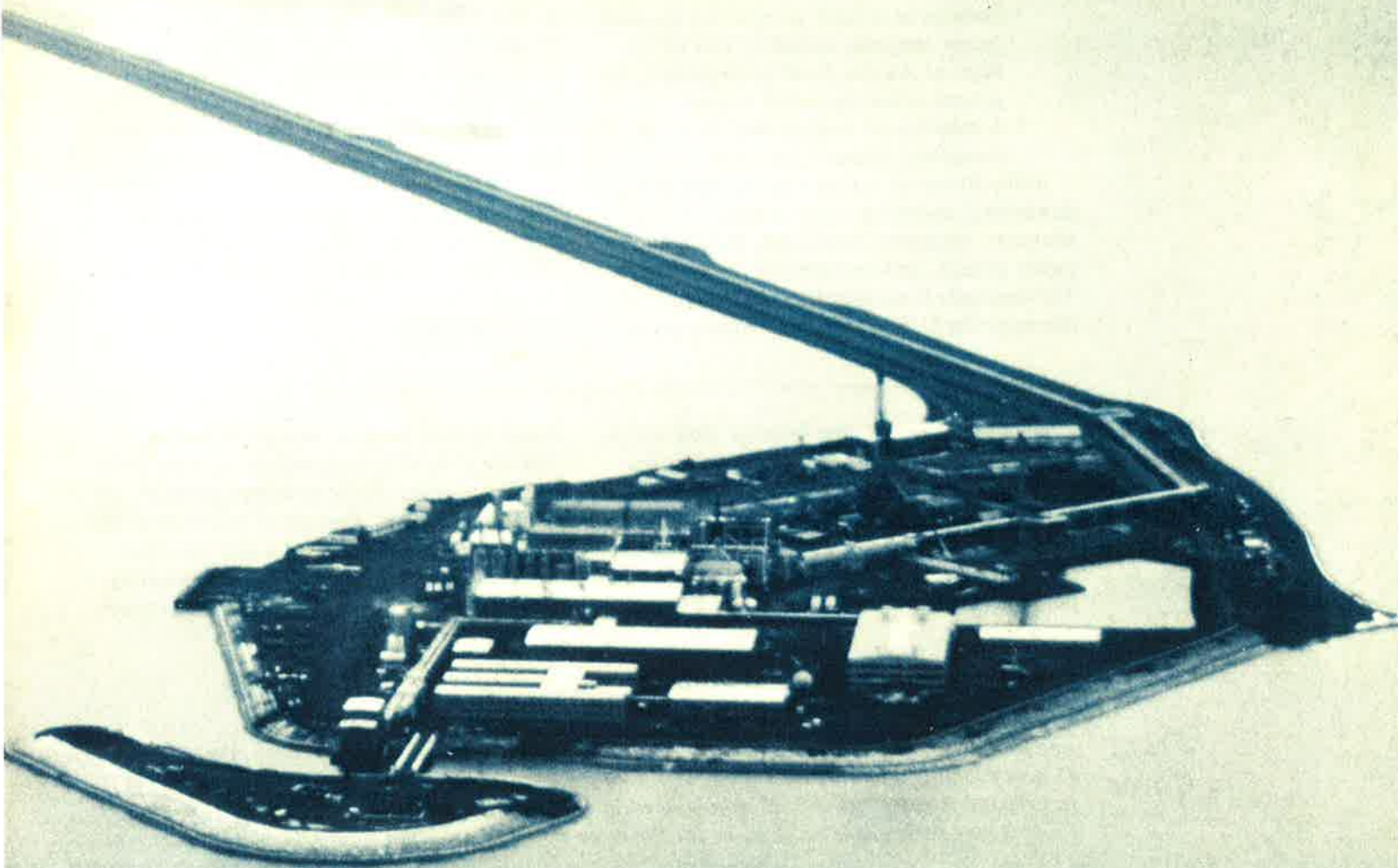


VOLUME 2

SPRING 1988

# ARCTIC RESEARCH

## OF THE UNITED STATES



INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE

## About the Journal

The journal *Arctic Research of the United States* is for people and organizations interested in learning about U.S. Government-financed Arctic research activities. It is published by the National Science Foundation on behalf of the Interagency Arctic Research Policy Committee and in cooperation with the Arctic Research Commission. Both the Interagency Committee and the Commission were authorized under the Arctic Research and Policy Act of 1984 (PL 98-373) and established by Executive Order 12501 (January 28, 1985). Publication of the journal has been approved by the Office of Management and Budget.

*Arctic Research* contains

- Reports on current and planned U.S. Government-sponsored research in the Arctic.
- Reports of ARC and IARPC meetings.
- Summaries of other current and planned Arctic research, including that of the State of Alaska, local governments, the private sector and other nations.
- A calendar of forthcoming local, national and international meetings.

*Arctic Research* is aimed at national and international audiences of government officials, scientists, engineers, educators, private and public groups, and residents of the Arctic. The emphasis is on summary and survey articles covering U.S. Government-sponsored or

-funded research rather than on technical reports, and the articles are intended to be comprehensible to a non-technical audience. Although the articles go through the normal editorial process, manuscripts are not refereed for scientific content or merit since the journal is not intended as a means of reporting scientific research. Articles are generally invited and are reviewed by agency staffs and others as appropriate.

As indicated in the *United States Arctic Research Plan*, research is defined differently by different agencies. It may include basic and applied research, monitoring efforts, and other information-gathering activities. The definition of *Arctic* according to the ARPA is "all United States and foreign territory north of the Arctic Circle and all United States territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers; all contiguous seas, including the Arctic Ocean and the Beaufort, Bering, and Chukchi Seas; and the Aleutian chain." However, areas outside of the boundary are discussed in the journal when considered relevant to the broader scope of Arctic research.

It is our intent to publish two issues per year initially; one will be devoted to summaries of U.S. Government programs of the previous fiscal year, and the other to non-government reports.

## In This Issue

The articles in this first issue of 1988 are divided into three main sections. The first focuses on non-Federal research in Alaska and selected Federal support activities involving data and information acquisition, storage and dissemination. The second section presents reports on meetings and activities of interna-

tional interest predominantly originating outside the U.S. The third section contains brief reports of other Arctic research activities, primarily in the U.S. Reports of meetings of the Arctic Research Commission and the Interagency Committee and notices of upcoming meetings are a regular feature of the journal.

## Front Cover

*Aerial oblique photo of the Endicott Oil Field production island, Prudhoe Bay, Alaska. This 45-acre island is operated by Standard Alaska Production Company. The small island in the foreground is Endeavor Island, constructed in 1980 and used for exploration drilling of the field; it now serves as a breakwater for the main island.*

# ARCTIC RESEARCH

## OF THE UNITED STATES

### Interagency Arctic Research Policy Committee

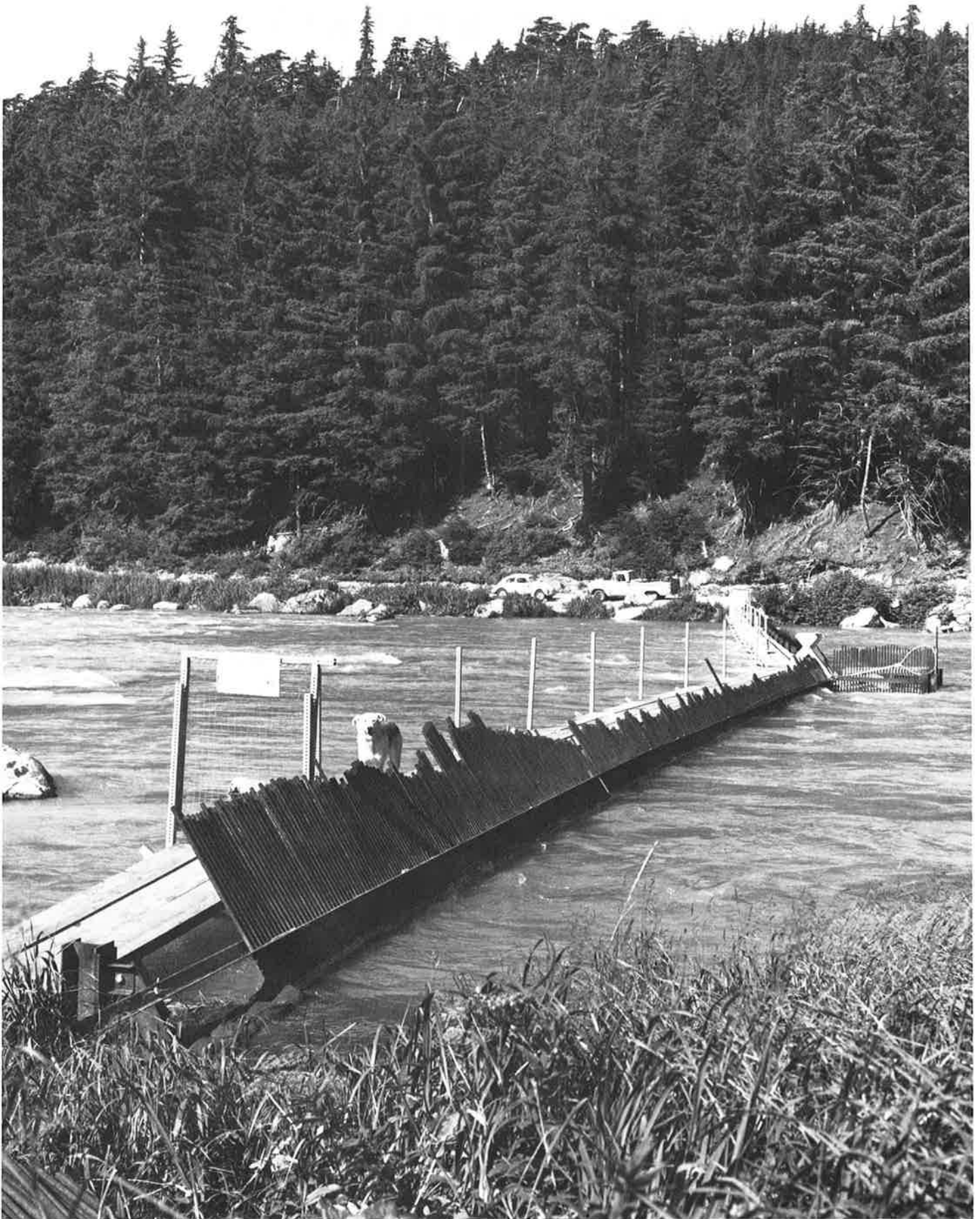
National Science Foundation	
<i>Erich Bloch, Chairman</i>	
Department of Commerce	
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Department of Defense	
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Smithsonian Institution	
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Office of Management and Budget	
<i>Norine E. Noonan, Observer</i>	
Office of Science and Technology Policy	
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*Chilkoot River salmon weir, which temporarily blocks passage of spawning fish so an accurate count can be made.*

# Research Activities of the State of Alaska

HENRY COLE

## Introduction

Alaska scientific and technical research and development has proceeded along two main lines. One is through State agency and private sector applied research relating to State resource development needs; the other is the more traditional, largely Federally funded university research. The recent commitment by the State of Alaska for State funding of science and technology will serve to integrate and enhance both of these paths.

The export of raw commodities has been the driving force for much modern Alaska development. Whether the commodities were sea otters, gold, salmon, copper, wood products or oil, non-Alaska corporations with a knowledge of world markets usually initiated the enterprises and provided the skills to complete them. Export of valuable resources expanded the local Alaska economy but kept it dependent on outside market prices and control. In the case of mineral or oil development, such as the massive Prudhoe Bay oilfield, major non-Alaska corporations provided engineers, scientists, specialized equipment and financial support.

Construction has been the other major development effort. The Alaska Railroad, built in 1918, inaugurated development in Anchorage. Military installations and huge defense expenditures in the 1940s brought in technical skills and introduced a powerful Federal economic presence, with its attendant control and stability in the state. The \$9 billion Trans-Alaska Pipeline construction project in the 1970s provided a huge influx of workers and a stimulus to growth.

These development characteristics were, of course, unavoidable in a rich state with a very small resident population. Alaska lacked broad technical support for major enterprises with accelerated development schedules. But when a rush subsided, frequently as rapidly as it grew, some workers stayed and the technical community slowly grew. Even so, Alaska developed internationally recognized science and engineering expertise in specialized areas, such as upper atmospheric research, earth sciences, oceanography and biology. But the numbers of scientists working in these fields were low, and their funding was from the Federal government. Federal funding levels

held at about \$90 million, and State support for research, particularly innovative research, remained limited. Furthermore, because of the \$4 billion yearly State income from Prudhoe Bay oil in the early 1980s, there was little pressure for expansion or diversification of the economy.

This complacent situation ended abruptly when world oil prices dropped from \$32 to \$9 per barrel over the 18-month period ending in mid-1986, triggering a sharp Alaska recession. What was revealed then was what Alaskans had known all along but had chosen to disregard: the economy was hostage to a single source of revenue and there was no strategy to achieve diversification.

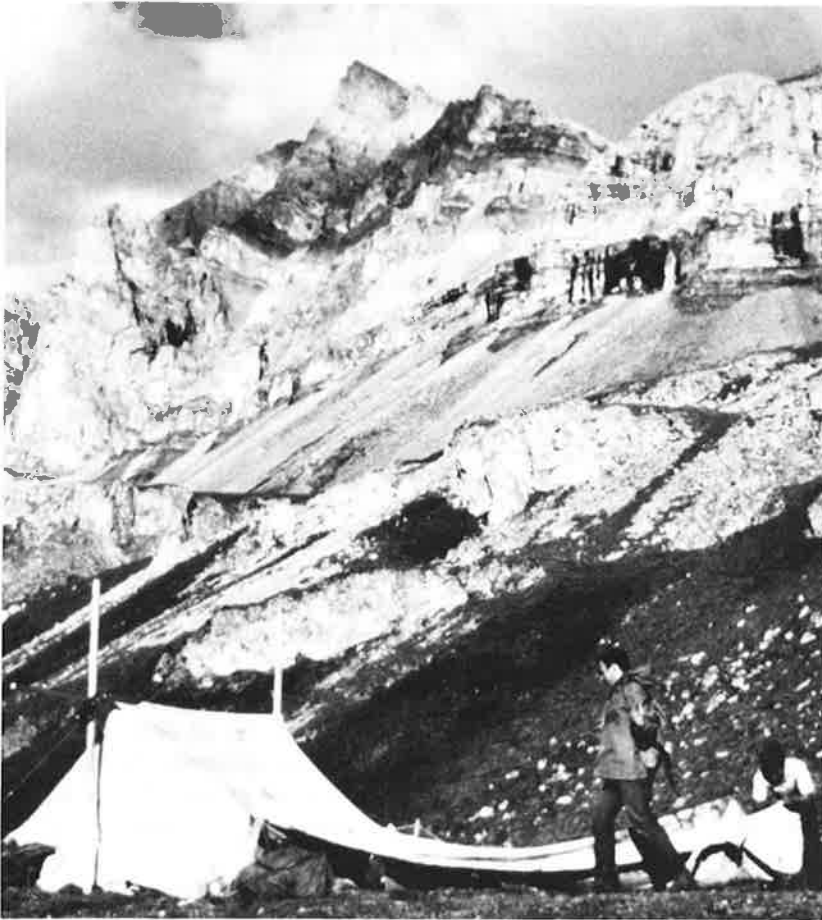
At the same time, however, under the Arctic Research and Policy Act of 1984, Congress authorized the creation of the Arctic Research Commission and the Interagency Arctic Research Policy Committee to coordinate and promote Arctic research. Encouraged by that event, Governor Bill Sheffield signed the Alaska Research Policy Act of 1986 establishing the Alaska Science and Engineering Advisory Commission, whose goal is to formulate State research needs. The State government now recognized that science and engineering in Alaska would not improve without special attention. This was a critical advance; the Alaskan scientific community had always argued that a broad scientific base in Alaska was essential for developing natural resources and managing the environment.

Governor Steve Cowper, on December 1, 1986, took office in the face of a severe State recession. Cowper had long been committed to science and technology as the tools for economic modernization and diversification. This led him to draft the legislation for forming a science foundation, and he signed the Alaska Science and Technology Foundation Act into law on May 13, 1988. The State thus acquired an instrument for funding a wide range of scientific and economic development goals.

## *The Alaska Science and Technology Foundation*

The purpose of the Alaska Science and Technology Foundation is "to promote and enhance, through basic and applied research:

*Henry Cole is the Senior Science Advisor to Governor Cowper and serves as the Chair of the Alaska Science and Engineering Advisory Committee.*



*Base camp for geologic mapping project near Atigun Gorge in the Brooks Range.*

economic development and technological innovation in Alaska; public health; telecommunications; and sustained growth and development of Alaskan scientific and engineering capabilities." Further priorities and research goals will be set by the Alaska Science and Engineering Advisory Commission. Although the stated intent of this Foundation is to assist in diversifying the Alaska economy, there is no doubt that a wide range of research issues will be funded.

The nine-member board of directors of the new Foundation is chosen by the Governor. Members will serve staggered four-year terms. Two members are to be Alaskan scientists or engineers, one of whom is employed by the University of Alaska. Two are to be scientists or engineers residing outside Alaska. Four will be public representatives (at least two of whom have expertise in resource development, manufacturing, finance, telecommunications or public health). The ninth member is employed by a department or agency of the State, other than the University of Alaska. The board will choose an executive director and staff. A panel of recognized technical experts, not limited to Alaskans, will provide

peer review for evaluating proposals and recommendations for the board.

Proposals will be funded that will solve Alaska problems. Preference will be given to valid proposals submitted by Alaskan scientists and institutions. If sufficient Alaskan expertise does not exist for a given investigation, Alaskans will be encouraged to join with a suitable out-of-state institution. Conversely, interested scientists from outside the state will be encouraged to join with an in-state group in submitting proposals. Grants may fund salaries, operational costs and equipment but not buildings. Scientists anticipating discoveries, directly marketable products or patents that result from funded research will negotiate with the board over the disposition of royalty income or patents. Proposals matched by the private sector or by the Federal government would have an advantage.

Six million dollars is appropriated for Foundation research for FY89 and 90. In addition, up to \$100 million is authorized for deposit over the next three years; this will be an endowment managed by the Alaska Permanent Fund Corporation. Interest income from this endowment will provide the basic funding for research indefinitely.

The next steps include the Governor's selection of board members, the executive director, staff, technical experts for the review panel, regulations and procedures for the receipt of proposals and the management of funds. The Foundation headquarters will be determined by the board. It is anticipated that the first open solicitation for proposals will occur late in 1988, with funding decisions completed by the spring of 1989.

### *Alaska Science and Engineering Advisory Commission*

The Alaska Science and Engineering Advisory Commission was created in 1986 by former Governor Bill Sheffield, with Dr. Richard Nevé, former State Science Advisor, as the first chairman. The Commission's primary function is to set research priorities for the Science and Technology Foundation. In addition it performs a wide range of scientific and advisory tasks: to formulate and recommend an integrated State research policy; to provide scientific judgment and assistance to the Governor, the legislature and State agencies; to improve logistic planning and the efficient management and dissemination of scientific data and information; to promote educa-

Commission members:  
*Henry Cole, Governor's  
 Science Advisor, Chair;  
 Brian J. Allee,  
 Alaska Department of  
 Fish and Game;  
 Joseph M. Colonell,  
 Consultant, Anchorage;  
 Donald E. Pickering,  
 Pediatrician, Anchorage;  
 Paul Reichardt,  
 Department of Chemistry,  
 University of  
 Alaska-Fairbanks;  
 Peter McRoy,  
 Institute of Marine  
 Sciences, University of  
 Alaska-Fairbanks;  
 there are 2 vacancies.*

tion and training for young scientists and engineers; and to cooperate with the Arctic Research Commission.

Eight commissioners are appointed by the Governor. One is associated with university research, one is from research in medicine or the natural environment, one is with State agencies with research activities, and one is from private industry. One member must have knowledge of national and international research programs, and one at-large member is from the general public. The Governor's Science Advisor (the Chair of the Commission) and the executive director of the Alaska Science and Engineering Foundation complete the eight-member board.

Activities funded by the Commission are restricted to public forums, workshops, study

contracts and grants that benefit a wide range of scientific users. Grants to individual investigators are not allowed, since the intent is to develop policy rather than support specific research projects.

The Commission conducted four meetings in the summer of 1987 to analyze existing science foundation legislation from other states and foreign countries and to draft an initial proposal. The proposal, presented to the Governor on October 1, 1987, served as a starting point for the Governor's final drafted legislation presented to the Alaska legislature this last session.

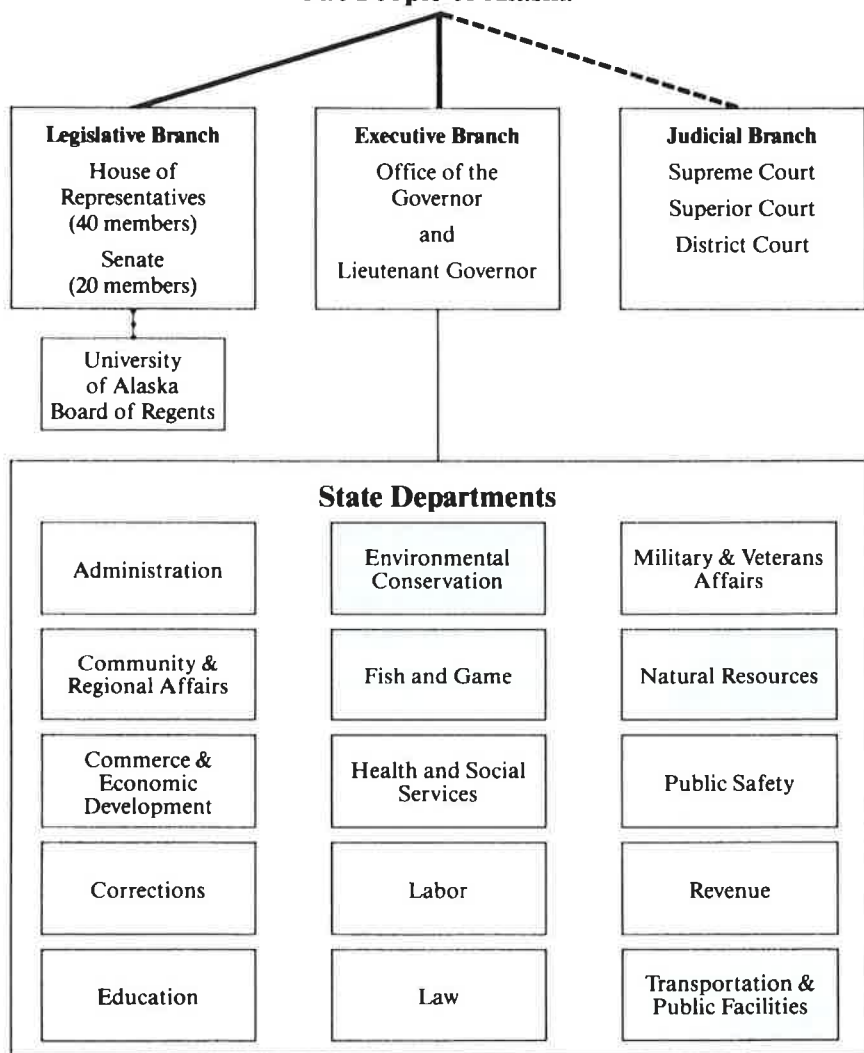
Subsequent meetings of the Commission held on December 7, 1987, and January 29 and April 22, 1988, gathered testimony on health issues, engineering licensing and education, and fisheries. Testimony from the public, academic, government and industry interests provide the basis for formulating research priorities. In the next several months the Commission will assist in devising guidelines and preliminary research priorities for the initial funding cycle of Foundation.

The U.S. Arctic Research Commission is represented at all Alaska Commission meetings. State research needs will tend to be more applied and local than Federal goals, and it is useful to coordinate the goals and objectives of these two approaches.

In response to a request of the U.S. Arctic Research Commission, the Alaska Science and Engineering Commission sponsored the preparation of a data base for land-based logistics: "Alaska Research Sites and Support Facilities Inventory." It includes detailed descriptions and section maps of 60 remote Alaskan field research sites managed by the Federal Departments of Agriculture, Commerce and Interior; as well as State Departments of Fish and Game, and Transportation; universities in Alaska and Washington; and Native corporations. In addition, descriptions and data on 29 Alaskan ports, several hundred airports and runways, and communications and emergency services are listed. This compilation is not a policy statement but may serve as the basis for the implementation of a land-based Arctic logistics plan. The report, currently under review, will be available through the Office of the Science Advisor, Office of the Governor, Box AD, Juneau, Alaska 99811.

Research activities take place within several State agencies. The following provides a general description of research and related activities of four State departments (see diagram of State government).

## The People of Alaska



- Elected by popular vote.
- Justices and judges of the courts are nominated by the Judicial Council, selected by the Governor, and thereafter subject to voter approval.
- Department heads are appointed by the Governor and confirmed by the Legislature.
- ..... Regents are appointed by the Governor and approved by the Legislature. The University's budget is subject to legislative approval.

# Alaska Department of Transportation and Public Facilities

*This section is based on a summary provided by DOT&PF Commissioner Mark S. Hickey and John Martin, Chief of Planning and Research. Information on research publications may be requested from: Publications, Department of Transportation and Public Facilities, Research Section, 2301 Peger Road, Fairbanks, Alaska 99709.*

In the Alaska Department of Transportation and Public Facilities (DOT&PF), research is carried out by the Statewide Research Section. As directed by statute, this Section administers practical research and development projects aimed at reducing costs and improving the usefulness and performance of highways, buildings, airports and marine transportation facilities.

The Section has three main roles in the Department. The first is to assist DOT&PF personnel in solving problems so that the Department's mission can be fulfilled. Since DOT&PF's mission is very large, design, construction and maintenance personnel are so involved in day-to-day activities that they do not have time to perform the literature searches, conduct the investigations, and develop solutions to Department problems. The Section provides the time, talent and resources to solve these problems. It strives to make these solutions as practical and simple as possible to facilitate implementation of the research results. After developing a practical solution, the Section then aids in implementation by conducting the necessary training. A second role of Statewide Research is to maintain current awareness of the latest developments in new products, technologies and methodologies that may assist the Department in reducing costs and maximizing facility performance and safety. After these new ideas have been identified and accepted, the Section initiates projects to adapt them to the Department's needs. The third role of research is to improve existing procedures and products that are now in use by the Department. This results in decreasing life-cycle costs of transportation facilities and assists the Department in maintaining and preserving existing facilities.

The Statewide Research Section consists of a small group of professionals who provide expertise in a wide variety of disciplines, including

- Permafrost engineering.
- Pavement design and management.
- Building design and maintenance.
- Environmental engineering.

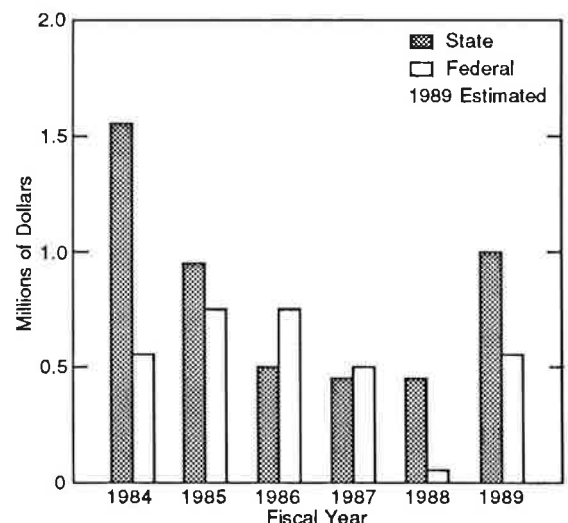
Their accomplishments have received national and international recognition.

In past years the largest percentage of the cost was borne by the State. With cutbacks because of declining State revenues, the Fed-

eral portion of the funding is now supporting half of the program. Federal funds, however, only support highway research. Therefore, other areas of concern, such as energy conservation, improved building construction and maintenance techniques, fire protection of rural facilities, and handicapped building accesses, are seriously curtailed. The reduction in State funding has severely affected current staffing levels and has sharply reduced the amount of new work that the Section can handle. The Statewide Research Section's operating budget currently is only 0.4% of the Department's annual operating budget.

About one-third of the total funding that comes to the Research Section goes to support staff salaries. The remaining funds go to support field and laboratory research projects. The University of Alaska is frequently utilized as a cost-effective means of performing research projects. The Statewide University System can assign staff and students to analyze DOT&PF engineering problems and develop innovative solutions. The Research Section also works with consultants and national organizations and institutions when tackling problems requiring specialized expertise.

Research topics for consideration come from a variety of sources, both inside and outside of the Department. These ideas are then scrutinized by Research Section personnel to determine the project scope and the most cost-effective method for implementing the project. It is important that each proposed



State and Federal contributions to the DOT&PF research budget.



*Experimental insulation being installed to control thawing of permafrost underlying a highway.*

topic address a recognized problem within the Department. After this evaluation, accepted topics are submitted to the Research Advisory Board for consideration at the annual board meeting.

The Research Advisory Board is annually appointed from within the ranks of the Department and also includes one Federal Highway Administration representative who participates in an ex-officio role. The Department personnel are selected from a wide spectrum of departmental functions and locations. Together they evaluate the proposals presented and produce a prioritized list of projects that the Research Section staff can use as a guide in developing their annual work plan. Examples of current projects follow.

Air duct freezing, geofabric usage, reflective surface coatings, shading, and embankment insulation are among the methods fully developed or under test to stabilize structures over permafrost. Data are now available to show where these methods are most effective and, more significant, which methods are not effective and should not be employed in future designs. Savings on maintenance costs and improved performance are the primary goals of this program.

Measurements of pavement conditions, including strength, cracking, rutting and roughness, enable the Department to evaluate and provide a statewide comparison of pavement deterioration rates and repair costs. These data are used to predict construction and maintenance actions required to maintain a given level of service. The use of similar systems in other states has resulted in improved levels of service and decreased maintenance costs.

Significant modifications to pavement structure design methods and material specifi-

cations have been implemented following extensive research and testing. This will save an estimated \$250,000 annually in required soils testing alone, and it will also reduce construction costs and increase pavement life.

Joint research with the Department of Fish and Game into the ability of fish to migrate through culverts has established new guidelines that allow culverts to be installed in many locations at a fraction of the cost of alternative bridge structures. Costs for replacing culverts with bridges have exceeded \$4 million on the highway from the Yukon River to Prudhoe Bay alone. Some of the installations have since been found to be of no value in improving fish passage.

The use of deflection data collected by the falling weight deflectometer has become an integral part of the Department's planning, design and maintenance procedures. Savings are realized by the trucking industry through a 30% reduction of load restrictions amounting to an estimated \$1 million per year, and an additional \$1.5 million per year is saved through reduced roadway damage. Approximately \$3 million per year is saved in construction costs, through more innovative designs that require deflection data.

Four railroad crossing signals and three railroad communication repeater stations now operate using solar energy, saving a projected \$400,000 over the life of the installation. This technology is now being tested for preventing culvert icing.

Through seminars, training programs, newsletters and other publications, the results of research and new technologies are disseminated to DOT&PF personnel and to other State, Federal and local agencies. Information is also exchanged with researchers in other states and in many foreign countries.

# Alaska Department of Fish and Game

*This section is based on a summary provided by ADF&G Commissioner Don W. Collinsworth and W. Lewis Pamplin, Jr., Director, Game Division; Bruce Baker, Deputy Director, Habitat Division; Brian Allee, Director, FRED Division; Doug Eggers, Chief Fisheries Scientist, Division of Commercial Fisheries.*

The Alaska Department of Fish and Game (ADF&G) is one of three State natural resource departments in Alaska. Its Commissioner is directed by statute to "... manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state."

## Game Division

The Game Division's research program is designed to provide insight into Alaska's wildlife needs and to give managers the necessary information for proper management of the resource. In FY88, 38 research projects are providing information on a wide range of subjects, such as new techniques, habitat requirements, impacts of development on wildlife, ecological relationships among species, and basic life history requirements. These projects involve almost \$2 million in salaries and operating expenses derived from four sources: Federal Aid (the Pittman-Robertson Act), the State General Fund, the Fish and Game Fund, and Special Projects.

Federal Aid research projects totaled about \$1.35 million in FY88. In these cooperative projects the State matched one dollar for each three dollars contributed by the U.S. Fish and Wildlife Service. These funds are spent on a variety of research projects but the top priorities are

- Grizzly and brown bear (31% of FA research funds, five projects).
- Moose (29%, three projects).
- Caribou (21%, six projects).
- Deer (10%, one project).

The other 9% of these funds are being spent on lynx, black bear, serologic surveys and herbivore-plant community relationship projects.

The Game Division annually budgets about \$600,000 for Special Projects. These funds are transferred from many different agencies, including National Marine Fisheries Service, Marine Mammal Commission, National Oceanic and Atmospheric Administration, National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Air Force, U.S. Army, Ducks Unlimited, and the Alaska Bowhunters. FY88 projects are addressing research needs in marine mammals, grizzly bear, caribou, elk, muskox, Dall sheep, peregrine falcons, black bear, wolves and potential impacts of new radar stations on wildlife. As the title implies, these cooperative projects usually examine specific fish and game problems of interest to the particular granting agency.

This management-oriented research program provides the basic knowledge necessary to keep abreast of changing populations, new techniques and new demands from a changing public. Without this information, Alaska would not be able to keep pace with the needs of the resources as well as the needs of society.

## Habitat Division

The Habitat Division assists the Commissioner in protecting the State's fish and wildlife habitat from unnecessary disturbance or destruction. The Division also assists the Commissioner in promoting and maintaining access to and opportunities for use of fish and wildlife resources. The Division must consider various user groups in formulating its decisions and recommendations. These include commercial, subsistence and recreational users.

The Habitat Division fulfills these responsibilities by approving, conditioning or denying permits for various activities that affect fish, wildlife and habitat resources. Specifically the Division issues permits for various activities that affect anadromous fish streams, obstruct

*Measuring a radio-collared and ear-tagged wolf. Home range and food habits will be determined after the wolf is released.*





*Biologist carrying a young grizzly bear (tranquilized). The bear will be measured and collared for further research.*

fish passage in any fish-bearing waters, or occur in legislatively designated special areas. Special areas, totaling approximately 2.5 million acres, consist of Alaska's 26 State Game Refuges, Critical Habitat Areas, and State Game Sanctuaries.

The Division also reviews projects and provides information and recommendations to other governmental agencies with regulatory or permitting responsibilities, such as the Alaska Department of Natural Resources, the Alaska Department of Environmental Conservation, and the U.S. Army Corps of Engineers. In the course of reviewing permit applications, the Division is available to advise applicants of methods that have been successful in protecting habitats in similar situations. In this way the Division can assist applicants in meeting statutory requirements and in obtaining expeditious review of their applications.

The Habitat Division recognizes the value of area-wide resource management planning as a backdrop against which individual project applications can be reviewed. The Division actively participates in the land and water management planning activities of various State, Federal, municipal and private agencies or organizations. These include but are not limited to land classification, disposal and access, timber harvest, and petroleum and energy development.

The Habitat Division depends heavily on the research of other governmental and university organizations in developing descriptions of fish, wildlife and habitat resources and the resource allocation and specific mitigation methods that will protect them. Examples include studies of the effects of placer mining activities on stream invertebrate and fish populations; the effects of timber harvest on old-growth-dependent wildlife; the effects of oilfield development on caribou feeding, calving and movement; the effects of offshore mining on benthic populations; the sizing of culverts to pass fish; and the relationships between wildfire and wildlife habitat.

Although the Habitat Division is more of a user than a generator of research information, it has received limited funding to conduct original studies. Recent examples include assessments of mined and unmined stream habitat and a suitability assessment of moose winter habitat. A current study is directed toward rehabilitating North Slope gravel pits to provide deep overwintering fish habitat, a relatively scarce environment on Alaska's North Slope.

The Habitat Division is interested in working with research organizations in identifying

high-priority, habitat-related research projects. Interested parties are encouraged to call the Division at (907) 465-4105 or write to ADF&G Habitat Division, P.O. Box 3-2000, Juneau, Alaska 99802.

## *Fisheries Rehabilitation, Enhancement and Development Division*

The Fisheries Rehabilitation, Enhancement and Development (FRED) Division carries out statewide applied research in a number of areas related to supplemental production technologies.

The Division is developing culture processes for fish species that have never been produced in the hatchery environment: sheefish, grayling and Arctic char are examples. New incubators are being designed, built and tested. Experiments are being carried out on gas supersaturation and ways of eliminating it,



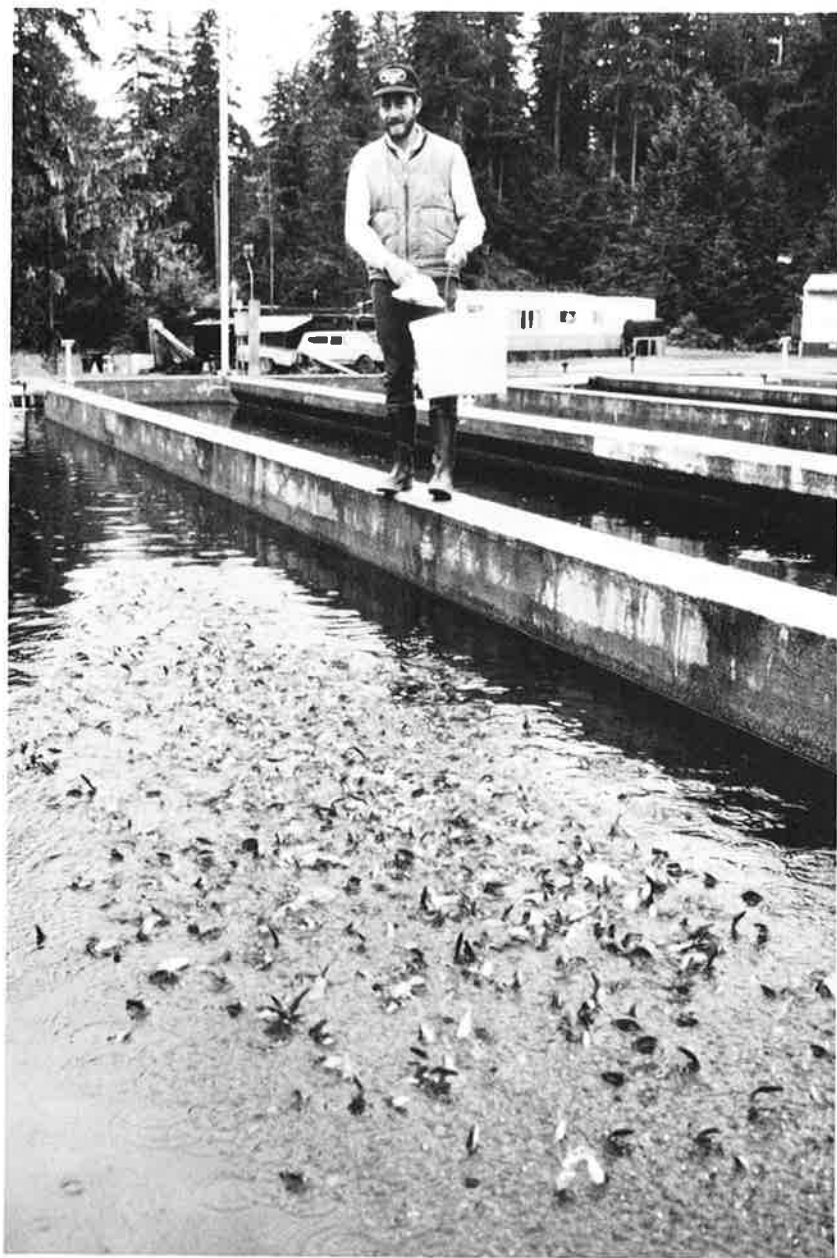
*Emergent pink salmon with coded-wire tags. The tags are 0.5 mm long.*

and the effects of rearing density and subsequent marine survivals are being tested.

Investigations in fish biology largely involve strategies concerning the size at time of release to optimize the marine survival of fish released from enhancement facilities. Stock performance under varying cultural regimes is also being examined. Smoltification and its measurement are being studied. Various studies have tested available methods for marking and tagging fish, and new methods are being sought. The Division is evaluating the contribution made by hatchery releases, fish passes, and lake fertilization to the various fisheries.

Investigations into the diseases of fishes focus primarily on collecting data on what diseases are present, with special attention given to the salmonid species. Much work has

*Feeding salmon fry at  
Crystal Lake Hatchery.*



been done on infectious hematopoietic necrosis virus (IHNV) in sockeye salmon. FRED Division leads the world in the culture of sockeye salmon. Bacterial kidney disease in hatchery stocks of coho and chinook salmon is probably our number one problem today. Disease screening of shellfish also occurs, and a data bank has been started. Research continues on bitter crab disease of Tanner crabs. Research is also being conducted on IHNV under the auspices of the Western Regional Aquaculture Consortium.

A decade of work has been done to understand the dynamics of lakes in Alaska that are important producers of sockeye salmon. Lakes have been fertilized to improve their capacity to rear juvenile sockeye salmon. Systems models have been developed and validated through lake manipulation experiments. Work is continuing on all aspects but recently has concentrated on developing algorithms for setting escapement goals for major sockeye-salmon-producing lakes. Many reports have been written describing nutrient budgets, phosphorus cycling, heat budgets, and plankton dynamics in Alaskan lakes. Pioneering work on the hydroacoustic assessment of fish biomass in lakes has also been done.

FRED Division initiated economic work within the Alaska Department of Fish and Game on the economic value of resources within the state. Early work concentrated on the return on investments in salmon hatcheries around the state. More recently these studies have evolved into more complex undertakings, such as attempting to understand the impacts of these investments on all levels of the socioeconomic community, in addition to benefits to fishermen. Valuation studies of recreational fisheries performed by private contractors are being utilized.

Studies have been conducted on establishing genetic profiles of hatchery broodstocks. Attention today focuses on selection experiments with rainbow trout. The Broodstock Development Center at Fort Richardson Hatchery is a major laboratory for rainbow trout broodstock development.

### *Division of Commercial Fisheries*

The Division of Commercial Fisheries is responsible for managing renewable fishery resources within the territorial waters of the State of Alaska for sustained harvests to subsistence and commercial fisheries. In support of that activity, the Division conducts a wide



*Commercial catch  
of sockeye salmon,  
Bristol Bay, Alaska.*

variety of research. The principal activity is annual monitoring of the return of Pacific salmon for all major stocks utilized by fisheries. This requires enumerating catches and escapements, sampling for age composition, and identifying catches by stock of origin. Methods used for stock identification include discriminant analysis based on scale patterns and attributes such as age at maturity and genetic markers. Escapement enumeration methods include aerial surveys, visual count-

ing from towers, counting weirs, and side-scan sonar.

The latter is particularly important in Arctic areas. In the Arctic, Pacific salmon return to large rivers that are highly turbid because of glacial meltwater. Much research is directed at developing real-time enumeration of upstream-migrating salmon by side-scan sonar, and development of species apportionment based on target strength estimated by dual-beam sonar.

## *Alaska Department of Natural Resources*

*This section is based on  
a summary provided by  
DNR Commissioner Judith  
Brady and Carol Wilson,  
Special Assistant, Office of  
the Commissioner, DNR.*

The Department of Natural Resources (DNR) manages all of the State's surface and subsurface resources except fish and game. These resources include the two largest oil-fields in North America, the most extensive State park system in the U.S., as well as the State's land, water, timber, mineral and agricultural base.

DNR encourages the settlement of State land and the development of its resources by making them available for use consistent with the public interest.

DNR contributes to the State treasury and stimulates investment and employment through the sale of oil and gas leases, land, coal and mineral permits and leases, gravel, timber,

firewood and other resources. The Department provides business and industry with resource inventory data and analyses, records all real and personal property transactions in Alaska, and helps promote tourism by providing recreational facilities for the use of visitors as well as Alaskans.

DNR has eight divisions and is headquartered in Juneau. The divisions of Land and Water Management, Oil and Gas, Mining, and Parks and Outdoor Recreation are based in Anchorage, while the divisions of Management and Forestry are based in Juneau. In addition, the Division of Agriculture is based in Palmer and the Division of Geological and Geophysical Surveys is based in Fairbanks.

Most divisions maintain regional offices in Fairbanks, Anchorage and Juneau, and some maintain small offices in other locations.

The Commissioner is the chief executive officer of the Department, responsible for establishing resource management policies in accordance with State statutes and regulations, and for directing all departmental resource management programs and services. The Deputy Commissioner, two Special Assistants, and appeals and regulations staff are located in Juneau, while the Assistant Commissioner and the Public Affairs Office are located in Anchorage.

### *Division of Geological and Geophysical Surveys*

The Division of Geological and Geophysical Surveys collects, analyzes, interprets and publishes data on Alaska's natural resources so that Alaska lands may be responsibly managed in the public interest. The State Geologist serves as Director of the Division.

The Resource Investigations Section collects, analyzes and makes available information on the geology and the mineral and energy resources of the State. Geologic maps and reports illustrate the location, quality and quantity of the State's mineral, oil and gas, coal and geothermal resources. Estimates of the mineral resource potential of Alaskan lands are produced in cooperation with Federal agencies.

The Water Resources Section monitors surface water and groundwater activities throughout Alaska. Water contamination studies are conducted in cooperation with State agencies, while studies of water quality and availability are conducted in cooperation with the U.S. Geological Survey and other Federal agencies.

The Engineering Geology Section collects, analyzes and makes available engineering geologic data. Information on soils and rock and materials properties is used in siting dams, buildings and other structures. In addition, a statewide inventory of sand and gravel provides information related to the sale and lease of these resources.

The Administrative Section manages the Division's fiscal affairs and is responsible for publishing and distributing the results of the Division's field studies.

### *Division of Land and Water Management*

The Division of Land and Water Management is responsible for selection, surface use, development and management of the State's land, water and resources. It acquires and defends the land and water resources and assures management of State lands and waters. The Division transfers rights to resources into private hands where possible.

The Division produces revenues through the sale of State-owned lands and materials and provides basic land- and water-related services to the public. It has three sections: Land Management, Resource Allocation, and Cadastral Surveys. The Division's three regional offices are located in Anchorage, Fairbanks and Juneau.

The Land Management Section is responsible for overall policy development for the Division's land and water management programs. This section also administers transfers of State land.

The Resource Allocation Section selects land for transfer from the Federal government to the State, determines which water bodies are navigable for title purposes, reviews Native allotments to identify conflicts with State interest, reviews Federal conveyances under the Alaska Native Claims Settlement Act, and identifies easements and certain rights-of-way to protect public interest. It also prepares and updates regional plans for the management of State land.

The Cadastral Survey Section is responsible for boundary and control surveys on Depart-



*Geologists conducting a survey near Marsh Creek in the Sadlerochit Mountains, Arctic National Wildlife Refuge.*

*Sampling geothermal waters at Kanuti Hot Springs near the Dalton Highway.*



ment-administered lands and the defining of limits of State coastal and submerged land ownership and territorial sea limits for the State's oil, gas and other mineral leasing programs. Through its Coastal Marine Boundary Unit, Cadastral Survey works with the Minerals Management Service and National Geodetic Survey to collect data necessary for coastal charting and seaward boundary litigation.

The Regional Offices provide land status and other information and assistance to the public. They conduct land lotteries and auctions, sell gravel and other material to the public, and provide materials at no cost for use by other State agencies in the construction of highways and other activities. They implement various land use plans, prepare classification orders, issue rights of way, and process pipeline right-of-way applications.

### *Division of Mining*

The Division of Mining is responsible for managing the State's mineral resources in a manner that promotes responsible development.

The Property Management Section keeps the records and adjudicates all State mining

claims and uplands mining leases. It also issues and administers coal leases, offshore prospecting permits and offshore leases, and it collects all required rent and royalty payments from such leases.

The Field Operations/Permitting Section issues permits to mine on State land, participates in all land use plans, and provides expert technical assistance to miners. Field inspections to assure compliance with permit and lease terms are conducted. Mining Information Offices in Anchorage and Fairbanks are part of this section.

The Surface Mining Section reviews and issues exploration and mining permits under the Alaska Coal Surface Mining Program. This section also administers the Abandoned Mine Lands Program.

### *Division of Oil and Gas*

The Division of Oil and Gas is responsible for ensuring that prospective oil, gas and geothermal lands potentially capable of generating future revenues and jobs for Alaskans are made available for competitive leasing. The Division assures that the State receives full

value for its resources, that all State revenues arising from leasing and production from State leases and Federal onshore and offshore leases are received, that full value is received for the State's in-kind royalty through oil sales and contracts, and that lessees' operations are conducted in an environmentally sound manner. The Division also works closely with the Commissioner's and Governor's staffs on issues related to oil, gas and geothermal resource development in all of Alaska.

This Division contributes to the State treasury and the general economic environment through the leasing of State-owned land for oil and gas development. State earnings directly attributable to these projects totaled \$739.5 million in FY87.

The Resource Evaluation Section carries out the seismic and geologic studies that are used to identify potential lease sale areas and generate petroleum resource estimates for use in the Division's economic analysis and the selection of bidding terms. The Section also performs geological analyses of disputed areas claimed by both the State and Federal governments, Federal offshore lands from which revenues are shared, Federal onshore and offshore lands that provide necessary information for regional analyses, and Federal refuges (such as ANWR) from which the State would receive revenues if development were to occur.

### *Division of Forestry*

The Division of Forestry manages State forest lands for multiple use and sustained yield, and protects forested land and watersheds from fire and other destructive agents. The State Forester serves as Director of the Division. Three regional foresters, located in Fairbanks, Anchorage and Juneau, and ten area foresters direct the Division's field activities in all areas of resource management and protection.

The Division provides forestry assistance and services to private operators to promote good forest practices, and it provides technical assistance to landowners and small mill operators for soil erosion control, stream protection, forest management and efficient sawmill management. The Alaska State Forest Nursery in Eagle River provides seedlings for both State and private reforestation.

The Division develops forest management plans for legislatively designated State Forests, and it provides fuelwood, house logs and lumber to residents and industry. The Divi-

sion also inventories forested lands to provide the basic information necessary for good management decisions, and it manages forested lands to produce forest products, in perpetuity, for the people of the State.

In cooperation with other State and Federal agencies and local volunteer fire departments, the Division protects 134 million acres of land from the ravages of wildfire. Fire management planning with the State's major landowners has saved the State millions of dollars since its inception and resulted in prioritized firefighting efforts.

### *Division of Agriculture*

The Division of Agriculture provides basic services to producers of food and farm products, and to consumers and users of these products. There are five sections within the Division, several of which are involved in research and its applications.

The Plant Materials Center tests and distributes high-latitude plant varieties suitable for revegetation, landscaping and crop production, and provides technological assistance to Alaskan and other Arctic and Subarctic resource industries (agriculture, petroleum, mining, forestry, parks) that are attempting to meet environmental objectives or improve cropping efficiency.

The Land Conservation Section works in conjunction with the Division of Land and Water Management to protect agricultural soils and to make lands with agricultural potential available to the private sector.

The Inspection and Marketing Section inspects and grades agricultural products and promotes Alaska-grown products. The Agricultural Revolving Loan Fund provides credit and capital to the agricultural industry, and the Asset Management Section manages the State's investments in processing plants and storage facilities.

### *Division of Parks and Outdoor Recreation*

The Division of Parks and Outdoor Recreation acquires, develops, designs, operates and maintains the Alaska State Park System. It also administers Federal and State grants-in-aid programs for outdoor recreation and historic preservation.

The Division administers 115 State Park units from three regional offices and several

area offices. It is responsible for the uniformed park ranger staff, search and rescue, enforcement of park regulations and State statutes, and interpretive programs and guided nature programs. It also administers the public-use cabin rental program.

The Economic Programs Office develops concession contracts for use of park lands, expedites permits for commercial operations, and implements the park fee program.

The Administrative Services Section is the fiscal and budget arm of the Division and handles personnel matters, develops operating policy and administers the Federal Land and Water Conservation Fund grant program.

The Design and Construction Section prepares specific site plans for parks and recreation areas and develops the sites using both State park crews and private contractors. The section is responsible for improving and rehabilitating designated sites and developing new facilities. The History and Archaeology Section reviews important historic and prehistoric sites suitable for the National Register of Historic Places and submits nominations to the Historic Sites Advisory Committee for State approval or disapproval. It reviews all development proposals submitted by State and Federal agencies and recommends courses of action that will prevent damage or destruction of important historic and prehistoric sites. The section provides technical assistance and

guidance for State preservation projects. The chief of the section is also the State Historic Preservation Officer, who gives final approval for distribution of Federal preservation grant funds in Alaska.

## *Boards, Commissions, Committees and Councils*

A number of boards, commissions, committees and councils work with the Department: The Agricultural Revolving Loan Fund Board, Association of Soil and Water Conservation Districts Boards, Board of Forestry, Navigability Advisory Council, Historic Sites Advisory Committee, Plant Materials Center Advisory Board, and the Water Resources Board. Citizens' advisory councils have also been established for many units of the State Park System.

The Department provides administrative services for the Citizens' Advisory Commission on Federal Areas in Alaska, whose purpose it is to determine the impact of Federal regulations and land management decisions on Alaskans and to advise the Governor on Federal land management issues. This commission also offers assistance to Alaskans experiencing difficulty with Federal land management agencies.

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# *Alaska Department of Environmental Conservation*

*This section is based on a report provided by DEC Commissioner Dennis D. Kelso and Larry Dietrich, Director, Division of Environmental Quality, DEC.*

The Alaska Department of Environmental Conservation is responsible for controlling water, land and air pollution to enhance the health, safety and welfare of the people of the State. The Department accomplishes this through three divisions.

## *Environmental Quality Division*

The Environmental Quality Division carries out regulatory control functions in the traditional area of water pollution control, oil and hazardous substance pollution control and emergency response, public drinking water, hazardous waste management, air quality management, and solid waste management. The operation of the Department's environmental monitoring laboratory also falls under this Division. Augmenting these traditional pollution control programs are newly developing programs focusing on underground stor-

age tanks, groundwater protection and hazardous waste site investigations. These programs are a response to a growing statewide awareness for a need to curb environmental pollution by improving the standards for containing and handling potentially harmful substances, as well as cleaning up sites already affected.

Activities in the Division's programs include

- Establishing and enforcing environmental protection regulations.
- Issuing permits and plan approvals for facilities that conform with established regulations.
- Performing inspections to assure that facilities meet conditions of regulations or permits.
- Providing technical information and guidance to industry and the public.

Although the primary activities of the Division are regulatory, a number of research pro-

jects are developed each year aimed at assessing impacts of pollutants on public health and the environment. Research in air quality has recently focused on particulate emissions in two urban areas (Juneau and Eagle River) and on Arctic dispersion of air pollutants generated from the Prudhoe Bay area. Wastewater research in the Division has covered on-lot wastewater treatment failures in two communities, the fate of dispersion of wastewater from a broken marine outfall line, and efficacy of waste disposal practices in the Prudhoe Bay industrial area.

### *Facilities Construction and Operations Division*

The goal of this Division is to provide water, sewage and solid waste facilities that will improve sanitation and protect the health and well-being of Alaska's residents. It accomplishes this through activities in three programs:

- Construction Grants
- Village Safe Water
- Operator Training and Certification.

The Construction Grants program provides grants for up to 50% of the non-Federally financed costs for water, sewage and solid waste improvements. The program has funded over 570 projects in 45 communities since 1970. The program includes funding for constructing wastewater treatment systems that use innovative treatment technologies.

The Village Safe Water program provides up to 100% funding to villages for constructing sanitation improvements. It includes the remote maintenance worker program, which has addressed the need for proper operation and maintenance of village water and wastewater systems by using traveling maintenance worker circuits in over 75 remote communities. Other program activities include occasional demonstration projects that apply new technology for small rural water and wastewater systems.

The Operator Training and Certification program administers training and certification to increase operator competence. The program consists of a combination of hands-on training by Department personnel, contracted operator training workshops, and a lending library of audio-visual materials, books and correspondence courses.

### *Environmental Health Division*

This Division is responsible for enforcing regulations governing food service and other public facilities, seafood processors, pesticide management, animal and dairy industries, and meat and poultry inspection. The Division's goal of minimizing unsanitary conditions in these areas is approached by an aggressive inspection program and by education of facility owners or operators and the public. The Division's Palmer laboratory provides analytical support for the program's activities.

# The Role of the North Slope Borough in Arctic Environmental Research

THOMAS F. ALBERT

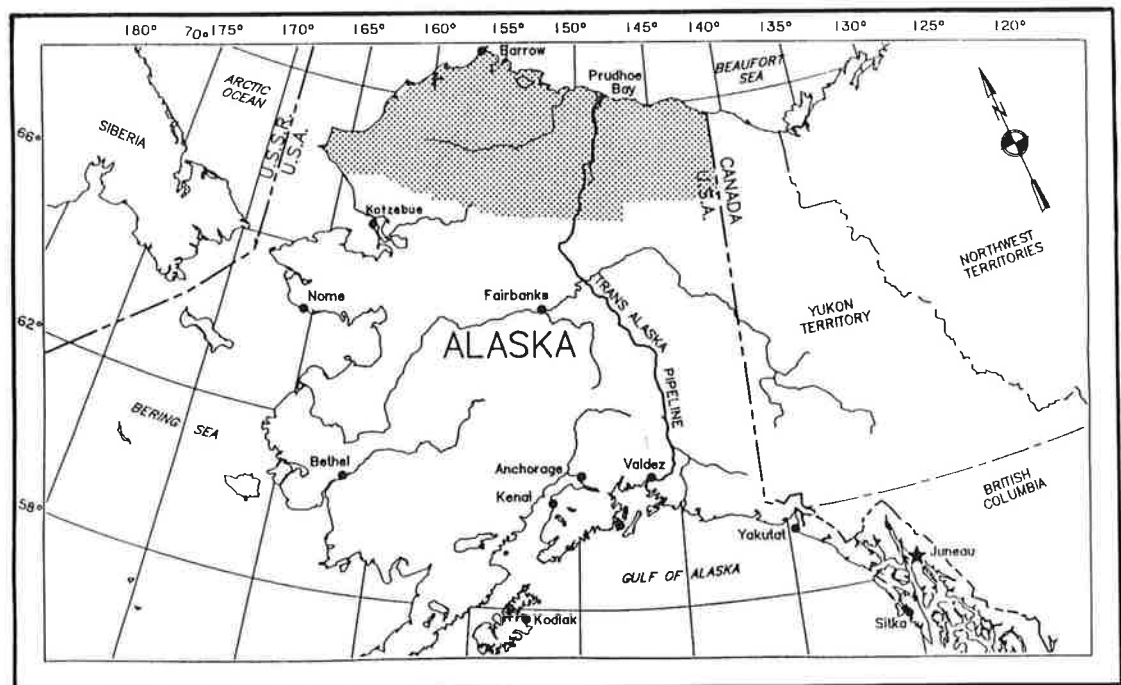
The North Slope Borough was incorporated in 1972 as a political subdivision (like a county) of the State of Alaska. It is large (approximately 88,000 square miles), occupies most of the State's area north of the crest of the Brooks Range, and is bordered on the north by the Beaufort Sea and on the west by the Chukchi Sea. The Borough's approximately 8000 full-time residents live in and around eight villages. Most residents are Inupiat Eskimo with close ties to the land, and they depend heavily on the availability of various subsistence-use resources. These wildlife resources within the Borough and in the adjacent marine waters include bowhead whales, beluga whales, ringed seals, bearded seals, walruses, caribou, fish, waterfowl and polar bears.

Also within the Borough is a major industrial complex that includes North America's two largest producing oilfields (Prudhoe Bay and Kuparuk) and the northern portion of the Trans-Alaska Pipeline System. This industrial complex is serviced by approximately 3500 workers, the vast majority of whom reside in other areas of the State. In addition to existing industrial production activities, major natural gas, petroleum and coal reserves are known to exist within the Borough. It is suspected

that additional major petroleum resources exist in areas such as the coastal plain of the Arctic National Wildlife Refuge (ANWR).

During the past two decades there have been significant changes in the way of life of the Eskimo people of northern Alaska. A major factor in this regard has been the exploitation of petroleum resources in the Alaskan Arctic, with the associated financial and employment benefits to residents of the State. As industrial and governmental interest (Federal and State) has increased in northern Alaska, the North Slope Borough has had to increase its own level of technical sophistication. This was necessary if the Borough was to help protect the subsistence way of life so important to most of its residents while not overly interfering with an orderly exploitation of nonrenewable resources. Within the past decade there has been an avalanche of technical data (primarily from government and industrial studies) having some impact on the North Slope Borough. To respond, the Borough must determine the relevancy and validity of appropriate data and identify areas where additional studies are needed so that sound management decisions can be made. As part of its efforts to increase its technical sophisti-

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*Location of North Slope Borough (shaded).*

cation, the Borough has taken a series of deliberate steps regarding environmental research in the U.S. Arctic. The discussion below will briefly focus on why and how the Borough supports Arctic science.

## *Why the Borough Supports Arctic Science*

The Borough, being Arctic in location and being significantly affected by various aspects of science and technology, has at least four reasons for supporting Arctic science.

The first, and a basic reason for local support of Arctic science, is the positive feeling of many Borough residents towards science. By the mid-1970s many of the people moving into decision-making positions in the North Slope Borough government, the Arctic Slope Regional Corporation, and the Ukpiaq Corporation had earlier worked at the Naval Arctic Research Laboratory (NARL) in Barrow, Alaska, or they had worked in the field with NARL scientists. Almost without exception this involvement with NARL and its scientists helped create a positive outlook toward both research itself and the uses of science for helping Native people. NARL helped establish the idea that science was "good." Surely one of the most profound effects that Federal Arctic research has had on residents of the Arctic Slope has been through NARL.

The second reason for local support of science is that there is a widespread feeling that Arctic residents will benefit from Arctic research. Most people realize that studies of weather, sea ice, animal migration, and vegetation, for example, will provide data useful at the local level. Involvement by local people in both the design and conduct of scientific studies is a way to not only influence events but also to learn directly from visiting scientists. In addition, local involvement provides an opportunity to show scientists that the local people themselves can provide meaningful data resulting from their long and close involvement with the environment.

The third reason is that the Borough sees science as a direct way to provide assistance to its citizens. An example is the research support given to the Alaska Eskimo Whaling Commission (AEWC). Such support is formalized through a memorandum of agreement between the Borough and the AEWC and will be described in more detail below.

A fourth reason why the Borough supports Arctic science is that a wide range of scientific data is needed to assess (and potentially mitigate) impacts related to the development of nonrenewable natural resources. Some areas where such data can help in identifying and mitigating impacts are

- Bowhead whales in relation to offshore petroleum industrial activities.
- Anadromous fish and their use of coastal waters and rivers in relation to industrial activity in the nearshore area (such as gravel causeways built to reach offshore oil deposits).
- Habitat use by caribou in relation to industrial activity (such as may occur on the coastal plain of ANWR).

## *How the Borough Furnishes Support*

The Borough supports science in at least three ways: encouraging quality in science, conducting and funding research, and providing logistical support for visiting researchers.

### *Encouraging Quality*

The Borough encourages quality in Arctic science through its Arctic Science Prize and through its Science Advisory Committee. The Arctic Science Prize is an award given to distinguished scientists who have made a significant contribution to man's understanding of natural processes in the Arctic. The purposes of the prize are to recognize the recipient's contributions, to further stimulate excellence in Arctic science, and to focus attention on the Arctic and its unique problems. It was established by action of the North Slope Borough Assembly on March 1, 1983, and is awarded once every two years. The award consists of a certificate and a gift of \$10,000. A candidate review committee nominates and reviews candidates and chooses the recipient. The committee consists of 11 members (9 U.S., 2 Canadian), with appropriate scientific expertise, and has representatives from government, industry and academia. In 1984 the prize was first awarded to Robert L. Rausch, D.V.M., Ph.D., of the University of Washington. In 1986 Maxwell Dunbar, Ph.D., of McGill University became the second recipient.

Another way in which the Borough encourages quality in science is through its Science

Advisory Committee. This committee, established in 1980, consists of 24 scientists, most of whom are affiliated with universities. The primary purposes of the committee are to provide peer review of research proposals and reports and to provide specific technical advice on proposed actions by the Borough or other government or industry groups whose actions or findings may significantly affect the Borough. A recent example of the Science Advisory Committee's activity is the report *North Slope Borough Environmental Science and Engineering Needs: 1985-1989*. This report helped the Borough provide detailed comments regarding preparation of the Federal government's recommendations for the Arctic Research Plan.

### *Conducting and Funding Environmental Research*

A second way in which the Borough supports science is by funding research and by actually conducting research. By being directly involved in research, the Borough is better able to participate in forums that focus on information needs in the U.S. Arctic. Most of the Borough's environmental research program pertains to subsistence-use wildlife (marine mammals, caribou, fish, etc.). The primary focus is on the bowhead whale, *Balaena mysticetus*, a large, ice-associated baleen whale 50 or more feet in length. This emphasis is reasonable because the bowhead whale is a major subsistence-use animal, with the hunt and sharing of the food being significant cultural activities. The hunt of the whale is highly regulated, with harvest levels influ-

enced by whale population estimates. The Borough's bowhead whale research program has become quite complex, with funding coming primarily from the Borough itself and additional support provided by the State of Alaska, the National Marine Fisheries Service and the U.S. Bureau of Indian Affairs. The driving forces behind the Borough's bowhead whale research program are

- The need for bowhead whale population estimates so that the Alaska Eskimo Whaling Commission (AEWC) will have the data needed for its dealings with the National Oceanic and Atmospheric Administration (NOAA) and the International Whaling Commission (IWC).
- The need for data that will allow the prediction of likely effects to individual whales should they encounter oil-fouled waters.

### *Bowhead Whale Population Estimates*

Population data are provided to the AEWC by the Borough. The Borough conducts such studies on its own behalf and on behalf of the AEWC. This research relationship with the AEWC is formalized through a cooperative agreement.

The subsistence hunt of bowhead whales is heavily regulated at the local level (through the AEWC), at the national level (NOAA through the National Marine Fisheries Service), and at the international level (through the IWC). Since the level of harvest is influenced by population size estimates, these data must be as precise as possible. This intense regulation stems from concern that harvest levels not cause the population to decline. In the late 1970s the IWC expressed major concern over bowhead whale population size estimates, resulting in harvest quotas and efforts to determine the population size. The National Marine Fisheries Service (NMFS) began bowhead whale censusing efforts off Point Barrow, Alaska, in 1976. Because of budget restrictions, NMFS was unable to continue the yearly censusing effort, and by 1982 the North Slope Borough assumed responsibility for conducting the research off Point Barrow. Over the years the census effort has evolved into a very sophisticated program with three field components: visually sighting whales from the edge of the shorefast ice, acoustically locating vocalizing whales, and visually sighting whales from aircraft.

Censusing of the whales off Point Barrow is based on the assumption that most bowhead whales migrate northward in the spring

*First recipient of the North Slope Borough-sponsored Arctic Science Prize, Dr. Robert L. Rausch of the University of Washington. To Dr. Rausch's left is his wife; to his right are the three living mayors of the North Slope Borough. From Dr. Rausch's right are George N. Ahmaogak, Sr. (present mayor), Jacob Adams (second mayor), and Eugene Brower (third mayor). The Borough's first mayor, Eben Hopson, Sr., is deceased.*



*Visual censusing perch located at seaward edge of shorefast ice. There are usually 2-3 observers at a time on duty at the site. Note the large number of drifting ice "chunks" in the lead.*



from the Bering Sea, through the Chukchi Sea, into the Alaskan portion of the Beaufort Sea, and then eastward to their summer feeding ground in the Canadian portion of the Beaufort Sea. The spring migration route follows the shear zone, which is the dynamic area between the stationary shorefast ice and the moving pack ice. Winds and currents move the pack ice, opening and closing "leads" of open water within the shear zone. The floating ice can firmly abut the edge of the shorefast ice, resulting in a "closed" lead. However, shifting winds and currents can move the floating ice so that a closed lead can quickly become an open expanse of water extending seaward from the shorefast ice.

This spring migration route brings the whales through the hunting areas of people from seven of the nine villages represented in the AEW (Gambell, Savoonga, Wales, Kivalina, Point Hope, Wainwright and Barrow). Eskimo hunters at most whaling villages take advantage of the spring migratory path and position their camps at the ice edge in favorable areas. Captured whales are pulled onto the ice, with the food resource being shared precisely. During their fall return migration from the Beaufort Sea, the whales pass westward through the hunting areas of the remaining two AEW-represented villages (Kaktovik and Nuiqsut), as well as again pass-

ing Point Barrow on the way to their wintering grounds in the Bering Sea.

During the spring migration the whales pass relatively close to Point Barrow, so this is a logical place to conduct a census. Most of the whales pass this site from mid-April through early June. The visual census now includes 15-20 observers, with the counting station located at a favorable site at the seaward edge of the shorefast ice off Point Barrow. Although whales are known to pass on a "front" that may extend several miles seaward from the censusing site, some whales come within a few feet.

Census observers use temporary camps on the ice, but the major logistical support site is the Borough's Arctic Research Facility at the UIC-NARL complex approximately three miles north of Barrow. The UIC-NARL complex is the former Naval Arctic Research Laboratory (NARL), which is now being operated as a multi-use facility (including support of science) by the Ukpavik Inupiat Corporation. The Borough's Arctic Research Facility (ARF) is a structure capable of housing 20 people on a bunkhouse basis; it consists of the laboratory and office section of the former Animal Research Facility of NARL.

Because of environmental influences (such as storms and drifting ice) and the limited range of vision of observers, the visual cen-

susing effort is often severely hampered. However, as many as 2100 whales have been seen in a censusing season. Soon after major visual censusing efforts were begun, Eskimo hunters repeatedly commented that many whales were passing unseen, that is, passing beyond the range of vision of census personnel and also passing by through broken ice areas (and therefore obscured from vision). To estimate population size more precisely, it is necessary to get a better estimate of the proportion of the population that passes beyond the range of vision of the census observers ("distant whales") or through areas of ice cover.

Two methods of detecting these distant whales are aerial surveys and passive acoustical location of vocalizing whales. Intensive aerial surveys are not acceptable to the local subsistence hunters since the low-flying aircraft may disrupt hunting activities. Although intensive aerial surveys over the spring lead system are viewed by some as excessive disturbance, there has been an effective limited aerial survey effort (conducted by NMFS) documenting some aspects of the "across the lead" distribution of whales in relation to the ice-based census site. These limited aerial survey efforts, which also use aerial photogrammetric techniques, provide information that is valuable in trying to assess recruitment. These

data include information on whale length frequency distribution and the photographic re-identification of individual bowhead whales. Because intensive aerial surveys have been ruled out, passive acoustical localization methods with a limited aerial survey involvement are being used.

Because of the difficulty in documenting the passage of whales that observers cannot see, a major effort began in 1982 to use passive underwater acoustical techniques to help locate whales that vocalize. After evaluation of the technique it has become an integral portion of the bowhead whale census effort since 1984. The passive acoustical localization technique uses a linear array of three hydrophones spaced about one-half mile apart along the shorefast ice edge of the nearshore lead near the visual census station. When a bowhead vocalizes, the sound reaches the three hydrophones at different times. Using the time interval between arrivals of a bowhead sound, the bearing from a pair of hydrophones to the vocalizing whale can be obtained. Three hydrophones produce three bearings. The distance to the whale can be calculated from the point at which the bearings cross. This method has worked to localize vocalizing whales that are 10 miles from the ice-based visual census station, far beyond the range of reliable visual detection.



*Visual census technician viewing a passing bowhead whale a few feet from the shorefast ice edge. Note the large expanse of water characteristic of an open lead.*

The combined visual and acoustic effort is directed at estimating the following as proportions of the passing population: those that are seen only, those that are heard only, those that are both seen and heard, and those that are neither seen nor heard. Determining these proportions is necessary in order to make full use of the acoustic localization data for the area beyond the range of visual detection. If the proportion of the passing whales that vocalize within the visual range of detection can be determined, that proportion can be applied, as appropriate, to the area beyond the range of visual detection. A major aspect in preparing a population size estimate is the tracking of individual passing whales, using both visual and acoustic data. Appropriate individual acoustic locations and individual visual sightings are linked to form individual whale tracks. Individual whales (single locations or linked locations) that are passing can therefore be identified more precisely, and a population estimate can be prepared that is more inclusive than an estimate that relies only on visual sightings or only on acoustic location data. Most of the acoustic data are evaluated for the North Slope Borough through the efforts of cooperating scientists from Cornell University, Marine Acoustics, Inc. (Cotuit, Massachusetts), and Analytical Software, Inc. (Seattle, Washington).

The actual population size estimate is derived from an intensive statistical evaluation of current and previous ice-based visual sightings data, acoustic location data, and sightings data from aircraft. This statistical effort, conducted by cooperating scientists at the University of Washington, has resulted in a revised bowhead whale population estimate of  $7200 \pm 2400$ . These data are subjected to an additional rigorous evaluation when presented each year to the Scientific Committee of the International Whaling Commission.

### *Examination of Subsistence-Harvested Whales*

In addition to censusing efforts a significant portion of the Borough's bowhead whale research program involves examining subsistence-harvested whales, collecting specimen materials, and evaluating specimens through the efforts of cooperating scientists. Information from harvested animals is collected in cooperation with AEWC personnel and includes date and location of harvest, sex, length, and presence or absence of stomach contents. The collection of specimen materials from subsistence-harvested bowhead whales was begun by

NMFS personnel in 1974. This effort was soon expanded by personnel funded by the U.S. Department of Interior, and since 1981 it has been conducted primarily by the Borough. Specimen materials (collected under Federal permit) are taken through the active cooperation of the individual hunters and the AEWC. A wide range of specimen materials have been taken by Borough personnel in support of morphological and microbiological studies being conducted by cooperating scientists at the Louisiana State University, Texas A&M University, the University of Georgia, and the University of Florida. These studies are focused primarily on the morphological determination of systems pertaining to reproduction and digestion, and systems (integumentary, visual, respiratory and digestive) that may be affected if the animal contacts spilled oil. Examination of these specimens has been fruitful over the past several years, resulting in a much better understanding of the structure of the skin, kidney, respiratory system, reproductive tract and digestive tract.

### *Logistical Support*

A third way in which the Borough supports science is through logistical support. With the unfortunate closure of NARL in 1980, research logistical support in the Point Barrow area became quite difficult. This prompted the Borough to establish its own support capability in order to conduct the bowhead whale field program. The Borough's research support site was initially a small dedicated structure in Barrow. However, a more suitable site (the Borough's Arctic Research Facility) became available with the reactivation of the UIC-NARL facility. During this time the Borough has provided, at no cost, basic logistical support (food, lodging, two-way radios, heavy clothing, snowmachines, etc.) to a few visiting scientists each year. This modest support is intended primarily to assist graduate students and young investigators who are trying to establish themselves in some facet of Arctic science. This program has been somewhat formalized through a memorandum of agreement between the Borough and the Arctic Institute of North America (AINA). The Institute is helping the Borough identify potential participants by evaluating research proposals that require logistical support in the Point Barrow area. As time progresses, this small program will assist in training the next generation of Arctic scientists.



Former Naval Arctic Research Laboratory (NARL). It is now operated by the Barrow-based Ukeagvik Inupiat Corporation as a multi-use facility designated as UIC-NARL.

## Publications

Readers may obtain further information on some of the research described in this article from the following publications:

*Some thoughts regarding the possible effects of oil contamination on the bowhead whale, Balaena mysticetus*, by T. Albert: Tissue Structural Studies and Other Investigations on the Biology of Endangered Whales in the Beaufort Sea (T.F. Albert, Ed.), p. 945-953. Report to the Bureau of Land Management from Department of Veterinary Science, University of Maryland, 1981.

*The bowhead whale, Balaena mysticetus*, by H. Braham: Marine Fisheries Review, vol. 46, no. 4, p. 45-53, 1984.

*A preliminary account of the acoustic study conducted during the 1985 spring bowhead whale, Balaena mysticetus, migration off Point Barrow, Alaska*, by C. Clark, W. Ellison and K. Beeman: Report of the International Whaling Commission, vol. 36, p. 311-316, 1986.

*Report of the 1982 spring bowhead whale census and harvest monitoring including 1981 fall harvest results*, by R. Dronenburg, G. Carroll, D. Rugh and W. Marquette: Report of the International Whaling Commission, vol. 33, p. 525-537, 1983.

*Report of field activities pertaining to the spring 1986 census of bowhead whale, Ba-*

*laena mysticetus, off Point Barrow, Alaska, with observations on the subsistence hunt*, by J. George, G. Carroll, R. Tarpley, T. Albert and R. Yackley: Report of the International Whaling Commission, vol. 37, p. 301-308, 1987.

*Epidermal and papillary dermal characteristics of the bowhead whale, Balaena mysticetus*, by J. Haldiman, W. Henk, R. Henry, T. Albert, Y. Abdelbaki and D. Duffield: Anatomical Record, vol. 211, p. 391-402, 1985.

*Gross anatomy of the respiratory system of the bowhead whale, Balaena mysticetus*, by R. Henry, J. Haldiman, T. Albert, W. Henk, Y. Abdelbaki and D. Duffield: Anatomical Record, vol. 207, p. 435-449, 1983.

*Distribution of bowhead whales in the vicinity of Point Barrow, Alaska: Aerial observations, 1984 and 1985*, by M. Nerini and D. Rugh: Report of the International Whaling Commission, vol. 36, p. 359-361, 1986.

*A description of a tracking algorithm and its application to bowhead whale acoustic location data collected during the spring migration near Point Barrow, Alaska, 1984-85*, by R. Sonntag, W. Ellison, C. Clark, D. Corbit and B. Krogman: Report of the International Whaling Commission, vol. 36, p. 299-310, 1986.

*Observations on the anatomy of the stomach and duodenum of the bowhead whale, Balaena mysticetus*, by R. Tarpley, R. Sis, T. Albert, L. Dalton and J. George: American Journal of Anatomy, vol. 180, p. 295-322, 1987.

*Introduction: A scientific perspective of the bowhead whale problem*, by M. Tillman: Marine Fisheries Review, vol. 42, no. 9-10, p. 1-5, 1980.

*Population size estimation for the bowhead whale, Balaena mysticetus, based on 1985 and 1986 visual and acoustic data*, by J. Zeh, P. Turet, R. Gentleman and A. Raftery: Report of the International Whaling Commission, vol. 38, in press.

*Cumulative impacts of oil fields on northern Alaskan landscapes*, by D. Walker, P. Webber, E. Binnian, K. Everett, N. Lederer, E. Nordstrand and M. Walker: Science, vol. 238, p. 757-761, 1987.

# Petroleum Industry Research in Arctic and Subarctic Frontier Areas

ARDATH MERBS

The Alaska Oil and Gas Association (AOGA) is an association of companies engaged in oil and gas exploration, production, refining, transportation and marketing activities in Alaska. It provides a forum for its member companies to coordinate common public and government affairs efforts. The Lease Planning and Research Committee (LPRC), a special committee of AOGA, provides a forum for contractors and industry members to propose joint industry projects to prospective participants. The Association maintains a listing of research projects in a reference book entitled *A Compilation and Description of Industry Research Projects in Alaska Frontier OCS Areas*.

Research projects are undertaken by participating companies in their own names, not in the name of LPRC or AOGA. Companies

and government agencies that are not members of AOGA or LPRC may be participants if they consent to the terms of project agreements. Project participants receive confidential reports of results and agree to keep this information confidential for a specific time, usually five years. After that time, results may be made public. Individual company participation in joint research projects with shared costs allows a greater number of essential studies to be conducted in Arctic frontier areas where the cost for research is extremely high and the cost to a single company would be prohibitive.

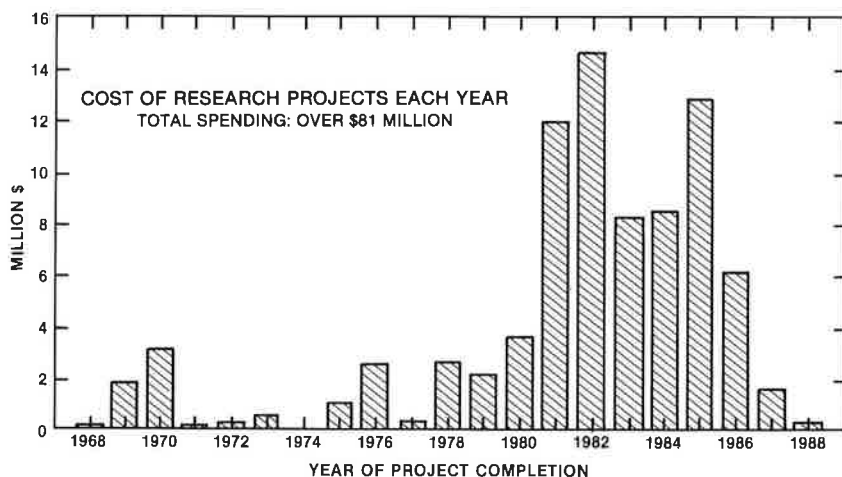
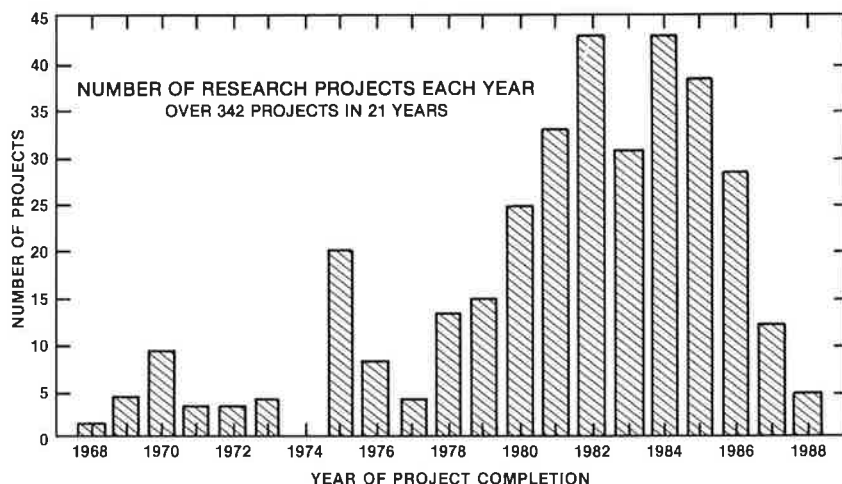
More than 342 research projects have been conducted jointly by the oil and gas industry to gain knowledge necessary for petroleum exploration and production in Alaska. These projects have been undertaken at a cost of over \$81 million.

Historically, oil industry research projects have investigated ice features such as ridges, movement patterns, freezeup and breakup times, and properties such as ice strength. Many other projects have been devoted to the design of platforms, pipelines, ships and other structures suitable for Arctic and Subarctic conditions. Still more projects have gathered weather, oceanographic and seismic data. Research has been conducted to gather data on oil spill prevention and cleanup techniques.

More recent research has focused on bowhead whales to ascertain current populations and reproductive patterns. Research on the effects of ice movement, forces and loads on offshore structures has been performed for use in designing exploratory structures for the Chukchi, Bering and Beaufort sea frontier areas.

The following summary of the oil industry's research efforts was developed from articles appearing in the *Alaskan Update* newsletter. The newsletter is published periodically by the member companies of the LPRC. It features in-depth articles on specific research projects and provides a listing of new projects being undertaken by individual oil companies. To get on the mailing list, write to Editor, *Alaskan Update*, P.O. Box 99427, Seattle, Washington 98199.

Ardath Merbs is the Public Affairs Manager of the Alaska Oil and Gas Association, 121 W. Fireweed Lane, Anchorage, Alaska 99503-2035.



## Bowhead Whale Research

Research projects to study various aspects of the bowhead whale population in Alaska and Canada have been undertaken by a number of individual companies and government agencies. Studies have included

- Use of aerial surveys to obtain information on the numbers, movements and distribution of bowhead whales.
- Investigation of the health of the whale population by observing and counting whales.
- Assessment of the response of bowhead whales to noise from a drill ship.
- Compilation of historical records for analysis to explain the great variation in the number of whales observed.
- Test methods utilizing satellite monitoring tags.
- Interrelationships between whale distribution and habitat by using oceanographic factors.

These bowhead whale studies also were used for oil spill risk analysis and characterization of whales by size, age and sex.

## Use of Ice Studies in Designing Structures

The petroleum industry has conducted many projects to measure the direction and speed of moving sea ice in Alaska offshore areas. The information has been used to design exploration and production structures that can withstand the most severe ice conditions at specific sites, as well as to plan construction and supply logistics. Also, once structures are on site, surrounding ice movement is measured to provide early warning of conditions that could be hazardous to the structure and to make sure the ice causes no damage. Later, the measurements may be analyzed to aid designs for future structures.

The industry has used the following techniques to measure sea ice movement in offshore Alaska: wireline stations, time-lapse photography, aerial photography, acoustic systems, laser systems, radar of various types, and satellite systems.

Most ice research has involved field studies of sea ice features such as ridges, floes, rubble piles, breakup, freezeup and ice movement. Besides these field studies, laboratory tests have been performed to learn more about the nature of sea ice, including strength and crystal structure. The purpose for the lab

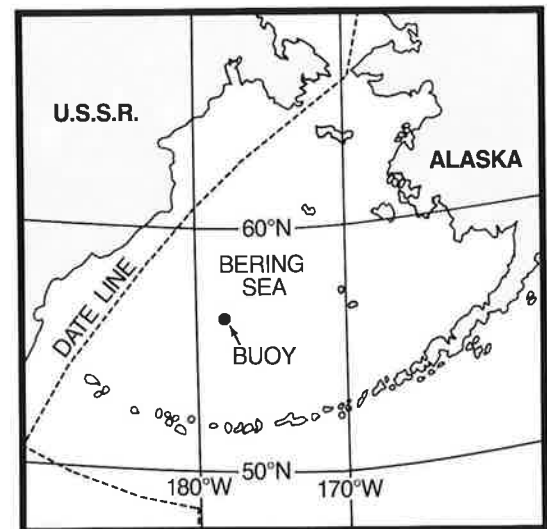
studies has been to aid in design of offshore structures. Engineers need to know the strength of sea ice in order to design structures that can survive the forces of sea ice moving against them or to design barriers that protect structures from direct contact with moving ice.

Test results also have been used to design exploration islands, airstrips and roads built of man-made ice that is strong enough to support equipment and to survive a winter season in the midst of natural ice forces. As an example of how research results have been applied to engineering, tests showed that an ice sheet moving against a structure exerts less force when it bends and breaks on a sloping configuration than when it crushes into a vertical structure. Consequently, some offshore exploration structures have been designed with sloping sides at the waterline.

As a result of intensive ice research, the oil industry designs most offshore structures for the American and Canadian Arctic so that their shape causes ice that strikes them to self-destruct, i.e., to be crushed or bent until it breaks under its own force and weight.

## Meteorology and Oceanography Research

A significant part of the research conducted by oil companies preparing to drill exploratory wells in offshore Alaska has been in meteorology and oceanography. This knowledge is needed to design offshore structures and to



Shown at 56°N, 178°W is the site where a weather and oceanographic buoy, jointly funded by six oil companies and the U.S. Government, was installed.

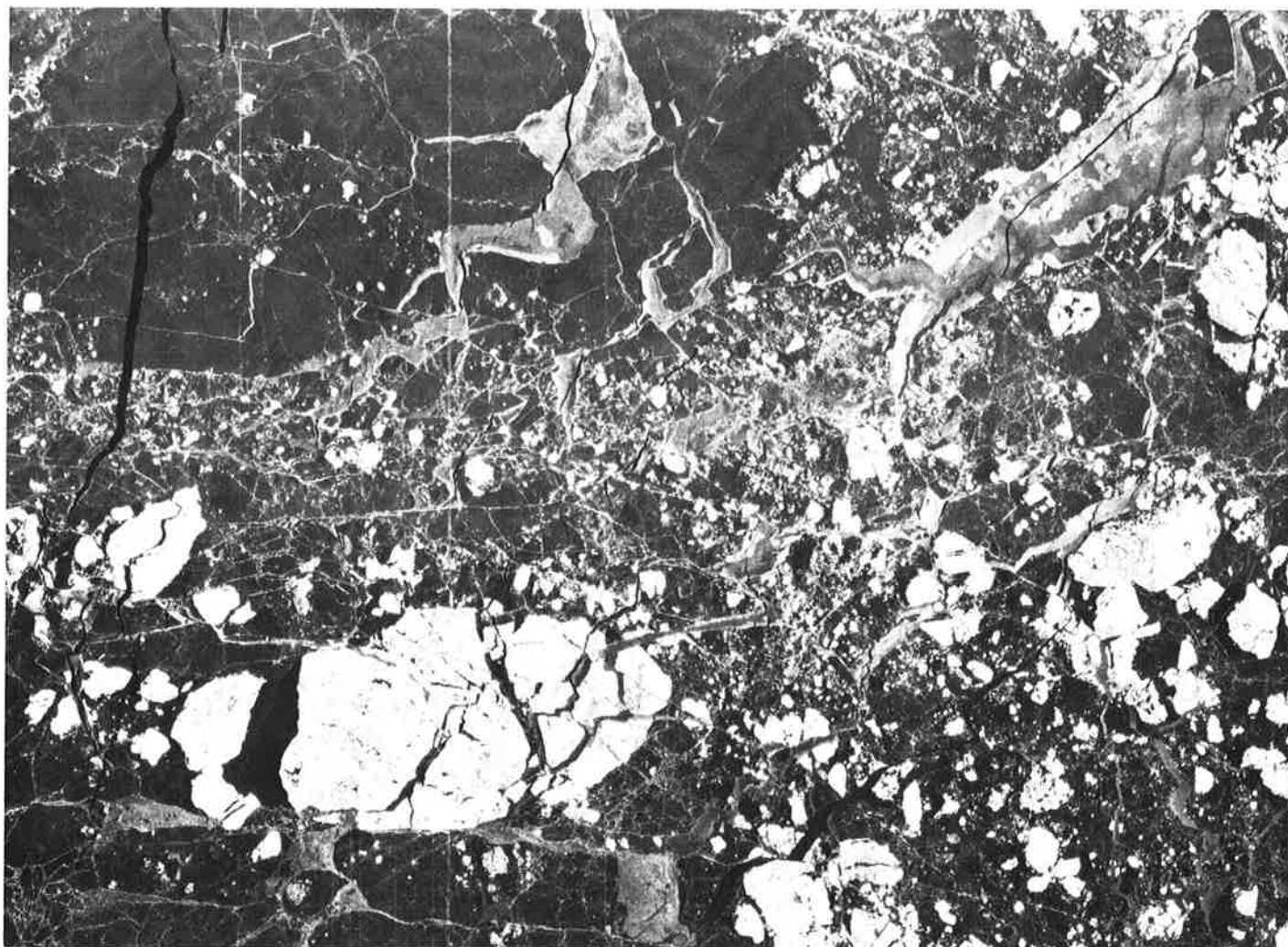
plan the logistics of transporting people and equipment.

Oil companies have carried out 173 meteorology and oceanography research projects in the Beaufort Sea, Chukchi Sea, Bering Sea, Cook Inlet and Gulf of Alaska. These projects have obtained some or all of the types of meteorologic and oceanographic information in the list at the right. Studies of sea ice, which may incorporate both meteorologic and oceanographic factors, are listed separately.

Oil companies have joined with government in several important projects such as those conducted by the U.S. Coast Guard icebreakers *Polar Sea* and *Polar Star* for the past six years. Another project is the deployment of a buoy to improve weather forecasts for the Bering Sea. These data are of particular value to the Alaska public, especially the Alaska fishing industry, because they have given advance notice of severe storms. The people and equipment involved in transportation and fishing, as well as the petroleum industry, are more secure because of this joint effort.

*Synthetic-aperture radar (SAR) image of ice in the Beaufort Sea. The dark area is new ice; the lightest area is older, possibly multi-year ice.*

Studies	Number of projects
<i>Meteorology</i>	
Storms	18
Winds	40
Air temperature	16
Barometric pressure	18
Precipitation	2
Humidity	1
Visibility	2
Forecasting procedures	5
General (all or most of the above)	13
<i>Oceanography</i>	
Sea temperature	10
Salinity	2
Depths	5
Bottom pressure	2
Currents	30
Marine life	6
Waves	32
Storm surges	13
Tides	13
General (all or most of the above)	8
<i>Sea ice</i>	
Site studies	131
Mechanical properties	21



# The Alaska SAR Facility: An Update

GUNTER WELLER AND W.F. WEEKS

## Project Goals

Under sponsorship and with funding from NASA, the Jet Propulsion Laboratory at Pasadena (JPL) and the University of Alaska-Fairbanks (UAF) are developing a ground receiving, processing, archiving and distribution facility for synthetic aperture radar (SAR) data.

In the 1990s the Alaska SAR Facility (ASF), to be located at UAF's Geophysical Institute, will process radar data from three satellites: the European Space Agency's ERS-1 satellite, the Japanese National Space Development Agency's (NASDA) ERS-1 (J-ERS-1) and Canada's Radarsat. From 1990 until at least 1999 these systems will provide the continuous flow of radar data necessary for geophysical analyses. Data received at ASF are expected to be used extensively for the study of air-sea-ice interactions of the Arctic Ocean and Alaskan waters. However, the SAR data will also be used to study features of the open ocean and ice margins, glaciology, geological processes of river and delta formation, and seasonal vegetation changes.

## Major Systems

Development of the ASF is currently underway at JPL, with the design and construction of four ground segments of the station: the Receiving Ground Station (RGS), the SAR Processor System (SPS), the Archive and Operations System (AOS), and the Geophysical Products System (GPS). At UAF an interactive image analysis system is being designed, and facilities are being modified to house the ASF. UAF is also providing technical personnel at JPL to assist with SPS and AOS development. UAF will eventually operate and maintain the ASF.

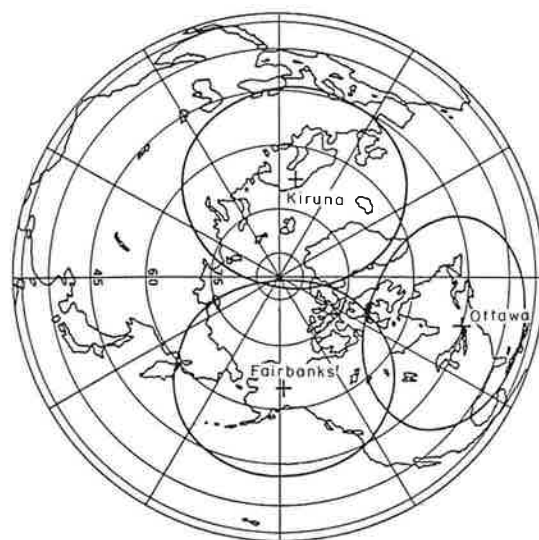
## Data Acquisition

Acquisition and recording of signal data are the primary functions of the RGS, which consists of a 10-m parabolic antenna, an attendant control computer, and X-band (8000-8400 MHz) and S-band (2200-2300 MHz) receivers

and data recorders. The system components are being integrated from existing technology of the Landsat type. To maximize coverage poleward, the antenna will be located atop the eight-story Elvey building on the UAF campus, which has an unobstructed view to the horizon. The station will be able to receive real-time SAR data from satellites located over a large area of the Arctic. In fact, the combined coverage of ASF with stations located at Kiruna, Sweden, and near Ottawa, Canada, will give almost complete Arctic coverage. Also, since J-ERS-1 and Radarsat will both carry tape recorders, the SAR coverage will become world-wide in 1992, constrained only by the power limitations of the satellites.

### Timetable of ASF tasks.

Building modifications completed	15 July 1988
Receiving Ground Station installed	1 October 1988
Archive and Operations System completed	15 August 1989
SAR Processor System shipped to Alaska	1 October 1989
Installation and testing of entire system completed	31 March 1990
Launch of ERS-1 satellite	April 1990



Approximate station masks for the ERS-1 satellite at Kiruna, Sweden; Fairbanks, Alaska; and Ottawa, Canada. Coverage of the Arctic Ocean is almost complete.

*Gunter Weller is Chairman of the National Research Council's Polar Research Board. W.F. Weeks is on leave from the Cold Regions Research and Engineering Laboratory and has specialized in sea ice research for over three decades. Both are presently at the Geophysical Institute, University of Alaska-Fairbanks, Alaska 99775-0800.*

### SAR satellite and sensor characteristics.

	<i>ERS-1</i> (ESA)	<i>J-ERS-1</i> (Japan)	<i>Radarsat</i> (Canada)
Launch date	April 1990	1992	1994
Mission duration (yr)	2	2	5
Orbit altitude (km)	785	568	790
Orbit inclination (deg)	97.5	97.7	98.5
Radar frequency (Ghz)	5.3 (C-band)	1.3 (L-band)	5.3 (C-band)
Data rate (Mbps)	105	60	100
On-board storage	None	~ 10 <sup>11</sup> bits	To be determined
Other instruments	Radar altimeter	Optical sensor	To be determined

### Data Processing

In the SPS, signal data will be played back and correlated in a custom pipeline processor that operates at  $\frac{1}{10}$  real time. Output from the SPS consists of one-look complex, full-resolution (four-look) and low-resolution images. The frame sizes of images are about  $100 \times 100$  km. The spatial resolution of one-look images is about 10 m, that of four-look images about 30 m, and that of low-resolution images about 240 m. The number of looks indicates the number of independent images that are averaged together to reduce speckle intensity. All images will be georeferenced (i.e., each pixel is Earth located). Post-processing, consisting of geocoding, will be performed on demand. Geocoding is a process whereby an image is resampled to a map projection and rotated to true north. Some geocoding procedures will also correct images for terrain-induced distortions.

In addition to producing digital images, 20% of the full-resolution images and 100% of the low-resolution images will be recorded on film. All products produced in the RGS and SPS will be permanently stored in the AOS for archiving, duplicating and disseminating to investigators.

SAR gives a view of the Earth's surface that is different from what one is used to seeing. Bright portions of the image indicate that relatively large amounts of the energy of the electromagnetic radar pulses emitted by the SAR system are returning to the system's receiver after scattering either off the Earth's surface or from within the near-surface layers (at typical SAR frequencies, penetration into most Earth materials is limited to distances of a few meters or less). Dark portions of the image, in turn, indicate a low return to the receiver, which can result from the radar pulse being absorbed by the material or being scat-

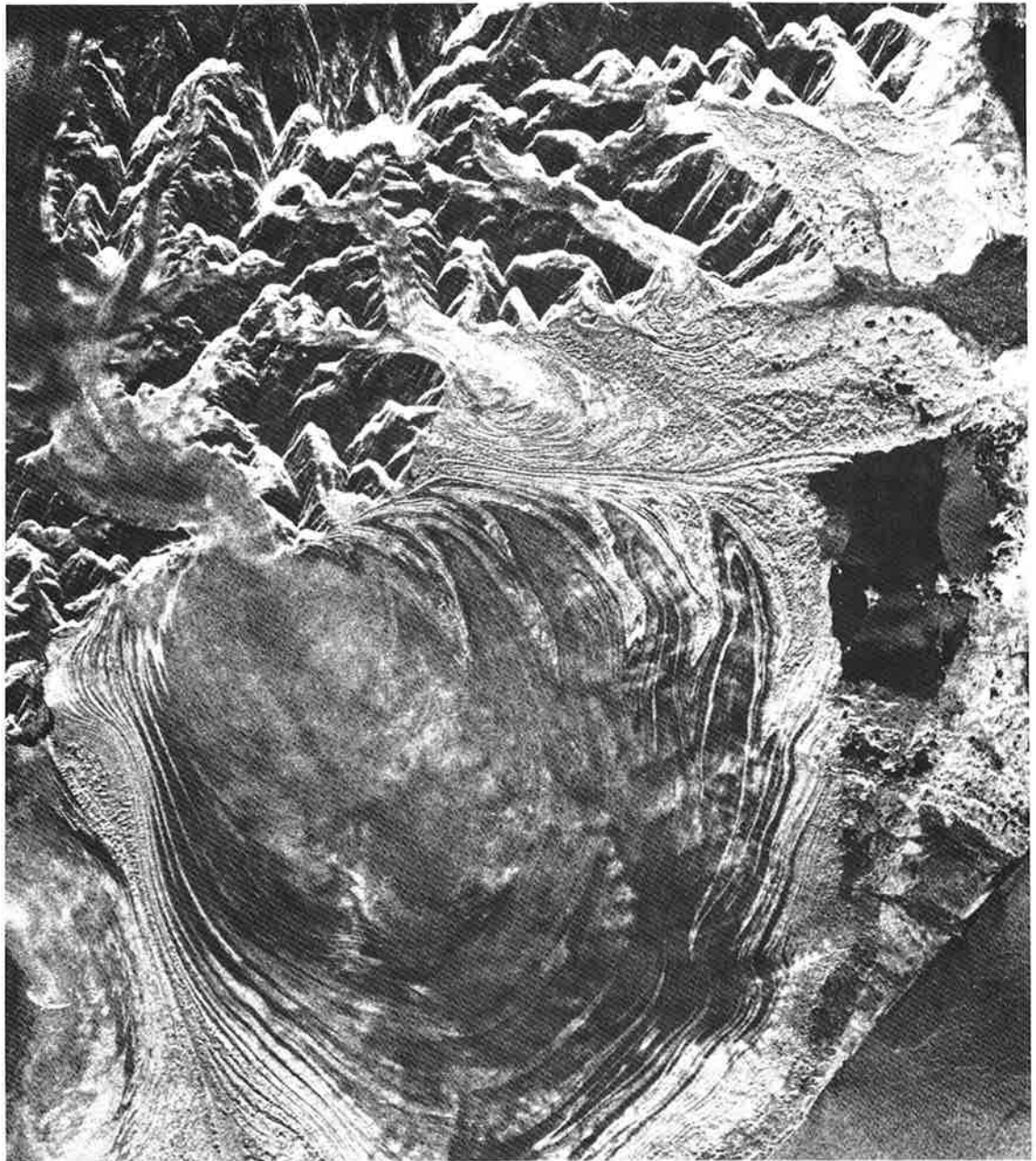
tered forward so that the amount of energy returned to the receiver is small. Classic examples of this latter phenomenon are a calm sea and flat first-year sea ice; both give strong radar returns but little, if any, of the energy returns to the receiver.

Surface features, such as moraines, leads and pressure ridges, are easy to identify. For other features, exact identification or cause of the backscatter is less confidently explained. Even the most experienced SAR analyst invariably encounters these questions. This problem is particularly true in the Arctic, where experience with SAR is more limited than in more accessible portions of the Earth. One of the initial tasks of ASF is to spearhead the resolution of many of these questions. Fortunately this task should not be difficult because the correspondence between identifiable surface features and backscatter patterns should allow the more important scattering mechanisms to be identified and quantitatively analyzed.

### Geophysical Products System

One unique aspect of the ASF is its geophysical data analysis capability. Although SAR images contain a great deal of information, it is commonly not in a form that is directly useful to the general scientific community. In some cases the extraction of this information from the SAR data set by using image analysis techniques is not routine and involves hundreds of hours of expert investigator time. Such studies will be carried out on the Interactive Image Analysis System (IIAS) being designed at UAF. In other cases the analysis is highly repetitive and in principle can be carried out with minimal human supervision through the use of automated procedures, even if the procedures themselves are computationally very involved. This last task is the function of the Geophysical Products System (GPS) under development at JPL.

The need for such a system has been clear since the Seasat experience, when several types of analyses with obvious scientific and operational potential were only possible months after the fact. GPS capabilities are expected to include procedures for providing topographically corrected SAR images and for obtaining ice movement vectors and mean velocities via automated tracking of identifiable ice features. As experience is gained after launch, procedures will be implemented for classifying ice types and characterizing surface wave fields.



*Seasat SAR image of the Malaspina Glacier and coastal mountains in southern Alaska, taken on August 4, 1978.*

The continual expansion, improvement and verification of this line of derived products will be an important ASF activity during its initial period of operation. Routine procedures that are developed and tested on the IIAS will gradually be automated and transferred to the GPS.

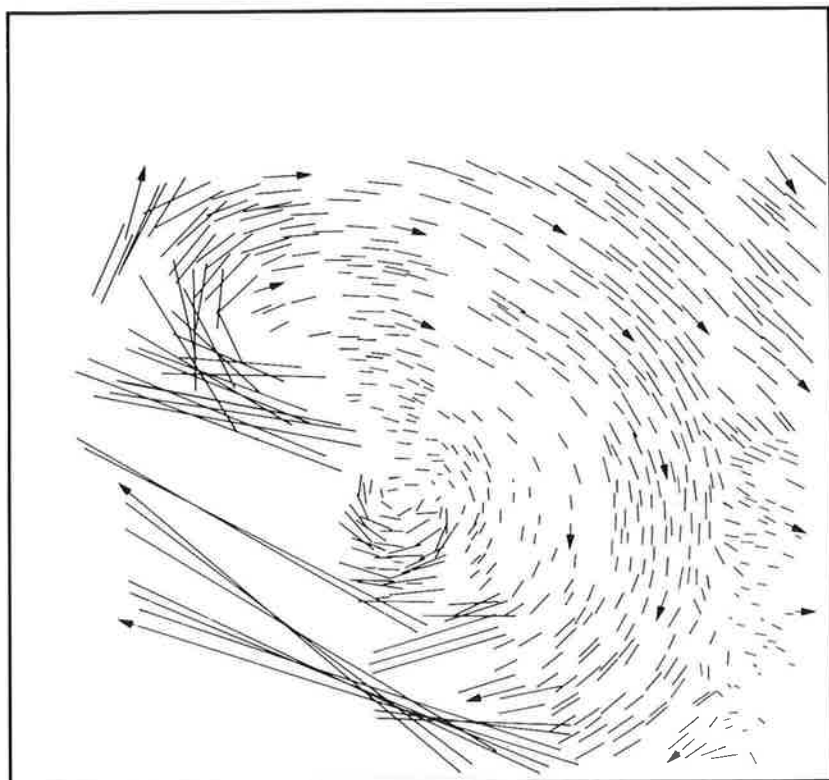
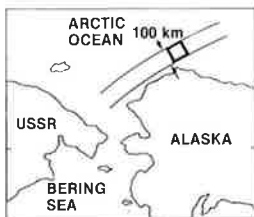
### *Data Distribution*

The AOS consists of an Archive Catalog Subsystem and a Mission Planning Subsystem. The Mission Planning Subsystem will provide the ASF station scientist and manager with tools for predicting satellite ground swath coverage and site viewing opportunities

and for administering investigator data requests. A daily plan for ASF data acquisition will be conveyed to ASF operators and will also be reviewable from the on-line catalog.

Management of SAR data and information about data is the Archive Catalog Subsystem's primary function. An on-line catalog and inventory, built on the NODS GOLD catalog and the JPL SAR catalog experience, will provide investigators with the opportunity to interactively select and order data products. High-density digital tapes containing signal, one-look and full-resolution data and computer-compatible tapes containing low-resolution data will be stored in the off-line archive. Film products will also be managed by the permanent archive.

The ASF catalog will be accessible via the Space Physics Analysis Network. Investigation requests for digital images will be filled on computer-compatible tapes and digital optical disks (DOD). The 5.25-inch write-once-read-many DOD is envisioned as a major medium for data distribution in the 1990s. Furthermore, distribution of images via telecommunication networks may be feasible for browse purposes by using a data compression scheme before transmission. A decoding algorithm on a receiving computer would then restore images to approximately the original fidelity.



*Ice motion from SAR. The lower diagram shows sea ice motion determined over four days by tracking features in consecutive Seasat SAR images on October 4 and 8, 1978. A translation of about 17 km northward was subtracted from all the individual points to better depict the jets and the anticyclonic eddy apparent in the motion field. The map shows where the data were taken.*

## Science and Applications Programs

A Prelaunch Science Working Team has been established by NASA to assist in the development of the ASF and to prepare for the use of ASF SAR data in scientific and applications research. This working group is being co-chaired by project scientists from the University of Alaska and JPL and is developing ASF Science and Applications Plans. The development of the science plan is proceeding in three stages. Attention is being focused on SAR-only opportunities offered by ERS-1. Later the document will be expanded to consider the further research opportunities that will be possible by combining the different

frequency and incidence angle data offered by different satellite pairs. Also under consideration are applications that will result from combining SAR data with the optical data that are expected to be down-linked to ASF from J-ERS-1. These two data sets will be highly complementary, particularly when applied to a variety of "land" processes.

The "ERS-1 only" science plan is expected to be completed by late 1988 and will discuss research opportunities in a variety of subject areas. The oceanography and ice portion of the report is essentially completed; it identifies a number of primary scientific thrusts to which SAR data will be able to make significant contributions.

## Sea Ice

SAR data will help in sea ice studies that

- Observe the circulation of ice in the Arctic Ocean and its peripheral seas.
- Determine the fluxes of heat and mass in the Arctic and their role in the global climate system.
- Examine the effect of change in ice pack morphology on air-ice-ocean momentum transfer.
- Resolve the rheology of sea ice as it depends on location, season, ice thickness and type.
- Examine air-sea-ice interactions in the marginal sea ice zone.
- Examine the effectiveness of SAR data in initializing, updating and verifying sea ice models.
- Develop the study of ice kinematics.

## Polar Oceanography

SAR data will also help in studies that

- Examine the occurrence and evolution of mesoscale circulation features.
- Clarify the interaction of gravity waves and currents with bottom topography.
- Determine the fine-scale wind field and surface fluxes for inputs into oceanographic models.
- Determine the surface wave climatology of Alaskan waters.
- Study the occurrence and energy distribution of internal waves.
- Study the effects of surfactants on air-sea interactions.
- Examine the effectiveness of SAR data in initializing, updating and verifying ocean wave and circulation models.

## Land Processes

The land processes portion of the plan is further from completion because the subject areas are more diffuse and the data interpretations are less clear-cut. However, obvious science opportunities exist in a variety of fields, including glaciers, ice sheets and ice shelves, geomorphology and glacial and periglacial geology, hydrology, hydraulics, structural geology, vulcanology and ecology. Although the listing of research thrusts has not been finalized, a number of obvious inclusions would be the following:

- Monitor glacier and ice shelf motions in general and glacier surges in particular. (For instance, while this paper was being prepared a major surge started on the West Fork Glacier located on the south side of the Alaska Range south of Fairbanks. Aircraft SAR observations were made of this area in March 1988 in anticipation of more extensive future studies of this general phenomenon via ASF SAR data. The aircraft data are being analyzed now.)
- Monitor soil conditions beneath dry snow packs and snow characteristics during the melt season.
- Map changes in river channel morphology in braided streams and in river delta regions.
- Monitor eruptive events and morphological changes in Alaskan volcanoes.
- Monitor the formation and drainage of glacier-dammed lakes.
- Utilize SAR in structural and morphological mapping of Alaskan accretionary terranes.
- Explore the application of SAR data to studies of permafrost regions and solifluction processes.
- Apply SAR data to studies of vegetation patterns and revegetation.

## Applications

As mentioned, an Applications Demonstration Plan is also being developed. There is no clear-cut boundary separating many applications from related research. A few examples of possible SAR applications that are of interest are:

- Support offshore operations and ship routing around and through ice-infested waters.
- Monitor changes in sea ice characteristics

in nearshore areas in support of studies of over-ice traffic and marine mammal habitat.

- Assist in locating suitable ice floes for offshore camps, landing strips and experimental areas.
- Monitor natural revegetation sequences that develop following forest fires, land clearings or vehicular activity.
- Monitor natural catastrophic events and help in search and rescue missions.

Clearly the Science and Applications Plans are not intended to be all-inclusive, and it is hoped that many unanticipated, innovative programs will ultimately develop to use SAR data. The subject areas in which obvious SAR applications exist are both varied and complex. The data collected by the ASF will hardly resolve the myriad of problems associated with these topics. However, SAR, with its high-resolution, all-weather view of the Earth's surface, has a most important role to play in Arctic science. After the launch of ERS-1 in 1990 there will still be innumerable aspects of the Arctic that are not well understood. However, the number of aspects that are unobserved will be significantly reduced.

## Publications

Readers may obtain further information on some of the research described in this article from the following publications:

*The Alaska Synthetic Aperture Radar (SAR) Facility project*, by F. Carsey, K. Jezek, J. Miller, W. Weeks and G. Weller: EOS, vol. 68, no. 25, p. 593-596, 1987.

*A post-processing system for automated rectification and registration of spaceborne SAR imagery*, by J.C. Curlander, R. Kwok and S.S. Pang: International Journal of Remote Sensing, in press.

*Rectification of terrain induced distortions in radar imagery*, by R. Kwok, J.C. Curlander and S.S. Pang: Photogrammetrical Engineering and Remote Sensing, in press.

*Science program for an imaging radar station in Alaska*, by G. Weller, F. Carsey, B. Holt, D.A. Rothrock and W.F. Weeks, Report of the Science Working Group, Jet Propulsion Laboratory, 400-207, 1983.

*A digital fast correlation approach to produce Seasat SAR imagery*, by C. Wu: Proceedings of IEEE 1980 Radar Conference, Arlington, Virginia, IEEE Aerospace and Electronic System Society, p. 153-160, 1980.

*A quarterly newsletter and poster of Seasat SAR images of Alaska are available free of charge. Contact: Alaska SAR Facility, c/o Geophysical Institute, University of Alaska, Fairbanks, Alaska 99775-0800, Tel. (907) 474-7954.*

# World Data Center-A for Glaciology

## National Snow and Ice Data Center

ROGER G. BARRY AND ANN M. BRENNAN

World Data Center-A for Glaciology [Snow and Ice] (WDC-A) is one of three international data centers serving glaciology. The other two are WDC-B in Moscow, U.S.S.R., and WDC-C in Cambridge, England. The centers were established during the International Geophysical Year to facilitate the international exchange of data on all forms of snow and ice. The subject matter includes avalanches, freshwater ice, glaciers, ground ice and permafrost, ice sheets, paleoglaciology, sea ice and snow cover.

Until 1971 the WDC-A for Glaciology was operated by the American Geographical Society in New York; from 1971 to 1976 the responsibility for WDC was held by the U.S. Geological Survey in Tacoma, Washington. In 1976 the National Academy of Sciences' Geophysics Research Board proposed that WDC-A be transferred to Boulder, Colorado, where it would be operated under a joint arrangement between U.S. National Oceanic and Atmospheric Administration (NOAA) and the University of Colorado. This step was approved and implemented in November 1976, and WDC-A was formally included among the WDC responsibilities then exercised by the Environmental Data Service of NOAA represented by the National Geophysical and Solar-Terrestrial Data Center (NGSDC). The WDC celebrated its tenth anniversary of operations at the University of Colorado in November 1986 with a seminar attended by representatives of NOAA, the University and other institutions. The papers presented at this celebration were published as *GD-19*, in the *Glaciological Data* series.

The WDC continues to be operated under a contractual agreement between the Cooperative Institute for Research in Environmental Sciences (CIRES) of the University of Colorado and the National Environmental Satellite, Data, and Information Service (NESDIS) of NOAA. Also located with WDC is the National Snow and Ice Data Center (NSIDC) established by NOAA in 1982. This center functions as a national information and referral center for the snow and ice community. The center is housed in research buildings adjacent to the NOAA-Environmental Research Labor-

atories and the National Geophysical Data Center.

## Activities

One of the principal directives of the glaciology section of the *Guide to International Data Exchange Through the World Data Centers* is to "collect, store and disseminate information and data on glaciology..." To fulfill this directive and to meet the increasing interest in cryosphere and climate studies on a global scale, WDC/NSIDC maintains an active program to acquire published material in all areas of snow and ice research.

Currently the Information Center contains 4,750 monographs and technical reports and approximately 10,000 reprints; 90 serials are regularly received. During 1987 approximately 1,300 items were added to the collection.

All materials received are cataloged and assigned subject and geographic descriptors. Primary access to the collection is provided by Citation, the in-house online catalog. At the end of 1986, there were about 22,000 records in the data base. The file is updated quarterly and 400-500 records are added each time. The subject headings in Citation are those used by the Cold Regions Research and Engineering Laboratory in their CRREL bibliography and Cold data base. The collection holds materials on all aspects of snow and ice research; however, the focus in recent years has been on snow cover and sea ice data and the interactions of the cryosphere and climate. Online searches of the collection are performed on request.

## Publication Program

Two series, *New Accessions List* and *Glaciological Data*, are published by WDC/NSIDC. *New Accessions List (NAL)*, a product of the Citation data base, is a quarterly list of documents, categorized by subject, received and cataloged during a given period. This publication, which fulfills much of the information exchange role stipulated by

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World Data Center System guidelines, is mailed worldwide to about 350 scientists, research institutions and libraries. During FY87, three NAL issues were completed.

*Glaciological Data (GD)* is the principal publication of WDC/NSIDC. Issues focus on a single topic and include specialized bibliographies, inventories and survey reports relating to snow and ice data prepared by WDC/NSIDC staff, as well as invited or contributed articles on data sets, data collection and storage, methodology and terminology in glaciology. The current circulation for *GD* is approximately 950 copies, 50% of which are mailed to addresses outside the United States, in exchange for publications submitted to the WDC. Whenever possible, *GD* publication costs are obtained through specific agency or project support.

The most recent issue in this series, *GD-20*, was published in February 1988. It contains the report and recommendations of an NSF-sponsored workshop on the U.S. Antarctic Data Delivery System. Twenty-eight invited participants convened in Boulder on September 10-11, 1987, to develop recommendations for improving the current status of archives of meteorological data from U.S. Antarctic stations and other research programs. The findings are addressed to the NSF Division of Polar Programs. Appendices provide preliminary inventories of existing data and their location. Other recent issues include the proceedings of Snow Watch '85 (*GD-18*) and the Tenth Anniversary Seminar/Microwave Radiometry Bibliography (*GD-19*).

A forthcoming number will be an updated Permafrost Bibliography. This issue, which updates *GD-14*, will cover permafrost literature published from 1983 through 1987. It is being prepared with support from the U.S. Army Cold Regions Research and Engineering Laboratory for distribution at the Fifth International Conference on Permafrost to be held in Trondheim, Norway, in August 1988.

## *Data Holdings*

In recent years the emphasis at WDC/NSIDC has shifted from collecting published and other hard-copy material, sea ice charts and glacier photographs toward archiving computer-compatible data. The majority of these data sets relate to snow cover and sea ice, but there are also data available in the areas of glacial geophysics (including radio-echo sounding records and some ice core data), Great Lakes

ice-related environmental studies, and satellite microwave research.

A significant data holding of WDC/NSIDC is the collection of global satellite imagery acquired from the U.S. Air Force. NSIDC is in the fifth year of service as the national archive for image products from the U.S. Air Force Defense Meteorological Satellite Program (DMSP). During FY87, approximately 78,500 positive-transparency images were sorted, cataloged and archived into the collection, now amounting to about 1.25 million pieces of imagery. More than 55,500 entries, referring to single orbit strips, were added to the searchable computer data base.

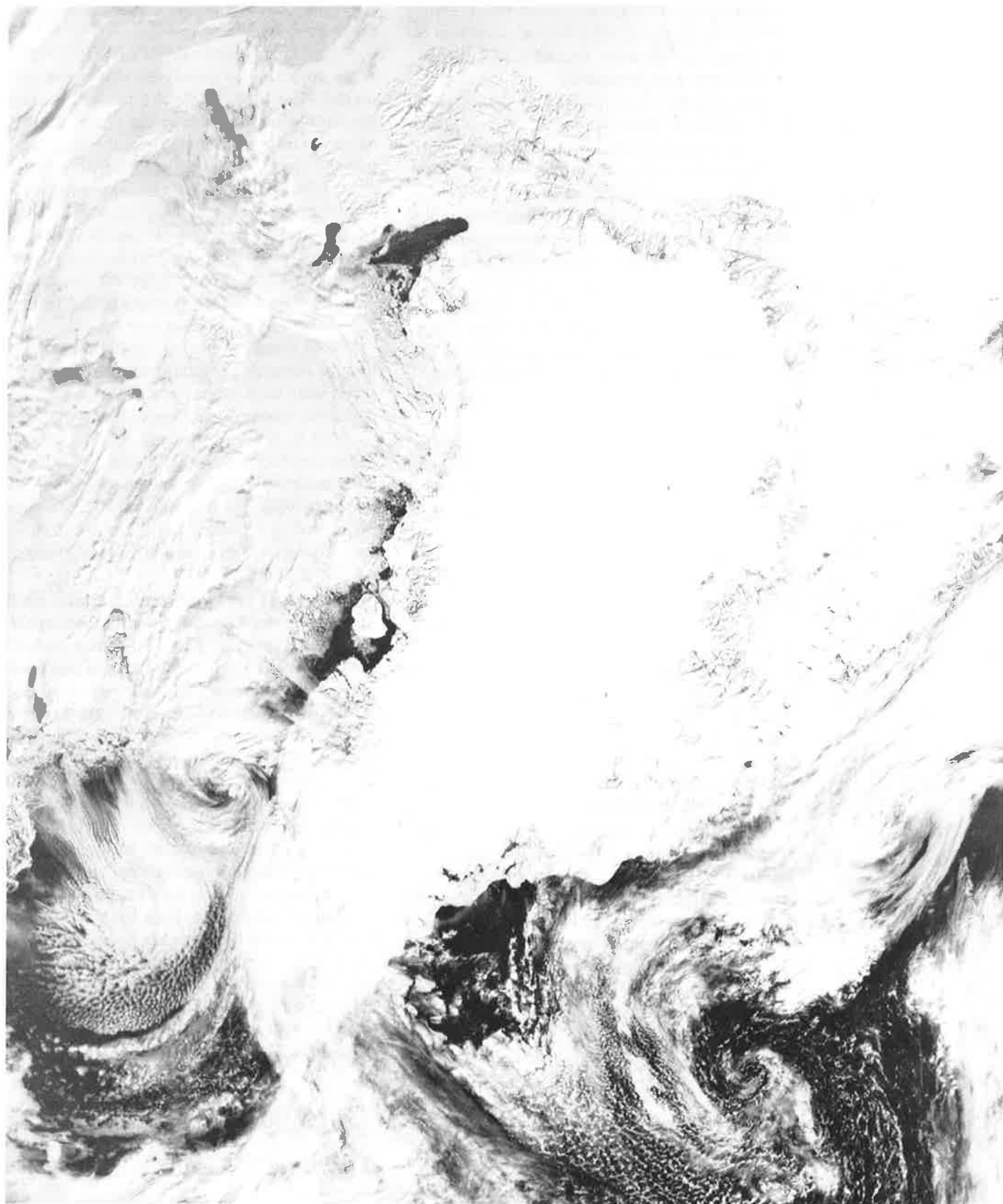
DMSP imagery is being used in a variety of bipolar research projects. Images of the Antarctic were used extensively in support of the Antarctic Ozone Hole Experiment, conducted by NOAA, NSF, NASA and NCAR, to study depletion of ozone. DMSP visible- and infrared-band data were used to document meteorological conditions and help analyze measurements taken during flights of DC-8 and ER-2 aircraft flying over the Antarctic from Punta Arenas, Chile.

DMSP data are being used in a joint study by NSIDC and Lamont-Doherty Geological Observatory of variations in summer snow melt on Arctic sea ice. Data on the seasonal progression of snow melt and surface albedo on Arctic pack ice, mapped at three-day intervals for four seasons from DMSP visible images, have been published. The geographical and temporal patterns of melt and surface albedo changes show substantial interannual differences in the melt regime, especially in May-June. These results are being used in support of the parameterization and verification of climate models by Ross and Walsh. Continued funding has been obtained from NSF for completing another six years of analysis and for examining apparent relationships between the snow melt data and atmospheric variables in the Arctic Basin. Ten years of digitized melt data will be made available as a data set following completion of the research.

## *Data Management*

### *Marginal Ice Zone Experiment*

NSIDC provides data management support for the Office of Naval Research's Marginal Ice Zone Experiment (MIZEX), which began during 1983. Data from the study of the mesoscale interaction of air-sea-ice processes



*Difference in visible-band brightness between largely snow-covered surfaces and snow-free surfaces in the Arctic Basin. The first image was collected on May 2, 1986; the second was collected on August 10, 1986. The Greenland ice cap remains snow-covered throughout the year. These images were produced from DMSP transparencies archived at WDC/NSIDC.*



## Cryospheric Data Management System

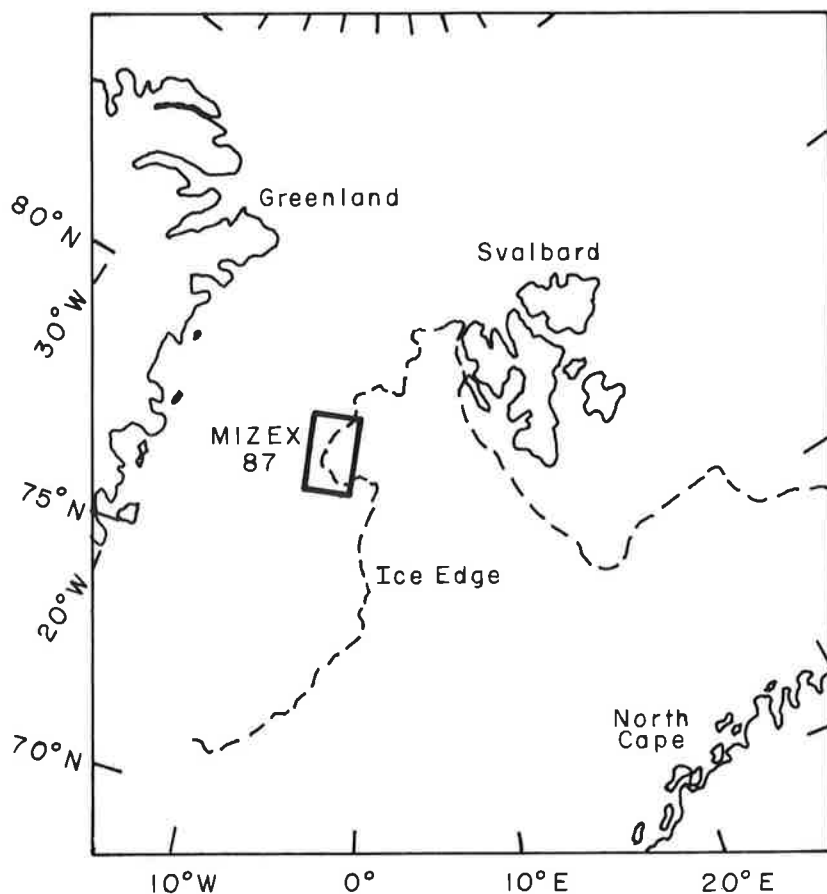
NSIDC is funded by the NASA Polar Oceans Program to develop a computer-based Cryospheric Data Management System (CDMS). The CDMS design aims to provide a single focal point for snow and ice data sets, improved access to a subset of the currently produced digital data sets (e.g., SMMR), and software tools to aid data analysis. The CDMS is an enhanced version of the Jet Propulsion Laboratory's NASA Ocean Data System (NODS) designed for the archival of Special Sensor Microwave Imager (SSM/I) data and production of cryospheric data sets, and it will be a node on the network of NODS centers.

In June 1987 the Defense Meteorological Satellite Program (DMSP) successfully launched the SSM/I, a high-resolution microwave imager that will provide near-real-time microwave data on sea ice, atmospheric moisture and precipitation, soil moisture and ocean parameters. The instrument operates at four frequencies: 19.3, 22.2, 37.0 and 85.5 GHz. Vertical and horizontal polarizations are provided for each frequency, except the 22.2-GHz channel, which has only vertical polarization. The satellite orbital characteristics permit daily global coverage with repeat coverage possible every 12 hours due to the orbital overlap. NSIDC expects to begin receiving the SSM/I orbital Sensor Data Records (SDRs) about April 1988.

NSIDC will receive SSM/I data from the Fleet Numerical Oceanography Center through the Satellite Data Services Division (SDSD) of the National Environmental Satellite, Data, and Information Service. Data will be received from SDSD via magnetic tape and then archived into the CDMS.

The SSM/I orbital brightness temperatures will be reformatted into a rapid-access archive and stored on optical disk. Daily brightness temperature grids will be produced for both the northern and southern hemispheres. Three-day ice concentration grids will be calculated from the brightness temperature grids using the Nimbus Team Algorithm as specified by the NASA Sea Ice Algorithm Working Group. Six-day metafile images binned at 100-km resolution will be available for each of the archived grids, providing a mechanism for perusal of the SSM/I inventory.

The inaugural issue of a new data center publication was published in August 1987.



*Location of the MIZEX-87 field experiment during March and April 1987. An ice edge analysis for March 24, 1987, is indicated by the dashed line.*

during the 1983 and 1984 field experiments in the Fram Strait between Greenland and Svalbard are archived at NSIDC. Additional data from the winter 1987 field experiment in the same general area have also begun to arrive.

The data management plan for MIZEX established by NSIDC not only provides for long-term data archiving and storage but also maintains a centralized access point for the data as soon as they become available. The plan is an example of the effort to address the task of data management at an early stage in a large, multi-year research project. Additional management responsibilities include the establishment of standards for the flow of data among principal investigators and other data centers. Data services are initially restricted to the project personnel, some 200 in all 11 participating nations, but two years after collection, data become unrestricted and available to the scientific community at large. The collection currently contains 225 individual data sets ranging from listings of raw data to technical reports, with many of the larger data sets available on magnetic tape. A regularly updated computer listing of the complete data catalog is available through an electronic mail system. Funding for this work is provided by the Office of Naval Research.

### SSM/I instrument characteristics.

Frequency (GHz)	19.35	22.235	37.0	85.5
Polarization	V,H	V	V,H	V,H
Wavelength (cm)	1.55	1.35	0.81	0.35
Footprint (km)	70×45	60×40	38×30	16×14
Temperature accuracy (K)	1.5	1.5	1.5	1.5
Bandwidth (MHz)	500	500	2000	3000

*CDMS Notes* is a newsletter reporting information to the research community about current events at NSIDC. The focus of *CDMS Notes* will be the Cryospheric Data Management System, new acquisitions of snow and ice data products, and the status of applications using NSIDC products.

## Related Research Projects

### University Research Initiative

The objective of this program, funded by the Office of Naval Research, is to improve the understanding and prediction of ice-atmosphere interactions in the Arctic on synoptic to interannual time scales through

- Studies of the mechanisms of changes in sea ice extent, concentration, thickness and distribution.
- Determination of the space-time characteristics of snow cover melt, leads and polynyas, and ice thickness distribution.
- Analysis of Arctic cloud regimes and synoptic activity and their interactions with the ocean and ice surfaces.

Ice conditions are being determined from analysis of satellite imagery and passive microwave data and submarine under-ice sonar measurements. Work during the first year (FY87) has concentrated on three projects: interannual variations in ice motion of the Beaufort Gyre in the Canada Basin; climatology of Arctic cyclones and anticyclones; and analysis of lead response to changing synoptic conditions. The results from these analyses will be used as model input and validation data by collaborators at Dartmouth College and by scientists at NORDA seeking to improve prediction capabilities for Arctic sea ice.

The highlight of Year 1 has been the identification from the ice velocity data provided by the Arctic drifting buoys (1979–1985) of a recurring reversal of ice motion in late sum-

mer in the Canada Basin. This previously unrecognized phenomenon occurs in response to changes in atmospheric forcing as the mean anticyclone, which persists over the area from October through early summer, is replaced by quasi-stationary cyclones. This finding is reported in *Geophysical Research Letters*.

### Arctic Cloud Project

Research, supported by the NASA Climate Program, is underway to determine the spectral and spatial characteristics of polar clouds and underlying surfaces. The multispectral signatures of the various types of cloud and cloud-surface mixtures are categorized using cluster diagrams, spatial coherence plots and “whisker” plots to detect situations that are likely to be inseparable using standard spectral classification schemes. This information is being used to evaluate the potential performance of existing cloud algorithms, including clustering routines, split window techniques, and the operational International Satellite Cloud Climatology Program (ISCCP) algorithm. Methods of improving the performance of cloud mapping routines are being investigated. These methods include

- Use of passive microwave data to provide surface information such as extent of snow cover and the presence and concentration of sea ice.
- Incorporation of textural data.
- Applicability of the AVHRR 3.7- $\mu\text{m}$  channel for snow-cloud discrimination.
- Integration of spatial coherence, dynamic threshold, and multilayer cloud detection methods with the ISCCP algorithm.
- Use of nontraditional clustering methods to describe more realistically the multispectral properties of clouds and surfaces.

The results of this study will be combined with radiative transfer modeling to develop a hybrid “physical-statistical” classifier based on the physical and statistical properties of polar clouds and surfaces.

### Plans for the Future

National and international concerns over global change and associated program plans recognize the importance of polar regions and cryospheric phenomena. Existing and new research programs identify the need to determine changes in sea ice, snow cover, ice sheets and permafrost as well as to extract paleocli-

matic data from ice cores. The WDC, as part of a NOAA paleoclimate initiative, plans to expand its management role for ice core data. If funding becomes available, the Cryospheric Data Management System will be expanded to incorporate snow cover products from the SSM/I data. In the near term, the development of homogeneous, continuous passive microwave data sets from ESMR (1973-1976), SMMR (1978-1986) and the current SSM/I series will be of high priority.

## ***Publications***

Readers may obtain further information on some of the research described in this article from the following publications:

*The cryosphere and climate change*, by R.G. Barry: Detection of CO<sub>2</sub>-Induced Climatic Change, Chapter 6, p. 109-148, U.S. Department of Energy, DOE/ER-0235, 1986.

*The sea ice data base*, by R.G. Barry: The Geophysics of Sea Ice (N. Untersteiner, Ed.), Plenum Press, New York, p. 1099-1134, 1986.

*Snow cover data management: The role of WDC-A for Glaciology*, by R.G. Barry and R.L. Armstrong: Hydrological Sciences Journal, vol. 32, p. 281-295, 1987.

*Guide to international data exchange through the world data centers*, by International Council of Scientific Unions, Panel on World Data Centers, fourth edition, 113 p., 1978.

*The Marginal Ice Zone Experiment (MIZEX-*

87), by D.E. Johnson and J.D. Hawkins: European Science Notes, vol. 41, no. 10, p. 567-570, 1987.

*Analysis of under-ice topography in the Arctic Basin as recorded by the USS Nautilus, August 1958*, by A.S. McLaren: Arctic, vol. 41, no. 2, 1988.

*Seasonal variations of sea ice motion in the Canada Basin and their implications*, by A.S. McLaren, M.C. Serreze and R.G. Barry: Geophysical Research Letters, vol. 14, p. 1123-1126, 1987.

*Analysis of interannual variations of snow-melt on Arctic sea ice mapped from meteorological satellite imagery*, by D.A. Robinson, G.R. Scharfen and R.G. Barry: Large-Scale Effects of Seasonal Snow Cover (B.E. Goodison, R.G. Barry and J. Dozier, Ed.), IAHS Publication no. 166, Wallingford, U.K., p. 315-327, 1987.

*A comparison of simulated and observed fluctuations in summertime Arctic surface albedo*, by B. Ross and J.E. Walsh: Journal of Geophysical Research, vol. 92, no. C12, p. 13115-13125, 1987.

*Large-scale patterns of snow melt on Arctic sea ice mapped from meteorological satellite imagery*, by G.R. Scharfen, R.G. Barry, D.A. Robinson, G. Kukla and M.C. Serreze: Annals of Glaciology, vol. 9, p. 200-205, 1987.

*Passive microwave data for snow and ice research: Planned products from the DMSP SSM/I system*, by R. Weaver, C. Morris and R.G. Barry: EOS, vol. 68, no. 39, p. 769, 776-777, 1987.

# Arctic Air Chemistry

RUSSELL C. SCHNELL

"Seen through the window of the imagination, the Arctic is one of the last pristine areas on Earth. Remote and mysterious, it is a realm of ice and midnight sun, of polar bears and untraced tundra. It seems as far from the dross of civilization as we can go without leaving the planet," writes John Carey. Reality is somewhat different.

Beginning in the early 1970s, scientists such as Glen Shaw of the University of Alaska and Ken Rahn of the University of Rhode Island noted that at Barrow, Alaska, the view over the ice was obscured by haze in winter and spring. "The sky was a whitish color, not a deep blue. I was able to deduce that the atmosphere was filled with very tiny particles of a size that could represent air pollution," says Shaw. He was puzzled and excited by his discovery. But when he spread the word, he got another surprise. Nobody believed him. "I got two responses," he says. "One was that I had made a mistake. The other was that I had observed ice crystals in the air. I knew that neither answer was right."

These observations, though unique, were not the first to report a mysterious pall over the Arctic. Back in 1956, a young Air Force meteorologist named J. Murray Mitchell had written a paper about what was even then being called Arctic haze. "What really impressed me was how thick the darned stuff was," Mitchell remembers.

In subsequent years, Rahn and Shaw showed, through chemical analysis of the Arctic haze aerosol, that it consisted mainly of anthropogenic air pollution. But from where?

Through a study of elemental composition of various Arctic air samples, Rahn developed a distinctive "fingerprint" for air of different geographical origins. Armed with these signatures, Rahn and Douglas Lowenthal of the University of Rhode Island analyzed the haze at Barrow. Their conclusion: most of the pollution comes from the central Soviet Union and Europe. Contributions from North America—even though oil fields and industry in Alaska do cause local pollution problems—are negligible.

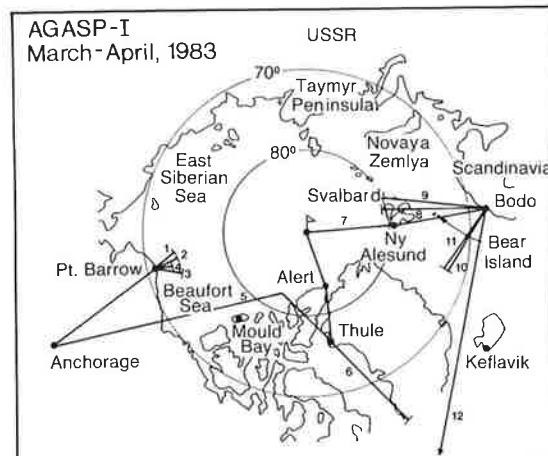
The results do not mean that the Old World is inherently dirtier than the New World. Instead, they reflect global circulation patterns. Most of the pollution from North

America is rained out over the Atlantic. In contrast, emissions from Europe and the Soviet Union are pulled north by weather systems, especially by those that predominate in winter. Since winter also means higher emissions from European and Asian power plants, Arctic haze is thickest during winter and spring.

Just how murky is the pall over the Arctic? "It's unbelievable!" says atmospheric scientist Francisco Valero of NASA's Ames Laboratory. "I expected the Arctic to be clean and beautiful. But no! It looks dirtier than New York City."

In the spring of 1983, six research aircraft—one from Norway, two from the Federal Republic of Germany and three from the United States—studied Arctic haze in a concentrated international effort coordinated with established fixed-base ground measurement programs. One major portion of the United States contribution to the study, the Arctic Gas and Aerosol Sampling Program (AGASP-I), used a long-range National Oceanic and Atmospheric Administration (NOAA) WP-3D Orion research aircraft to study haze during flights spanning the Arctic from Alaska to Norway. Scientists from five countries representing 17 research institutions conducted 35 experiments on the AGASP flights.

The flights were coordinated with ground-based measurements at baseline stations at Barrow, Alaska; Alert, Canada; and Ny Alesund, Svalbard. The results of the AGASP-I program have been published in special issues



Approximate flight tracks of the NOAA WP-3D during the AGASP-I project.

*All comments in quotation marks in this report are from John Carey's article in International Wildlife, vol. 18, p. 26-28, 1988.*

*Russell C. Schnell is Director of AGASP and is located at the Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, Colorado 80309.*



Field crew of the NOAA  
WP-3D on AGASP-II.

of *Geophysical Research Letters*, vol. 11, 1984; and *Atmospheric Environment*, vol. 19, 1985; and in a book, *Arctic Air Pollution*, Cambridge University Press, 1986.

The research reported in these publications confirms that the Arctic troposphere contains high concentrations of anthropogenic gases and aerosols mainly of Eurasian and Soviet origins. They further show that these enhanced concentrations are advected across the Arctic in distinct layers, on time scales of 10 days or less, and that the haze layers have an appreciable impact on the flux of solar radiation reaching the ground in the high Arctic.

Building on the successes of AGASP-I, a second study, AGASP-II, was conducted in March–April 1986 with extensive ground measurements at the Alert and Barrow baseline stations and Arctic-wide aircraft measurements. In one phase of the program, two U.S. and one Canadian research aircraft overlapped flights above the Alert baseline station in a coordinated effort to provide a multisensor, multidimensional view of Arctic haze. The NOAA WP-3D used in AGASP-II was staffed with an international group of scientists.

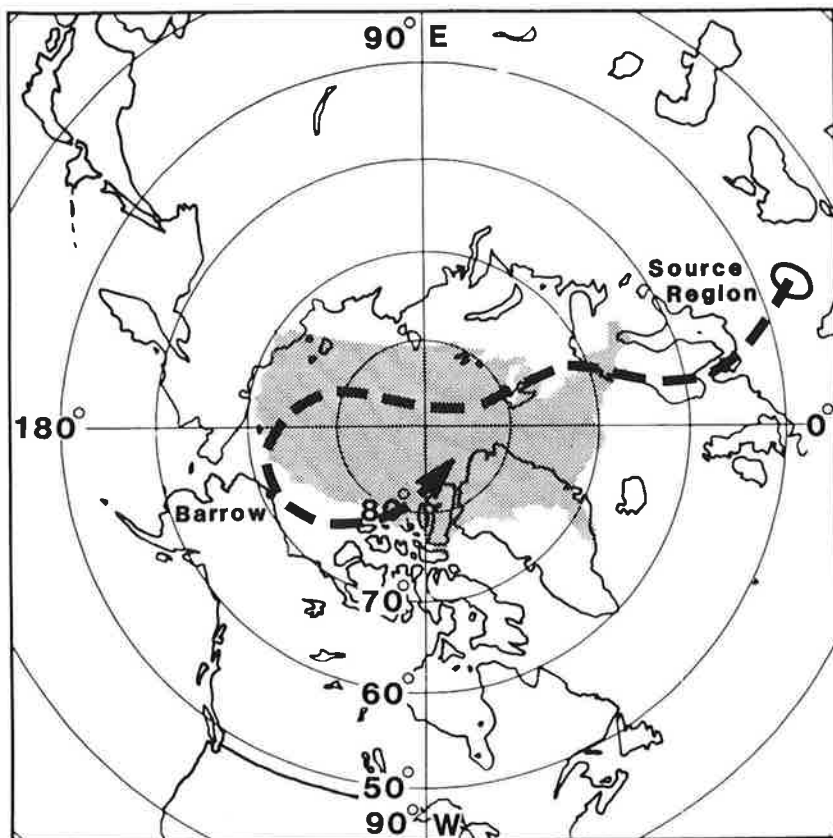
A scientific highlight of the AGASP-II program was the tracking of a haze event that originated in south-central Europe and flowed north across the Scandinavian surface air pol-

lution network. Once in the Arctic the haze traveled over the ice north of the Soviet Union, curved around to pass north of Barrow, and flowed in an easterly direction towards the northern regions of the Canadian Arctic.

After traveling this 10,000-km distance, the haze still had  $\text{SO}_2$ , aerosol black carbon,  $b_{\text{sp}}$ , anthropogenic trace gas, and CN concentrations equal to or in excess of those measured with the same aircraft in air pollution episodes sampled off the east coast of the United States in January of the same year. This suggests that both diffusion and haze removal by precipitation are severely limited in the cold, stable Arctic atmosphere, thus allowing for exceptional long-range transport of anthropogenic pollutants into and across the Arctic Basin.

According to Valero this haze was producing a heating rate of up to  $0.2^\circ\text{C}$  per day in the layer. This heat would of course be distributed throughout the Arctic troposphere with as yet unknown effects or detectability at the surface. In addition, the dark haze particles that fall on snow and ice absorb the sun's heat, possibly increasing the rate of melting in the summer, also with unknown consequences.

A third AGASP field program will be undertaken in March–April 1989 focusing on the finer aspects of the Arctic radiation budget



Track of a major haze flow (April 1986), indicated by the broken line. This haze traveled about 10,000 km. Overlay of the United States on the Arctic is shown for scale.

and how it is affected by anthropogenic gases and aerosols. In addition, an aerosol lidar and cloud physics instruments will be used to determine the role of ice crystals in visibility reduction associated with the haze. Results from AGASP-II suggest that clear air ice crystals are playing a significant role in both visibility reduction and radiative balance over the Arctic ice cap.

The Fourth International Symposium on Arctic Air Chemistry was held in Hurdal, Norway, September 29 through October 2, 1987. It was hosted by the Norwegian Institute for Air Research (NILU), Lillestrom, Norway, and organized by Dr. B. Ottar, Director, NILU, and Professor K. Rahn, Uni-

versity of Rhode Island. Seventy-five scientists from eleven countries participated. The Symposium was divided into seven sessions consisting of 42 invited or submitted papers. The field research papers discussed recent measurements of Arctic aerosols and gases (both surface and airborne), the transport and deposition of anthropogenic pollutants in the Arctic, and the origins of these pollutants. Papers addressing trajectory and transport models, possible climatic effects of Arctic haze and plans for future programs rounded out the meeting. Accepted papers from the Symposium will appear in a special issue of *Atmospheric Environment* in late 1988.

In summary, what are some recent results of Arctic haze research?

- Arctic haze is also present on occasion in high concentrations in summer above the Arctic stratus clouds.
- Ozone is being destroyed in the Arctic troposphere in spring beneath the temperature inversion through photolytic reactions with bromine gases.
- Carbon dioxide, methane and soot carbon in the haze are highly correlated, suggesting a common combustion source for all three haze components.
- Long-range transport of Arctic air pollution has been documented over an 8,000- to 10,000-km path from its source in southeastern Europe across Scandinavia and the ice cap to Alaska and beyond.
- Precipitation in the Arctic (infrequent during the cold months) is an excellent means of transferring pollutants to the Arctic surface ice. Exotic pesticides are now being detected in Arctic mammals.
- Trajectory and transport models in the Arctic are generally in excellent agreement with measurements over long distances, due in part to the stable, nonconvective nature of air flow over the Arctic ice cap.

# Access to Arctic Research Areas in North America

CHARLES E. MYERS

The conduct of research in Arctic areas requires permission that goes beyond the funding agency. Legal and administrative requirements must be observed by researchers who wish to conduct field research in the Arctic. National policies differ from country to country and within national jurisdictions. The following is a discussion of the procedures required for U.S. researchers to gain access to research sites in the North American Arctic.

## Alaska



The State of Alaska provides a one-stop service office, the Permit Information Center, for information on all Federal, State and local requirements for conducting research in Alaska. The office requests that applicants complete a master application form before planning field research in Alaska. From the information provided on the form, the Permit Information Center will suggest how the applicant is to comply with any other requirements. For information, researchers should write or call: Permit Information Center, Department of Environmental Conservation, Southeast Regional Office, State of Alaska, P.O. Box 32420, Juneau, Alaska 99803; Telephone (907) 465-2615.

The Federal government manages about two-thirds of the land area of Alaska. The majority of the Federal lands in Alaska are managed by either the U.S. Forest Service (Department of Agriculture); the Bureau of Land Management, National Park Service, or U.S. Fish and Wildlife Service (Department of the Interior); or the U.S. Army or U.S. Air Force (Department of Defense).

The public lands are Federal lands managed by the Bureau of Land Management (BLM). Before research or study is initiated on these public lands, a casual-use or temporary-use permit is required. To apply for a permit, send a letter to the BLM District Manager for the area in which you plan to work. The two BLM districts covering northern Alaska are the Arctic and the Kobuk. The offices for both of these districts are located in Fairbanks. The Anchorage office administers the southwestern areas of the state, including the

Aleutian Islands. Investigators wishing to do excavation for paleontological or cultural resource studies must obtain a permit through the Chief of Resources at the BLM Alaska State Office located in the Federal Building in Anchorage.

When you apply for a permit, the request is reviewed by BLM staff responsible for each of the resources that could be impacted by the work. For instance, an application to do vegetation studies might also be reviewed by a BLM ornithologist to be sure that there would be no disturbance to rare or endangered birds and by an archeologist to assure that no cultural resources are likely to be disturbed.

The various units of the National Wildlife Refuge System are Federal lands managed by the U.S. Fish and Wildlife Service. Researchers desiring to work on these lands should contact the Anchorage Regional Office, Division of Refuges, for information about special-use permits.

The individual components of the National Park System in Alaska are Federal lands managed by the National Park Service. Information about obtaining permits for conducting research in units of the National Park System is provided by the State Permit Information Center. In general, contact the superintendent of any unit of the National Park System within which you plan to do research (well in advance of the proposed field dates) regarding permits, special conditions that must be observed, and reporting requirements. In addition, specific park permission will be needed for collecting, ground disturbance, archeological research and paleontological research. The superintendent will verify that the prospective researcher holds or has applied for any specific permits that may be needed from other Federal or State entities for threatened or endangered species, marine mammals, migratory animals or other special-case resources. Any application to a park superintendent for a permit to conduct research must include a copy of the research proposal together with copies of any other relevant permits the researcher may already hold. Park personnel will review each application and the attached proposal and permits to determine appropriateness, possible impacts to park resources,

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and possible impacts to park visitors and other users. They will also determine the possible need for coordination of the proposed research with other research projects that may be ongoing or proposed for the same area or discipline. The Park Service encourages research that contributes directly to management information needs identified in park resource management plans.

Researchers should be aware of the land ownership status of any area they plan to enter. For lands controlled by local governments or Native corporations in Alaska, prior coordination of research plans with local government or corporate officials is advisable and may be necessary.

## Canada



The Government of Canada has issued guidelines for scientific activities in northern Canada. These guidelines were developed by the concerned Canadian Federal agencies represented in the Canadian Advisory Committee on Northern Development.

The guidelines encourage the participation of the Native people of the North in scientific research activities. For research that affects the Native people, there should be prior consultation leading to informed consent of the people involved. Research involving the Native people should include Native participation in the research itself and feedback of results to the concerned Native communities.

The guidelines also encourage full reporting of the results of scientific research in the open literature, and the participation of Canadian scientists in any significant scientific investigation in the Canadian North.

The Canadian Department of Indian and Northern Affairs has issued the following statement concerning planning of scientific expeditions in northern Canada:

“Concerned federal departments and agencies, and the Government of the Northwest Territories will offer all possible assistance to you in planning your expedition. To this end, your first contact should be in writing to those government Departments and agencies having an interest in the expedition. Your letter should include the following information (or as much of it as may be known at the time of writing):

- Date of arrival in Canada
- Port of entry and mode of transport
- Purpose of expedition/travel
- Proposed itinerary

- Mode of transport during expedition
- List of stores and equipment
- Sponsor's name
- Short biographical profile of each participant including nationality and previous experience

Departments advised will reply as may be necessary. This will enable you to take any necessary corrective action to ensure that your project goes forward with the fewest possible delays or problems.”

The Polar Continental Shelf Project Office (PCSP) of the Canadian Department of Energy, Mines, and Resources, located at 344 Wellington Street, Ottawa, Ontario K1A 0E4, Canada, serves as a central coordinating organization for logistics support in the Canadian high-latitude areas and provides information on research requirements. In the Continental Shelf area of northern Canada and in the adjacent ocean and islands, the PCSP provides facilities and support services to assist bona fide scientific research organizations. On Canadian ice islands the PCSP coordinates both science and logistics. The PCSP requests that researchers contemplating scientific research in northern Canada complete an information form by mid-November of the year before the research is to be conducted. The PCSP will notify individuals about the support to be provided by mid-February of the year in which the project is to be conducted.

For research in the Northwest Territories, scientists should apply to the Science Institute of the Northwest Territories, Yellowknife, N.W.T., Canada, for an explorer's license. This advises the N.W.T. of your presence. If a firearm is to be carried, a Firearms Acquisition Certificate (FAC) must be acquired from G Division, Royal Canadian Mounted Police, Yellowknife, N.W.T. If samples (rock, fossils, artifacts, etc.) are to be removed from Canada for examination and study, a permit for export must be obtained. This is obtained from the Secretary of State, Ottawa, Ontario. It is advisable to have this permit in hand before trying to remove the samples.

For research in the Yukon or Northwest Territories, researchers may need to obtain land-use permits. Researchers should contact the Regional Manager of Lands, Yukon Region, Indian and Northern Affairs Canada, 200 Range Road, Whitehorse, Yukon Territory, Canada Y2A 3V1, or the Regional Manager of Lands, Indian and Northern Affairs Canada, Yellowknife, Northwest Territories, Canada X1A 2R3.

## Greenland



Greenland is a self-governing part of the Kingdom of Denmark. Scientists wishing to enter Greenland do so on the same conditions as for entry into Denmark. Most non-Danish citizens must obtain a special permit if they want to stay in Greenland for more than three months.

The Danish Commission for Scientific Research in Greenland has developed a special process for review and approval of scientific research projects in Greenland. The following is a description of the procedures required for U.S. citizens, regardless of the source of funding. Researchers from other countries follow similar procedures.

The leaders of all scientific research projects must make application to the Danish authorities to conduct research in Greenland. For U.S. researchers, the application is made on a special application form, the Project Proposal/Data Sheet for U.S. Scientific Research in Greenland. The form is available from U.S. funding agencies or from the U.S. Department of State, Office of Polar Affairs, Room 5801, 22nd and C Streets, N.W., Washington, D.C. 20520. The Project Proposal/Data Sheets must be submitted to funding agencies or the Department of State no later than December 1 of the year before the research is to be conducted in Greenland. After review by funding agencies and the U.S. Department of State, the Project Proposal/Data Sheets for U.S. Scientific Research in Greenland are forwarded to the Danish Foreign Ministry and, via the Ministry, to the Danish Commission for Scientific Research in Greenland and to appropriate Danish government agencies.

Each April the Danish Commission for Scientific Research in Greenland meets in formal session in Copenhagen for the annual presentation of U.S. scientific research proposals in Greenland. At this meeting, representatives of U.S. funding agencies, and in some cases prospective or funded principal investigators, present detailed information on new or continuing projects. The Danish authorities discuss logistic and operational questions with the U.S. representatives. After the meeting the Danish authorities consider all the information that has been presented concerning the individual projects and approve or disapprove the proposed project. In many instances, the approvals are subject to special conditions specific to the individual project.

Other approvals may be necessary for researchers conducting work in Greenland. For

example, special regulations are in force in connection with the use of radio, firearms and aircraft, as well as with the collection of scientific samples. These special regulations involve the collection of geological samples, meteorites, archeological findings, rare plants, birds (including eggs), mammals, reindeer antlers and human biological samples. Archeological, ethnological and similar cultural historical research, as well as social scientific research, are the sole responsibility of the National Museum of Greenland and the University of Greenland. Normally only Greenlandic and Danish researchers carry out research of this kind, but foreign research may also be approved provided that such research is taking place in integrated cooperation with the Greenlandic research institutions. These institutions have, however, very limited resources and are therefore only able to cooperate with foreign scientists to a limited extent.

Some areas of Greenland are subject to special travel regulations. For example, entry to the Danish-American defense areas (Thule Air Base and Sondrestrom Air Base) requires special clearance. Entry to Danish military areas requires a special permit from the Danish military authorities. Entry to the world's largest national park, in northern and eastern Greenland, also requires a special permit from the Home Rule authorities; the permit is arranged, however, by the Commission for Scientific Research in Greenland.

This discussion has touched on only the major requirements for gaining access to research areas in Greenland. For complete, up-to-date information, researchers should contact their funding agencies, the U.S. Department of State (address above) or the Commission for Scientific Research in Greenland, 10 Oster Volgade, DK-1350 Copenhagen K., Denmark (Telephone 45.1.11 36 66). The Commission has published a leaflet, *Guidelines on Greenland Expeditions*, that can be obtained at the above address. It contains more detailed information on obligations such as the requirements for early submission of a preliminary field report and scientific publications. Also, a newsletter on Greenland research is available from the Commission at the same address.

## Conclusion

This brief summary of procedures to gain access to Arctic research areas is intended to guide the prospective Arctic researcher to

sources for further information. Researchers are encouraged to consult with funding agencies for other specific requirements and to be aware of the long lead times that may be required to gain access to Arctic areas. Furthermore, investigators in the U.S. Arctic are encouraged to consult with and involve residents in their research.

### *Publications*

Readers may obtain further information on some of the procedures described in this article from the following publications:

*General Procedures on Processing the Master*

*Application*, by Alaska Permit Information Center, Alaska Department of Environmental Conservation, Juneau, Alaska, 1988.

*Newsletter*, by The Commission for Scientific Research in Greenland, No. 16, December 1987.

*Guidelines on Greenland Expeditions*, by The Commission for Scientific Research in Greenland, February 1984.

*Guide for Expeditions to the Canadian Arctic Islands*, by Department of Indian and Northern Affairs, Ottawa, Canada, 1984.

*Guidelines for Scientific Activities in Northern Canada*, by Department of Indian and Northern Affairs, Ottawa, Canada.

### *International Cooperation in Arctic Science*

*U.S. participants in the meeting were: Robert W. Corell, Assistant Director for Geosciences, NSF; Juan G. Roederer, Chairman, U.S. Arctic Research Commission; Jerry Brown, Head, Arctic Staff, NSF; James Zumberge, President, University of California and former Chairman, Arctic Research Commission; and W. Timothy Hushen, former Executive Director, U.S. Arctic Research Commission and Staff Director, Polar Research Board, U.S. National Research Council.*

The Royal Swedish Academy of Sciences hosted a three-day meeting in Stockholm, March 24–26, 1988, to explore mechanisms for international cooperation for Arctic science. Twenty-nine scientists and science administrators from eight Arctic nations attended (Canada, Denmark/Greenland, Finland, Iceland, Norway, Sweden, the Soviet Union and the United States). It was agreed that an International Arctic Science Committee should be established to promote international cooperation and coordination of scientific research in the Arctic for the benefit of the peoples of the region and for the advancement of world scientific knowledge. The meeting was chaired by Professor Bert Bolin, of the University of Stockholm, and the following is adapted from a report of the meeting.

The proposed committee is intended to meet the increasing need for scientific knowledge from Arctic regions that is required for the wise development and management of those regions, as well as to ensure that Arctic research contributes fully to world science for the benefit of all mankind. It would serve as a body for international discussion and communication on science matters of international interest having to do with Arctic lands, seas, atmosphere and space, and as such would be a focal point for cooperation and interaction among Arctic scientists. The committee's scope would include both basic and applied research in all fields where international cooperation and coordination is desirable or necessary, including the natural and human sciences.

The committee would seek to determine priorities for Arctic research, increase the efficiency and effectiveness with which scientific resources and facilities are used, improve the

cooperation and exchange between scientists, and foster the linkage between different fields of study in the Arctic.

A working group was formed to prepare a proposal on how to organize the IASC. It was agreed that a secretariat should be formed and located in one of the Nordic countries. An invitation from the participants of the U.S.S.R. to hold a conference on Arctic Science Cooperation in the Soviet Union at the end of 1988 was gratefully received.

In addition to a list of specific projects, four research themes were identified for possible collaboration:

- Deglaciation and the development of the Arctic terrestrial ecosystems during the Holocene, and the role of the Arctic in the carbon cycle with regard to both carbon dioxide and methane.
- Atmospheric pollution in the Arctic region.
- The circulation of the Arctic Sea, its ecosystem and its role for the heat budget of the northern hemisphere.
- Man and his environment in the Arctic region.

It was emphasized that important bilateral and multinational research projects are being pursued in the Arctic. Such research will be continued by concerned parties, and in a longer time perspective it will be important to find the best means for interactions between different projects.

The workshop report is available from the Royal Swedish Academy of Sciences, Polar Research Committee, P.O. Box 50005, S-10405, Stockholm, Sweden. It is being distributed to international organizations having interests in Arctic research.

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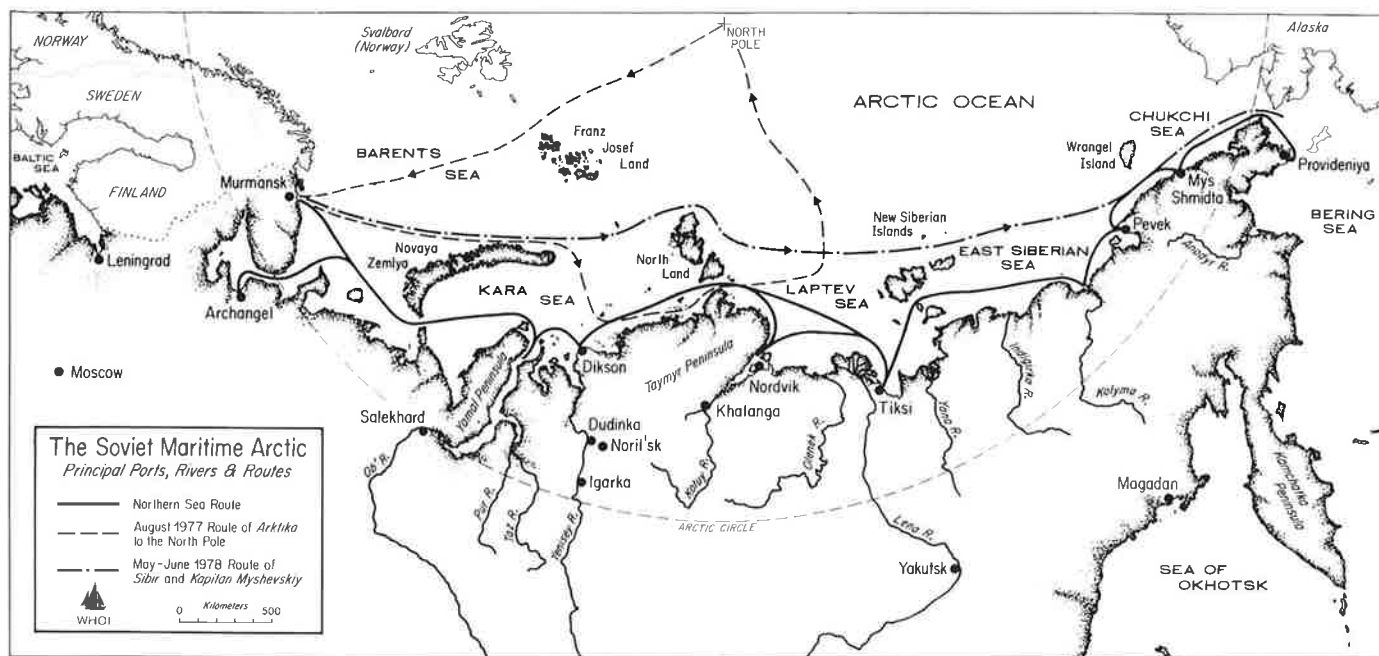
*Prepared by Lawson Brigham, Commander, U.S. Coast Guard. He was Guest Investigator at the Marine Policy Center, Woods Hole Oceanographic Institution in 1986–1987, during which time he organized the workshop. He is an authority on Soviet icebreakers, shipping and maritime affairs.*

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### *Workshop on the Soviet Maritime Arctic*

The Marine Policy Center of the Woods Hole Oceanographic Institution has initiated studies that focus on Soviet policies affecting the use of its extensive Arctic maritime region. A first step was taken on May 10–13, 1987, with the hosting of an international workshop at Woods Hole, Massachusetts. A grant from

the John D. and Catherine T. MacArthur Foundation of Chicago, Illinois, allowed the participation of recognized Soviet Arctic scholars from Canada, Great Britain, Norway and the United States. A book resulting from this workshop will present a unique and comprehensive review of the Soviet Union's rela-



tionship to the Arctic Ocean. Future workshops and meetings on this topic will hopefully involve the participation of Soviet scholars and policymakers.

The Workshop on the Soviet Maritime Arctic was divided into six sessions addressing a spectrum of interests—historical, cultural, legal, strategic, geopolitical, transportation, scientific, technological and resource development. Extensive group discussions were held following each session. A final summary session addressed the future of the maritime Arctic in terms of its importance to the Soviet Union. Major findings of the workshop include the following.

### History

Russian involvement in the Arctic Ocean spans more than 500 years. The Northern Sea Route across the top of Eurasia was in commercial use by 1600, and much of that coast had been explored and charted with surprising accuracy by 1743. Nothing in the North American Arctic compares to this legacy. (William Barr, University of Saskatchewan, Canada.)

### Arctic Identity

A hypothesis suggests that Soviet nationalism may be the primary driving force for the Soviet Union's record of success in the Arctic. The proposition is that this success is founded not so much on the perceived economic and security needs of the Soviet state, as on the positive cultural attachments to the Arctic of the Soviet people. (Franklyn Griffiths, University of Toronto, Canada.)

### Law of the Sea

Soviet legislative enactments indicate that the balance of political, economic, legal, strategic and other interests embodied in the Law of the Sea Convention is largely acceptable to the Soviet Union. This has important implications for the Arctic Ocean. Evidence shows that some of the more extreme doctrinal characteristics of the legal status of the seas north of the Soviet coast do not enjoy support in law or in state practice. In particular, those characterizations of sector lines as state boundaries (lines extending from the Soviet northern coast directly to the North Pole) are today without any support whatever, and so too are many of the historic seas (or bays) doctrines that date from periods of U.S.S.R. maritime weakness. Recent Soviet legislation on the creation of joint enterprises with capitalist and Third World countries opens up new opportunities for joint resource exploitation in the Arctic, which a number of Western nations may wish to pursue. (William Butler, University of London, United Kingdom.)

### Contrasting Arctic and Antarctic Policies

The Soviet Union has multiple polar interests in both the Arctic and the Antarctic. In Antarctica the Soviet Union does not recognize the validity of other states' claims. Soviet policy on scientific activities in the Arctic Ocean is governed by a restrictive consent system within the Exclusive Economic Zone, in part motivated by security considerations. However, in the Antarctic the Soviets ada-

manly favor absolute freedom and complete access, in support of the Antarctic Treaty. The Soviet government in recent years has tightened oversight of its national rights through the Northeast Passage, imposing restrictions on foreign shipping. Again, in contrast, in Antarctica the Soviet Union insists that all circumpolar waters are high seas with complete access to fishing and shipping opportunities. (Christopher Joyner, George Washington University, U.S.A.)

### *Strategic Concerns*

It is obvious that the Arctic Ocean is an important military theater for the Soviet Union. According to Soviet definitions, that theater contains not only the Central Arctic basin but also all adjacent Arctic seas. The Barents Sea serves both strategic and defense purposes in Soviet naval thought. However, the natural features of this sea, such as ice conditions, icebergs and restrictive depths, have profound influences on the operations of the Soviet Navy's Northern Fleet. (Charles Petersen, Center for Naval Analyses, U.S.A., and Willy Østreng, Nansen Institute, Norway.)

### *Arctic Marine Transportation*

The Soviet Union operates the world's largest fleet of polar ships, the majority of which are used along the Northern Sea Route. Technological advancement (including nuclear power for icebreaking ships), adaptation and technology transfer from the West have played leading roles in the development of this diverse fleet. Estimates from the Soviet press place the current levels of operation at approximately 600 freighting voyages carrying six million tons of cargo across the Soviet

maritime Arctic. Year-round navigation has been maintained in the Kara Sea for carrying Noril'sk nickel ore to Murmansk. The transport of gas industry freight, largely pipes, to Western Siberia and the Yamal Peninsula has also been an important use of the Northern Sea Route. (Terence Armstrong, Scott Polar Research Institute, United Kingdom, and Lawson Brigham, Woods Hole Oceanographic Institution, U.S.A.)

### *Siberia River Transportation*

Rivers, supplemented by winter roads, are usually the dominant transportation mode in pioneering areas of Siberia and the Soviet Far East. The next few years are likely to see an expansion at the overlap between river and sea transport in the Soviet Arctic. Cooperation will be preferable to competition, but easy cooperation between transportation ministries has not been characteristic of Soviet practice in the past. (Robert North, University of British Columbia, Canada.)

### *Soviet Arctic Offshore Oil and Gas*

The Soviet Arctic offshore area, including the Barents, Kara, Laptev and East Siberian seas, is the largest unexplored oil-and-gas region in the world. The first exploratory well on the Soviet Arctic continental shelf was drilled in 1982 in the Barents Sea, and Soviet plans call for extending exploration east and into the Kara Sea. Geological structures of the West Siberian onshore where major gas fields have been developed may play a key role in Soviet plans for potential oil and gas resources in the offshore Arctic. (James Clark, U.S. Geological Survey.)

### *Arctic Science and Engineering*

Soviet Arctic scientific and engineering efforts have been extensive. Technical innovations in Arctic shipping, ice forecasting and permafrost research are legendary. Contrary to generally held views, there is substantial published Russian material available about the Soviet Arctic. In particular, the basic scientific efforts have been extensively published for scrutiny by the world's scientific and academic community. (Andrew Assur, Cold Regions Research and Engineering Laboratory, U.S.A., and Gordon Watson, East-West Engineering Design Studies, Canada.)

### *International Arctic Cooperation*

It has been widely believed that the Soviet Union considers the Arctic too sensitive because of national security to be an appropri-

*Artist's conception of the Taymyr, a Soviet shallow-draft, nuclear polar ice-breaker under construction in Helsinki by the ship-builder Wartsila.*



ate focus for international cooperation. In fact, the U.S.S.R. belongs to conservation regimes involving fur seals and polar bears, the management regime for Svalbard archipelago (the 1920 Treaty of Spitzbergen), and an array of broader multilateral regimes (one being the International Whaling Convention of 1946) applicable to the Arctic. Recent events point to future Soviet cooperation, including joint scientific research and a comprehensive plan for protection of the northern environment. (Oran Young and Gail Osherenko, Center for Northern Studies, U.S.A.)

### *U.S.S.R.-Canada Arctic Exchanges*

Canada and the Soviet Union have pursued the promise of bilateral cooperation in Arctic sciences since the 1970s. During the period 1984-1987 12 Canadian and 12 Soviet delegations were exchanged. The delegations concentrated on four major themes: geoscience and Arctic petroleum, northern and Arctic environments, northern construction, and ethnology and education. A February 1987 protocol extends the range of program activities

and points to a new era of Canadian-Soviet relations in the Arctic. (Walter Slipchenko, Circumpolar Affairs Division, Canada.)

### *Conclusions*

The international workshop and ongoing studies have emphasized that Soviet concerns in the Arctic represent an amalgam of economic, environmental, resource, political, cultural and strategic interests. No one interest can be singled out as predominant to the exclusion of others. In particular, excluding the Barents Sea (where the Soviet Union operates the world's largest naval force), it is no longer clearly evident that security interests are as sensitive as in previous years. Continuing studies at the Marine Policy Center will focus on all current Soviet policies regarding the Arctic Ocean.

A Woods Hole Oceanographic Institution technical report (WHOI-88-5) entitled *The Soviet Maritime Arctic: Proceedings of a Workshop* is available from Ellen Gately, Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543.

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## *Recent Activities of the Arctic Ocean Sciences Board*

The Arctic Ocean Sciences Board (AOSB) was formed in May 1984 to promote ongoing and proposed national and international scientific activities in the Arctic Ocean and adjacent seas. Dr. Gotthilf Hempel, Director of the Alfred Wegener Institute for Polar and Marine Research (Bremerhaven, F.R.G.), is Chairman of the Board. The AOSB includes members from institutions and national organizations in Canada, Denmark, Federal Republic of Germany, Finland, Iceland, the Netherlands, Norway, Sweden, the United Kingdom and the United States. The principal activity of the AOSB has been to coordinate the Greenland Sea Project, a project designed to increase understanding of the large-scale, long-term interactions of the air, sea and ice in the Greenland Sea.

The seventh meeting of the AOSB was held in Santander, Spain, on October 1-2, 1987. United States scientific interests were represented by Dr. Robert W. Corell, Assistant Director for Geosciences, National Science Foundation; Dr. Vera Alexander, Director, Institute of Marine Sciences, University of Alaska; and Dr. John M. Edmond, Massachusetts Institute of Technology. Scientists

from each participating country reported on current Arctic activities. The status of and plans for the Greenland Sea Project (GSP) were reported in detail. The need for a well-focused remote sensing program for the GSP was emphasized in a presentation by Dr. Robert Thomas, NASA. The next AOSB project is to have an ecological focus. Growing interest in polynyas was identified and results of initial efforts in that area are reported below. Professor Hempel was requested to accept the Chairmanship of the Board for an additional year and he agreed. The next meeting of the Board will be held in the United States, tentatively in December 1988 in the Washington, D.C., area.

The Greenland Sea Project Committee met in early February 1988 in Copenhagen, Denmark. The purpose of the meeting was to make final plans for the summer 1988 field season in the Greenland Sea. In addition, future activities and satellite remote sensing programs were discussed.

A planning meeting for the International Arctic Polynya Project (IAPP) was held in Bremerhaven on February 24-26, 1988, hosted by the Alfred Wegener Institute for Polar

*Prepared by Lisa Lynch, Joint Oceanographic Institutions, Inc., Washington, D.C., based on contributions from Vera Alexander and John Edmond, minutes of the Seventh AOSB meeting, and the report Greenland Sea Project, published by National Academy Press in 1987.*

and Marine Research. There were 16 participants from 11 countries. Major scientific justification and objectives were identified, and preliminary operational plans were developed. The East Greenland Shelf polynya, the North Water polynya in Baffin Bay, and the St. Lawrence Island polynya in the Bering Sea were identified as study sites.

Major scientific objectives for the polynya project include determination of the physical and biological processes within polynyas and how these processes affect areas "downstream." Coordination of measurements from moored instruments, shipboard instruments, airborne instruments and satellites was discussed. Moored instruments identified as essential to the project included current meters capable of measuring temperature and con-

ductivity and bio-optical instruments capable of measuring food availability, ocean color and turbidity. Shipboard measurements include use of a CTD/rosette system for temperature and salinity fields, water sampling for nutrients and microplankton, benthic sampling using underwater camera systems, ROVs, trawls and grab samples. Studies of birds and mammal populations and ice algae abundance are also planned. Airborne systems for determining sea-surface temperatures and ocean color are considered vital to the project. Synthetic Aperture Radar (SAR) and Advanced Very High Resolution Radiometer (AVHRR) satellite measurements are also being considered. The AOSB will review the polynya plans in summer 1988, and a second workshop is planned for September 1988 in Alaska.

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## *MAB Workshop on the Northern Science Network*

*U.S. participants in the Workshop were Charles W. Slaughter, USDA Forest Service, Fairbanks; Frank Williamson, Director, Institute of Arctic Biology, University of Alaska, Fairbanks; Jerry Brown, Arctic Staff, NSF. Mel Dyer, UNESCO Headquarters, chaired the workshop, and Henrik Wallgren, Chairman, Finnish MAB Committee, University of Helsinki was the host.*

The UNESCO Man and the Biosphere (MAB) Program established the Northern Science Network (NSN) in 1982. The objectives of the international network are to enhance scientific understanding of the North and to facilitate improved communication and understanding among scientists, public and private policymakers, resource managers, and resident populations. The North was pragmatically defined as the circumpolar Arctic, adjacent coastal areas, and the taiga and northern boreal forest.

Three initial themes selected for NSN focus were

- Studies on the ecology and use of Subarctic birch forests.
- Development, monitoring and research in Biosphere Reserves and other protected areas.
- Land use of grazing animals: socio-economic, biological and environmental effects.

The MAB Northern Science Network met most recently from March 22-24, 1988, in Helsinki, Finland, to evaluate progress and consider new directions. Member states present (Canada, Denmark/Greenland, Finland, Norway, Sweden, U.S.A.) adopted a number of measures intended to improve the effectiveness of the NSN. The intention to facilitate and encourage international cooperation in circumpolar terms and to communicate and promote research and information transfer regarding northern MAB concerns (including stewardship of resources, research for and in-

volvement of indigenous knowledge and expertise of northern peoples, and development of cooperative circumpolar conservation strategies) remain central to the MAB Northern Science Network.

The NSN adopted four primary thrusts for the 1988-1991 period, building in part on earlier efforts. These four action areas are

- Protected areas and biosphere reserves in northern regions. The NSN will review the needs, accomplishments and recommended activities for monitoring and research in Biosphere Reserves and other protected areas at high latitudes, will work toward preparing a northern addendum to the Biosphere Reserves Action Plan, and will work toward completing an adequate circumpolar network of northern Biosphere Reserves.
- Birch forest ecosystem studies and ecotones/treelines. The NSN will undertake a summary review of research on Subarctic birch forests and will place particular emphasis on northern treelines and the taiga-tundra ecotone in the context of global climatic change.
- Sustainable development in the North. The NSN will work toward developing and implementing appropriate strategies for sustainable resource development in northern settings, in consideration of the recommendations of the World Conservation Strategy and the World Commission on Environmental Development (the Brundtland Report).

*Prepared by Charles W. Slaughter, who is a watershed scientist for the Institute of Northern Forestry, USDA Forest Service, and is the chair of the U.S. MAB/Arctic Directorate.*

- Geosphere-biosphere observatories and monitoring of environmental and social change. The NSN will seek to support and facilitate national and international efforts in long-term monitoring of environmental change and changes in human actions in response, in the context of emerging concerns and actions, including the International Geosphere-Biosphere Program, the International Hydrological Program's Northern Research Basins Program, the NSF Long-Term Ecological Research Program, the World Climate Research Programme, and other coordinated global or regional initiatives in environmental monitoring and research.

To support progress toward these actions, Finland offered (and the Network member states accepted) to host the NSN Secretariat, which will be transferred from North America to Scandinavia for the next term; the Secretariat will re-implement the periodic newsletter and will provide a focal point for MAB-related northern actions.

The MAB Northern Science Network is expected to play a major role in facilitating circumpolar high-latitude cooperation in resource and ecosystem research and management for the coming decade.

### *Publications*

Readers may obtain further information on

some of the research described in this article from the following publications:

*Northern land use and grazing animals*, K.V. Abrahamsson, Editor, Proceedings from a UNESCO-MAB Northern Science Network Symposium, Geographical Reports No. 8, Department of Geography, University of Umeå, Sweden, 1985.

*Report on the Subarctic Birch Forest Ecosystem Workshop, Southwest Greenland, July-August 1984*, Northern Science Network Newsletter, vol. 2, no. 2, p. 5-6. [Edited from a report submitted by Dr. Soren Odum, Royal Veterinary and Agricultural University Arboretum, Horsholm, which appeared in *Newsletter from the Commission for Scientific Research in Greenland*, December 1984.]

*Research and Monitoring in Circumpolar Biosphere Reserves*, by Norman Simmons, Milton Freeman and Julian Inglis, Boreal Institute for Northern Studies, Occasional Publication No. 20, University of Alberta, Edmonton, Alberta, Canada, 1988.

*Arctic Science Policy and Development*, by Milton Freeman and Charles Slaughter, United States Man and the Biosphere Program, Washington, D.C., 1986.

*Northern Science Network Newsletter*, published by UNESCO-MAB Northern Science Network Secretariat, Edmonton, Alberta, Canada.

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## *Restoration and Vegetation Succession in Circumpolar Lands*

The seventh conference of the Comité Arctique International (CAI), "Restoration and Vegetation Succession in Circumpolar Lands," was held in Reykjavik, Iceland, from September 7 to 13, 1986. It was attended by about 100 people from most circumpolar northern countries. The conference consisted of papers, posters, panel discussions and field trips. The field trips focused on the efforts of Icelanders to revegetate, afforest, and reclaim their extensively damaged range lands. The conference addressed the critical issue of the preservation and restoration of lands in Arctic and Subarctic regions, a very timely topic when large industrial, energy and mining developments are taking place around the Arctic Circle.

The conference was officially opened by his Excellency Steingrímur Hermannsson, the

Prime Minister of Iceland. Mr. Hermannsson was for many years the Director of the Icelandic National Research Council and as Minister of Agriculture was responsible for soil erosion control. The conference participants met with Mrs. Vigdís Finsbogadóttir, the President of Iceland, at her official residence.

The CAI is an organization of specialists, individuals and corporations who share a concern for the Arctic. Individual members are elected by an executive committee on the basis of their contributions to the welfare of Arctic people and Arctic arts and sciences. Corporate members to date have come from extractive industries and regional governments. CAI's principal role has been to organize multi- and trans-disciplinary conferences on Arctic issues. The CAI was founded in 1979 under the leadership of Professor Louis Rey

*The conference was organized by Patrick J. Webber, former Director, Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado 80309, currently Director of the Ecology Program, NSF, and Sturla Fridriksson, Agricultural Research Institute, Reykjavik, Iceland.*

of Lausanne, Switzerland, and the patronage of His Serene Highness Prince Rainier of Monaco, with its formal headquarters in Monte Carlo. Professor Rey completed his term as president soon after the seventh conference. The newly elected president is Dr. Brynjulf Ottar of the Norwegian Institute for Air Research, Lillestrøm, Norway.

Previous CAI conferences were held in London (1980) on the hydrology of the Arctic Ocean and the fate of pollutants, in cooperation with the Royal Geographical Society; in Rome (1981) on the early discovery of the Arctic regions, with the active support of the Vatican Library and Archives; in Oslo (1982)

on Arctic energy resources; in Stockholm (1984) on underwater operations in ice-covered areas, jointly with the Society for Underwater Medical Research; and in Fairbanks (1985) on the marine living systems of the far north, in cooperation with the University of Alaska. Proceedings of each have been published.

Papers from the seventh conference are available in a single issue of the journal *Arctic and Alpine Research*, vol. 19, no. 4, November 1987; INSTAAR, University of Colorado, Boulder, Colorado, 80309-0450 (\$11.00 U.S. for individuals or \$18.30 U.S. for libraries).

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## *International Union for Circumpolar Health*

On March 19, 1986, the International Union for Circumpolar Health (IUCH) was formally brought into existence with the signing of its constitution in Stockholm, Sweden. This simple act represented years of planning and work by pioneers in circumpolar health, such as Dr. Earl Albrecht, Dr. Fred Milan, Dr. Otto Schaefer and Dr. Henrik Forsius. It should provide a structure that will bring together northern medical research on a worldwide basis.

The interim Board elected at the Constitutional Assembly consisted of Dr. Bent Harvald (Denmark), President; Dr. Brian Postl (Canada), Vice President; and Dr. Ted Mala (U.S.), Secretary General and Treasurer. Also on the Board are Dr. John Middaugh (U.S.), Dr. Per-Ola Granberg (Sweden), Dr. David Martin (Canada), Dr. Lydia Novak (U.S.S.R. Medical Workers Union) and Dr. Yuri Nikitin (U.S.S.R.). These individuals held office until the elections at the General Assembly in Umeå, Sweden, during the 7th International Congress on Circumpolar Health. The Secretariat is located at the School of Health Sciences of the University of Alaska-Anchorage.

The Union has four major objectives:

- Promote international cooperation in the study of circumpolar health. Most effort in this area to date have been rather regionalized, and health workers have been isolated in their efforts. The Union seeks to close that gap by working with individual countries and world governmental bodies such as the World Health Organization and by promoting more joint health efforts between countries and individuals.

- Encourage and support research and exchange of scientific information in circumpolar health sciences. A recurring theme at the International Circumpolar Health Congress has been that individuals were unaware of the efforts of others in the field or did not wish to wait three years for another congress to learn about current areas of research. IUCH will actively promote information-sharing networks, especially utilizing computer and satellite technology linking circumpolar countries to one another. IUCH is currently exploring existing networks and will report further on this in the future.
- Promote public awareness of the current situation of circumpolar health. Events of importance will be included in future issues of *Arctic Medical Research*, the official journal of the Nordic Council for Arctic Medical Research.
- Provide a means of communication with other organizations and encourage active participation in the International Council of Scientific Unions.

IUCH is made up of four adhering bodies:

- The American Society for Circumpolar Health
- The Canadian Society for Circumpolar Health
- The Nordic Council for Arctic Medical Research
- The Siberian Branch of the U.S.S.R. Academy of Medical Sciences.

The U.S. and Canadian societies are non-governmental in nature and membership and are open to any interested individual within their particular country.

*Based on a report by Theodore Mala, University of Alaska-Anchorage, in Arctic Medical Research (no. 42, p. 49-51, 1986), and information provided by John Middaugh, Alaska State Epidemiologist.*

The Nordic Council for Arctic Medical Research is more closely tied to governmental organizations representing Sweden, Norway, Denmark (Greenland), Iceland and Finland. The Siberian Branch of the Soviet Academy of Medical Sciences represents Soviet, particularly Siberian, interests.

A second level of membership, called affiliated memberships, is open to those who do not feel that they can be adequately represented by these four bodies. Affiliates may include individual research workers, laboratories, institutions, associations or companies. All affiliates are placed individually on the IUCH mailing list.

The IUCH is directed by a Council and the General Assembly. The four adhering bodies each elect two delegates to represent them on the Council. The General Assembly elects two delegates to represent it, making a total of 10. The IUCH Constitution assures the Scientific Committee for Antarctic Research (SCAR) a seat on the Council (thus expanding it to 11) should they elect to join IUCH. The delegate from the World Health Organization Regional Office for Europe will take a place in Council negotiations as an official observer.

Officers of the IUCH include a president, a vice president and a secretary general, who is also the treasurer. Officers and members of the Council can serve on the Council for a maximum of three terms (about nine years, as the General Assembly meets every three years at the international congresses). The Council will have at least one meeting each year.

The role of president is to serve as Chair of the Council and as the legal representative of IUCH. The secretary general serves under the direction of the president and the Council and is responsible for the day-to-day business of IUCH, which includes keeping its records, including minutes of the Council meetings and the General Assembly. As treasurer, the secretary general is also responsible for the finan-

cial records of the Union. The treasurer prepares the annual financial reports and budgets for approval by the General Assembly.

Council decisions are made on a simple majority basis, with the Chair having the deciding vote in case of a tie. The statutes can be amended by a two-thirds vote of the total number of delegates.

Expenses for members of the Council are covered by the organizations they represent at present, although the Constitution states that expenses of the two General Assembly delegates will be covered by IUCH.

The society representing the U.S. in the IUCH, the American Society for Circumpolar Health, was founded in 1967 by then Commissioner of Health, Dr. Earl Albrecht. The purposes of the Society are to

- Serve as a vehicle for maintaining communication among people interested in all aspects of human health in the circumpolar regions of the world.
- Promote public awareness of the current situation of circumpolar health.
- Encourage and support human health-related scientific research and education in the circumpolar world.
- Serve as the vehicle for assuring U.S. attendance at international circumpolar health symposia.

Under Dr. Albrecht's leadership, the Society was instrumental in establishing the International Symposia on Circumpolar Health, held every three years since 1967. The Sixth International Symposium was held in Anchorage in May 1984, drawing 770 registered participants from 22 countries. The Seventh Congress took place in Umeå, Sweden, and was hosted by the Nordic Council for Arctic Medical Research.

*Proceedings, Circumpolar Health '87* contains 160 scientific reports and articles and is available for 500 SEK from 7th ICCH, Box 6105, SE90006, Umeå, Sweden.

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## *Agreement on Cooperation in the Field of Environmental Protection*

*Prepared by Jerry Brown,  
Head, Arctic Staff, National Science Foundation,  
with the assistance of  
Steven Kohl, U.S. Fish and Wildlife Service,  
Robert Etkin, U.S. National Climate Program Office, and Sidney Smith,  
U.S. Environmental Protection Agency.*

The Eleventh Joint Committee Meeting under the U.S.-U.S.S.R. Agreement on Cooperation in the Field of Environmental Protection was held in Moscow, February 1-4, 1988. The session was co-chaired by Lee M. Thomas, Administrator of the U.S. Environmental Protection Agency, and Yuriy A. Izrael,

Chairman of the U.S.S.R. State Committee for Hydrometeorology and Protection of the National Environment (GOSCOMGIDROMET). The 17-member U.S. delegation represented five Federal agencies. The U.S. and the U.S.S.R. signed the comprehensive Agreement in May 1972 during the visit of Presi-

dent Richard Nixon to Moscow. Since then, the Agreement has served as a basis for cooperation among scientists from the two countries and has included numerous exchange visits of scientists, resource managers, engineers and other technical specialists involved in many aspects of Arctic land and marine research and development.

The Agreement has been organized under 11 areas for cooperation in preventing pollution and controlling the impact of human activities on nature:

- I. Air pollution
- II. Water pollution
- III. Environmental pollution associated with agricultural production
- IV. Enhancement of the urban environment
- V. Protection of nature and the establishment of reserves
- VI. Marine pollution
- VII. Biological and genetic consequences of environmental pollution
- VIII. Influence of environmental changes on climate
- IX. Earthquake prediction
- X. Arctic and Subarctic ecological systems
- XI. Legal and administrative measures for protecting environmental quality.

Although Area X on Arctic and Subarctic ecological systems was identified in the original Agreement of 1972, actual exchanges concerning northern activities were never implemented under it. Most Arctic projects actually were conducted under Area V, coordinated by Steven Kohl, U.S. Fish and Wildlife Service. Soviet reluctance to implement Area X presumably was related to territorial and security concerns. Nevertheless, at the peak of detente, U.S. specialists ranged over previously inaccessible inland and coastal areas of Siberia. In 1974, for the first time since World War II, Americans visited the Magadan region. Numerous co-authored scientific papers and reports document those exchanges, which focused on northern ecology and terrain impacts and restoration related to large engineering projects, particularly large-diameter gas and oil pipelines.

As indicated, numerous activities conducted under Area V have traditionally focused on Arctic studies of mutual interest. Since 1972 the two countries have carried out joint work in the following areas:

- Marine mammals: Shipboard and aerial censuses of cetaceans and pinnipeds; walrus and sea lion rookery studies; surveys of seasonal movements; laboratory re-

search on odontocete aging and color pattern variations.

- Migratory birds: Implementation of the 1976 U.S.-U.S.S.R. Migratory Bird Convention protecting more than 200 shared species; nesting and seasonal movement surveys of snow geese, emperor geese and black brants.
- Ungulates: Studies of caribou/reindeer migration patterns across pipelines; introduction and acclimatization of Alaska muskoxen into U.S.S.R.
- Permafrost: Studies of the effects of large-scale engineering projects (roads, pipelines, buildings) on permafrost areas.
- Arctic botany: Studies of mosses and lichens; rare and endangered plant collecting expeditions; studies of relict steppes.
- Northern marine ecosystems: Periodic, large-scale joint expeditions (1977, 1981, 1984, 1988) resulting in a comprehensive ecological profile of the Bering Sea.

Specific activities in 1987 included an April conference in the U.S. to evaluate data from the 1984 Bering Sea expedition and prepare the findings for publication; a joint autumn walrus survey in the Bering and Chukchi seas to determine age and sex distribution, study feeding habits through analysis of stomach contents, and examine mitochondrial DNA in tissue samples; and a December meeting in Moscow to review implementation of the bilateral Migratory Bird Convention for the years 1981-1986.

In 1987, additional activities under Area V included National Park Service exchange visits to discuss proposals on natural and cultural resources conservation. These included extensive discussions on research for conservation units on both sides of the Bering Strait, including archeological field work in northwestern Alaska. Area VI, under the U.S. Coast Guard, provides for a bilateral contingency plan for mutual assistance in the event of a large-scale oil spill in the Bering and Chukchi seas. Under Area VII, oceanographic cruises aboard Soviet vessels continue to provide U.S. marine biologists and oceanographers opportunities to investigate the far reaches of the Bering Sea. Under Area XI, the Council of Environmental Quality is planning a symposium for June 1989 on legal and administrative questions relating to living resources in the Bering Sea.

Area VIII, perhaps one of the most active programs, has recently become involved in high-latitude research, including tropospheric chemistry, stratospheric ozone, methane pro-

duction from organic-rich terrain, and paleoclimate reconstructions, and has promoted cooperation on the use of permafrost geothermal measurements as an indicator of climate change. A meeting of experts on Arctic aerosols was held in Leningrad, September 21–25, 1987. Arctic topics were among those discussed at the twelfth meeting of Working Group VIII in Princeton, N.J., and Washington, D.C., from October 19–31, 1987, co-chaired by Dr. Alan D. Hecht, Director, U.S. National Climate Program Office, and Dr. M.I. Budyko, State Hydrological Institute.

Prospects for cooperation under Area X were much enhanced following a political speech by General Secretary Gorbachev in late 1987. The speech, among other things, underscored the importance of Arctic scientific studies and seemed to declare a Soviet openness to international cooperation, particularly in Arctic environmental protection. This theme surfaced in the December 1987 and May 1988 joint summit statements between President Reagan and General Secretary Gorbachev, which expressed support for the

development of bilateral and regional cooperation among the Arctic countries on issues relating to the Arctic, “including coordination of scientific research and protection of the region’s environment.” With these improved prospects for increased Soviet cooperation and interest in the Arctic, EPA Administrator Thomas formally proposed in February that Area X be activated under the Joint Agreement. As a first step, the sides agreed to initiate a project on the sensitivity of permafrost terrain to climate change. The U.S. co-chairmen of Area X will be Dr. Jerry Brown, National Science Foundation, and James Devine, U.S. Geological Survey. Both are involved in implementing the mandate of the Arctic Research and Policy Act of 1984, which calls upon the Interagency Arctic Research Policy Committee to coordinate and promote cooperative scientific research programs with other nations. On the U.S. side, it is proposed to coordinate Area X activities with related areas of the Agreement to ensure communications with other U.S. bilateral and multilateral activities in the Arctic.

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## *12th Annual Review of Hydrocarbon Developments in the Beaufort Sea*

The 12th Annual Review of Hydrocarbon Developments in the Beaufort Sea was held in Ottawa, November 17–18, 1987. Since the mid-1970s the United States and Canada have met annually to discuss hydrocarbon development and other issues related to the Beaufort Sea. This year the review covered

- Hydrocarbon exploration and exploitation in the Beaufort Sea and adjacent areas, including U.S. activities at Prudhoe Bay.
- Gulf Canada’s plans to develop its massive Amauligak find.
- Panarctic activities at Bent Horn, Bathurst Island, in the Canadian archipelago.
- An exchange of information about the two countries’ Arctic research programs.
- An exchange of information about each country’s environmental concerns.

The U.S. delegation was led by Raymond Arnaudo, chairman of the Interagency Arctic Policy Working Group, and included representatives from the Departments of State, Commerce (NOAA), Interior (Minerals Management Service), and Transportation (U.S. Coast Guard) and from the National Science Foundation and the U.S. Arctic Research

Commission. The Canadian delegation was headed by Brian Buckley, Director of the Transboundary Division in External Affairs, and included representatives of the Departments of External Affairs; the Environment; Energy, Mines and Resources; Indian and Northern Affairs; Fisheries and Oceans, as well as representatives from the Canadian Coast Guard, Canadian Oil and Gas Lands Administration (COGLA), the Government of the Yukon, and Gulf Canada.

The Gulf Canada spokesman reported that although Canadian oil production was down from previous levels, Gulf had started work on final delineation wells in the Amauligak formation, about 25 miles north of the Mackenzie Delta (Northwest Territories). Gulf expects that the wells will confirm the availability of some 800 million barrels of recoverable oil. During the testing phase (which will last at least two seasons), Gulf anticipates producing up to three million barrels of oil annually, which it plans to ship via shuttle tanker during the short ice-free season. Gulf currently anticipates that some 12–14 trips, each ferrying up to 150,000 barrels, will be made each

*Prepared by Harlan K. Cohen, Office of Oceans and Polar Affairs, Department of State, Washington, D.C., based on presentations and discussions of the November 17–18, 1987, meeting in Ottawa.*

season. The shuttle tankers may transfer their cargo to a larger tanker, probably in ice-free waters northwest of Point Barrow in international waters, for eventual shipment to Pacific Rim countries. Gulf has long-term plans to bring the oil to shore by pipeline and to build a 20- to 24-inch oil pipeline to connect with an existing pipeline at Norman Wells, N.W.T.

The Bent Horn field, on Bathurst Island in the Canadian archipelago, contains an estimated two to three million barrels of recoverable oil. The project consists of a single well, a storage tank and a flow line, which produced approximately 270,000 barrels in 1987. It is estimated that the well will produce 400,000 barrels in 1988. The oil is shipped by tanker east to Montreal. Panarctic is currently drilling one additional well in the area to act as a back-up for its operations. The company hopes that the second well will also confirm the presence of a second pool of oil with a possible additional three million barrels of recoverable oil.

Representatives from the Alaska regional office of the Department of the Interior's Minerals Management Service provided information on recent hydrocarbon activities in Alaska. Activity in the last two years has been limited because of depressed oil prices. Following the results of an Alaskan review of the environmental impact of hydrocarbon activities, which tied in with existing Canadian studies and provided a comprehensive overview of ocean patterns in the Beaufort Sea, the United States was to solicit and receive bids for leases in the U.S. Beaufort Sea in March 1988.

The Canadians reported that over one fourth of their Arctic geoscience projects deal with the Beaufort Sea. The projects include studies of marine geology, permafrost and paleoclimate, ground ice, geomorphology, geologic mapping and marine seismology. The Canadians reported that the main ice island that they are studying has again started to move and is expected to enter the Beaufort Sea in about 1991. The ice island has moved as fast as 1200 m/hr and has frequently been observed moving at a rate of 600 m/hr.

Another aspect of Canadian research is the Environmental Studies Research Fund Programme (ESRF), organized to finance environmental and social studies pertaining to the exploration and development of hydrocarbons in the North. In 1983 the program's budget was Can\$5.3 million. The budget has declined since 1984, and no additional funding was provided in 1987. Funding for the program is

derived from hydrocarbon-related sources. Eighty percent of the studies have been done by private consulting firms, and the remainder were done by the Federal government, oil companies or universities. The topics have included

- Bowhead whales
- Ice scouring, especially with regard to the safe burial depth of pipelines.
- The effects of oil spills.
- Waves.
- Iceberg detection.
- Iceberg trajectory forecasting.
- Socio-economic studies.

COGLA coordinates a separate marine engineering program that includes design criteria, structures engineering, ice-structure interaction and personnel safety.

The Canadians also reported on the Canadian Polar Science study, which was published in the spring of 1987. The study proposed the establishment of a high-level coordinating body in Canada for polar research, the Canadian Polar Research Commission, and a Polar House, to promote research in polar areas.

Regarding U.S. scientific activities, the staff representative of the Interagency Arctic Research Policy Committee (IARPC) reported on the Arctic Research Plan. Development of the Plan capped several years of work by the National Science Foundation, other government agencies, and representatives from the private sector. The Plan has established an agenda to help government agencies set Arctic research priorities; however, it does not provide a separate source of funding. The Plan has been approved and was submitted to Congress by the President in July 1987. Planning for the implementation stage has begun.

The U.S. agency representatives described research on bowhead whales, which has shown, among other things, that bowheads may avoid Arctic drilling activities. However, the data are inconclusive, and there is general agreement that more research needs to be done in this field. Alaska Natives have voiced concern about tanker traffic in the Beaufort Sea, fearing possible oil spills and the possibility that this traffic will drive the bowhead whales farther offshore. A Canadian Department of Indian and Northern Affairs spokesman reported that his Department is reviewing research findings to evaluate the hypothesis that tanker traffic and minor spills may reduce the western Arctic bowhead whale population. A workshop was held in March 1987 to examine the question, and it is expected that a report will be published in the spring of



1988. It is difficult to test the hypothesis that whales avoid certain areas in which industry is active, though initial results show that noise may mask the acoustical signals used by marine mammals for communication. There is growing interest in U.S. work to develop satellite transmitter tags for bowhead whales to directly measure their movements.

There was also a discussion on Arctic cisco and their migratory patterns. Speakers from both countries agreed that the Mackenzie River is the only spawning ground for Arctic cisco living in the Beaufort Sea, including those found in Alaskan rivers and coastal areas. After growing for several years in Alaskan waters, the adult fish return to the Mackenzie to spawn. Causeways constructed along the Alaskan coast may disrupt the band of brackish water used by the cisco for migration and summer feeding, thus disturbing normal migratory patterns and feeding habits. With more coastal development proposed for the American side, more information is needed to establish a data base on Arctic cisco. It

is thought that between 20% and 33% of all Arctic cisco migrate from the Mackenzie River into Alaskan waters.

U.S.-Canadian cooperation on ice studies was also discussed. The NOAA representative reported on the formation of a U.S.-Canadian ice working group in 1986, which had grown out of an earlier, less-formal relationship between the U.S. Joint Ice Center and the Ottawa Ice Center. The terms of reference for the joint ice working group include

- Coordination of ice information and data exchange.
- Effective systems to disseminate data.
- Recommendations for improved communications arrangements.
- Exchange of technical information.
- Ice analysis and forecasting.
- Establishment of priorities for ice information services.
- Equipment exchanges and loans.
- Definition of priorities for an ice data base.

Last, there was a discussion of Arctic transportation issues. The Canadians showed a film of a Canadian icebreaker in operation and discussed their plans for the construction of a new Class 8 icebreaker. They hope that the contract for the new icebreaker will be awarded in 1988 and that the new vessel will enter into service in 1993. The U.S. representatives presented a paper, which had been prepared by the Maritime Administration within the Department of Transportation, summarizing current Arctic transportation issues.

These talks once again provided a useful exchange of information between the United States and Canada on Beaufort Sea hydrocarbon and environmental issues. They allowed experts from Federal and local government, industry and the scientific community to meet and discuss relevant issues. The next meeting will be held in the United States.

## *Arctic Research Commission Appointments*

On May 17, 1988, President Ronald Reagan appointed Ben C. Gerwick, Jr., as a new member of the Commission, to succeed Dr. James H. Zumberge. Mr. Gerwick is a renowned specialist in Arctic engineering. He is a member of the National Academy of Engineering and was chairperson of its Marine Board. He is Professor of Civil Engineering at the University of California at Berkeley and is president of Ben C. Gerwick, Inc. President Reagan also reappointed Elmer E. Rasmuson for another term. Mr. Rasmuson has been Chairman of the Budget and Planning Committee for the National Bank of Alaska in Anchorage; he has played a crucial role in the State's private sector as well as being a Regent of the University of Alaska.

The Arctic Research Commission has appointed Dr. Philip L. Johnson as its new Executive Director. Dr. Johnson will be located in Washington, D.C., where the Commission recently established a new office. Dr. Johnson earned a Ph.D. in plant ecology from Duke University. As a researcher at the U.S. Army

Cold Regions Research and Engineering Laboratory during the sixties, he conducted remote sensing studies of ecological systems in the areas of Barrow and Yukon Flats, Alaska. From 1968 to 1974, Dr. Johnson was with the National Science Foundation in Washington, D.C. His positions were Program Director, Ecosystems Analysis Program; Deputy Head of the Office of Interdisciplinary Research; and Director of Environmental Systems and Resources. In 1973 he was recipient of the NSF Meritorious Service Award. Between 1974 and 1981 he was Executive Director of Oak Ridge Associated Universities, a consortium of southeastern U.S. universities.

He has served on numerous national and international committees, including the National Academy of Sciences, National Research Council Polar Research Board, on which he served from 1981 to 1985. His most recent position, assumed in 1981, was that of President of the John Gray Foundation and Director of the Foundation's research institute in Beaumont, Texas.

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## *Arctic Research Consortium of the United States*

A meeting was held at Boulder, Colorado, on January 18-19, 1988, to establish an organization under the title of Arctic Research Consortium of the United States (ARCUS). Prospective members are universities and other nongovernment organizations conducting research in the Arctic concerned with the earth sciences, the biological sciences, medicine, socio-economics and engineering. A prospectus and a set of by-laws are being prepared. They define a consortium dedicated to issues related to an overall enhancement of the quality and posture of research conducted by nongovernment institutions in the United States. Key issues include improved educational opportunities, curricula, student mobility, information exchange, logistics, and the development of interinstitutional partnerships in the conduct of interdisciplinary research programs according to the guidelines and priorities recently established by the Arctic Research Commission. To these ends the Consortium will strive to act as an open forum to

develop new ideas and approaches, and to encourage an ongoing discourse with Federal and State agencies supporting research in the Arctic.

Preliminary plans for the membership structure include institutional memberships (with representatives from all interested institutions in the United States), international institutional memberships, and invited associate memberships recognizing Arctic scientists not represented by member institutions. This three-tier membership will be reflected in the membership fee and voting structure.

The informal "founders' meeting" at Boulder in January 1988 selected Dr. Luis Proenza, Vice Chancellor for Research and Dean of the Graduate School, University of Alaska-Fairbanks, to act as chair. Mark Meier, University of Colorado, and Norbert Untersteiner, University of Washington, were asked to serve with Dr. Proenza on a steering committee. ARCUS anticipates that by the time of publication of the next issue of *Arctic Re-*

search of the United States they will be able to report that ARCUS has been formally established. Initial plans are for the first full meeting of the consortium to take place during the Annual Meeting of the AAAS Arctic

Division (the 1988 Arctic Science Conference in Fairbanks on October 7–10, 1988).

Additional information is available from Dr. Luis Proenza, University of Alaska, Fairbanks, Alaska 99775-1720.

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## Workshops on Arctic Interactions

The results of two multidisciplinary workshops held in January and March 1987, and attended by 47 U.S. and Canadian participants, will appear soon in a report prepared by the Office of Interdisciplinary Earth Studies (OIES). The workshops, organized by OIES of the University Corporation for Atmospheric Research (UCAR) in cooperation with the Institute of Arctic and Alpine Research (University of Colorado) and the Royal Society of Canada, identified and discussed a series of fundamental interactions including solar and geomagnetic impacts, atmospheric dynamics and heat balance, ocean circulation, sea ice, snow and glaciers, permafrost, hydrology, coastal processes, nutrient cycling, carbon storage, biological communities and ecosystem dynamics, and the record of environmental change.

Underlying multidisciplinary and interdisciplinary themes emerged as worthy recommendations for an Arctic component to the International Geosphere-Biosphere Programme and include sea ice and its sensitivity to per-

turbation, Arctic haze, glacier and ice-sheet changes and sea level, biota in relation to ocean-ice margins, peatlands and biogeochemical cycling, changes in permafrost due to climatic change, and the paleoenvironmental record.

Recommended next steps for developing and implementing the scientific goals include the development of a joint U.S.–Canadian action plan, a program for collecting “early-warning” data on global change, and examination of strategies to use present and planned surface and satellite observational systems for the Arctic. The scientific rationales and recommendations contained in the report will provide valuable input to the current U.S. interagency Arctic planning and implementation activities and provide a valuable link to the IGBP.

A forthcoming issue of *Earthquest* will provide highlights of the report and its recommendations. The report and *Earthquest* are available from John Eddy, OIES, P.O. Box 3000, Boulder, Colorado 80307.

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## Arctic Environmental Data Workshop

Under the auspices of the Interagency Arctic Research Policy Committee, NOAA, NASA, NSF and the USGS cosponsored a four-day workshop on the question of how to establish an Arctic environmental data system. The meeting was held in Boulder, Colorado, March 21–24, 1988. Approximately 60 individuals from U.S. and Canadian government agencies and universities attended the workshop.

The first part of the meeting was devoted to presentations describing various government and nongovernment Arctic data holdings and systems. This was followed by two days of intensive discussion in four subgroups:

- How to create an on-line and hard-copy Arctic environmental data directory.
- Identification of the next steps that interested organizations can and should take to create an Arctic data system.

- Technological problems and solutions associated with the development of a data system.
- Identification of key Arctic environmental parameters that should be monitored for the purpose of studying global and Arctic mesoscale change.

On the final day there was discussion and general endorsement of the recommendations of these subgroups.

The main findings of the meeting were that

- Work should begin immediately on an Arctic directory, in coordination with and as a prototype for global change efforts. Entry of Arctic data could begin on an existing system such as USGS's Earth Science Data Directory (ESDD).
- A multiagency working group of data experts should be established to oversee the

*Prepared by Tom Laughlin, workshop organizer and member of the IARPC staff, NOAA's International Policy Office, Washington, D.C. 20230.*

establishment of a directory. Agency data holdings should be publicized and efforts undertaken to identify other Arctic data holdings that should become part of the directory. Mechanisms for getting feedback from data users should be established. In the longer term the working group should be expanded and made more permanent. Finally, one essential next step is to raise the relative priority of data management activities in the budget process.

- In the technology area the need to provide for data migration across changing technologies and the importance of standards were emphasized. Three specific standards were recommended: structured query language, standardized generalized mark-up language (SGML), and a standard portable operating system environ-

ment (POSIX). Other standards must be developed. Finally, technology should be developed and applied for preserving fast-disappearing data bases, such as oral history.

- The parameters group identified the Arctic data needed to understand (not just detect) global and Arctic mesoscale change. Parameters were grouped as follows: atmosphere, ocean, hydrosphere, biosphere and solid earth. These parameters will be set forth in the final report of the meeting.

The availability of the report will be announced in the next issue of the Journal. At its May 2, 1988, meeting, the Interagency Arctic Research Policy Committee approved the establishment of a working group to develop the Arctic Data Directory (see p. 68).

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## *Research on Federally Protected Lands in Northwest Alaska*

The Alaska National Interest Lands Conservation Act established a network of Federally reserved land areas in Alaska. Those in northwest Alaska are under the administrative control of several agencies of the U.S. Department of the Interior, including the Bureau of Land Management, the Fish and Wildlife Service and the National Park Service.

The Alaska Quaternary Center, University of Alaska, convened a symposium and workshop called "Research on Federally Protected Lands in Northwest Alaska: Needs, Opportunities and Constraints," September 26-27, 1987, in conjunction with the AAAS Arctic Science Conference in Anchorage. This meeting was a response to growing interest in utilization, research and management of lands and resources in northwest Alaska, and, in part, to the 1984 Arctic Research and Policy Act.

The first day's symposium of invited papers centered on several complementary themes: the unique characteristics of the northwest Alaska landscape, which has had thousands of years of subsistence usage, but still has significant research needs; combining public interests, research and land management strategies with regional and local concerns; the need for continuing involvement of indigenous people in research and management of reserved lands; and unparalleled opportunities for research important both to the region and to statewide and circumpolar interests.

While managed by several different agencies, these Federally reserved lands share many features:

- Remoteness from major population centers (Kotzebue, the communications and commercial hub, has fewer than 4000 residents).
- Relative lack of influence by commercial activities (though that may be changing with respect to minerals, fisheries and tourism).
- Lack of surface transportation facilities other than natural waterways.
- Spectacular scenic values.
- Invaluable research potential in fields ranging from archaeology and paleoecology (the region holds many keys to developing a full understanding of early man's entry into North America) to contemporary human ecology and global climate change.

Renewable and nonrenewable resources of the region, including fisheries, wildlife and minerals, have both regional and national importance. Local people are determined to continue using and influencing the management of the lands and resources of northwest Alaska.

Over 100 participants in the second day's workshop wrestled with transforming information and concepts into recommendations, in nine simultaneous workshop sessions:

*The Steering Group for this effort included David M. Hopkins (Chair), Charles W. Slaughter, David W. Norton, Wendy H. Arundale, Robert Sattler, and David R. Klein, Fairbanks, Alaska, in cooperation with the National Park Service, Anchorage, Alaska.*

- Baseline information, inventories and long-term monitoring.
- Fire, erosion and landscape management.
- Biological aspects of subsistence research.
- Minerals and nonrenewable resources.
- Environmental degradation.
- Recreation and tourism.
- Climate and paleoclimate.
- Prehistory and oral history.
- Publication, curation and archiving.

Concerns that emerged as common issues included the need for

- Increased communication among the various agencies and residents of the region.
- Research programs that are more attuned to the needs and values of both the indigenous people and the managing Federal agencies.
- Increased, sustained local involvement in planning and implementing research programs.
- Sustained research support and site security for long-term programs to ensure continuity of effort.
- Accommodation of traditional values and procedures, including subsistence resource harvest, with nationally mandated man-

agement and protection policies of the various Federal agencies.

An often-voiced concern was the need for what might be termed a regional research and resource center that would serve visiting and resident scientists, incorporate education and training activities to facilitate involvement of indigenous people in research, encourage interdisciplinary and interagency collaboration, and provide a logistical service for science in northwest Alaska. Many of the areas of concerns and needs are directly related to the Man and the Biosphere (MAB) Action Plan for Biosphere Reserves. Since the Noatak National Preserve is a Biosphere Reserve, it and adjacent National Park Service and Fish and Wildlife Service lands are well suited to programs related to Biosphere Reserves. (See p. 50 for the results and recommendations of the related MAB meeting in Finland.)

The results of this symposium and workshop will be published in a report available from the Alaska Quaternary Center, University of Alaska, Fairbanks. The meeting was sponsored by the National Science Foundation with major participation of the U.S. National Park Service and other land-managing agencies.

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## *Kodiak Island Cultural Heritage Conference, Alaska*

The Kodiak Area Native Association (KANA) sponsored the Island's first cultural heritage conference on March 28-30, 1988, aided by a grant from the Alaska Humanities Forum. The goal of this conference was to promote the exchange of information among Native people, scholars and the general public. Additional goals were to build pride in, and increase awareness of, Native heritage and to build public support for a Native Museum and Cultural Heritage Center. This event was the first of its kind to be held in Alaska.

Thirty-seven papers were delivered by people from academic institutions, museums, historical societies, Federal agencies and Native associations. The gathering was national and international in scope. Non-Alaskans attending the conference came from Canada, Finland, Germany, Great Britain and Sweden, and there were at least 12 individuals from the "Lower 48." Opening remarks were delivered by the president of KANA, Native elders, the state senator, the state representative,

the borough mayor, the city mayor, and one of Kodiak's Russian Orthodox priests.

The conference was organized around four major topics: the archaeology of the Kodiak Island region, Koniag collections in world museums, museum and public outreach programs, and the ethnography and history of Kodiak Island Natives. Additional conference activities included several presentations by an Eskimo dance team, a tour of a predominantly Native village, and films that dealt with the struggle to reconcile traditional and modern values and life-styles in Greenland, and the construction of a Native cultural heritage center in British Columbia. Native students and elders also demonstrated traditional games and crafts. Evening receptions were hosted by the Kodiak Historical Society, the Kodiak Area Native Association, Kodiak Community College, and St. Herman's Seminary. The 300-500 participants enthusiastically endorsed the goals of the conference and the plans for a Native museum and cultural heritage center on Kodiak.

*Prepared by Richard H. Jordan, Chairman of Anthropology, Bryn Mawr College, Bryn Mawr, Pennsylvania 19010.*

# The University of Alaska-Siberian Medical Research Program

*Based on materials provided by Theodore Mala, University of Alaska-Anchorage, prime organizer of the joint program.*

The University of Alaska-Anchorage (UAA) has developed the first western agreement in medical research ever to be signed with the Siberian Branch of the Soviet Academy of Medical Sciences. The agreement calls for the exchange of medical information and researchers concerned with health in the North.

There are many good reasons for Alaskans and Siberians to work together. Alaska has strong historic ties with Siberia. Many Alaska Natives and Siberians are related through blood ties. Historically there has been much culturally based interchange. Moreover, the health problems of residents of circumpolar regions are similar. Siberia has a large population (over 40 million residents), so the Soviets have had the opportunity to conduct extensive medical research. International collaboration is likely to yield significant progress in health research.

The agreement has taken several years to develop. At the Reagan-Gorbachev summit in Geneva in 1985, the two leaders signed an agreement on general exchanges. In April 1987, the United States-Soviet Union Joint Commission on Health, at the first meeting of its kind in eight years, signed an agreement promoting the exchange of medical information and medical researchers between the two countries. The UAA-Siberia agreement was signed in Anchorage in November 1987.

The UAA-Siberian Medical Research Pro-

gram provides the base on which future exchanges will be built. The agreement calls for mutually beneficial studies in the areas of nutrition, circumpolar health information systems, adaptation to the North, and seasonal affective disorders. Also of interest are alcoholism, substance abuse and mental health. Several UAA proposals have been sent to the medical academy in Siberia for approval. Some joint efforts may begin as early as the fall of 1988.

In an effort to promote collaborative studies, an International Institute for Circumpolar Health Studies has been proposed for Alaska. The Institute would provide a base for the collection of medical information on the North. Studies are often performed in the North without the knowledge of other researchers, contributing to the duplication of efforts and to uncoordinated efforts to bring health data together.

To date, numerous Siberian medical publications have been collected and exchanged, and an extensive data base is being computerized that identifies researchers with an interest in the North by area of specialization and geographical location. The development of a "Who's Who in Circumpolar Health" as a data base will be of significant value not only for researchers but also for clinicians needing immediate assistance and consultation in a particular area of expertise.

*Signing of the agreement in Novosibirsk, Siberia. Shown (left to right) are V. Kaznecheev, Director, Institute of Clinical and Experimental Medicine; Yuri Nikitin, Deputy Chairman, Siberian Branch of the Academy of Medical Sciences of the U.S.S.R.; Donald O'Dowd, President, University of Alaska; Anne Parrish, President, Board of Regents, University of Alaska; and Theodore Mala, UAA.*



# *The Cold Regions Bibliography at the Library of Congress*

*Prepared by Geza  
Thuronyi, Editor, Bibliog-  
raphy on Cold Regions  
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For 38 years the Cold Regions Bibliography Project (CRBP) at the Library of Congress (LC) has been providing world-wide coverage of technical literature on topics of interest to the sponsoring agency: the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, N.H. This is probably the longest uninterrupted contractual agreement between two U.S. Government agencies for production of a bibliographic publication. As of this writing, over 111,000 items have been incorporated into the bibliography, many with abstracts. The project is administratively part of LC's Science and Technology Division, but it is funded exclusively by CRREL.

The bibliographic information differs from that found in library catalogs in that it does not stop at the level of the book or journal title, but deals with individual papers, e.g. journal articles, conference papers, etc. Another characteristic of the Bibliography on Cold Regions Science and Technology (BCRST) is its subject coverage. While most of the large abstracting and indexing services (Chemical Abstracts, Biological Abstracts, etc.) provide discipline-oriented coverage, BCRST is a multi-disciplinary, mission-oriented service that parallels the multi-disciplinary mission of CRREL. This tailor-made fit may account for the project's longevity.

The major sources of acquisition for BCRST are LC's vast collections of domestic and foreign books and periodicals (with special arrangements for pre-processing access by CRBP), gifts from authors and publishers, and loans from the sponsors and from other libraries. About two dozen commercial data bases are scanned regularly for titles that may have been missed. The constant endeavor to identify the elusive piece of literature (including the "gray" literature) consumes a large portion of the bibliographers' time, making the project labor intensive.

The subjects covered by BCRST are

- All aspects of snow, ice and frozen ground.
- Construction of buildings, railroads and hydraulic structures, drilling operations, and other engineering tasks in cold regions.
- Icebreakers and ice navigation.
- Arctic ecology, especially its disturbance by human activities.

- A number of related topics.

From time to time, coverage may shift as the sponsoring agency takes on or relinquishes projects or responsibilities.

The bibliographic information is entered in a conventional format into a computerized data base. Once the bibliographic records are stored in the file, they are available for the various products that are issued periodically.

Every year a bibliography containing new accessions for the year is published with author and subject indexes. This publication is available to the public through the National Technical Information Service, Springfield, Virginia. Five-year cumulative indexes are also published. Another publication extracted from the data base is a fully indexed listing of all writings of CRREL staff; this publication is updated on demand at irregular intervals. Finally, perhaps one of the most useful features of the data base is its commercial availability for on-line searching and retrieval through the Pergamon Infoline (formerly System Development Corporation) ORBIT system. That service is updated every quarter.

An eminent characteristic of the system is its flexibility. It can easily adapt to minor or major shifts in user requirements. Even now the data base accommodates another activity, the *Antarctic Bibliography*, with single input of records that apply to both bibliographies but with different output formats. This modular approach would technically allow other bibliographic projects to be added if the need and means should emerge. In other words, if resources are available, new projects or expansions could be accommodated without interfering with current obligations.

After the demise of the *Arctic Bibliography* in 1974, it became the general consensus that there is no single institution with funds and interest strong enough to undertake complete coverage of all Arctic literature. CRBP is only one of several dozen organizations engaged in bibliographic services relating to the North. Many efforts have been made, notably by an informal group of northern librarians and information specialists called the Northern Libraries Colloquy, to coordinate the work of these organizations. The 12th NLC (June 1988, Boulder, Colorado) provides practical suggestions for future integration of bibliographic services and products.

A recent networking study conducted by the Arctic Environmental Information and Data Center under the sponsorship of the National Science Foundation's Division of Polar Programs was aimed at similar goals. The final report on this study, *National Arctic In-*

*formation Network*, documents the bibliographic services available and areas not adequately covered by such services. It also contains recommendations for linking together all the scattered information and assuring the broadest and easiest user access.

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## *Some Recent Publications*

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) has published a comprehensive Alaskan bibliography of some 5000 publications that have resulted from research it has funded since its inception in 1975. The bibliography consists of five sections, with citations sorted alphabetically by author, sorted by citation number, and cross-referenced to information on lease areas and disciplines, research units, and published report volume and NTIS numbers. Geographic and disciplinary key-word descriptors are associated with each citation. Another recently pub-

lished OCSEAP report, *Beaufort Sea (Sale 97) Information Update* (April 1988), MMS 86-0047, contains reports presented at the first Information Update Meeting on March 6-7, 1985, in Anchorage. Copies may be obtained from NOAA, Ocean Assessments Division-Alaska Office, Box 56, Anchorage, Alaska 99513.

Another new report is *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*, available from the Marine Mammal Commission, 1625 I St., N.W., Washington, D.C. 20006.

# Interagency Arctic Research Policy Committee

### Fourth Meeting:

May 2, 1988

Committee Members or Agency Representatives Present: Erich Bloch, Chairman; Ted Cress, Department of Defense; Lennard Fisk, National Aeronautics and Space Administration; Joseph Fletcher, Department of Commerce; Robert Hoffmann, Smithsonian Institution; Kenneth Hood, Environmental Protection Agency; David Klein, Department of Health and Human Services; Helen McCammon, Department of Energy; Richard Smith, Department of State; James Ziglar, Department of the Interior,

Chairman Erich Bloch convened the meeting in the Secretary of the Interior's Conference Room. He reviewed the accomplishments of the Interagency Arctic Research Policy Committee since the March 1987 meeting: transmittal of the *United States Arctic Research Plan* to the President and Congress in July 1987; transmittal of the Biennial Report in January 1988; publication of the first issue of the new IARPC journal, *Arctic Research of the United States*; and steps taken to demonstrate the agencies' ability to plan and cooperate on research programs. Chairman Bloch then discussed the interagency budget plans as presented in Special Analysis J of the President's FY 1989 budget and details developed by the IARPC staff (see Table).

Agency	Actual 1987	Estimated 1988	Estimated 1989
(Thousands of dollars)			
Department of Defense	22,197	23,647	25,129
Department of the Interior	23,659	23,129	23,525
National Science Foundation	20,478	20,895	24,135
National Aeronautics and Space Administration	13,423	16,090	11,920
National Oceanic and Atmospheric Administration	4,555	4,935	4,935
Department of Energy	3,118	2,907	2,740
Department of Health and Human Services	1,579	1,182	1,180
Smithsonian Institution	519	700	700
Department of Transportation	400	10	150
Environmental Protection Agency	300	0	0
Department of State	16	16	16
Department of Agriculture	850	850	850
Totals	91,094	94,361	95,280

### Working Group Reports

Three working groups, Oceans and Atmosphere, Land and Resources, and People, are preparing recommendations and plans for the biennial update of the *United States Arctic Research Plan* due in July 1989. Ted Cress,

DOD; James Ziglar, DOI; and Robert Hoffmann, Smithsonian, reported on progress by each group.

### Oceans and Atmosphere

This section of the Plan deals with how the Arctic Ocean and atmosphere operate as a coupled system, including ice dynamics, weather, climate, marine ecosystems, and the relationship of the coupled earth-sun system to the Arctic environment and national defense interests. The Plan identified 35 primary recommendations relative to atmosphere and oceans. The Group reviewed these recommendations and identified three areas in which early emphasis should be placed and specific recommendations acted upon:

- Coupled ice-ocean-air system: Develop and verify coupling models; study the impact on marine ecosystems at the ice edge; develop instrument systems for required data bases, e.g. permanent regional monitoring, Alaska SAR Facility, SSM/I remote sensing capability.
- Geologic history and global climate: Determine the geologic, tectonic and paleoclimatic history of Arctic oceans and margins and Arctic responses to global climate change, including a focus on current global change issues.
- Upper atmosphere and near-earth space monitoring: Improve orbital and ground-based monitoring and measurement capability for solar-terrestrial interaction; improve the monitoring capability for interplanetary magnetic field, optical, radio and HF ground-based sensors to address ionospheric-magnetospheric coupling and key ionospheric processes.

### Land and Resources

This section of the Plan covers renewable and nonrenewable resources, interactions between the land and the atmosphere, coastal processes, and engineering research and systems. These research areas address policy is-

Preparations for and reporting of the meetings were undertaken by Jerry Brown and Charles E. Myers, Arctic Staff, National Science Foundation.

sues related to resource development with minimum environmental impact. They also involve research of direct concern to local residents and regional and global science. Fifty programs have been previously identified as land-related, with most of them performed in and adjacent to Alaska. The response of the land and its resources to natural and human-induced changes is a main focus for these programs. An example is the response of permafrost, peatlands and water resources, including snow and glaciers, to climate change. The history and geologic framework of Arctic land masses are of considerable economic and environmental interest. Accomplishing both individual agency and interagency programs requires increased use of advanced technologies including satellite and aircraft remote sensing, data processing, storage and retrieval, and logistical innovations. Since much of the research is conducted on protected Federal lands, a workshop was conducted in Anchorage in September 1987 to explore ways in which these activities can be performed in the best interests of land managers, local residents and scientists. The Land Group is assessing the numerous recommendations and is developing integrated plans for short- and long-term research.

#### *People*

The *United States Arctic Research Plan* noted that social science is topically diverse, is a relative newcomer to agency programs, is dispersed among many government agencies, has low priority and low funding compared to other research efforts, and lacks a lead agency to coordinate program growth. During the past year the IARPC Social Science and Health Group has been organized to coordinate social science policy among U.S. agencies. Representatives of all relevant Federal agencies attend its meetings. Activities include priority assessment, coordination of new work, and revision of the Plan for both social sciences and health.

#### *Social Sciences:*

- The need for Alaska-based coordination has resulted in the formation of the Alaska Interagency Archeological Group, which also has begun assessing research recommendations and priorities. A second Alaskan agency group, now being organized, will deal with socio-cultural research.
- The Polar Research Board has formed a Committee on Arctic Social Sciences. An initial meeting has been held and a study

of priorities and needs has been proposed for completion in late 1988.

- Actions to strengthen Native educational programs, needed to encourage young Native people to study science, are being taken by various agencies.
- The Smithsonian Institution has received Congressional funding for an Arctic Studies Program concentrating on archeological, anthropological and biological research. Exhibition, publication and Native science and museum training will be stressed. The Smithsonian will open a joint U.S.-Soviet exhibition, *Crossroads of Continents: Cultures of Siberia and Alaska*, in September 1988. A second Smithsonian exhibition, *Inua: Spirit World of the Bering Sea Eskimo*, will circulate in Europe in 1988-1990 under the auspices of the USIA Arts America Program.

#### *Health:*

- The Centers for Disease Control and the Indian Health Service are involved in extensive efforts to control hepatitis B and liver cancer. The CDC Arctic Investigations Laboratory supports a cancer surveillance program and studies of epidemiology and etiology among Alaska Natives. Serological screening and immunization programs have been conducted since 1983.
- *Haemophilus influenzae* type b (Hib) disease occurs among Native children five times more often at an early age than among other U.S. children. A vaccine testing program has just been conducted under the auspices of the NIH National Institute of Allergy and Infectious Diseases, and results are being analyzed.
- Nasopharyngeal cancer occurs at higher frequencies among Alaska Natives. NIH is supporting research on Epstein-Barr virus and cancer in Alaska Natives, which may be useful in detecting serological markers for nasopharyngeal cancer.
- Work has begun on a new vaccine for whooping cough. A large field study, partly supported by NIH, was recently conducted in Sweden.
- The Department of Defense is conducting medical research on several health-related issues affecting soldiers stationed in Arctic regions. The thrust of this work has been in three areas: prevention of cold-related injury, performance enhancement and adaptation to unusual conditions, and treatment of cold injuries. Within

DOD some informal discussion has taken place as to the potential for consolidation of the cold weather research program being carried out at or under the sponsorship of several DOD laboratories. If such consolidation were to be approved the potential exists for incorporation of not only Arctic but also Antarctic and high-altitude research.

#### *Role of the Arctic in Global Climate Change*

Following reports of the Working Groups, Chairman Bloch called on Joseph Fletcher, NOAA, to discuss the role of the Arctic in studies of global change.

Fletcher stated that the two polar regions are the dominant heat sinks forcing the circulation of the global atmosphere and ocean. The two working fluids respond to the thermal contrast between the polar regions and the tropics. Their circulation redistributes the solar heat reaching the planet.

It follows that the variation in time of the intensity of these planetary forcing centers is one of the most relevant aspects of global climate dynamics.

- How much and how suddenly do they change?
- What are the controlling energy processes?
- How have they changed in the past?
- How will they change in the future?
- How do they influence the rest of the planet?

These questions are now given new urgency by the mandate levied on the Federal agencies by the Global Climate Protection Act of 1987, requiring within 24 months assessments of possible measures for controlling the global climate and evaluations of the U.S. strategy and efforts to gain international cooperation to implement such measures.

What is the role of the Arctic in these issues? In short, the polar regions, being dominated by radiative exchange, are both primary forcing centers of the global system and also the simplest indicators of that changing radiative balance.

The demand for control measures is responding to the threat of "greenhouse warming." This alteration of the radiation budget would be exhibited most strongly by warming at the surface in polar regions in winter, decreasing thermal contact with the tropics, and weakening global circulation. Everyone has heard about the perceived side effects: mid-west drought, melting polar ice, and rising sea level. Well, *almost* everyone: maybe Mother

Nature hasn't gotten the word because

- The area of polar sea ice has been stable or increased in recent decades, in both hemispheres.
- A dramatic change of the last decade has been the expanding tongue of cold water from the Arctic into the North Atlantic.
- The strength of the atmospheric circulation, instead of weakening, has been increasing for decades, most strongly in the last decade.

To control the climate we must be able to predict the consequences of our actions. The global climate machine is characterized by highly nonlinear interactions on all time and space scales. There are positive and negative feedback loops, many as yet undiscovered. There are countervailing factors; for example, a 10% change in carbon dioxide is about balanced by a 1% change in cloudiness—a highly variable factor partly caused by human activities such as high-flying aircraft.

In spite of the complexities, there is a broad consensus that human intervention, already inadvertent, should also be purposeful. But the knowledge base needed for purposeful intervention in global climate has yet to be created, and the role of polar regions is an essential part of that knowledge base.

The structures for Federal coordination of these activities are now under active review. As the emerging structure takes shape, a discrete part of that structure should clearly delineate appropriate Federal implementation action to meet the knowledge needs.

#### *Report on the Arctic*

##### *Environmental Data Workshop*

Douglas Posson of the U.S. Geological Survey reported on the recent IARPC-sponsored workshop on Arctic data (see p. 59).

The principal recommendations of the workshop were

- Immediately begin to develop an Arctic data directory as a prototype for global change efforts, using existing efforts to the greatest possible extent and coordinating with the Interagency Working Group on Data Management for Global Change.
- Enter Arctic data on an existing directory such as the USGS's Earth Science Data Directory (ESDD) to be shared by all participants.
- Immediately form an informal multiagency working group of data experts to oversee the establishment of an Arctic data directory.
- Publicize existing agency Arctic data

holdings and identify and reference other Arctic data holdings.

- Establish data user feedback mechanisms.
- Eventually expand the working group and make it more permanent.
- Raise the relative budget priority of data management activities.
- Provide for data exchange across changing technologies; standards are key in areas of structured query language, generalized markup language, and a portable operating system, such as POSIX.
- Group parameters for atmosphere, ocean, hydrosphere, biosphere and solid earth to understand (not just detect) global and Arctic mesoscale change.

Following these five reports, formal comments in support of the agencies' implementation efforts were provided by Shelby Tilford, NASA; Helen McCammon, DOE; Robert Corell, NSF; and Richard Smith, DOS. Chairman Bloch requested that the agencies continue their emphasis on developing and implementing the integrative theme of the role of the Arctic in global change. Chairman Bloch reminded the agencies that a revised *United States Arctic Research Plan* is to be prepared by the spring of 1989. Several representatives commented that the Arctic Data Workshop had produced useful results. The agencies then endorsed the establishment of a working group on Arctic data systems.

### *International Activities*

Chairman Bloch called on Robert Corell, Assistant Director for Geosciences, NSF, to report on the recent meeting in Stockholm to examine mechanisms to promote scientific cooperation in the Arctic (see p. 46). Dr. Corell reviewed the history of this initiative, its international support, and the policy guidance developed by the Interagency Arctic Policy Group. He discussed the outcome of the meeting: strong international support for the concept of an International Arctic Science Committee. Agency representatives comment-

ed on the initiative and expressed support for the International Arctic Science Committee. The IARPC expressed its support for continued U.S. participation in the process to establish the Committee.

### *Logistics*

Arctic Research Commission Chairman Juan Roederer presented a report on the Commission's recently completed study of Arctic logistics. Agency representatives provided comments on the need to inventory Federal logistics facilities and agreed that scientific requirements should set the priorities for logistics support facilities. Chairman Bloch concluded the discussion with the request that the IARPC staff develop options on how best to develop mechanisms to satisfy the logistics requirements of the *United States Arctic Research Plan*.

### *Concluding Statements*

Juan Roederer presented a statement on behalf of the Arctic Research Commission. He noted that the Commission had just opened its Washington, D.C., office.

Mr. Bloch concluded the meeting with a summary of the actions agreed to by the IARPC:

- To continue the planning and implementation process and develop specific action plans.
- To establish and participate in the data working group.
- To support the development of the International Arctic Science Committee.
- To develop mechanisms for interagency logistics cooperation, including a working group.
- To continue to work with the Arctic Research Commission.

There were no comments submitted by the public. The next meeting of the IARPC, tentatively scheduled for spring 1989, will review progress on these actions and the biennial update of the Plan.

# United States Arctic Research Commission

## *Eleventh Meeting: September 24, 1987*

Commission Members  
Present: Juan G. Roederer, Vice-Chairman;  
Oliver Leavitt; Elmer E.  
Rasmuson; A. Lincoln  
Washburn; Robert Corell  
representing Erich Bloch.  
Staff: W. Timothy  
Hushen, Lyle Perrigo.  
Observers: Jerry Brown,  
National Science Founda-  
tion; Luis Proenza,  
University of  
Alaska-Fairbanks.

The Arctic Research Commission held its eleventh meeting in conjunction with the Arctic Science Conference in Anchorage, Alaska, on September 24, 1987. Vice-Chairman Roederer called the meeting to order in the Commission's Alaska offices, and indicated that the major agenda topics to be discussed included membership of the Commission, Arctic research logistics, Federal/State Task Force recommendations and the FY88 Commission budget.

### *Interagency Arctic Research Policy Committee Activities*

Dr. Robert Corell, Assistant Director of Geosciences, National Science Foundation, representing Erich Bloch, reported that the United States Arctic Research Plan had been transmitted by the President to Congress and that the Interagency staff is developing elements of the implementation plan. He reported that the ONR and the NSF formulated a memorandum of understanding calling upon them to act in unison on securing additional ships for the U.S. research fleet. There is a strong recognition that a dedicated research vessel with ice-breaking capability is needed for the Arctic. At the current time, the Government has identified a need for 700 ship-days in Arctic waters. Elmer Rasmuson noted that heavy-duty icebreakers should also be justified in economic terms.

### *Rotation of Members*

Vice-Chairman Roederer noted that a replacement needed to be identified for James H. Zumberge, who tendered his resignation as Chairman and as a member of the Commission on July 20, 1987. Until a new chairman is appointed he will continue to serve, but he could not attend this meeting because of previous commitments. Dr. Roederer suggested that members should submit names individually rather than the Commission submitting a slate. Mr. Rasmuson strongly supported this position. Regarding the Commissioners whose terms will end in 1988 (Rasmuson and Wash-

burn), Elmer Rasmuson suggested that members of the Commission Advisory Group should be considered to fill the slots designated for individuals from the research community.

The Commission discussed strategies to speed up the process of identification of a new Chairman. The Commission has momentum, and it is important that a new Chairman be identified as soon as possible.

### *Logistics*

The Commission is mandated to recommend methods for improving logistical planning and support of Arctic research. Lyle Perrigo briefly reviewed the draft report on U.S. Arctic Research Logistics and indicated that it would be revised to follow the general outline of the Commission's earlier report, *National Needs and Arctic Research: A Framework for Action*. The Commission agreed that the revised report should be distributed to the Commission's Group of Advisors for review.

The Commission agreed that the following points should be made in the conclusion section:

- A polar research vessel is urgently required, and as a short-term solution, the United States should lease such a vessel for use in the Arctic.
- Buoys should be considered for multiple use, including fisheries research.
- The United States should establish a centralized contact point for Arctic logistics information and support in the U.S. Arctic, as exists for Greenland and Canada.

The report is being coordinated with State of Alaska officials in their survey of research logistics support facilities in the State. Elmer Rasmuson indicated that it would be helpful if the draft report indicated the individuals who supported specific recommendations.

In March 1987 the Commission called for the near-term acquisition of an Arctic research vessel. The most expeditious means of satisfying a host of research demands appeared to be to charter one of the icebreakers laid up in foreign yards with an option to buy. Current estimates suggest that an ice-

Detailed minutes of  
Commission meetings and  
hearings are available di-  
rectly from the U.S. Arctic  
Research Commission Of-  
fice, Interstate Commerce  
Commission Building,  
Suite 6333, 12th and Con-  
stitution Avenue N.W.,  
Washington, D.C. 20423.

breaker could be modified for research and chartered for a five-year period for less than \$20 million.

The Office of Science and Technology Policy (OSTP) asked the Commission to review a proposal to modify a decommissioned submarine to be used as an ice-locked, Arctic research platform. The Commission reiterated its recommendation that Federal funds for Arctic Ocean research would be better spent by first chartering and then constructing an icebreaking research vessel for the Arctic. These vessels have the flexibility necessary for a broad spectrum of research.

### *Federal/State Task Forces*

The Commission noted that action was still pending on its recommendation to the President and Congress on the need for research on the role of sea ice in the Bering Sea ecosystem. Elmer Rasmuson and Oliver Leavitt agreed to call the need for this project to the attention of Senator Ted Stevens. They will also work with groups such as the Bering Sea Fishermen's Association to encourage support for the program.

The Commission reviewed the recommendations of its Federal/State Task Force on Arctic health research. The Task Force identified four areas in which significant and productive research could be conducted in the Arctic: injury control, cancer, diet and atherosclerosis, and infectious disease. The Commission found the proposed research programs to be well thought out and requested that the Commission Chairman officially transmit them to the President and members of Congress and recommend that they be funded. In addition, the Secretary of DHHS should be notified of the importance of these programs.

### *Administrative Activities*

The Commission agreed that it should meet some time during the period of December 9-11, 1987, in San Francisco in conjunction with the American Geophysical Union's fall meeting. As soon as a new Chairman has been identified, the Commission should seek to reschedule the previously planned Congressional meeting in Washington. The Commission briefly considered what it might do to better understand DOD's Arctic research interests. It was noted that earlier in 1987 Senator Stevens had encouraged the Commission to work with DOD on Arctic research issues. It was agreed that, as a first step, security clearances should be obtained for the members of the Commission.

## *Twelfth Meeting: December 11, 1987*

The Commission held its twelfth meeting in San Francisco, California, in conjunction with the fall meeting of the American Geophysical Union. This was the first meeting presided over by the newly appointed Chairman, Juan Roederer.

Dr. Roederer opened the meeting by remarking that he was honored to be appointed by the President of the United States as Chairman of the Arctic Research Commission.

Key issues and activities before the Commission requiring attention are logistics and data, new arrangements for international scientific cooperation, a protocol on research ethics relating to residents of the Arctic, review of the five-year plan and how well agencies are responding to it, amendments to the Act to improve the work of the Commission, the desire to consult more with the Commission's advisors, improving interactions with Congress, and a concentrated effort to better inform the general public of the activities, interests and mission of the Commission.

### *Congressional Comments*

David Garman, representing U.S. Senator Frank Murkowski, complimented the Commission on its efforts in promoting international cooperation in Arctic science. The Senator was aware of former Chairman Zumberge's international initiative that preceded comments in October 1987 by General Secretary Gorbachev. Mr. Garman believed that a meeting between President Reagan and the General Secretary on December 9-10, 1987, resulted in a statement favoring the Commission's initiatives.

### *Interagency Arctic Research Policy Committee Activities*

Jerry Brown reported that Peter Wilkniss had just returned to Washington, D.C., as a result of the unfortunate crash of the LC130 in the Antarctic.

He also reported that the first issue of *Arctic Research of the United States* was about to go to the printer. That journal would carry information on agency programs and reports of IARPC and Commission meetings and activities. On March 21-24, 1988, NOAA and USGS, on behalf of the IARPC, will convene a workshop in Boulder, Colorado, to identify environmental data access, storage and use, particularly for long-term changes. The bien-

Commission Members Present: Juan G. Roederer, Chairman; Oliver Leavitt; Elmer E. Rasmuson; A. Lincoln Washburn; Jerry Brown representing Erich Bloch. Staff: W. Timothy Hushen, Lyle Perrigo, Lisa Ramirez. Commission Advisory Group Members: James Baker, Joint Oceanographic Institutions; Ben C. Gerwick, University of California; Arthur Grantz, U.S. Geological Survey. Observers: Roger C. Barry, University of Colorado; Henry Cole, Office of the Governor, State of Alaska; David Garman, Office of Senator Murkowski; Mona Janopaul, NOAA; Mark Meier, University of Colorado; Bruce Molnia, National Research Council; Luis Proenza, University of Alaska; Gunter Weller, University of Alaska.

nial update of the five-year Arctic Research Plan is underway and will include research priorities for each of the main categories of the Plan. Other activities are

- Plans to sponsor the Northern Libraries Colloquy in June 1988.
- Preparation of an IARPC biennial report to the President due January 31, 1988.
- Discussions by the Federal Oceanographic Fleet Coordinating Committee (FOFCC) on requirements for an Arctic research vessel.
- An NSF request to the University-National Oceanographic Laboratory System (UNOLS) to develop a scientific rationale for an Arctic research vessel.
- NSF's response to the National Science Board's recommendations contained in the report *The Role of the National Science Foundation in Polar Regions*.

### *State of Alaska Activities*

Henry Cole, science advisor to Alaska Governor Steve Cowper, reported on science policy activities, pending legislation, and northern perceptions of research in Alaska.

The Alaska Science and Engineering Advisory Commission

- Focused attention recently on the four health science proposals prepared by a Commission Federal/State Task Force.
- Intends to examine the research needs of fisheries and engineering.
- Intends to circulate its logistics report in the next several months.

Governor Cowper plans to introduce a bill in the legislature in January to establish an Alaska Science Foundation. Information acquired recently from Kaktovik suggests that researchers continue to ignore local resident input in planning their projects.

### *International Cooperation*

Chairman Roederer asked W. Timothy Hushen to provide a brief history of recent efforts to promote international cooperation in Arctic research. Hushen described contacts at a SCAR meeting in 1986; a meeting in Oslo in early 1987 attended by several scientific leaders and the scientific attache of the Soviet Embassy; a report authored by E.F. Roots, O. Rogne, and J. Taagholt outlining a process to promote cooperation, encouraging comments in October from General Secretary Gorbachev; and indications that the Reagan-Gorbachev summit resulted in a statement encouraging such work. Follow-up is expected at a planning session to be held in Sweden in

early 1988. A meeting in late 1988 in the Soviet Union is also anticipated.

Arthur Grantz reported on the Polar Research Board Subcommittee trip to the Soviet Union in November 1987. The objective was to learn about Soviet interests and programs on the geology of the Arctic Ocean Basin and continental margin. Soviet scientists suggested a number of potential initiatives for cooperation, including deep-sea drilling, an icebreaker drift experiment, and seismic and sedimentation studies in the Arctic Basin.

Bruce Molnia advised the Commission of the visit by Frank Press, President of the National Academy, to the Soviet Union in January 1988. The U.S. Academy will propose studies on solid earth geophysics and Beringia to the Soviets.

Chairman Roederer remarked that several cooperative agreements have been signed recently with the Soviets. Cited as examples were a 1984 accord for the study of the upper atmosphere over Svalbard and a 1987 arrangement between Alaska and Siberia to undertake health and medical research. Also noted was the 20 years of activities leading to the successful organization of the International Union for Circumpolar Health, which involves health and medical scientists from all Arctic nations.

The Chairman directed attention to a proposed position statement entitled *The Role of the Arctic Research Commission in International Scientific Cooperation*. Although the Act assigns no specific duties to the Commission in this regard, the Chairman stated that basic scientific research does not recognize political boundaries. The Commission has been seeking methods to encourage work between scientists and nations with Arctic interests. In view of the situation, he felt that the Commission needed to issue a statement regarding its role in international scientific matters. Mr. Rasmuson remarked that the Commission exists to identify needs and make recommendations. The oversight in the Act should be corrected by an amendment assigning the promotion and overview of international scientific cooperation in the North to the Commission. The pros and cons of involvement with the International Council of Scientific Unions were addressed during an open discussion. Mr. Hushen reported that the statement before the Commission on international cooperation endorses the establishment of an international nongovernmental scientific community to promote international cooperation and scientific research in Arctic

areas. The statement has been reviewed by the advisors. Following discussion the Commission approved the statement, which includes recommendations that the U.S. participate in the proposed International Arctic Science Committee in cooperation with the Commission, the Interagency Arctic Policy Group, the IARPC and the National Research Council.

### *Arctic Data and Information Systems*

Chairman Roederer opened the discussion on this agenda item by saying that the Commission still needed to develop and endorse a position on Arctic data and information. The 1984 Act requires that the Commission suggest methods of improving efficient sharing and dissemination of data and information on the Arctic among interest public and private institutions. The *United States Arctic Research Plan* specifically requests that the Commission make recommendations on this issue. Chairman Roederer noted the completion of the project at the Arctic Environmental Information and Data Center supported by the NSF on northern information networks. The Commission must approve a statement setting forth its beliefs on how data and information issues should be addressed.

Jerry Brown indicated that in addition to the forthcoming Boulder workshop on data the NSF asked the Polar Research Board (PRB) to look at data sharing and dissemination in the social sciences.

Chairman Roederer asked the Commission to formulate a position on data and information. Proposed was the formation of a select subcommittee of the Group of Advisors with a charge to

- Examine existing statements in documents describing needs relating to Arctic data acquisition, transmittal, storage, dissemination and access.
- Collect information from experts on the current status of data use and disposition.
- Prepare a statement of findings regarding efficient sharing and dissemination of data.
- Provide solutions in the form of recommendations for action.

The findings and recommendations were to be short and concise. The subcommittee was to complete its task in six months. There was a consensus that these approaches were acceptable to the Commission.

### *National Arctic Research Consortium*

Chairman Roederer invited Vice Chancellor Luis Proenza, University of Alaska-Fairbanks,

to report on efforts to form a national Arctic research consortium. He described the Polar Research Board meeting in Fairbanks in September 1987 attended by representatives from a number of universities with Arctic research interests. There was general agreement that some arrangement was needed to foster cooperation among groups conducting research in the North. The need was particularly great in communications, logistics, and accessibility and dissemination of data and information. Representatives from interested institutions plan to meet in Boulder, Colorado, January 18-19, 1988, to draft articles of agreement and to address action needed to initiate the consortium. The Commission declined to make specific comments about preferred modes of operation or desirable relationships between the consortium and the Commission. The status of the consortium will be discussed at the next Commission meeting.

### *Logistics*

Chairman Roederer noted that a draft document prepared by the staff was nearly complete. The Commission agreed to delay action on a summary statement of logistics pending receipt of input from its advisors. The modified statement will be sent to Commission members for approval or modification.

### *Federal/State Cooperation*

Budgetary support for the proposals on fisheries and health was discussed. The research is directed toward gaps between existing Federal and State agency programs. The Commission previously had endorsed these proposals and recommended that they be supported by the Federal government. The Alaska Science and Engineering Advisory Commission has embarked on a campaign to publicize the need for the research described in the four health proposals.

### *Public Information*

Commissioner Rasmuson remarked that the Commission needed to relate research needs to economic issues, as well as to improve press and media coverage. Chairman Roederer announced his desire to hold a press conference in Anchorage before Christmas. To be emphasized to the media would be new Commission initiatives and support for efforts to establish an Alaska Science Foundation.

### *Administrative Activities*

Mr. Hushen noted that the Commission's annual report was to be submitted to the

President and Congress before February 1, 1988. The report will contain the proposals advanced by the Federal-State Health and Fisheries Task Forces. The Commission approved the draft report for publication.

Henry Cole asked the Commission to consider means of supporting Alaska Governor Steve Cowper's legislation to establish an Alaska Science and Technology Foundation. Support could be in the form of press conferences or testimony before legislative committees. The possibility of holding the next meeting in Juneau was discussed so that the Commission could stress the importance of the legislation. Elmer Rasmuson pointed out that the timing of this meeting was important and that the Commission would likely have its greatest impact sometime between late February and March. The Commission agreed to meet in Juneau, the specific date contingent on the availability of the Governor.

Additional administrative details were discussed in executive session. The FY89 budget request is \$500,000.

Chairman Roederer announced the pending closure of the Commission office in Los Angeles and the opening of an executive office in Washington, D.C. The Executive Director of the Commission would be located in Washington, D.C. Having the Chairman in Alaska should give increased emphasis to the role that State plays in U.S. Arctic research.

### *Thirteenth Meeting: March 10-11, 1988*

The Arctic Research Commission held its thirteenth meeting in Juneau, Alaska, on March 10 and 11, 1988. The Commission met in Juneau primarily to offer its views on the importance of the pending legislation on an Alaska Science and Technology Foundation and to review the status of a number of Commission activities.

Commission members met informally with Governor Steve Cowper and discussed a wide range of research topics, including the status of the bill on the Alaska Science and Technology Foundation. The Commission met separately with several legislative committees to discuss its views on the Foundation. These included the House Resources Committee, the Chairman of the State Oil and Gas Committee, the House and Senate Health, Education and Social Services Committees and the Senate Committee on International Trade, and members of the Senate Finance Committee.

The Commission also held a public meeting on March 11 in Juneau to hear comments on the proposed Foundation and other topics, including fisheries and related marketing needs.

### *Congressional Comments*

Lisa Sutherland reported that U.S. Senator Stevens would question Federal agencies about Arctic research expenditures and about where additional research support was needed, based on questions raised by the Commission. These questions would be put to the agencies when Congress reviews their budget requests. Ms. Sutherland said that Senator Stevens was interested in suggestions for additional research that might be conducted by R/V *Tiglax*, the U.S. Fish and Wildlife Service vessel now in use in Alaskan waters.

Elmer Rasmuson noted these interests would put the agencies on notice that the Commission was serious about discharging mandated duties. The Commission agreed to raise questions on the icebreakers, health and fisheries, and on compliance with the emphasis placed on these topics by the Commission.

David Garman commented on recent hearings concerning the Arctic National Wildlife Refuge (ANWR). Senator Murkowski intends to offer an amendment proposing that 1-2% of the Federal government's share of anticipated ANWR revenues be devoted to Arctic research. This amendment would be introduced from the floor if the bill progresses that far this year.

### *State of Alaska Activities*

Henry Cole described the strategy to develop and sustain support for the bill to establish the Alaska Science and Technology Foundation and its companion bill to provide an endowment. The administration is trying to raise public and legislative consciousness about the importance of research. The two bills are scheduled for debate and action during this session (see p. 3 for discussion of the bill signed by Governor Cowper on May 13, 1988). The Alaska Science and Engineering Advisory Commission completed a draft of its report on logistics support. That document describes the facilities and operations in Alaska available for research. Draft copies of the report are being circulated; a copy was given to the Commission and complements the document prepared by the Commission.

### *International Cooperation*

Chairman Roederer summarized the history leading to current efforts to reach an agree-

*Commission Members Present: Juan G. Roederer, Chairman; Oliver Leavitt; Elmer E. Rasmuson; A. Lincoln Washburn, Staff; W. Timothy Hushen, Lyle D. Perrigo. Commission Advisory Group Members: Thomas F. Albert, North Slope Borough; Ben C. Gerwick, University of California-Berkeley; John Middaugh, Alaska State Epidemiologist, Anchorage. Observers: Henry Cole, Office of the Governor, State of Alaska; David Garman, Office of Senator Frank Murkowski; Lisa Sutherland, Office of Senator Ted Stevens.*

ment encouraging international scientific cooperation in the Arctic. Federal agencies are seeking methods to ensure involvement in the development of this new policy. The Chairman, past Chairman, and Executive Director will attend the Stockholm meeting in late March, along with participants from the NSF (see the report of this meeting on p. 46). John Middaugh reported that international cooperation in circumpolar health was well advanced. The International Union for Circumpolar Health applied for adherence to the International Council of Scientific Unions (ICSU) and believes it will soon be recognized as a part of that body. Chairman Roederer remarked that it was important to keep the National Academy of Sciences involved in developing agreements relating to international scientific cooperation in the Arctic and later efforts for this group to gain admission to ICSU, since the Academy is the official adherent to ICSU in the United States.

### *Logistics*

The Act called for the Commission to review logistics and recommend methods of improving such support for scientific research. The Commission's report had been prepared in late 1987, discussed at the San Francisco meeting and revised in response to comments from the group of advisors. Tom Albert commented that the current statement did not address fully the need for land-based logistical sites. He believes the statement will send a message to the scientific community that land-based logistics is of low priority, and if such were the case, that would have unfortunate ramifications for facilities at Toolik Lake, Barrow, and elsewhere in the Arctic. A.L. Washburn suggested that use of the State's catalog of logistical sites and services may be a means of solving the problem resulting from lack of comment on existing land-based support facilities. The Chairman indicated that the Commission supports the concept of regional logistics centers. Elmer Rasmuson and Oliver Leavitt indicated that a statement should be added to the report that covers the needs for land-based systems.

### *Consortium*

Chairman Roederer reported on recent efforts to establish a national Arctic research consortium. Representatives from several universities, including San Diego State Univer-

sity, University of Alaska-Fairbanks, University of Washington, Ohio State University, and University of Colorado, met at Boulder, Colorado, in late January. Those attending decided to proceed with this endeavor. Dr. Luis Proenza, Vice Chancellor for Research, University of Alaska-Fairbanks, was named chairman. Ben Gerwick remarked that the statement of mission for the consortium does not mention engineering and that it should. Elmer Rasmuson liked the idea of having a consortium of universities focusing on Arctic problems. A viable consortium would be one more component in the larger system of Arctic research interests that could be called upon for support in achieving the mandated mission of the Commission.

### *Administrative Activities*

The question of a logo and possible designs was discussed. Lyle Perrigo suggested that greater Commission emphasis be placed on compiling a collection of photographs of its activities.

Chairman Roederer directed attention to the "job descriptions" proposed for the Chairman and Commission staff. Following discussion there was a consensus that these proposals should be redrafted and reviewed. Elmer Rasmuson requested that future minutes be sent in draft form to the advisory group in order to speed the transfer of information to the advisors.

In Executive Session, Chairman Roederer indicated that the position of executive director of the Commission is being advertised. Notice of the opening appeared in the March 11, 1988, issue of *Science*.

Chairman Roederer noted that Dr. Harold A. Mooney, biologist from Stanford University, has resigned from the Commission's group of advisors due to the press of other commitments. Positions as advisors were offered to and accepted by James Zumberge and Thomas F. Albert, former Commission chairman and senior scientist for the North Slope Borough at Barrow, Alaska, respectively.

The next meeting of the Commission was set for May 2-3, 1988, to be held in the Commission's new offices in the Interstate Commerce Commission Building, 12th and Constitution, Washington, D.C. The main topic for this meeting should be the discussion and approval of new initiatives of the Commission and of mechanisms on how to implement them.

## Forthcoming Meetings

*Listed here is a compilation of some forthcoming 1988 and early 1989 meetings, workshops and conferences on Arctic or northern topics and activities. Readers are invited to submit information on upcoming meetings, as well as reports on national or international meetings attended, to J. Brown, Arctic Research, National Science Foundation, Room 620, 1800 G St., NW, Washington, D.C., 20550.*

### **The 7th Northern Research Basins Symposium/Workshop: Applied Hydrology in the Development of Northern Basins**

**25 May–1 June 1988, Ilulissat/Jakobshavn, Greenland**

Contact: Danish Society for Arctic Technology  
c/o Greenland Technical Organization  
Hauser Plads 20  
DK 1127 Copenhagen K, Denmark

### **International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions,**

**6–8 June 1988, Joensuu, Finland**

Contact: Leena Rantajarvi, P.B. 436,  
SF-00101 Helsinki, Finland  
Phone: +358-0-19291  
Telex: 126086 VYH SF  
Fax: 6951326

### **Northern Libraries Colloquy 12: Northern Information: The Global Connection**

**5–8 June 1988, University of Colorado, Boulder, Colorado, U.S.A.**

Contact: Ann Brennan, WDC-A for Glaciology,  
CIRES, Campus Box 449, University of Colorado,  
Boulder, CO 80309, U.S.A.

### **POLARTECH '88**

**15–17 June 1988, Norwegian Institute of Technology Studies Administration, Trondheim, Norway**

Contact: Polartech '88,  
Norwegian Institute of Technology,  
Department of Continuing Education,  
N-7034, Trondheim, Norway  
Phone: 44 7 59 52 51  
Telex: 55637nth ad n

### **Fifth International Symposium on Ground Freezing**

**26–28 July 1988, Nottingham, England**

Contact: R.H. Jones  
Dept. of Civil Engineering  
University of Nottingham  
NG72RD, England  
Phone: 44 602 50 61 01 Ext. 3518/2676  
Telex: 37346 (UNINOT G)

### **V International Conference on Permafrost**

**2–5 August 1988, Trondheim, Norway**

Contact: V International Conference on Permafrost (VICOP), Norwegian Institute of Technology  
Department of Continuing Education  
N-7034, Trondheim, Norway  
Phone: 47 7 59 52 54  
Telex: 55637 nth ad n

### **2nd International Symposium on Cold Regions Development**

**9–13 August 1988, Hokkaido Development Engineering Centre, Harbin, China**

Contact: Harumi Sasaki  
Hokkaido Development and Engineering Center  
6-1, South 1, West 9  
Chuu-Ku, Sapporo, Hokkaido, 060, Japan  
Phone: (011) 271-3028  
Fax: (011) 271-5115

### **Symposium on Ice and Climate**

**21–25 August 1988, Seattle, Washington, U.S.A.**

Contact: Hilda Richardson, International  
Glaciological Society, Lensfield Road  
Cambridge CB2 1ER, United Kingdom  
Phone: 44 223 355974  
Fax: 44 223 336543

### **Offshore Northern Seas Conference and Exhibition**

**23–26 August 1988, ONS, Stavanger, Norway**

### **Ninth IAHR Symposium on Ice**

**23–27 August 1988, Hokkaido University, Sapporo, Japan**

Contact: Hiroshi Saeki, Dept. of Civil Engineering,  
Hokkaido University, Kita 13, Nishi 8, Kita-Ku,  
Sapporo 060, Japan  
Fax: 011-717-4745  
Telex: 932302 Hokuen J

### **Applied Glaciology—Third Symposium**

**4–9 September 1988, Norway**

Contact: Hilda Richardson, International  
Glaciological Society, Lensfield Road  
Cambridge CB2 1ER, United Kingdom  
Phone: 44 223 355974  
Fax: 44 223 336543

### **Northern Hydrocarbon Development in the Nineties: A Global Perspective**

**30 September–4 October 1988, Yellowknife and Calgary, Canada**

Contact: Freddie Frakling, Geotechnical  
Sciences Laboratory, Carleton University  
Ottawa, Ontario K1S 5B6, Canada  
Phone: (613) 564-2815  
Telex: 053-4232

### **Arctic Division AAAS, Science Education**

**7–10 October 1988, Fairbanks, Alaska, U.S.A.**

Contact: Neal B. Brown, Geophysical Institute,  
University of Alaska, Fairbanks, AK 99775-0800  
Phone: (907) 474-7558

### **Sixth Inuit Studies Conference**

**17–20 October 1988, University of Copenhagen, Copenhagen, Denmark**

Contact: Jens Dahl, Institute of Eskimology,  
Fiolstraede 10, 1171 Copenhagen K, Denmark  
Phone: 01-159166

### **Japanese Society of Snow and Ice 50th Anniversary**

**24–26 October 1988, Tokyo, Japan**

Contact: Committee for 1988 Annual Meeting  
308 Ban Cho Heim 1-2  
Nibancho, Chiyuda-Ku, Tokyo 102, Japan  
Phone (overseas): (813) 261-2339  
Fax: 03-262-1923

### **Polar Research Board**

**24–26 October 1988, Byrd Research Center, Ohio State University**

Contact: Tim Hushen, Polar Research Board,  
National Academy of Sciences,  
2101 Constitution Ave., Washington, D.C.  
Phone: (202) 334-3479

**Second National Student Conference on Northern Studies**

**24-25 November 1988, Conference Centre,  
Ottawa, Ontario, Canada**

Contact: National Student Conference on Northern Studies, Association of Canadian Universities for Northern Studies, 130 Albert Street, Suite 1915, Ottawa, Ontario, Canada K1P 5G4  
Phone: (613) 238-3525

**Civil Engineering in a Winter Environment:  
Building and Maintaining Infrastructure  
Fifth International Cold Regions Engineering  
Specialty Conference**

**6-8 February 1989, St. Paul, Minnesota**

Contact: Tom Krzewinski, Conference Chairman, Lakehead Testing Laboratory, Inc., 226 North Central Avenue, Duluth, Minnesota, 55807, U.S.A.  
Phone: (218) 628-2295

**8th (1989) International Conference on Offshore Mechanics and Arctic Engineering**

**19-23 March 1989, The Hague**

Contact: Jin S. Chung, Colorado School of Mines, 1500 Illinois Street, Golden, CO 80401  
Phone: (303) 273-3573, 420-8114  
Telex: (910) 934-0190 CSM GLDN  
Fax: (303) 273-3283

**Tenth International Conference on Port and Ocean Engineering Under Arctic Conditions (POAC 89)**

**12-16 June 1989, Lulea, Sweden**

Contact: Lena Karbin, S-951 87 Lulea, Sweden  
Phone: +46 920 917 75  
Telex: 80207 Centek S  
Fax: 2 +46 920 997 26

**American Society of Limnology and Oceanography  
18-27 June 1989, Fairbanks, Alaska, U.S.A.**

Contact: Institute of Marine Sciences  
University of Alaska  
Fairbanks, Alaska 99775-1080  
Phone: (907) 474-7531

**National Meetings with  
Themes and Special  
Sessions on  
Arctic Science**

American Geophysical Union, December 5-9, 1988, San Francisco.

American Association for the Advancement of Science, January 14-19, 1989, San Francisco.

***Illustration  
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Facility, University of Alaska, Fairbanks. Pages 34 and 35: National Snow and Ice Data Center, University of Colorado, Boulder. Page 36: Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Pages 39, 40 and 41: Russell Schnell, University of Colorado, Boulder. Page 47: Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Page 48: Wärtsilä Shipbuilding Co., Helsinki, Finland. Page 57: Minerals Management Service, Alaska. Page 62: Rob Stapleton, University of Alaska, Anchorage. Back cover: Thomas F. Forhan, Division of Polar Programs, National Science Foundation, Washington, D.C.

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**Catalog of Federal Domestic Assistance Number 47.050, Geosciences**

*Back Cover* The Soviet icebreaker Mudyug demonstrating icebreaking in the White Sea. Built as a conventional icebreaker in 1982, the ship was fitted with a new bow in 1986. The design is unique in that it breaks ice by shearing as the bow rides over the ice, leaving an essentially ice-free wake behind the ship and significantly reducing fuel consumption. A group of Canadian, German and U.S. professionals with interest in this field were aboard the vessel for ten days in February, 1988, as guests of the ship operator, the Northern Shipping Company of Archangelsk, U.S.S.R.

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