent naturalist Robert Kennicott to collect from the Mackenzie District in 1858. Kennicott's explorations in Alaska and the purchase of Alaska from Russia in 1867 set the stage for a massive drive to document the natural history and cultures of this *terra incognita*. Baird's goal was to conduct the first complete scientific inventory of an extensive, pristine natural region anywhere in the world. In the decades that followed, the Smithsonian dedicated substantial resources to gather carefully documented collections, publish reports, interpret the finds, and preserve the collections.

In the 1980s, curators in the Anthropology Department mounted a major effort to reveal the Alaska Native ethnographic collections that had been under wraps, literally in the attic, for more than 100 years. Bill Fitzhugh and his colleagues at the NMNH have assembled groundbreaking scholarly exhibitions such as *Inua: Spirit World of the Bering Sea Eskimo* and the joint Russian-American show *Crossroads of Continents: Cultures of Siberia and Alaska*. Both toured nationally. Fitzhugh and his colleagues have organized smaller versions of these shows that could tour locally to towns and villages throughout Alaska, Canada, and Europe; recently *Crossroads Siberia* became the first American exhibit ever to travel in the Russian Far East.

With help from my predecessor Bob Adams and then Director of NMNH Frank Talbot, the Museum staff organized the Arctic Studies Center (ASC) in 1988, secured Congressional funding, and began participating in the Interagency Arctic Research Policy Committee (see *Witness* Autumn 1996) and other national and international bodies. The ASC is now a small but active unit of the NMNH (see Member Insert), which has ensured that research and education programs concerning Alaskan Native issues are high on the priority list of the Museum and the Smithsonian. The Center's media programs have brought its activities to broad audiences, and its prize-winning Internet presentations have pioneered new methods to reach vast audiences, especially in the North. Most recently, the Center participated with our National Museum of American History in mounting *Oil from the Arctic*, a celebration of the 20th anniversary of the Trans-Alaska Pipeline.

In 1994, the NMNH began a new phase of its outreach to Alaska by entering into agreement with the Anchorage Museum of Art and History and the City of Anchorage to open a regional ASC office in Anchorage. This alliance has brought a Smithsonian presence and some of the beautiful objects of Native heritage back to Alaska. Having nearly completed the first five years with able direction from Aron Crowell, we are now developing a longer term vision. Bob Fri, Director of NMNH, and Pat Wolf, Director of the Anchorage Museum, have been working with Fitzhugh, Crowell, Stephen Loring, Igor Krupnik, and others at the ASC to produce an exciting new long-range plan that will build a concrete new vision of Smithsonian-Alaskan partnerships.

The Anchorage office of the ASC offers the Smithsonian's educational resources and programs to arctic communities. For example, as tourism grows in the North, more museums and cultural centers are opening, needing trained staff. ASC/Anchorage has shared the Smithsonian's expertise with these developing museums through a series of museum-training seminars. The ASC will also act as a link between teachers in northern communities and the Smithsonian's outstanding education programs, including lesson plans, resource guides, and partnership and outreach services. Native cultural and historic material are prominent in many of these education programs.

By using the new tools of the information age and by physically reaching out to its Alaskan constituents, the Smithsonian has begun to fulfill its contemporary intention to cultivate a fruitful two-way relationship with arctic peoples. The Institution's repository of arctic treasures is becoming more accessible to its sources, contributing to arctic research endeavors, and educating northern citizens.

I. Michael Heyman has been Secretary of the Smithsonian Institution since 1994. He is Chancellor and Professor Emeritus at the University of California, Berkeley. In the 1970s, he worked as a lawyer on the negotiations that led to the development of the Trans-Alaska Pipeline.

Illustration: Ivory carving of the powerful Sea Spirit Sedna who controls the whereabouts of animal souls (Artist: Susie Silook; photograph courtesy of the Arctic Studies Center, National Museum of Natural History, Smithsonian Institution).

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wit·ness (wit nis) *n.* 1.a. One who has heard or seen something. b. One who furnishes evidence. 2. Anything that serves as evidence; a sign. 3. An attestation to a fact, statement, or event. —*v. tr.* 1. To be present at or have personal knowledge of. 2. To provide or serve as evidence of. 3. To testify to; bear witness. —*intr.* To furnish or serve as evidence; testify. [Middle English *witnes(se)*, Old English *witnes*, witness, knowledge, from *wit*, knowledge, wit.]

Calendar

August 3-4, 1998 The Arctic Buoy Program. Seattle, WA. Contact Tordis Villinger at the Arctic Climate System Study (ACSYS) Program Office in Oslo, Norway (+47/22 95 95 73; fax +47/22 95 96 01; tvilling@npolar.no; http://www.npolar.no/acsys/seattle98/index.htm).

August 5-6, 1998 Sea Ice Charts of the Arctic. Seattle, WA. Contact Tordis Villinger at the Arctic Climate System Study (ACSYS) Program Office in Oslo, Norway (+47/22 95 95 73; fax +47/22 95 96 01; tvilling@npolar.no; http://www.npolar.no/acsys/seattle98/index.htm).

August 17-20, 1998 Second International Conference on Climate and Water. Espoo, Finland. Contact Risto Lemmelä in Tuusula, Finland (+358/92 75 38 35; fax +358/94 51 38 27; rlemmela@ahti.hut.fi; http://ahti.hut.fi/wr/caw2/).

August 24-28, 1998 Polar Aspects of Global Change. International symposium and field trip to Svalbard. Tromsø, Norway. Contact the International Symposium on Polar Aspects of Global Change, c/o Norsk Polarinstitutt in Tromsø (+47/77 60 67 00; fax +47/77 60 67 01; jaklin@tromso.npolar.no; http://www.tromso.npolar.no/polaraspects).

September 20-25, 1998 The 17th Polar Libraries Colloquy. Reykjavik, Iceland. Contact Palina Hedinsdottir, Icelandic Institute of Natural History (+354/5629822; fax +354/5620815; palina@nattfs.is; http://www.hafro.is/hafro/Joint/conf.html).

September 23-26, 1998 International Workshop on Environmental and Climatic Variations and their Impact in the North Atlantic Region. Reykjavík, Iceland. Contact Hjördís Hendriksdóttir at the Icelandic Research Council (+354/5621230; fax +354/5529814; hjordis@rannis.is; http://www.rannis.is/english/news-adv/workshop/index.html).

October 5-7, 1998 Remote Sensing for Marine and Coastal Environments. Fifth International Conference. San Diego, CA. Contact ERIM International (313/994-1200; fax 313/994-5123; marine@erim-int.com; http://www.erim-int.com/CONF/marine/MARINE.html).

October 6-8, 1998 SCICEX 2000: A Workshop to Plan for Submarine-based Arctic Science. Warrenton, VA. Contact Drew Rothrock in Seattle, WA (206/685-2262; fax 206/543-3521; rothrock@apl.washington.edu) or Wieslaw Maslowski at the Naval Postgraduate School (408/656-3162; fax 408/656-2712; maslowski@ncar.ucar.edu; http://psc.apl.washington.edu/scicex/scicex2000.html).

October 25-28, 1998 International Cooperation in Arctic Research: Detecting Global Change and its Impacts in the Western Arctic. 49th Arctic Division Science Conference, American Association for the Advancement of Science. Fairbanks, AK. Contact Syun Akasofu at the University of Alaska Fairbanks (907/474-7282; fax 907/474-5882; fnmrf@uaf.edu; http://www.gi.alaska.edu/). ■

For more information, see the Calendar on the ARCUS Web site (http://www.arcus.org/).

Publications

Arctic Environmental Protection Strategy (AEPS): Process and Organisation, 1991-1997: An Assessment. Norwegian Polar Institute (+47/22 95 95 00; fax +47/22 95 95 01; sale@npolar.no).

Circum-Arctic Map of Permafrost and Ground Ice Conditions. (1:10,000,000) U.S. Geological Survey Circum-Pacific Map Series CP-45. 40" x 58". $4.00 plus $3.50 handling (800/USA-MAPS).

Greenlanders, Whales, and Whaling: Sustainability and Self-Determination in the Arctic. Richard A. Caulfield. 1997. University Press of New England. Hanover, NH. 224 p. (800/421-1561; fax 603/643-1540; http://www.dartmouth.edu/acad-inst/upne/).

Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion. 1997. Canadian Arctic Resources Committee. Ottawa, Ontario. 98p. (613/241-7379; fax 613/241-2244; ay385@carleton.freenet.ca). ■

A Note from the Executive Director

Most of our time at ARCUS is spent working with the arctic research community to envision and implement; there is little time for introspection. While working on this issue of *Witness*, however, I saw many references to the value of teamwork, which led me to think back on the ten issues of *Witness* that we have produced, our partnership with the arctic research community, and what we have all accomplished.

Summer is busy in the Arctic, as plants, animals, scientists, tourists, and builders try to squeeze the maximum amount of productivity into an all too brief season. Many arctic researchers are in the field now working with teams of students and colleagues. Arctic field research remains compelling, in spite of the frequently rigorous conditions, because of opportunities for advancing knowledge, collaborating with colleagues, educating students, as well as learning about an amazing environment.

Several lessons can be drawn from these arctic field experiences, especially about the importance of planning and cooperation during what may be difficult times. The attitude of the team leader is vital to maintain group cohesion in the face of adversity. The supporting logistical infrastructure is crucial to protect the group's safety and get the work done. Keeping an eye on the long term—remembering that ups and downs are inevitable—will maintain sanity. Efficiency of effort matters. Planning ahead is always a good idea. Vision and leadership are critical, as are persistence, creativity, and plain hard work.

These lessons apply as well to the diligence of the arctic research community in science planning. I look back to our first issue of *Witness*, published in Winter 1992, and note several things: the ARCSS Program was in its infancy, NSF did not yet have a dedicated Arctic Sciences Section, many broad arctic logistics needs were unmet, the Arctic Environmental Protection Strategy had only recently been formulated. Considerable progress has been made in all of these areas in six years because of the cooperation of many people, who contributed to joint planning enterprises on top of the demands of their individual research programs.

The arctic research community has persevered through its share of difficult times and continued to propose and develop exciting and important research initiatives and logistics investments. Much of this research is now producing compelling results, and the logistics needs are receiving deserved attention. These successes are due to hard work by this active community, rigorous and vital research efforts, and the fact that we have cooperated effectively on issues that affect the community as a whole. In the demanding world of arctic research, uniting our efforts—synergy—makes the best use of our individual expertise.

Wendy K Warnick

Inside

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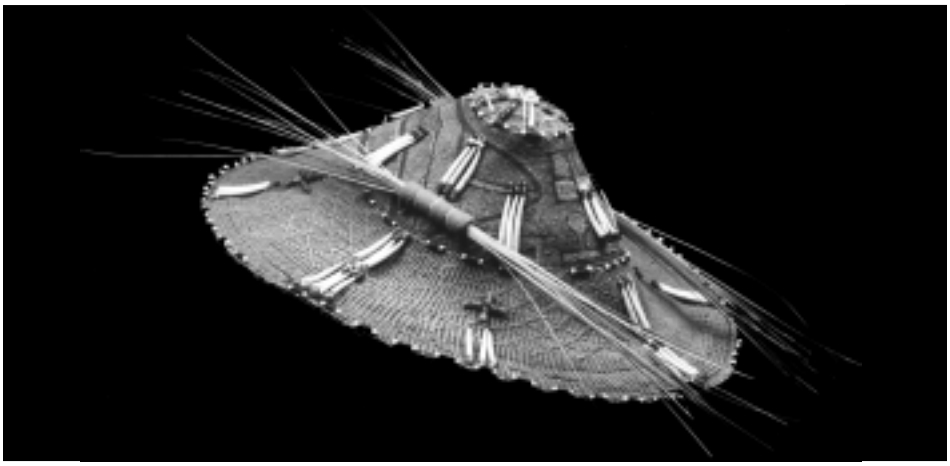
Arctic Studies Center, Smithsonian Institution

The Arctic Studies Center (ASC) was created by the Smithsonian's National Museum of Natural History (NMNH) in 1988 to promote the study of arctic peoples, cultures, and environments. Building on 150 years of Smithsonian arctic exploration and science, its mission lies in cultural, biological, and environmental studies in the Arctic and Subarctic, particularly in Alaska, but also throughout the circumpolar North.

The ASC is the primary U.S. government program with a special focus on arctic cultural research and education. In keeping with the Smithsonian commitment to "the increase and diffusion of knowledge," the Center conducts field research and museum studies, builds and maintains collections and archives, produces exhibition and outreach programs, and conducts museum-based educational programs. Training of museum professionals and outreach enhancing legacies of northern peoples are central to its mission. Fellows and interns provide support for scientists and community scholars. ASC collections and research programs involve close collaboration with northern communities and Native groups in areas of exhibition, museum training, and research.

Research, collection development, and public programs are essential to Smithsonian scholarship and public education programs. ASC work is multidisciplinary, circumpolar, international, and community-based. Our fundamental concern is with the preservation of arctic cultural legacies.



A Koniag (Aluutiq) woven spruce root hunting hat collected by William J. Fisher from Karluk, Kodiak Island in 1884. Decorations include sea lion whiskers, dentalium, and glass beads (NMNH, Smithsonian Institution).

Research

ASC research explores problems and topics of the arctic and subarctic world. Center staff emphasize anthropological archeology, ethnology, ethnohistory, and related aspects of biology and natural science. Research problems commonly include a variety of cultural studies involving human-environmental interactions from the Pleistocene to modern times. The ASC also investigates modern processes of cultural contact and transformation from perspectives of history, contemporary affairs, demography, geography, and ecology.

Over the past 20 years, Smithsonian northern studies have concentrated on research in three circumpolar regions:

- Inuit-European transformations in the Eastern Canadian Arctic;
- trans-Beringian contacts and evolutionary systems in the Greater North Pacific region; and
- recent culture history and transformations involving modernization and industrial development in the Yamal region of Western Siberia.

From Trash to Treasures

Having pursued northern studies since the 1850s, the Smithsonian possesses one of the world's finest anthropological collections from arctic regions. The most important early collections are ethnological materials acquired by Smithsonian naturalists between 1858 and 1890 from the Mackenzie District, Ungava, Baffin Island, Coppermine, Alaska, and Siberia. These collections were purchased from Native people with highly prized Western trade goods. Edward W. Nelson, who collected now priceless materials in Western Alaska in 1877-81, was called by his Yup'ik friends "the Man Who Buys Good-For-Nothing Things."

Unlike many museum collections, the Smithsonian's are early, comprehensive, systematic, and well-documented. Archival holdings include first-hand field notes, photography, and unpublished reports. NMNH also houses large collections of northern fauna, flora, minerals, and paleontological remains which provide valuable baseline data for studies of global change, pollution monitoring, and paleoenvironmental reconstruction.

Policy and Partnerships

While its basic mandate lies in cultural studies, Center programs address natural sciences, humanities, and arts. Outside the Institution, ASC cooperates with NSF, the National Park Service, State Department, NOAA, and other federal and Alaskan state agencies; and with universities, Native communities, and foreign partners.

The ASC represents the Smithsonian at various federal agencies and on research boards such as Interagency Arctic Research and Policy Committee (see *Witness* Autumn 1996), the U.S. Arctic Research Commission (see page 12), and ARCUS; and advises government and international bodies on northern cultural issues. It also works with the National Museum of the American Indian (NMAI), which recently became part of the Smithsonian.

The First Ten Years

In recent years, the ASC has expanded its earlier focus on North America into international research, collection sharing, exhibition, and public education. Major initiatives have included:

- Crossroads of Continents—An international joint venture with the Soviet Union led to *Crossroads of Continents: Cultures of Alaska and Siberia*, an exhibition exploring history, art, and interaction of cultures of the North Pacific region.
- Crossroads Alaska/Siberia—A smaller traveling exhibit to present North Pacific collections to local audiences in Alaska and the Russian Far East in 1993-97. A color catalog, educational materials, and media programs were produced, and 5,000 Russian language catalogs were provided free to Siberian museums, Native associations, village schools, and local communities.
- Community Archeology—Field archeology is an important method of strengthening community links to its past in ways that inspire Native youth and bind communities together. Community-based field projects conducted in Labrador, Baffin, and Alaska have provided opportunities for Smithsonian staff to work with local communities and for northern residents and scholars to work with Smithsonian scientists, collections, and archives.

A Yup'ik painted image from the bottom of a wooden serving dish shows a caribou linked to its spiritual likeness—its inua or an ancestor spirit. Collected by Edward Nelson in Nulukhtulogumut, near Baird Inlet, ca. *1879 (NMNH, Smithsonian Institution).*

- Archeology of the Frobisher Voyages—One of the great sagas of European exploration is Martin Frobisher's search for a Northwest Passage in 1576-78 and discovery of "gold mines" in southeast Baffin Island. Smithsonian research in 1981 and 1990-93 brought attention to the historic remains of this first English venture in the New World and produced evidence of early European impacts on Inuit culture. The project stimulated a large international research program involving Inuit oral history, historical archeology, and environmental sciences.
- National Park Surveys—The National Park Service funded ASC/Anchorage in 1993-96 to conduct archeological surveys and paleoenvironmental research in Katmai, Kenai Fjords, Glacier Bay, Wrangell-St. Elias, and Lake Clark National Parks. The data advanced knowledge of human adaptations and paleodemography across a broad region, while identifying impacts of glacial advances and changing sea levels on preservation of the archeological record. Results will assist NPS in management and research planning efforts.
- Western Aleutian Archeology and Paleoecology—Since 1992, the ASC has participated in the Western Aleutian Human Paleoecology and Biodiversity Project, an interagency (with the U.S. Fish and Wildlife Service), international, and interdisciplinary initiative in the Western Aleutians. Building upon 19th-century Smithsonian work, the project seeks to unravel settlement chronology, dynamics of human and avian biogeography, and cultural change in a remote oceanic archipelago.
- Historical Archeology of Russian Contact—From Anchorage, the Center has continued research on the interaction of Russian fur traders and indigenous populations of southern Alaska at the Russian Three Saints Bay colony on Kodiak Island. Data from new contact-period sites are providing information on material culture change and village abandonment that fill major gaps in historical knowledge about the effects of Russian contact.
- Living Yamal—Research on the Yamal Peninsula of Western Siberia grew from the need to evaluate Western Siberian cultural resources in the face of rapid industrial development. Three archeological surveys (1994-97), a photograph exhibition, several video films, and public and scholarly materials were produced by a Smithsonian-Russian team. The project pioneered museum-arbitrated roles between industry and Native culture.
- Outreach, Media, and Small Exhibits—The annual ASC Newsletter, print media, radio, and TV carry information about ASC activities nationally and internationally. Video documentaries, including *Secrets of the Lost Red Paint People*, *Viking America*, *Northern Clans/Northern Traces*, and *In Caribou Country*, have been produced. The Center's prize-winning Web site (www.nmnh.si.edu/arctic) and multi-media communications offerings (in cooperation with *Live From the Poles* this spring) bring ASC work to a rapidly-growing cyberspace audience. Recent small exhibits include *Canadian*

Inuit Sculpture (Canadian Embassy), *Arktis/Antarktis* (KAH/Bonn), and *Oil from the Arctic* (Smithsonian Institution/American History).

Current Projects

The major rationale for ASC program development is the integral relationship between research and public programs. Past success, new links to Alaska and Russia, and international and local partnerships provide a foundation for a variety of future programs.

- Kamuy: Spirit of the Ainu—For several years the Center has been developing a special traveling exhibition featuring the history, culture, and art of the Native Ainu people of northern Japan and southern Okhotsk Sea from 10,000 BC to the present. Coming at a time of Ainu cultural rebirth and political recognition, the exhibition is being produced in partnership with the Ainu people and will emphasize the formation of Ainu ethnicity.
- West-Viking: Norse in the New World—A major exhibition is planned for the millennium era at the 1000th anniversary of Leif Eriksson's discovery of America. Exploring Viking expansion from Europe across the North Atlantic to Iceland, Greenland, and the New World, West-Viking will review Nordic history through Icelandic sagas and recent research in archeology, environmental studies, and history. With an emphasis on discovery, Native-Norse interaction and the creation of modern nordic ethnicity in North America, the exhibition will also explore the myth of the Viking past and its modern popular expressions.
- Jesup II—The exhibition, which will feature studies of culture change and transformation in the greater North Pacific region, is the Center's evaluation of historical change 100 years after the pioneering Morris Jesup North Pacific Expedition of 1897-1902. Jesup II includes joint publications, training of Siberian/Alaskan Native researchers, sharing of archival and collection resources, and new museum and field research programs.

The Alaska Regional Office

The Alaska Regional Office of the Arctic Studies Center was established in 1994 by the National Museum of Natural History, the Anchorage Museum of History and Art (AMHA), and the Municipality of Anchorage. The five-year agreement established a Smithsonian presence in Alaska to provide access to Smithsonian cultural resources. An Alaska office also strengthens ASC research capabilities by placing it in direct contact with Native Alaska and its cultural resources. Affiliation with the Anchorage office of the National Park Service has allowed the ASC to pursue archeological surveys in national parks in addition to conducting outreach and public programs. In 1997, a grant from the NMAI added an education outreach coordinator to the Anchorage office.

For its first four years, the Center occupied an office in the Anchorage Museum with additional space for research and collection storage. Early in 1997, it moved into new offices adjacent to the Museum made available by the City of Anchorage. Plans announced in 1996 call for expansion of the AMHA complex to bring the ASC back into the Museum proper. This will enable the Center to fully integrate its research, collection, and training activities with Anchorage Museum programs.

An Alutiiq Exhibition

Having a regional office in Alaska provides ASC with opportunities to undertake collaborative research and public programs that foster discussion and information exchange with Alaska Native communities. In September 1997, the Anchorage office of ASC, the Alutiiq Museum in Kodiak, and the Kodiak Area Native Association co-hosted an elders conference in Kodiak to discuss themes and materials for the forthcoming exhibition *Looking Both Ways: Heritage and Identity of the Alutiiq People*. This exhibit will feature previously unreported 19th-century collections made by William J. Fisher. The meeting was attended by 38 Alutiiq elders and many younger cultural leaders from 17 communities in Kodiak, Prince William Sound, Cook Inlet, and the Alaska Peninsula.

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Fellows, volunteers, and interns provide assistance and receive research training. Each year the ASC hosts several foreign scholars under its Visitor's Research Program, while the Community Scholars Program brings northern Native artisans and scholars to Washington, DC to work with Smithsonian collections.

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A Millennium Plan

Based on the accumulated experience of the past 15 years, the ASC has formulated a plan for future development of the Anchorage Office that builds upon the following elements:

- Research—Continued cooperation with NPS survey and assessment programs. Opportunities for expanding archeological research into Western Alaska may also appear, especially if Jesup II finds financial support.
- Research Associates and Networks—Anchorage Office programs will be expanded in collaboration with Research Associates, university researchers, regional museums, and community scholars.
- Training and Intern Residencies—ASC will work to expand current Smithsonian fellowship and internship programs in collaboration with the University of Alaska and others.
- Library—Arrangements are being made to acquire a major anthropological research library as the research core of the Anchorage office. This library will add immensely to the existing library of the Anchorage Museum.
- Collections—Alaskan access to Smithsonian (especially NMNH) collections are central to the Alaska Office rationale and an expanded Anchorage operation. In 1998, part of our E.W. Nelson Western Alaskan collection will return to Anchorage, soon to be joined by portions of the W.J. Fisher Kodiak collection, to remain in Anchorage for five years as part of the Center's rotating Alaska ethnographic reference collection. Within a few years this loan collection could grow to represent all key cultural regions of Alaska. Rotating periodically between Anchorage and Washington, over time many of the Smithsonian's Alaskan collections could be seen in Alaska. The NMAI has also indicated interest in developing an Alaskan loan program. Together, the two collections might provide up to 1,000 ethnographic objects at a time in Alaska.

A Center for Museum Studies

New facilities and access to a small reference collection would provide ASC/Anchorage with the basis for an expanded museum-based research and education program. Together with other institutions, the Alaska Office has the potential to become a regional museum-training center. Access to Washington as well as local resources would provide students and ASC staff with materials to develop an Alaskan center for museum studies that could be an important asset to university degree programs, attracting students from Alaska and other circumpolar regions, including Russia. Japan's expanding education and research presence in Alaska will also provide museum connections. The major ASC interest, however, would be Native and rural Alaska, as museums and cultural legacy programs are expected to play an expanding role in regional economies. Models for the operation of such a center have already been established through the ASC workshops, conferences, and traveling exhibitions.

Conclusion

During its first decade, the ASC succeeded in building internationally acclaimed exhibits, research programs, training, and publication projects. Thanks to these efforts, Smithsonian collections have been brought out of "the nation's attic" into the North and have been introduced to a new constituency of scholars and northern peoples around the globe. With its program well defined and a new foothold in Alaska secured, the primary ASC objective for its second decade is to consolidate its Alaska program while maintaining its commitment to the time-tested values that have nurtured the Smithsonian for the past 150 years. ■

Museum Training Seminars

As part of its educational mission, the Anchorage office has offered a series of museum training seminars to meet the need for trained museum personnel to staff Alaska's rapidly growing roster of museums and cultural centers. These offerings include:

- Tribal museum and museum education seminars—Conducted yearly since 1995 at the Alaska Federation of Natives meetings in Anchorage.
- Preserving our Heritage: A Seminar on Community Research and Cultural Documentation—Anchorage (October 1995). ASC provided assistance to the Alaska Native Human Resource Development Program, University of Alaska, in conducting this seminar; 40 students, statewide participation.
- Preservation of Cultural Objects—A workshop at the Anchorage Museum of History and Art (May 1996). A five-day intensive training program attended by 25 participants from 16 Alaska museums; taught by Smithsonian ethnographic conservators Carolyn Rose and Greta Hansen.
- Alaska Native Museums and Culture Centers: Planning and Management—A workshop at the Anchorage Museum of History and Art, February 1998.
- Museum Studies Distance Delivery Classes—In cooperation with the University of Alaska Fairbanks and Ilisagvik College in Barrow, six undergraduate courses for a museum studies minor (1994-present). Remote participation by audio-conference from 25 communities. Class visit to NMNH in March 1996 to study Alaska collections. Student internships and projects at ASC and the Anchorage Museum.
- Tatitlek CD-ROM Project—Village students worked with research materials provided by ASC and technical training from the Chugach School District to create an interactive catalog of objects in the William J. Fisher collections, December 1995.
- Museum Studies in Anthropology—Undergraduate course taught through the University of Alaska Anchorage, spring semester 1997.
- Lectures and Presentations—Given at conferences, arctic science meetings, museums, and community meetings around the state of Alaska. ■

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Second Annual ARCUS Student Award Winners Announced

In February 1998, ARCUS announced the winners of the Second Annual ARCUS Award for Arctic Research Excellence. A panel of senior scientists from ten universities reviewed the 22 student papers submitted for this competition. The four winners selected were major contributors to the research and primary authors of the papers they submitted:

- Kurt M. Cuffey (and G.D. Clow), Department of Geological Sciences, University of Washington, Seattle, WA: Temperature, accumulation, and ice-sheet elevation in central Greenland through the last deglacial transition.
- Brenda Ekwurzel, Department of Earth and Environmental Sciences, Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY: Distribution and variability of freshwater sources within the Arctic Ocean surface and halocline waters.
- Sadredin C. Moosavi (and P.M. Crill), Department of Earth Sciences, University of New Hampshire, Durham, NH: CH_4 oxidation by tundra wetlands as measured by a selective inhibitor.
- Brian T. Person (and C.A. Babcock and R.W. Ruess), Department of Biology and Wildlife, University of Alaska Fairbanks, AK: Forage variation in broodrearing areas used by pacific black brant geese on the Yukon-Kuskokwim Delta, Alaska.

The award is designed to encourage undergraduate and graduate students to pursue their interests in arctic sciences. The winners received a $500 award and presented their papers at the March 1998 *Arctic Forum* in Washington, DC.

For the 1999 competition, papers must be submitted by December 1998. Students from any institution may apply.

For more information, see the ARCUS Web site (http://www.arcus.org/), or contact any ARCUS Member Institution Representative or ARCUS.

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