U.S. AMAP National Implementation Plan
Spring 2000

Introduction

Recognizing the sensitivity of the Arctic to pollution by contaminants that are generated both in the Arctic and at lower latitudes, and conscious of the degree to which the human population of the Arctic is dependent on the health of the region's ecosystems, in June 1991, in Rovaniemi, Finland, the governments of the eight Arctic nations adopted the Arctic Environmental Protection Strategy (AEPS). In this strategy, the Arctic nations committed themselves to international cooperation to ensure the protection of the Arctic environment and its sustainable and equitable development, while protecting the cultures of indigenous people.

Believing that there should be more governmental attention to Arctic issues, especially in the area of sustainable development, in 1996 the eight Arctic governments created the Arctic Council. This Council is to promote cooperation and coordination among the Arctic states; oversee and coordinate the programs that were established under the earlier AEPS; oversee and coordinate a sustainable development program; and disseminate information, encourage education and promote interest in Arctic-related issues. The U.S. is chair of this Council for the period 1998-2000.

There are five working groups under the Arctic Council: Protection of the Arctic Marine Environment (PAME); Conservation of Arctic Flora and Fauna (CAFF); Emergency Prevention, Preparedness and Response (EPPR); Arctic Monitoring and Assessment Program (AMAP); and Sustainable Development (SD).

The principal purposes of AMAP are to document levels and trends of environmental contaminants; assess the effects of contaminants on Arctic biota and ecosystems; anticipate adverse biological, chemical and physical changes in Arctic ecosystems; and evaluate potential risks from environmental contamination to Arctic residents and ecosystems and recommend actions required to reduce such risks. AMAP is also concerned with potential impacts on the Arctic region of climate change and increased ultraviolet radiation.

The first phase of AMAP (1991 - 98) concluded with the publication of a comprehensive assessment of the effects on Arctic ecosystems of persistent organic pollutants, heavy metals, radioactivity, acidification and Arctic haze, petroleum hydrocarbons, climate change, ozone depletion and ultraviolet radiation. AMAP also had a subgroup dealing with the subject of pollution and human health. The AMAP working group presented a summary report entitled *Arctic Pollution Issues: A*

State of the Arctic Environment Report to Ministers of the Arctic nations in 1997. The text of this report is available on the web site http://www.amap.no/ . The much larger and more technical *AMAP Assessment Report: Arctic Pollution Issues* was published in 1998. This document is available as a CD-ROM.

The 12th meeting of the AMAP working group, Helsinki, December 7 - 9, 1998, marked the effective beginning of the second phase of AMAP. During this phase, AMAP will not attempt to produce another comprehensive assessment of effects of contaminants on the Arctic environment. Instead, it will focus over the next five years on production of a limited number of assessment reports on specific pollution issues that will be presented to Ministers and Senior Arctic Officials for their consideration. At the Helsinki meeting a timetable for production of these reports was developed; but it was also emphasized that, whenever possible, the timetable should be adjusted so that assessment reports can be presented at other relevant international environmental fora. The U.S. came out of the Helsinki meeting with responsibility for leading the development of assessment reports on Arctic environmental effects of climate change, ultraviolet radiation, and heavy metals. The U.S. will also participate in preparation of other assessment reports where it does not have the lead.

It should be recognized that AMAP and, indeed, all of the Arctic Council programs do not operate in a vacuum. Many Arctic problems are components of global, hemispheric, regional, national or local issues that are being addressed in other fora; and this fact must be taken into account in assessing the potential impacts of contaminants on the Arctic region.

The U.S. plan

The U.S. views its National Implementation Plan as something of a loose leaf binder rather than a hard bound volume. That is, the U.S. plan will be a changing one, with new programs and projects being added as agencies in local, state and Federal governments together with private organizations begin new projects, and with completed activities being dropped from the plan. In line with this approach, the information presented here is a selection of some AMAP-related activities that agencies plan to pursue over the next few years. Other relevant projects and programs will be added in subsequent versions.

In the sections that follow, we describe a complementary set of science objectives being addressed by U.S. federal and state agencies and local organizations. First, we describe two rather broad federal agency programs, supported by the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA), that support research on a variety of AMAP-related topics. Then we say a few words about NOAA's new Arctic Research Office, which is acting as coordinator of U.S. AMAP activities. Finally, we present detailed outlines of a number of projects that fit under the headings of persistent organic pollutants and heavy metals, radioactivity, petroleum hydrocarbons, climate change and ultraviolet radiation, human health, and multiple stressors.

NSF's Arctic contaminant research

Understanding of contaminant behavior within the Arctic's atmospheric, marine, terrestrial and estuarine systems requires an in-depth examination of complex, interdependent natural processes. Quantification of these processes provides the foundation for development of a multi-faceted perspective and predictive understanding that contributes to the knowledge base used by management and policy decision makers in planning, development, pollution avoidance, remediation, and restoration activities. Such understanding is fundamental to appreciating and mitigating the impacts of contaminants on human physical and socioeconomic systems.

The U.S. National Science Foundation (NSF) encourages and supports a wide variety of special studies relevant to contaminants in the Arctic. These fundamental research projects focus either on aspects of individual systems or on fundamental interrelationships among multiple systems. They range from microscopic to global in scale and organization. A specially developed 1999 Arctic initiative, AContaminant Behavior and Impact in Northern Polar Regions, has recently awarded $4.0 million in support of 13 two-year and three-year projects focused on a wide variety of contaminants. NSF is encouraging continued submission of proposals on contaminants, including heavy metals, radionuclides, persistent organic pollutants, hydrocarbons and aerosols. For at least five years, the type of research encouraged by this initiative will continue to be considered by NSF's Office of Polar Programs.

Non-exclusive examples of studies appropriate for consideration under NSF's Arctic contaminant emphasis include fundamental research projects on:

- transport pathways, rates, processes and reservoirs of contaminants B from microscopic to global scales B within atmospheric, marine, terrestrial, and estuarine systems;
- impact on transport of molecular-scale interactions involving microbes, inorganic and organic compounds, and colloids;
- influence of unique Arctic conditions (e.g., temperature and light) on the transformation and fate of contaminants;
- biomagnification of contaminants in marine and terrestrial foodwebs and the dynamics of change in contaminant concentrations;
- effects of combined contaminants on biota;
- influence of UV-B on contaminant behavior in aquatic systems;
- development of novel chemical methods or sensors for determining contaminant levels under polar conditions;
- socioeconomic impacts of contaminants on marine and terrestrial resources and their effects on human communities;
- risk perception and risk assessment for environmental contaminants; and
- role of traditional knowledge in contaminant studies.

NOAA's Arctic Research Initiative

In 1996, as part of an omnibus appropriation measure, the U.S. Congress appropriated $1.0 million to support an Arctic Research Initiative within the National Oceanic and Atmospheric Administration (NOAA) during FY1997. NOAA's Office of Oceanic and Atmospheric Research and the Cooperative Institute for Arctic Research at the University of Alaska Fairbanks subsequently issued a joint announcement of opportunity inviting proposals in two principal areas: natural variability of the Western Arctic/Bering Sea ecosystem, and anthropogenic influences on the Western Arctic/Bering Sea ecosystem. Fifty-seven proposals were received, and 15 of them received support: 6 under the heading of Green Belt biology, 2 under air-ice-ocean interactions in the Bering Sea, 1 under boundary layer processes, 4 under Arctic haze and UV flux, and 2 under contaminants. Progress reports on these projects are available on the website http://www.cifar.uaf.edu .

The Arctic Research Initiative continued during FY1998 and FY1999 at a budget level of $1.65 million each year. Funded projects involved scientists from the University of Alaska Fairbanks; other Alaskan universities; nine non-Alaskan universities; Russian, Canadian and Japanese institutions; the Alaskan Department of Fish and Game; the Eskimo Walrus Commission; the Barrow Arctic Science Committee; the North Slope Borough; and Denali National Park and Preserve. Six projects were supported under the heading of Green Belt biology, 2 under air-ice-ocean interactions in the Bering Sea, 3 for the previous two topics combined, 6 under Arctic haze and UV flux, 5 under contaminants, and one under data management. Copies of a report entitled *NOAA's Arctic Research Initiative: The First Three Years* are available from NOAA's Arctic Research Office.

In FY1999, NSF transferred funds to NOAA for support of the International Arctic Research Center (IARC) in collaboration with the Cooperative Institute for Arctic Research (CIFAR) at the University of Alaska Fairbanks. NOAA's Office of Oceanic and Atmospheric Research and the University of Alaska Fairbanks agreed to combine those funds with the Arctic Research Initiative for FY2000 in a joint announcement of opportunity. Awards totaling over $7 million were subsequently awarded to a number of U.S. and foreign institutions to support 58 projects on global climate change and its effects on the Arctic, including detection; interactions and feedback modeling; paleoclimates; Arctic haze, ozone and UV; contaminants; and impacts and consequences on biota/ecosystems.

Coordination

On October 1, 1999, NOAA created an Arctic Research Office (ARO) within its Office of Oceanic and Atmospheric Research. ARO provides a focal point for NOAA's activities in the Arctic, Bering Sea, and North Pacific regions. ARO manages the Arctic Research Initiative and other funds allocated to it, supporting both internal and extramural research activities. ARO participates in U.S. interagency fora and in international activities related to the Arctic and adjacent regions. In particular, ARO represents NOAA on the Interagency Arctic Research Policy Committee, leads U.S. involvement

in the Arctic Monitoring and Assessment Program (AMAP) under the Arctic Council, and promotes coordination of AMAP with other working groups of the Council. ARO provides a technical focal point for the Cooperative Institute for Arctic Research at the University of Alaska Fairbanks. ARO prepares or coordinates NOAA budget initiatives relating to the Arctic and adjacent regions.

As the leader of U.S. participation in AMAP, ARO will maintain regular communication with the AMAP Secretariat in Oslo; communicate frequently about AMAP-related programs with involved federal, state and local U.S. agencies; represent the U.S. government at international AMAP meetings; interface with the U.S. Department of State on activities of the Arctic Council; and take responsibility for coordinating the next assessment of the impacts of climate change, increased ultraviolet radiation, and persistent organic pollutants on the Arctic. ARO plans to establish a U.S. AMAP website.

PERSISTENT ORGANIC POLLUTANTS AND HEAVY METALS

The AMAP Assessment Report documents gaps in our understanding of contaminant inputs, their transport processes, and food web interactions. For example, detailed long-term monitoring data on concentrations of toxic contaminants in biota and habitats of the Alaskan Arctic are lacking. Although marine food webs are poorly understood, biomagnification of contaminants via food webs is an area of major concern. The AMAP report recommended the following priorities for POPs in the next phase of AMAP: (1) monitoring spatial distribution, contaminant levels and biological effects in Arctic species that have body burdens of POPs at or above levels of concern; (2) improving our understanding of the adverse effects of POPs on human populations, especially on child development; and (3) filling data gaps, specifically from U.S. and Russian sites.

A number of researchers have begun to address recommendations of the AMAP reports. A project on the *Investigation of Heavy Metal and Organochlorine Concentrations in Polar Bears (Ursus maritimus) Tissues collected in Alaska* is filling data gaps for this species in the U.S. Arctic. The polar bear is a potential indicator species of the Arctic ecosystem and is one of the species recommended to be monitored under AMAP. Comparison of POP and metal levels in polar bears with contaminant levels in other populations will provide an indirect measure of the health of polar bears and their habitat within Alaska. Alaska Natives are concerned about contamination levels in the marine animals they eat. Data from this study will be useful in epidemiological studies to assess the potential risks from contaminants for subsistence consumers.

For researchers to be able to address questions of spatial distribution and levels of contaminants in Arctic species, it is necessary to have a reliable source of good-quality samples, such as those collected through the Alaska Marine Mammal Tissue Archival Project (AMMTAP). AMMTAP maintains a specimen bank of samples that can be analyzed in the future as new and better techniques for chemical analysis are developed and when new contaminants appear in the environment. Half of each sample in the National Biomonitoring Specimen Bank (NBSB) is archived for long-term storage and future analysis, and the other half is available for immediate analysis. The NBSB also maintains all the data and information associated with the samples, e.g. results of analyses and measurements of the animals from which the samples were taken.

In order to protect Arctic ecosystems and indigenous populations from the adverse effects of POPs, a project titled *Multilateral Cooperative Pilot Project for Phase-out of PCB Use, and Environmentally Safe Management of PCB-containing Wastes in the Russian Federation* is being conducted under the auspices of the Arctic Council and AMAP. This study is addressing the problem of PCB production, use and storage in the Arctic and near-Arctic regions of Russia. These sources in Russia are thought to be a particular threat to the Arctic environment and ecosystems, as outlined in the 1998 AMAP Assessment Report.

Investigation of Heavy Metal and Organochlorine Concentrations in Polar Bear (*Ursus maritimus*) Tissues Collected in Alaska

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Goals/Objectives

- Determine concentrations of metals in liver, kidney, and muscle tissues of polar bears harvested in northern and northwestern Alaska. Levels of methyl mercury in muscle tissues will also be analyzed.

- Determine concentrations of organochlorine pesticides and PCBs in fat tissues from polar bears harvested in northern and northwestern Alaska.

- Determine if metal or organochlorine concentrations in polar bear tissues differ between geographical areas or population stocks within Alaska and compare these levels with other Arctic populations.

- Establish baseline levels of metal and organochlorine contamination of polar bears in Alaska. Monitor polar bear tissues to determine trends in contaminant levels. Develop and maintain a contaminant database for polar bear tissues in Alaska.

Description of Project

The increase in atmospheric contamination within the Arctic and sub-Arctic through long-range transport from lower latitudes has raised concerns about the potential effects of metals and organochlorine contamination on marine mammal and human populations. Although the major use of organochlorines occurs in the industrial centers at more southern latitudes, they are transported to the Arctic via rivers, air and ocean currents. The Arctic ecosystem is particularly sensitive to environmental contamination due to the slow rate of breakdown of organochlorines and the presence of long-lived organisms with low rates of reproduction and high lipid levels. Due to the lipophilic nature of organochlorines, the highest levels are usually found in the blubber and fat of animals at the top of the food chain such as polar bears (*Ursus maritimus*). Polychlorinated biphenyls (PCBs) were six to fifteen times greater in polar bear fat tissues than fat tissue from ringed seals (*Phoca hispida*) collected near Barrow Strait near Resolute, NWT. The most abundant organochlorines found in polar bears are PCB's and chlordane compounds. Recent studies in the Canadian Arctic and the Svalbard area, Norway, have documented regional differences in the levels of organochlorines such as DDT, PCBs, dieldrin, chlordane-related compounds, toxaphene, and chlorobenzenes in polar bear, ringed seal, and Arctic cod (*Boreogadus saida*). Although PCBs have not been linked to reproductive failures in polar bears, this has been documented for other marine mammals including ringed seals. The ability to identify more organochlorine compounds has been augmented by recent advances in gas chromatography-mass spectrometry techniques.

Although elevated metal and organochlorine concentrations have been documented in Canadian polar bear populations, relatively little information is available for populations in Alaska. Prior to the major oil and gas development on the North Slope (ca 1976), metal and organochlorine concentrations polar bears were documented. However, when compared to Canada and Norway, there is relatively little recent information on metal and organochlorine levels in polar bears from Alaska. Data are needed to assess the environmental impact of recent and planned industrial activities in the Arctic, and the long-range transport of contaminants from remote sources.

Polar bears are widely distributed throughout the Arctic and sub-Arctic region and range over large areas in search for food. Data collected through satellite telemetry indicates that there are at least two polar bear population stocks in Alaska, one in the southern Beaufort Sea and the other in the

Chukchi/Bering seas. An area of overlap occurs from Point Barrow to Point Hope. Seasonal movements are closely associated with movements of the sea ice, which in turn influences the distribution and concentration of their primary prey, ringed and bearded seals (*Erignathus barbatus*). Polar bears move south with the ice in the fall and winter and move north as the pack ice melts in the spring and summer.

The Arctic food web is simple and fragile. In the spring, eponic algae blooms on the underside of the sea-ice in the Beaufort, Chukchi, and Bering seas. The eponic algae are eaten by zooplankton, which are eaten by fish, mostly Arctic cod. Polar bears feed primarily on ringed seals, which in turn feed on Arctic cod and large amphipods. Polar bears often eat only seal blubber, where the highest concentrations of organochlorines are found.

Polar bears are ideally suited for monitoring the level and distribution of metal and organochlorine levels in the Arctic ecosystem because of their position at the top of the Arctic marine food chain, relatively simple food web, and their wide distribution. Differences in the origin and movements of currents, rates of atmospheric or geological deposition of metals and organochlorines, and differences in the feeding ecology of polar bears between the Beaufort and the Chukchi/Bering seas may affect metal and organochlorine concentrations found in the two stocks. For example, polar bears in the Chukchi/Bering seas feed more heavily on Pacific walrus (*Odobenus rosmarus divergens*) carcasses and bearded seals. Previous information indicated that mercury concentrations in liver tissues were seven times greater in polar bears from the Southern Beaufort Sea Population than polar bears from the Chukchi/Bering seas population. Current data from adult male polar bears, eight from the Southern Beaufort Sea and seven from the Chukchi/Bering Sea, suggests that the mercury in liver tissues are approximately two times higher in the Southern Beaufort Sea population compared to the Chukchi/Bering seas population.

Hunting and utilizing marine mammals remains an important part of the Alaska Native subsistence lifestyle. Under the Marine Mammal Protection Act of 1972 (MMPA), Alaska Natives are exempt from the general moratorium on taking of marine mammals, which they hunt for food. PCB levels in breast milk from the Inuit in northern Quebec were approximately three times greater than levels in breast milk from Caucasian women in southern Quebec. Alaska Natives are concerned about contamination levels in the marine mammals they eat, primarily ringed, spotted (*Phoca largha*), and bearded seals, Pacific walrus, bowhead whales (*Balaena mysticetus*), and polar bears. The data from this study will also be useful in epidemiological studies to assess the potential risks from contaminants for the primary consumers and assist FWS in protecting subsistence use of this species in Alaska.

Progress to Date

Ninety six adult males have been taken in the past three years during the subsistence harvest with 63 harvested from the Chukchi/Bering Sea population and the remaining 33 from the Southern Beaufort Sea population. Despite the total number of adult males harvested, acquisition of polar bear

specimens from Native hunters assisting in this study has remained relatively consistent at eight bears per year. Twenty-four adult male polar bears have been sampled during the past three years. The number of adult males taken in any one harvest season is dependent upon four main factors: ice conditions, availability of adult male polar bears to hunters, hunter selectivity, and hunter participation. The fall movement of the pack ice to the Alaskan coast has been delayed due to warmer than normal ocean temperatures during the past three years. Due to the slow acquisition of samples, the project will have to be extended for at least two more years.

To date, the investigators have the results for organochlorine analyses from 24 adult males, eight from the Beaufort Sea population and 16 from the Chukchi/Bering seas population. Levels of total polychlorinated biphenyls (Σ-PCBs ppm wet weight) averaged 2.41 ppm (n=24, range 0.90-5.06 ppm) were not high relative to levels found in Hudson Bay, Canada, and Svalbard, Norway, two areas which have some of the highest documented levels of PCBs in polar bears. The highest levels of Σ-PCB were found in one subadult from Point Lay (7.75 ppm) and three adult males from Barrow and Savoonga (5.06 ppm, 5.01 ppm, 5.05 ppm). Six congeners 99, 153, 138, 180, 170, and 194 constituted approximately 87% of the Σ-PCB in the sample.

Mean levels of total hexachlorocyclohexanes (Σ-HCH ppm wet weight) for the 16 bears recently analyzed was 0.87, which is similar to the high levels reported for the Chukchi and Bering Seas by Norstrom et al. (1996). Beta-HCH, the most persistent HCH isomer, constituted about 92% of the sum HCHs. The levels of Σ-HCH in the Chukchi and Bering Sea polar bears are among the highest reported within the Arctic region. Suspected sources are from Asia, carried north via the Japanese current, and from Russian rivers to the north.

Investigators examined 19 trace elements in the muscle, livers, and kidneys of 16 adult male polar bears taken in northern and western Alaska. Only nine samples were used to calculate the average methyl mercury levels because some of the mercury levels in the muscle samples were below the detection limit. The methyl mercury/mercury rations in the muscle tissues averaged 57%. Several elements (Al, As, B, Ba, Be, Mo, Pb) were near the detection limit in all tissues. Preliminary results (n=16) indicate that Hg levels in Alaska polar bear livers (both population stocks combined) are lower than those reported for western Canada in 1986 and levels of Cd and Cu are somewhat higher.

Connection to International AMAP Activities and Priorities

Polar bear is a potential indicator species of the Arctic ecosystem, and it is one of the species identified to be monitored under the Arctic Monitoring and Assessment Programme (AMAP). AMAP is an international effort to assess the health and ecological risks to the Arctic region associated with contamination from radioactive waste, persistent organics, and other contaminants. Under the 1973 International Agreement on the Conservation of Polar Bear, signed by Canada, Norway, Denmark (Greenland), Russia, and the United States, each nation has the responsibility to protect polar bears and their habitat. Comparison of metal and organochlorine levels in polar bears with contaminant levels in

other populations will provide an indirect measure of the health of polar bears and their habitat within Alaska. The lack of information concerning contaminants in Arctic Alaska is particularly evident when compared to work in Canada and Norway.

Resources

The Division of Environmental Contaminants of the U.S. Fish and Wildlife Service (FWS) has contributed a majority of funds to date. British Petroleum contributed $15,000 for this study and these funds were matched by $15,000 from the National Fish and Wildlife Foundation. FWS has coordinated with the Alaska Nanuuq Commission and received in-kind support from the North Slope Borough on the collection of samples for contaminant analysis. The Marine Mammals Management Office has contributed significantly to this project by providing funds for travel and salary for the principal investigator. The metal and organochlorine analyses have been contracted with labs associated with the Patuxent Research Lab. In addition, analysis for organochlorines is being contracted through Dr. Ross Norstrom, Canadian Wildlife Service. The reason for using the Canadian Lab is so that our results are directly comparable with the work done in Canada. Our specimens are also being used to compare results between different labs as part of an effort to improve quality assurance and quality control of specimen analyses at participating laboratories.

Opportunities for Others to Participate in the Project

FWS is open to developing partnerships with Native corporations and organizations (Arctic Slope Regional Corporation, North Slope Borough), petroleum companies active on the North Slope (BP, Phillips Petroleum), Alaska Department of Fish and Game, Alaska Department of Health, and other Federal Agencies (Minerals Management Service, Environmental Protection Agency). Within FWS we have submitted proposals to the Division of Environmental Contaminants, Challenge Cost Share Program, and the Bering Sea Ecosystem Team. Contacts have been made with the British Petroleum, Alaska, Inc., ARCO, Alaska, Inc., North Slope Borough Native Corporation, Alaska Nanuuq Commission, Coastal Marine Institute, and the Environmental Protection Agency. Although positive feedback has been indicated from everyone who has reviewed or been made aware of this project, the only non-federal funds received to date have been from British Petroleum. When and if Russia resumes polar bear hunting, it would be useful to analyze samples collected in Russia from the Chukchi/Bering sea population.

Alaska Marine Mammal Tissue Archival Project (AMMTAP)

This project, which began in 1987 with Minerals Management Service (MMS) funding, under the Outer Continental Shelf Environmental Assessment Program**,** is now conducted jointly by USGS/ Alaska Biological Science Center, NOAA/National Marine Fisheries Service/Office of Protected Resources, and the National Institute of Standards and Technology.

The purpose of the project is to collect tissue samples from Alaskan marine mammals and to store these samples under the best conditions so that they can be analyzed in the future for environmental contaminants. A developing related project for 1999 is the Seabird Tissue Archival and Monitoring Project (STAMP) which will mirror the AMMTAP in purpose and procedure. Stamp is a partnership of USGS, NIST, and the U.S. Fish and Wildlife Service.

Specimens Archived to date:

Species	Location (years)
N. fur seals	St. Paul Island (87, 90, 97)
Ringed seals	Barrow (88, 91, 94-99)
	Nome (89, 91, 93-99)
Bearded seals	Barrow (89,96)
	Nome (89, 93, 94, 98-99)
Harbor seals	Prince William Sound (90, 94)
	Cook Inlet (94,97)
	Aleutian Islands (96-97)
Spotted seals	Nome (91, 96)
Steller sea lions	Cook Inlet (90)
	Aleutian/Pribilof Islands (97)
Walrus	Nome & St. Lawrence Island (93-99)
	Round Island (96, 98)
Belugas	Point Hope (89,97)
	Point Lay (90, 96,99)
	Cook Inlet (92, 94-96, 98)
	Nome (96-96)
Bowheads	Barrow (92-94, 96-97)
Polar bears	Barrow (96-99)
Seabird Eggs	Cape Lisburne (98)
	St. George Island(98-99)
	Barren Island (98-99)
	St. Lazeria (98-99)
	Diomede Islands (99)

Tissues collected for archival are primarily liver, fat (blubber), and kidney. Blood, muscle, and other tissue types, as well as bile, are sometimes collected for special purposes. Teeth and claws are collected for age determinations and additional tissue samples are collected for histopathology. Currently only eggs are collected under STAMP.

Sampling procedures are standard for each species. Tissue samples are only collected from freshly killed animals taken by subsistence hunters, animals accidentally caught in fishing nets, or animals that strand alive (e.g., Cook Inlet beluga whales). One 300-g sample of each tissue-type (liver, fat, kidney, and sometimes muscle) is taken from each animal. This amounts to a piece of tissue ~ 5 inches long by 3 inches in diameter.

Only procedures designed for this project are used to collect samples; these procedures are presented in two NIST publications: NBSIR 88-370 (1988) and NISTIR 4529 (1991). The steps used to take the samples are carefully recorded from the moment the animals expire until the samples reach the specimen bank. Only equipment specifically designed for this project is used in sampling (e.g., titanium and Teflon tools, Teflon sample containers, special gloves, etc.). Samples are frozen as soon as possible in liquid nitrogen and shipped to the National Biomonitoring Specimen Bank.

Measurements are made of the levels of hexachlorabenzene, dieldrin, mirex, toxaphene, total PCBs with selected congeners, and chlordanes. Also the metals mercury, cadmium, arsenic, lead, selenium and silver.

The National Biomonitoring Specimen Bank (NBSB) is located at NIST, Gaithersburg, Maryland. In 1997, marine samples archived in this specimen bank were moved to a NIST satellite specimen bank facility in Charleston, South Carolina.

The specimen bank maintains collections of environmental samples that can be analyzed in the future as new and better techniques for chemical analysis are developed, and if and when new environmental contaminants appear in the environment. Half of each sample in the NBSB is archived for long-term storage and future analysis. The other half is available for immediate analysis. The NBSB also maintains all the data and information associated with these samples (e.g., results of analyses, measurements of the animals from which the samples were taken, etc.)
The sample archival procedures insure stability during long-term storage. Samples are stored in the NBSB at 150 ^{o}C (-238 ^{o}F). This low temperature is required to minimize sample changes during storage.

Organizations collaborating with AMMTAP are: North Slope Borough Department of Wildlife Management (Barrow), Natural Resources Department of Kawerak, Inc. (Nome), NOAA National Marine Fisheries Service (Anchorage), Fish and Wildlife Service, Marine Mammals Management (Anchorage).

AMMTAP coordinates with and has provided information on contaminants in marine mammals to many organizations, including: the North Slope Borough Department of Wildlife Management, the North Slope Borough Fish and Game Management Committee, the Alaska Eskimo Whaling Commission, the Kawerak Natural Resources Department, the Alaska Beluga Whale Committee, the Cook Inlet Marine Mammal Council, RurALCAP, the Eskimo Walrus Commission, the Alaska Department of Fish and Game, and the Alaska Department of Health and Social Services. AMMTAP has also worked with the North Slope Department of Wildlife Management (Dr. Todd O'Hara) and the Alaska Department of Health and Social Services (Dr. Grace Egeland) in special investigations of subsistence foods and human health.

Analyses of the marine mammal tissues for contaminants are not conducted by AMMTAP on a large scale because only small amounts of funding are available; therefore, the limited money requires that samples be prioritized early in the funding cycle. In order to expand the possibility of analyses, the project actively seeks additional funding as well as other researchers with their own funding who are interested in analyzing the banked samples. If samples are provided to outside investigators, the researchers are required to provide the results to the AMMTAP in a timely manner and to those local parties and appropriate agencies who have a need for the results. The researchers are also required to participate in a NIST quality assurance program in order to insure that the results are accurate and that their quality can be documented and verified.

So far, most of the analyses for pesticides, PCBs, and trace elements (including potentially toxic heavy metals) have been conducted on beluga whales (Point Lay, Point Hope, and Point Lay), bowhead whales (Barrow), and ringed seals (Nome). The results have been provided in both technical reports, scientific journal articles, and special summary reports for local organizations.

Reports resulting from this project include annual reports to the sponsor, government agency technical reports, an article for the general public, special summary reports for local organizations, and scientific journal articles.

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Multilateral Cooperative Pilot Project for Phase-out of PCB Use, and Environmentally Safe Management of PCB-containing Wastes in the Russian Federation

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Goals/Objectives

The objective of this project is to protect the Arctic ecosystems and indigenous populations, including Native Alaskans, by assisting the Russian Federation to (1) cease the use of polychlorinated biphenyls (PCBs); (2) develop and construct/retrofit facilities for production of PCB substitutes; (3) decommission PCB facilities and provide safe disposal of PCBs and PCB-contaminated equipment and material; and (4) remediate PCB sites that have the greatest potential to impact the Arctic.

Description of Project

The project is divided into three phases. Phase I involves estimation of the source term including production facilities, amounts of PCB inventories in storage, and estimated annual environmental releases from PCB production, destruction and storage facilities. The Phase I study has a special focus on those activities that have the highest potential impacts on the Arctic environment. Phase II involves a feasibility study for application of existing alternatives for PCBs, or improved practices, on an individual industrial sector/source term basis, against the inventory developed under Phase I. Phase II evaluates the benefits and problems associated with conversion/retrofits. Again, with special emphasis on the Arctic environment, Phase II also includes selection of sites for construction/retrofit of a prototype facility for production and use of PCB substitutes; selection/development of environmentally sound technologies for destruction of PCB-containing liquids, containers, and equipment; and identification of technologies for rehabilitation of PCB-contaminated areas. Phase III involves the selection of an actual pilot/demonstration project, or projects, for implementation, including demonstration projects of production and use of PCB substitutes, destruction of PCB-containing liquids, containers, and equipment, and rehabilitation of PCB-contaminated areas.

Progress to Date

The first phase of the project was officially endorsed by the Arctic states (Canada, Denmark, Finland, Iceland, Norway, Sweden, Russia and the United States) in the *Iqaluit Declaration* at the first

Arctic Council ministerial meeting in Iqaluit, Northwest Territories, Canada, in September 1998. The Phase I report will be presented at the Arctic Council Ministerial meeting in October 2000.

Connection to International AMAP Activities and Priorities

Phase I of the project is being conducting under the auspices of the Arctic Council and the Arctic Monitoring and Assessment Program (AMAP) to address the problem of PCB production, use, destruction and storage in the Arctic and near-Arctic regions of the Russian Federation. These sources in Russia are thought to be a particular threat to the Arctic environment and ecosystems, as outlined in the 1998 AMAP publication, *AMAP Assessment Report: Arctic Pollution Issues*. It is expected that this multilateral project will further encourage the Russian Federation to become a party to the Convention on Long-Range Transboundary Air Pollution (LRTAP) Protocol on Persistent Organic Pollutants (POPs).

Resources

The U.S. has contributed funds for the Phase I effort, as have all the other Arctic nations, except Russia (which is providing in-kind contributions). The U.S. and other Arctic nations are also contributing technical expertise, in addition to their funding commitments.

Upcoming Events

A PCB Steering Group meeting is planned for June 2000 to discuss the final report for Phase I and the commencement of Phase II.

Assessment of Atmospheric Mercury Transport and Deposition to the Arctic

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Goals/objectives

The purpose of this initiative is to investigate the geographical extent of a phenomenon termed the *Arctic Sunrise* where atmospheric mercury levels have been shown to drop drastically during the Arctic Spring when the sun rises.

This project aims to close what has to date been a gap in mercury measurements by providing mercury speciation and accompanying trace metal deposition rates. Together with back-trajectory modeling and source apportionment analysis, sources and source regions of atmospheric mercury can be identified. With development of a recent state-of-the-art technology for taking such measurements, such analysis can distinguish reactive forms of mercury from elemental mercury and, in conjunction with models, determine local versus regional transport impacts.

The Arctic is especially vulnerable to incursions of air pollutants. It is relatively pristine, and low levels of pollution can therefore have grave consequences. Atmospheric mercury is injected into the atmosphere by numerous natural and industrial processes. Once emitted, it is dispersed widely through the air as it is transported downwind and is eventually deposited to surfaces. We now realize that mercury exists in air in two important forms, elemental mercury vapor (Hg^o), and reactive gaseous mercury (RGM or Hg^{2+}), the combination of which (including trace organic species) is termed total gaseous mercury (TGM). RGM may comprise ~2-5% of TGM, but is important because of its reactivity, and may dominate its deposition flux to surfaces (Lindberg and Stratton 1998).

Description of Project

This project is the first to make speciated mercury measurements in the U.S. Arctic. In particular, investigators will obtain data which, in conjunction with back-trajectory modeling and principal component analysis, will help determine the potential for long-range transport of mercury at that location. Additionally, they will have data to help us understand the processes associated with the Arctic Sunrise phenomenon which is now known to occur in Arctic Alaska as well as in the Canadian Arctic.

This is a cooperative effort between the U.S. Environmental Protection Agency, NOAA, and the Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL). The project has established an atmospheric mercury monitoring site in the U.S. Arctic at Barrow, Alaska. The site is supported by the Observatory Operations Group of NOAA's Climate Monitoring and Diagnostics Laboratory.

The Observatory Operations group operates staffed atmospheric baseline observatories at Barrow, Alaska; Mauna Loa, Hawaii; Samoa; and the South Pole from which numerous in situ and remote atmospheric and solar measurements are conducted, such as measurements of greenhouse gases, aerosols, ozone, ozone-depleting gases and solar and terrestrial radiation. Only at the Barrow

site are atmospheric mercury measurements made. The overall scientific programs and administrative functions of the four observatories are handled from Boulder, Colorado, with on-site station chiefs caring for day-to-day station activities. The meteorological data from each observatory is monitored, processed and put on the Internet on a daily basis by the Observatory Observations Group.

- Barrow station details can be obtained at http://netsrv1.cmdl.noaa.gov/obop/brw/index.html.
- Barrow isentropic plots are available at http://netsrv1.cmdl.noaa.gov/ozwv/traj/plots/brw.html

NOAA and EPA investigators are conducting atmospheric mercury measurements of speciated gaseous mercury (elemental mercury and RGM) using continuous mercury analysis instrumentation. A Tekran7 Model 2537A Ambient Mercury Vapor Analyzer measures elemental mercury in air using Cold Vapour Atomic Fluorescence Spectrophotometry (CVAFS). RGM is measured using a Tekran7 Model 1130 Mercury Speciation Unit. The 1130 speciation unit incorporates a KCl coated annular denuder to quantitatively remove RGM from the sampled air stream. The denuder is periodically thermally desorbed to convert the captured RGM to elemental mercury that is subsequently quantified by the Model 2537A Mercury Vapor Analyzer.

Although the majority of atmospheric mercury is present in elemental form, differentiation is important due to the greater local impact of reactive forms. RGM has much higher wet and dry deposition rates than does elemental mercury. Speciation is of particular interest in the Arctic due to the observed depletion of elemental mercury from the atmosphere during the Arctic Sunrise. Measurements of RGM may help elucidate the transformation processes leading to this depletion.

In addition, atmospheric trace metals are being analyzed at Barrow.

Progress to Date

The continuous mercury analyzer has been operating at Barrow since September 1998. With this instrument, the Arctic Sunrise phenomenon has been confirmed at Barrow. The RGM analyzer has been operating at Barrow since September 1999. Modeling efforts are underway and include input from both EPA and NOAA.

Connection to International AMAP Activities and Priorities

The State of the Arctic Environment Report (1997) noted that mercury is an important pollutant in the Arctic posing a threat to the health of indigenous peoples by bioaccumulating in the fish and mammals they eat. The U.S. has also recognized the importance of mercury and is developing a variety of strategies to reduce mercury emissions.

Resources

EPA provided about $100K to DOE and NOAA for the RGM measurements and modeling. NOAA provided about $100K for purchase of the continuous mercury analyzer and for the modeling work.

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RADIOACTIVITY

JCCEM Contaminant Transport Studies

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Participating Agencies

U.S. Department of Energy (EM-50) and Ministry of Atomic Energy of the Russian Federation under the bilateral agreement *Joint Coordinating Committee for Environmental Management (JCCEM)*

Goals/Objectives

Establish unequivocally the historic field relations, hydrogeologic framework, and migration of radioactive contaminant plumes of the West Siberian Basin from past and ongoing releases of contaminants related to nuclear and hazardous waste disposal operations at the Mayak, Tomsk, and Krasnoyarsk sites to better understand and model contaminant migration at the field scale in the U.S. and to identify cooperative programs for the mutual benefit of the Environmental Restoration and Waste Management Branch of the U. S. Department of Energy (DOE) and the Former Soviet Union.

Description of Program

The Former Soviet Union (FSU) has an extensive nuclear power program with numerous supporting waste management activities that currently involve *ad hoc* storage of low- and intermediate-level wastes by shallow-land burial and in surface-water impoundments, and storage of high-level wastes. Radioactive releases from Mayak, Tomsk, and Krasnoyarsk related to commercial and defense nuclear activities are probably the largest in the world, aggregating over 2 billion curies in current activity. These releases of radioactivity and other hazardous wastes at these sites have resulted in what might be considered as "large-scale long-term experiments." These sites have been monitored over relatively long periods of time and are well known to FSU scientists who have been collecting data and modeling the migration of these contaminants.

The same radionuclides and radionuclide mixtures are of concern at contaminated DOE and MINATOM nuclear production sites. Spatial variability of properties can significantly affect the mobility of radionuclide-organic complexes, as shown in smaller scale laboratory experiments, and by laboratory and field scale chemical manipulation experiments. For credible application of predictive contaminant-

transport models to contaminated sites, the mechanisms controlling large-scale migration of these contaminants need to be assessed at the field scale in the presence of natural geologic media with spatial variations. Because the U.S. has had no accidental or deliberate large-scale releases of radioactive contaminants such as ^{137}Cs and ^{90}Sr in which the field-scale migration is highly instrumented and the possibility exists for approval to test remediation methods at the field scale, this project was established for U.S. contaminant-transport modelers to work jointly with their Russian counterparts to use long-term contaminant-migration data from heavily contaminated Russian sites to develop and validate field-scale, contaminant-transport models for application to U.S. and Russian sites. Cooperative work between U.S. DOE and FSU scientists examining these "large-scale long-term experiments" as well as any planned site characterization and remediation activities will be of mutual benefit to both the DOE and the FSU since it will provide a means for technology evaluation, improvement, and transfer in the important global problem area of site characterization, contaminant monitoring, long term predictive transport modeling, and remedial action design and implementation.

Progress to Date

In FY 1991, DOE's Pacific Northwest National Laboratory (PNNL) initiated this effort by examining the regional geology and hydrology of the West Siberian Basin and Mayak, Tomsk, and Krasnoyarsk areas, based on available literature. From that effort, we defined the detailed site-characterization data and executed the exploratory regional and detailed local ground-water modeling required to understand the overall surface- and ground-water flow directions and contaminant travel times at the Mayak and Tomsk sites:

- PNNL's regional hydrogeologic characterization and hydrogeologic and contaminant- transport modeling of the West Siberian Basin, was initiated in FY 1991 and completed in FY 1995.
- PNNL's hydrogeologic models were tested and benchmarked against our Russian counterparts' models in a FY 1996 model intercomparison study of a simplified site representative of the Mayak Site.
- PNNL, PA Mayak, and PSA Hydrospetzgeologiya initiated a detailed, three-dimensional local hydrogeologic model of the Mayak Site in FY 1997, which was completed in FY 1999, that will be the framework in which detailed contaminant-transport modeling of the Lake Karachai plume can be performed.
- PNNL, VNIPIPromtechnologii, and PSA Hydrospetzgeologiya also initiated site characterization for a detailed, three-dimensional local hydrogeologic model of the Tomsk Site in FY 1997, which was to be completed in FY 1998 preparatory to actual model development in FY 1999. However, the Russian contribution to this work was not funded in FY 1998, and therefore not completed until FY 1999 resulting in re-initiation of PNNL model development being delayed to FY 2000.

This work provides the detailed, quantitative basis necessary for developing and validating joint field-scale contaminant-transport model of the Lake Karachai plume at the Mayak Site (fractured rock case) and an injection plume at the Tomsk Site (sandy sediment case).

Resources

Approximately $4M funding from FY 1992 through FY 2000; FY 2000 funding to U.S. and Russian participants is about $550K.

Amchitka Workers Medical Screening Program

Principal Investigators

Alaska State District Council of Laborers
Alaska Department of Environmental Conservation
Alaska Department of Labor

Background

The Atomic Energy Commission, predecessor of the Department of Energy (DOE), used Amchitka Island in the Aleutians for underground nuclear tests between 1965 and 1971. Section 3162 of the Defense Authorization Act of 1993 directed the Secretary of Energy to develop medical monitoring programs for former DOE workers at significant risk of work-related illnesses due to exposures while employed at DOE. This program at Amchitka is one of several such pilot programs at DOE sites throughout the U.S.

Objectives

The objectives of the medical screening program are (1) to identify former Amchitka workers at potential high risk for work-related illnesses, (2) to offer voluntary participation in a medical screening program, and (3) to determine whether the former worker has suffered an occupational illness from exposure at Amchitka.

Description of Project

An initial needs assessment will determine the nature and degree of potential hazardous exposures and the number of former Amchitka workers who were exposed. Contact will be made with those workers, an interview will be administered to obtain detailed occupational history, and a directed physical examination will be offered. Following completion of the examination, the worker will be informed of the results and conclusions.

Status

An Agreement in Principle was completed between the State of Alaska and DOE. The project started in late 1999.

Resources

Funding is being provided by DOE's Office of Environment, Safety and Health. The initial award is for $229,000. The Office of Health Studies will serve as a point of contact within DOE. Collaboration

will be encouraged with other former worker projects currently in operation at nine other DOE sites.

Point of Contact

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PETROLEUM HYDROCARBONS

Levels and sources of petroleum hydrocarbons, polycyclic aromatic hydrocarbons, and other contaminants in coastal Beaufort Sea

Principal Agencies

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Minerals Management Service, Alaska OCS Region, Anchorage, Alaska

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Background

The North Slope of Alaska is very rich in petroleum and hard mineral resources. Since the discovery of a major oilfield near Prudhoe Bay in 1968, the North Slope has remained the primary focus of petroleum exploration and development activities in the U.S. Arctic. To date, the Prudhoe Bay oilfield and adjacent reservoirs have produced about 12 billion barrels of crude oil (1 cubic meter equals 6.29 barrels) and 3 trillion cubic feet of natural gas (1 cubic meter equals 35 cubic feet). It is estimated that the remaining petroleum reserves in this area consist of over 7 billion barrels of crude oil and 31 trillion cubic feet of natural gas, representing 31 percent and 18 percent of total U.S. reserves, respectively. In addition, the National Petroleum Reserve-Alaska and the Arctic National Wildlife Refuge may contain very substantial and economically recoverable reserves of oil, natural gas, and coal.

Offshore, the Northstar oilfield is being developed and Liberty oilfield appears to be promising. Both are located in the vicinity of Prudhoe Bay. Preliminary test results indicate that Northstar oil is likely to be very light, having API gravity of 42; and Liberty heavy, having API gravity of 25. In comparison, the API gravity of Prudhoe Bay crude oil is 28. As such, the two offshore oils are likely to be quite different from each other in both physical characteristics and chemical composition.

A large amount of data exists to describe the background levels of petroleum hydrocarbons and polycyclic aromatic hydrocarbons in sediments of the Beaufort Sea. Data reported to date show that sediment hydrocarbon concentrations, notably PAH concentrations, in coastal Beaufort Sea are

considerably higher than in other coastal areas of the U.S. Arctic. There are sub-regional differences in both saturated and aromatic hydrocarbon concentrations: the highest values, mean PAH concentration of ca. 2,500 ng/g, are usually found in East Harrison Bay. In general, lower values are found in eastern Beaufort Sea and in deeper waters offshore. As is the case in other areas, petroleum hydrocarbons and PAHs in this area could be derived from natural sources (such as natural petroleum seeps, diagenesis of biogenic precursors, and fires) or from municipal and industrial sources (e.g., urban runoff, spillage of petroleum and refined products, fossil fuel combustion). Although the possibility of forest fires contributing to the levels of PAHs in this area is very remote, the local custom of preparing smoked meats may contribute significantly to PAH intake by people.

The presence of certain biogenic markers in the hydrocarbon samples (such as steranes and titerpanes), source diagnostic ratios of petroleum hydrocarbons and PAHs, and hydrocarbon concentrations in riverine sediment and peat strongly suggest that discharge from the Colville River and erosion of coastlines are the primary hydrocarbon sources. The Colville River drains a major portion of the Brooks Range as it traverses seasonally thawed tundra, coal and oil-shale outcrops, natural petroleum seeps, and peat-laden soils. The relatively high background concentration of hydrocarbons, many of which derive from fossil fuels, may potentially confound the contribution from petroleum industry activities in the region. It is therefore important to refine and augment the existing database, improve capabilities to detect and interpret small compositional changes in hydrocarbons, and conduct targeted research to define source terms.

Planned Studies

The National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, and the Minerals Management Service (MMS), U.S. Department of the Interior, are performing studies in coastal Beaufort Sea to examine the levels and temporal trends in hydrocarbon concentration in sediments and selected biota. The NOAA study, part of its National Status and Trends Program, is to examine sediment geochronology to reconstruct historical trends in coastal contamination. The MMS study, part of its ANIMIDA project, is to document sediment quality (contaminant concentrations and ancillary measurements) in anticipation of petroleum development and production activities offshore.

(1) Historical Trends in Coastal Contamination

A large variety of contaminants from industrial, maritime and urban activities have a strong affinity to adsorb on to particulate matter and, as such, they can settle to the bottom near their point of entry in the coastal zone. Thus changes in the levels of contaminants due to local anthropogenic sources, for example oil and gas development and maritime activities in the U.S. Arctic, as well as hemispheric transport of contaminants and natural fluxes of certain toxic contaminants may be recorded in accumulated sediments. Segments of sediment cores can be dated by the presence of pollen, radiochemistry or other geochemical techniques. As part of the *Historical Trends* component of its National Status and Trends Program, NOAA has collected sediment cores from relatively undisturbed

areas to reconstruct the historical chronology of environmental contamination in different estuaries and coastal areas. Previous analyses of historical trends in contamination using sediment cores from 10 different coastal areas, none in the Arctic, have been successful. Analysis of core samples involves not only the determination of the levels of various contamination at different time periods, they also include diagnosis of the likely source(s) of contaminants. The results of historical trends in contamination in San Francisco Bay were recently published in a special volume of the journal Marine Chemistry (Volume 64, Nos. 102, 1999).

(2) ANIMIDA Project

The ANIMIDA (Arctic Nearshore Impact Monitoring In the Development Area) Project, sponsored by MMS, is designed to establish background conditions in order to verify projected impacts from development and production of petroleum resources in coastal areas under Federal jurisdiction. The project, to be implemented with contributions from and close cooperation with indigenous people and other interested parties, will also provide information needed in post-leasing decisions to help further minimize these impacts.

In addition to measurements of the levels of contaminants in the sediment, and ancillary measurements (i.e. grain size, organic carbon content), the MMS-sponsored study will also examine ambient and presumed construction level of noise and vibration, factors affecting the release and resuspension of sediment in the water column. New studies will be designed to examine the effects of such environmental changes on a nearshore kelp community, seasonal pattern of the bowhead whale migration, and other biological and cultural resources. The scope and detailed objectives of these latter aspects of the ANIMIDA study will be defined in light of petroleum development scenarios in the area.

Goals and Objectives

The overall goal of these studies is to further increase scientific understanding of the levels, distribution and temporal trends in environmental quality parameters in the Beaufort Sea. Special emphasis will be placed on contaminants associated with petroleum exploration and development activities. Specific objectives include:

1) to document historical trends in the concentration of contaminants in coastal Beaufort Sea, and
2) to describe current levels and potential sources of contaminants in coastal Beaufort Sea, with particular reference to the areas that would affected by petroleum development in offshore waters.

Progress to Date

Both studies began in summer 1999. Field sampling and analytical protocols for these studies are benefitting from previous research and monitoring projects in the area, dating back to 1974.

Sediment cores for the NOAA study were collected in August 1999 at randomly selected sites in Elson Lagoon located near Barrow. The lagoon offers a minimally disturbed record of accumulated,

fine-grained sediment. Geochemical analyses of the sediment core samples have begun. Field sampling for the initial phase of the ANIMIDA project started in the 1999 open water season. Strong consideration is being given to field sampling and analytical procedures that would assure compatibility with data from previous studies in the area, in terms of quality control and quality assurance protocols as well as reporting of results.

Relevance to AMAP

The AMAP Assessment Report (1998) provided an excellent compendium and analysis of data on petroleum hydrocarbons and PAHs in the Arctic (Chapter 10). Unlike some other chapters, this chapter highlighted a considerable amount of data and information products from U.S. coastal and offshore areas. The AMAP report recommended that environmental research and monitoring of petroleum hydrocarbons and PAHs be continued in areas where petroleum production is already occurring or is imminent. This was further reiterated during deliberations at a Ministerial Conference in Alta, Norway, in 1997. Furthermore, as new data become available it would be possible to refine and verify a number of source diagnostic ratios for petroleum hydrocarbons and PAHs, examine the synergistic behavior of certain PAHs in the presence of UV-radiation in causing genotoxicity, and conduct a more realistic environmental assessment, including ecological risk assessment.

Resources and Collaboration

Both studies are being funded under the institutional authority and funding authorization of the respective Federal government agencies. As a general practice, study components are funded through competitive procurements, grants and cooperative agreements. Requests for complementary analyses, including chemical analysis of sub-samples, exchange of data, and data interpretation are encouraged. Although there are no immediate plans for international participation in either study, data from the Canadian Beaufort Sea, particularly from the Mackenzie River delta and adjoining shelf region, will be used for comparison and establishing a regional context.

CLIMATE CHANGE AND ULTRAVIOLET RADIATION

Arctic Climate Impact Assessment

Participating Agencies

National Science Foundation (NSF)
National Oceanic and Atmospheric Administration (NOAA)
University of Alaska Fairbanks

Goals

The goals of the Arctic Climate Impact Assessment (ACIA) are:

- To evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences, and
- To provide useful and reliable information to the governments, organizations and people of the Arctic region in order to support policy-making processes.

The assessment will include environmental, human health, and social and economic impacts and will recommend further actions. The assessment will be conducted in the context of other developments and pressures on the Arctic environment, its economy, regional resources, and people.

Description of Project

The ACIA is being overseen by an Assessment Steering Committee (ASC) that is composed of experts and stakeholders from all the Arctic nations. The ACIA will be strongly based on an analysis of existing and forthcoming information, including peer-reviewed publications, indigenous knowledge, and other documented information and data.

This assessment of the consequences of climate change in the Arctic region will lead to the development of fundamental and useful information for the Arctic nations. Examples include:

- Providing clear scientific evidence on climate and UV variability and change within the Arctic, indicating the nature of impacts on human health, the natural environment, and food and water resources;
- Supporting the Arctic nations' interests and needs to address the consequences of climate and UV variability and change on such issues as human health, food and water resources, and flora and fauna of the region;
- Identifying gaps in basic knowledge and fundamental data that need to be acquired in order to better understand climate variability and change at a range of scales;

- Providing a clear and structured basis for future research into climate change, UV and their impacts, including interactive modeling;
- Identifying key strategies for future monitoring programs;
- Providing a foundation for adaptive and coping strategies to be developed;
- Providing benchmarks for future climate assessments; and
- Offering guidance with respect to national and international policy on issues relevant to climate change and ozone depletion, including their combined impacts.

The assessment will yield three documents:

- Scientific document. A series of assessment reviews and analyses that lead to an integrated understanding for the Arctic region. The scientific document will be fully referenced. Its contents will be the responsibility of lead authors and writing teams. It will be subject to peer review guided by the ASC.
- Synthesis document. A comprehensive summary that synthesizes the main findings of the assessment. This volume will be prepared by the ASC in concert with a scientific editor and lead authors in a simple, jargon-free language meant for policy-makers and the general public. It will be subject to peer review guided by the ASC.
- Policy document. AMAP and CAFF will produce a final volume that will relate the information from the scientific and synthesis documents to the policy needs of the Arctic Council and provide recommendations for follow-up measures.

FY 2000 - 2001 Activities

The U.S. hosted an ACIA Scoping Workshop in February 2000 at which all the Arctic nations were represented. During FY 2001, experts from the U.S. and other countries with Arctic interests will begin to prepare the assessment documents. There will be a number of general workshops (e.g., modeling, scenario development) and workshops focused on preparing specific chapters of the assessment report. A communications and outreach strategy will be implemented to ensure that indigenous people and other Arctic residents and stakeholders are involved in ACIA.

Coordination Mechanisms

Both NSF and NOAA are represented on the Assessment Steering Committee, and in this way both are involved in first order planning of the assessment. The two agencies are working together to establish an ACIA Secretariat at the University of Alaska Fairbanks. The involvement of the two agencies is defined in a proposal from the University to NSF and in an agreement between the University and NOAA. Specific funding arrangements have been identified and agreed to by NSF and NOAA.

Atmospheric Radiation Measurement Program: North Slope of Alaska Field Site

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Participating local, state and federal agencies

Barrow Arctic Science Consortium
Ukpeagvik Inupiat Corporation, Science Division
Barrow Environmental Observatory
North Slope Borough
NOAA Climate Monitoring and Diagnostics Laboratory
National Science Foundation
National Aeronautics and Space Administration

Goals/objectives

The overarching goal of the Department of Energy's (DOE's) Atmospheric Radiation Measurement Program is to improve the performance of atmospheric general circulation models used for climate research and prediction. ARM's specific objective is to improve, or develop, new models and parameterizations of cloud and radiative processes (i.e., solar radiation and heat re-radiated from the earth, clouds and atmosphere) that impact the performance of these climate models. Applied to the high latitude environment, these objectives focus largely on the radiative impact of the extremely low water vapor environment in the Arctic winter, the representation of Arctic stratus and cirrus clouds, radiation propagation processes in the presence of cold clouds, validation of satellite remote sensing techniques in cold environments, and instrument technology to acquire needed data in the harsh Arctic environment.

Description of program

The DOE/ARM program was established to support the development of a new generation of improved models and parameterizations of cloud and radiation processes for use in climate models. This objective required data of higher accuracy and precision than previously obtained through continuous, routine meteorological measurement of the atmosphere. To this end, field sites were designed to satisfy data requirements to model the instantaneous radiative flux through the atmosphere and to model the presence and life cycle of clouds in general circulation models of the atmosphere. This objective also required the acquisition of data from a range of climatological regimes. Three sites were selected to provide a data set encompassing mid-latitude, tropical and Arctic environments. The Arctic site was placed in the vicinity of Barrow, Alaska, to provide for logistical supportability and to take advantage of data being acquired by related programs such as NOAA's Climate Monitoring and Diagnostics Laboratory. The Barrow site is complemented by a limited set of instruments installed at the village of Atqasuk, about 100 kilometers south of Barrow, to document and take advantage of the differences between coastal and inland locations regarding cloud cover and net radiative fluxes. The Arctic site as a whole is primarily focused on the radiative flux experiment, but it will be periodically augmented with radiosonde and aircraft data to address the Arctic stratus cloud life cycle as predicted and represented in climate models.

Progress to date

The facility at Barrow was dedicated on July 1, 1997, and began routine data acquisition during spring 1998, in time for the NASA FIRE Arctic Cloud Experiment (http://eosweb.larc.nasa.gov/ACEDOCS/index.html)
In parallel, a somewhat more limited ARM instrumentation suite was operated within the Arctic ice pack as part of the NSF/ONR SHEBA experiment between October 1997 and October 1998 (http://sheba.apl.washington.edu). In late spring 1999, the ARM instrumentation originally deployed as part of SHEBA was redeployed to Atqasuk. For a more complete description of the North Slope ARM site, including instrument lists for both Barrow and Atqasuk, see http://www.arm.gov/docs/sites/nsa.

Connection to international AMAP activities and priorities

At the Arctic Environmental Protection Strategy ministerial meeting in Alta in 1997, the ministers asked AMAP to address problems associated with changes in climate and UV radiation. At the first meeting of the Arctic Council in Iqaluit in 1998, the ministers requested CAFF to monitor and assess, in collaboration with AMAP, the effects of climate change and UV-B radiation on Arctic ecosystems. In the process of pursuing its own programmatic goals, ARM measures radiometric and meteorological parameters of value to fulfillment of these objectives. The ARM instrumentation at Barrow is immediately adjacent to the Barrow Environmental Observatory, where a plethora of ecological research is ongoing. The ARM instrumentation at Atqasuk is also in the immediate vicinity of several ecological research plots.

Resources committed to the project and availability of grants or contracts

The ARM infrastructure of sites, instruments and data system are fully funded by DOE; and infrastructure finding is limited to the operation of the sites and acquisition of data required by the DOE-funded ARM Science Team. The ARM Science Team is funded directly by DOE through proposals received in response to periodic announcements of grant opportunities, nominally on an annual cycle. The Science Team selection process is competitive through scientific peer review and an assessment of the relevance of proposals to the objectives of the ARM Program.

Opportunities for others to participate

The ARM field site at Barrow provides a foundation data set for many research objectives. ARM collaborates regularly with other programs in field measurements at Barrow and other ARM site locations. ARM's installation at Atqasuk can provide a complementary data stream, but collaborative support possibilities are quite limited there.

HUMAN HEALTH

Over the last several years, there has been growing concern about the effects of pollutants on the health of people who live in the U.S. Arctic. An active human health subgroup has developed as part of U.S. participation in AMAP, and the Department of Health and Human Services has encouraged participation by several of its constituent agencies in AMAP-related studies.

The Alaska Native Tribal Health Consortium, which derived from and is closely affiliated with the Indian Health Service, is sponsoring an Alaska Native Cord Blood Monitoring Program, with additional support from other federal, state and local organizations. The Arctic Investigations Program of the Centers for Disease Control and Prevention is contributing to the human health research agenda through its study of emerging and re-emerging infectious diseases in the Arctic. Finally, there would be significant value in developing more sensitive indicators of exposure to, and possible adverse effects of, various pollutants found in the Arctic environment. Sensitive biomarkers, based on genetic or biochemical tests, could advance the medical research agenda considerably if they are properly understood and applied. With this in mind, the National Institute of Environmental Health Sciences sponsored an International AMAP-2 Biomarkers Conference in Anchorage, Alaska, May 2000. All three of these efforts are described in detail below.

Alaska Native Cord Blood Monitoring Program

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Participating Agencies

Centers for Disease Control/National Center for Environmental Health

Centers for Disease Control/Center for Infectious Diseases Arctic Investigations Program
Environmental Protection Agency
Alaska Native Health Service
Alaska Native Tribal Health Consortium
Arctic Slope Native Association
Yukon-Kuskokwim Health Consortium
Alaska Native Health Board Epidemiology Center
State of Alaska Department of Health and Social Services, Epidemiology Section
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Objective

The objective of the Alaska Native Cord Blood Monitoring Program is to gather a statistically significant yearly number of maternal-infant blood samples, at a site serving Alaska Natives with a Bering Sea exposure (Yupik Eskimo) and a site serving Alaska Natives with an Arctic Ocean exposure (Inupiat Eskimo), in order to make a comparative analysis of contaminant uptake in populations that rely on Arctic food chains for sustenance.

The ultimate objectives of the program are to analyze infant and maternal health data for any possible association with pollutants, and to give Alaska Native communities data on health effects of organic and heavy metal contaminants with which they can develop risk reduction strategies.

Background

The Alaska Native Cord Blood Monitoring Program was designed to monitor the levels of selected heavy metals (including mercury) and persistent organic pollutants (including PCB congeners) in umbilical cord blood and maternal blood of indigenous groups in the Arctic, with an initial focus on Alaska Native American populations. The program was developed in response to Alaska Native concerns about the effects of organic and heavy metal contaminants that are accumulating in subsistence food species in the circumpolar north and their effects on the health of mothers and infants.

Description of Program

Patient recruitment: Project investigators seek the voluntary participation of pregnant Alska Native women and obtain their informed consent.

Dietary information collection: A dietary history detailing subsistence food consumption is completed when participants are registered. Personnel from the University of Alaska Anchorage Institute for Circumpolar Health Studies will carry out the dietary survey with each participant and will analyze the data for associations with blood contaminant levels, maternal micro-nutrient levels, and maternal and infant health outcomes.

Specimen collection: A specimen of whole blood is collected at the first prenatal climic visit during routine prenatal care. At delivery, a specimen of umbilical cord blood is obtained, and the paired maternal and infant specimens, along with the maternal dietary survey and medical/demographic information, are sent to the Arctic Investigations Program (AIP) laboratory B part of the National Center for Infectious Disease at the Centers for Disease Control in Anchorage. AIP sends samples of each specimen to the Alaska Native Serum Bank and to the NCEH laboratory in Atlanta for analysis. When results of the analysis are received from NCEH, they are entered in the program database and maintained at AIP.

Sampling: Specimens are obtained from 15 percent of the deliveries at three small coastal hospitals on the Arctic Ocean and Bering Sea coasts. This represents a total of 300 specimen pairs each year.

Data analysis: Several of the participating institutions are collaborating in data analysis. The program depends heavily on the Health Studies Branch of NCEH for statistical support. Interpretation and presentation to Alaska Native groups will be done principally by the Alaska Native Tribal Health Consortium and the Alaska Native Health Board Epidemiology Center. Medical complications of pregnancy, infant health outcomes including growth, development, infections and malformations will be examined for association with individual contaminants and combinations of contaminants.

Surveillance of emerging infectious diseases in the Arctic

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Background and Rationale

Infectious diseases are a continuing menace to all peoples of the globe regardless of age, gender, lifestyle, ethnic background, and socio-economic status. They cause suffering and death, curb sustainable economic development, and impose an enormous financial burden on all societies. Arctic populations have long endured the debilitating effects of both endemic and epidemic infectious diseases, the effects of which have impacted both social and economic development in circumpolar regions of the globe. With the advent of antibiotics, tuberculosis and other life threatening infections seemed conquerable, and the incidence of diseases of childhood such as diphtheria, whooping cough, and meningitis were reduced dramatically through the use of vaccines. These advances, together with improvements in sanitation and water quality, dramatically lowered the incidence of infectious diseases in many people throughout the developing world including those of the Arctic. As we enter the 21st Century, however, the specter of new virulent and antibiotic resistant forms of old diseases such as tuberculosis, measles, diphtheria, and meningitis...once again is threatening circumpolar communities. Our communities are now threatened by a number of newly emerging diseases, such as HIV, hepatitis C, and a host of food and waterborne illnesses. Moreover, several infectious agents have now been commonly associated with the development of malignancies in Arctic peoples: hepatitis B virus, hepatitis C virus (liver cancer), *Helicobacter pylori* (gastric cancer), human papilloma virus (cervical cancer), Epstein-Barr virus (nasopharyngeal cancer). Factors that have contributed to this change in disease incidence in Arctic communities, include:

1. rapid population growth and familial crowding,
2. redistribution of population due to decreased employment opportunities in small Arctic communities,
3. urbanization of Arctic people and ensuant social and economic alienation changes in governments, self-governance, and fiscal policies,
4. increased global travel and potential for introduction of new infectious agents into Native populations,
5. mass-production and globalization of the food supply,

6. changes in human behaviors such as increased substance abuse, intravenous drug use and risky sexual behavior, elevated use of antibiotics in remote Arctic communities, hastening the development of antimicrobial resistance,
7. climatic fluctuations and shifts in animal insect and sea-life habitats, and
8. contamination of the subsistence food supply with pesticide residues with deleterious effects on the developing immune system.

U.S. Government Interagency Recommendations

In December 1994, a U.S. government interagency working group was convened to consider the global threat of emerging and re-emerging infectious diseases. The working group, consisting of representatives from 17 different government agencies and departments, was established under the aegis of the Committee on International Science Engineering and Technology Policy (CISET), of President Clinton's National Science and Technology Council. Led by the Centers for Disease Control & Prevention (CDC), the Department of State, USAID, the Food and Drug Administration, NIH, and the Department of Defense, the working group made the following recommendations for action by the U.S. government.

Work in partnership with other countries, with WHO, and with other international organizations to improve worldwide disease surveillance, reporting and response by:

- Establishing regional disease surveillance and response networks linking national health ministries, WHO regional offices, U.S. government laboratories and field stations abroad, foreign laboratories, medical centers, and WHO Collaborating Centers;
- Ensuring that reliable lines of communication exist between local and national medical centers and between national and regional or international reference facilities, especially in parts of the world where modern communications are lacking;
- Developing a global alert system whereby national governments can inform appropriate worldwide health authorities of outbreaks of infectious diseases in a timely manner, and whereby individual health authorities can access regional centers;
- Identifying regional and international resources that can provide diagnostic reagents for low incidence diseases and help identify rare and unusual diseases;
- Assisting WHO to establish global surveillance of antibiotic resistance and drug use, as a first step toward the development of international agreements on antibiotic usage;
- Encouraging and assisting other countries to make infectious disease detection and control a national priority;
- Preserving existing U.S. government activities that enhance other countries' ability to prevent and control emerging and reemerging health threats;
- Identifying and strengthening WHO collaborating centers that serve unique reference centers for diseases whose re-emergence is feared; and
- Establishing the authority of relevant U.S. government agencies to make the most effective use of

their expertise in building a worldwide disease surveillance and response network.

In keeping with these recommendations, a number of international alliances have been created to promote international emerging infectious disease surveillance and response networks. These include a U.S.-EU multi-national agreement and a working group on surveillance and response focused on food borne diseases (SALMNET, ENTERNET and AMR). These systems provide good access to infectious disease surveillance information within and between Sweden, Finland, Norway, and Denmark. A binational agreement between the U.S. and Russia has also been formed promoting collaborative surveillance projects on tuberculosis, hepatitis, HIV, and sexually transmitted diseases. These agreements, together with existing cooperation between the U.S. and Canada in other areas of health protection, the International Union for Circumpolar Health, create a unique opportunity to establish a circumpolar emerging infectious disease surveillance network.

International Circumpolar Surveillance (ICS) Initiative

With the heightened global concern of new emerging and re-emerging infectious disease problems, the CDC's Arctic Investigations Program, together with Health Canada, have initiated a pilot program linking public health laboratories in Alaska, Yukon Territory, Northwest Territories, northern Quebec, and Labrador to monitor invasive diseases among indigenous populations caused by *Streptococcus pneumoniae, Hemophilus influenzae*, *Neisseria meningitidis*, and Group A Streptococcus. Other infectious diseases of community concern, such as tuberculosis, HIV, hepatitis, food (botulism) and waterborne diseases, and respiratory diseases of children caused by respiratory syncytial virus, can be added to this system as needed. This surveillance system, which now spans the entire arctic region of North America, will allow the standardization of laboratory and data collection methods, the monitoring of disease rates in Arctic communities, the evaluation of effectiveness of vaccination programs on disease rates, the monitoring of emergence of antimicrobial resistance, treatment failures associated with these infections, and focused design of collaborative applied research on risk factors for infection and prevention strategies. Future collaboration with public health laboratories in Greenland (Denmark), Iceland, Norway, Sweden, Finland, and Russia will complete a circumpolar network of laboratories for surveillance on new and reemerging infectious disease in arctic communities. In keeping with the CDC's global strategy for prevention of emerging infectious disease, the ICS will link with other infectious disease surveillance networks to provide detection and intervention of emerging problems world wide.

Connection to International AMAP Activities and Priorities

The 1997 AMAP assessment report [*Arctic Pollution Issues: A State of the Arctic Environment Report*] identified several groups of people in the Arctic who are exposed to varying levels of environmental contaminants. Exposure to persistent organic pollutants (POPs) and heavy metals are of primary concern because of their accumulation in the marine food chain and ultimately in the subsistence food sources of many Arctic residents. The potential effects of these pollutants on human fetal, infant and child development are of concern and are now priority areas of investigation by

both the AMAP and Sustainable Development working groups of the Arctic Council. Studies have also shown that both POPs and certain heavy metals impact key elements of the immune system, thereby compromising the human primary defense against bacterial, viral, and parasitic infections. The surveillance of infectious diseases in Arctic populations will allow measurement of baseline rates of disease, comparisons between Arctic regions, and evaluation of environmental pollution as risk factors for increased rates of infectious diseases.

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International AMAP-2 Biomarkers Conference

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Objective

The purpose of the AMAP-2 biomarkers conference, April 30 - May 3, 2000, was to bring scientists with expertise in developing biomarkers together with scientists and public health specialists who are knowledgeable about Arctic human health issues. The product of the workshop will be a report that makes recommendations for programs and scientific approaches that contribute to the better assessment of the health consequences of environmental pollutants in the Arctic.

Progress to Date

The National Institute of Environmental Health Sciences (NIEHS), a component of the National Institutes of Health, spearheaded the planning and convening of the international biomarkers conference under the auspices of AMAP-2 (human health subprogram) and the Arctic Council. Primary funding was provided by NIEHS, with additional support provided by the National Science Foundation, the National Oceanic and Atmospheric Administration, BP Exploration, the Department of the Navy, the National Aeronautics and Space Administration, the Centers for Disease Control, the National Toxicology Program, the U.S. Geological Survey, the University of Alaska, and the Agency for Toxic Substances and Disease Registry.

The conference was held April 30 - May 3, 2000, at the Anchorage Marriott Downtown Hotel in Anchorage, Alaska, immediately following a meeting of Senior Arctic Officials.

MULTIPLE STRESSORS

Combined Effects from Multiple Stressors in the Arctic-Bering Sea: Symposium and Workshop

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Participating Agencies (preliminary)

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Goals

- Build a conceptual framework for research design and data synthesis to determine the combined effects of multiple stressors on the Arctic Bering Sea ecosystem.
- Create a team of U.S. scientists working toward U.S. goals under the AMAP Phase II

Objectives

- Symposium: establish a forum for discussing the effects of known stressors including heavy metals, organochlorines and other contaminants, as well as global climate change, fishing pressure and habitat alteration, to stimulate thought and discussion and establish a baseline frame of reference for the work shop.
- Work shop: build conceptual models linking activities to stressors to effects on key values of concern, based on draft models presented at the symposium.
- Training: Inform U.S. science team on how to format and input data into the AMAP Thematic Data Centers.

Description

Assessing the effects of a single stressor on an ecosystem is often a daunting task. Far worse is

trying to determine and distinguish the combined effects of multiple stressors. Scientific approaches typically target a single stressor and single effect because of the complexity of trying to discriminate among stressors, or assess an ecosystem. Current research tools are best used for specific experimental applications ill suited for assessing ecosystem level risk. As the need for Arctic ecosystem assessments becomes more urgent, and recognition that multiple stressors must be addressed, standard scientific approaches must be augmented by a new way of looking at the problem. Conceptual models developed by interdisciplinary, interagency teams for watershed ecosystems in the U.S. have been successfully used to identify key pathways, data gaps, and better research questions for addressing multiple stressors and combined effects. This symposium and work shop will use the same approach to engage U.S. and other Arctic scientists in this powerful process.

Progress to Date

Preliminary work was completed on the *Activities and Sources* portion of an Arctic conceptual model based on the AMAP Phase I results. Substantial work has also been done in Alaska, particularly within Native communities, to identify key ecological and human values. These values form the foundation for the assessment process. Logistical planning is just beginning and partnerships are being established. The preliminary meeting target date is September, 2000.

Connection to AMAP

The Multiple Stressors-Combined Effects symposium and workshop are directly responsive to a newly established goal to address combined effects during AMAP Phase II. Workshop results will be provided to AMAP for consideration by the Combined Effects work group.

Resources and Opportunities

EPA is providing $50K to organize and run the symposium and workshop. The University of Alaska Fairbanks will provide conference facilities. It is anticipated that small contracts will be awarded to scientists to prepare materials for the symposium. An interagency steering committee has been established to enhance resource availability, planning and participation.

Open Invitation

The symposium and workshop will principally focus on U.S. Arctic areas, particularly the Bering Sea. However, stressors and effects impacting the Bering Sea are very similar across the Arctic, and the process of constructing conceptual models is the same. Transference will be high. We therefore welcome and encourage participation by experts from all Arctic nations.