

2. *Special Focus*

Interagency Research Programs

The Interagency Committee's research policy states:

The IARPC agrees that a more comprehensive approach to funding of research and baseline programs is required to ensure a long-term, viable research and development presence in the Arctic. This presence will ensure support of the national needs, which include renewable and nonrenewable resource development, environmental protection, and partnerships with the private sector and residents of the Arctic. It will complement other national and international scientific programs, such as Global Change. To this end the IARPC agencies agree to develop an integrated interagency program sufficient for meeting national needs.

For this biennial revision of the plan, agencies agreed that the following six programs are ready for immediate attention as multiagency focused efforts:

- The International Polar Year (IPY)
- Study of Environmental Arctic Change (SEARCH)
- Developing a Research Plan for a Sustainable Bering Sea
- Arctic Health Research
- Research on Resource Evaluation
- Research on Civil Infrastructure.

These coordinated, multiagency programs are being designed to:

- Focus research activities in concert with national policy;
- Build on individual agency efforts in reconnaissance, monitoring, process studies, and modeling;
- Facilitate research and logistics coordination through regionally focused programs;

- Take maximum advantage of remote sensing and new technologies;
- Strengthen interagency data and information management;
- Draw on the strengths of the academic, industrial, and government research communities in planning and implementing programs;
- Support and enhance programs to acquire long-term measurements of key parameters and environments; and
- Enhance international research collaboration.

The U.S. has a substantial economic, strategic, and environmental stake in the Arctic. Domestic energy reserves and the growth in Bering Sea fisheries harvests are two examples of our dependence on Arctic resources. Sound management decisions for sustainable development of Arctic resources hinge on enhanced understanding of the environment, leading to better forecasts. In addition, there is a strong international commitment to collaborate.

Benefits to the Nation from Arctic research include improvements in:

- Knowledge of fishery resources and controlling dynamics;
- Models and data for assessing past climates and global change and their effects;
- International cooperation in a strategic region;
- Forecasts of weather, ice, and ocean conditions;
- Protection of the Arctic environment;
- Understanding of the causes, effects, and limits of air and water pollution; and
- Protection and understanding of cultures and cultural resources.

2.1 *The International Polar Year: 2007–2008*

The years 2007–2008 will mark the 50th anniversary of the International Geophysical Year (IGY) and of the third International Polar Year. This period has been designated the fourth International Polar Year (IPY) by the National Academies of Sciences (NAS), the International Council for Science (ICSU), the World Meteorological Organization (WMO), the Antarctic Treaty System and its adhering nations, the Arctic Council, and many other international organizations. The National Science Foundation (NSF) was designated by the President's Office of Science and Technology to be the lead U.S. agency in organizing IPY activities.

Preparations are underway worldwide to make the IPY a period of intense activity that promises, in the words of the NAS publication *A Vision for the International Polar Year 2007–2008*, to “further our understanding of physical and social processes in the polar regions, examine their globally connected role in the climate system, and establish research infrastructure for the future, (and) ... serve as a mechanism to attract and develop a new generation of scientists and engineers with the versatility to tackle complex global issues” (see <http://books.nap.edu/catalog/11013.html>).

The 1957–1958 IGY and IPY activities greatly increased our knowledge of the world around us and provided profound legacies that continue to benefit research and researchers today. These activities also resulted in the 1959 Antarctic Treaty, which “promotes international scientific cooperation including the exchange of research plans and personnel and requires that results of research be made freely available.” The U.S. played a leading role in shaping and implementing the 1957–1958 IGY activities and plans to do so again in 2007–2008. IPY activities planned for this period are consistent with agency missions and the NAS report of an implementation workshop (*Planning for the International Polar Year 2007–2008: Report of the Implementation Workshop*, <http://books.nap.edu/catalog/11110.html>). U.S. activities during IPY 2007–2008 will focus on research, education, and public outreach efforts and will be coordinated among the Federal agencies and international partners that support research in polar regions.

The following is a discussion of Federal agency planning for the International Polar Year.

2.1.1 *National Science Foundation*

International science years of the past, including IPY 1882–1883, IPY 1932–1933, and the International Geophysical Year of 1957–1958, provided bursts of internationally coordinated research that led to significant discoveries about our planet and left a long-term legacy of data and observations for future generations. In particular, the IGY of 1957–1958 brought a tremendous increase in our ability to predict weather worldwide, to measure the thickness of the Antarctic ice sheets, and to understand the dynamics of Earth's magnetosphere. However, there are still significant gaps in our understanding of the polar regions and the processes that structure polar environments. For example, the factors in the Arctic that are responsible for increasing surface air temperature and decreasing sea ice cover are poorly understood. In the Antarctic, little is known about why a portion of the West Antarctic ice sheet is rapidly melting, thinning, and retreating, thereby contributing to global sea level rise. In both polar regions, many organisms are adapted to withstand prolonged periods of darkness and extreme cold, yet we do not understand how these adaptations evolved or how these organisms may respond to increased variability in the polar environment.

The NSF views IPY 2007–2008 as offering the potential for scientific advances of global importance comparable to those achieved in the previous IPYs. NSF is poised to support the IPY in a variety of ways and will emphasize three major research areas in an Announcement of Opportunity due to be released in the late summer of 2005. These areas of emphasis are compatible with the guidelines developed by ICSU and the U.S. National Academies. They have evolved within the research community as high-priority topics derived from workshops and existing science programs. Education and outreach are also areas where NSF, with its partners in other agencies, can make a significant impact on the understanding of how polar regions influence society and the global environment. Thus, NSF has a particular interest in conducting activities in the polar regions that will leave a lasting legacy of data, observing capabilities, and educational resources for scientists and educators of the future.

Within NSF, the Office of Polar Programs (OPP)

is committed to implementing these activities with the assistance of the research and education directorates. Partnerships for IPY will occur at many levels—within NSF, through interagency collaborations, and in the international arena. The NSF directorates that have expressed interest include Biological Sciences (BIO), Computer and Information Sciences and Engineering (CISE), Education and Human Resources (EHR), Engineering (ENG), Geosciences (GEO), Mathematical and Physical Sciences (MPS), and Social, Behavioral and Economic Sciences (SBE). Federal agencies such as NOAA, NASA, NIH, USGS, DOE, EPA, and the Smithsonian Institution, as well as national science agencies of other countries, have closely related interests. Thus, maximizing the value from partnerships is a key overarching theme for NSF as we plan for IPY.

The following are areas where NSF will play a significant role in IPY.

Study of Environmental Arctic Change

SEARCH is a broad interdisciplinary, multi-scale interagency program with the core goal of achieving a predictive understanding of recent and ongoing changes in the Arctic environment. In addition to understanding how changes in the Arctic are interrelated, SEARCH will investigate the links between Arctic change and global processes and will assess the impacts that Arctic change may have throughout the Northern Hemisphere. SEARCH will evaluate the possibility that observed changes in the Arctic can be used to anticipate changes elsewhere on the globe.

For the period of the IPY (2007–2008), NSF's principal interest related to SEARCH is the implementation of an Arctic Observing Network (AON). The purpose of AON will be to understand environmental change in the Arctic system and its interplay with global oceanic and atmospheric circulation. AON will employ an Arctic-wide coverage of standard integrated measurements, long-term observations, and modeling and analysis. Development of the AON system by U.S. scientists will be closely coordinated with related efforts being planned by the EC and a number of other nations. The combined international effort will result in a substantial increase in our ability to monitor and study change in the Arctic.

Research related to the Bering Ecosystem Study (BEST) is also under consideration. The Bering Sea supports one of the most productive fisheries in the world, contributing about 40% of all finfish and shellfish landings in the U.S., yet

it is one of the least-studied areas of U.S. waters. In recent years, it has become evident that this seasonally ice-covered sea is subject to decadal changes in climate that have resulted in abrupt and unexpected changes in the ecosystem. Of particular concern is the possibility that the combined effects of climate change and fisheries removals may shift marine ecosystems into alternate stable states that may have a lower yield of species valuable to people. Identifying the mechanisms driving ecosystem change, including social and cultural factors, in the Bering Sea is a key research need.

Ice Sheet Stability, Dynamics, and History

The global ice sheets are dynamic features that contain unprecedented records of climate over the past several hundred thousand years. Future changes in the ice sheets of both polar regions will affect sea level, and this is one of the major uncertainties in Intergovernmental Panel on Climate Change (IPCC) climate models. In Antarctica, NSF expects to emphasize studies of the stability and history of the major ice sheets. How do they work, how fast are they changing, and what will they be like in the future decadal-to-century time frame? Inquiry into these questions involves direct studies of ice sheet dynamics but also includes work to understand processes important for interactions of ice sheets with the lithosphere, oceans, and atmosphere. The combination of space-based and surface-based studies is critical to success in this area.

A comparison of the dynamic behavior of the Antarctic and Greenland ice sheets is also a potential topic of IPY research. One component of this comparative work may include obtaining a high-temporal-resolution ice core in West Antarctica for comparison with the climate records obtained from the Greenland ice cores. There will likely be an opportunity to leverage logistics support to the ice-core camp with support for other ground-based activity in West Antarctica and to couple detailed ground- and space-based observations. The work in West Antarctica might include traverse-based studies, or other types of work that will be possible from our logistical hubs, that could be linked to related work in East Antarctica as well as a study of change in the Ross Sea region.

Because of the long lead time required for developing and implementing ice coring programs, NSF is also looking at the IPY as an avenue to create an international collaborative framework to facilitate international ice coring projects beyond

the IPY. The Center for Remote Sensing of Ice Sheets (CReSIS), a Science and Technology Center led by the University of Kansas and supported jointly by NSF and NASA, will conduct and foster multidisciplinary research that will result in technology and models necessary to achieve a better understanding of the mass balance of the polar ice sheets (e.g., Greenland and Antarctica) and their contributions to sea level rise. The focus areas for CReSIS relate closely to the goals of IPY.

NSF-supported studies of ice sheet stability, dynamics, and history will be conducted in close coordination with related work supported by NASA, the British Antarctic Survey, the Institute Polaire Emil Victor (France), and other nations.

Frontiers in Polar Biology: Life in Extreme Cold and Prolonged Darkness

Ecologically important biogeochemical processes begin before the traditional operational season in polar regions and continue beyond the end of the traditional field season. Living organisms are known to continue functioning at temperatures well below freezing and during periods of prolonged darkness. New technologies (genomics, proteomics, etc.) offer the opportunity to gain a deep understanding of how organisms have adapted to these extreme environments. The Long Term Ecological Research (LTER) sites at Toolik Field Station in Alaska, at Palmer Station on the Antarctic Peninsula, and in the McMurdo Dry Valleys, as well as research platforms operating the Arctic and Southern Oceans, offer the opportunity to bring these new technologies to bear in research on the polar regions. A recent NAS report, *Frontiers in Polar Biology in the Genomics Era* (<http://books.nap.edu/catalog/10623.html>), describes some potential research benefits of these new tools. Within NSF, there is interest in OPP and in the Biology and Geology Directorates in this area of research. OPP has examined the technical feasibility of extending Antarctic operations into the austral fall and early winter and may be able to implement such capability by 2007. Supporting winter work elsewhere in the polar regions will require evaluation of options on a case-by-case basis.

Education and Outreach

The Office of Polar Programs has maintained strong support for linking research in the polar regions with formal education and outreach to the public. NSF has fostered U.S. scientists' interests in sharing their research with broad audiences. Many polar researchers have been successful in

seeking support from education programs for more directed efforts, such as NSF's IGERT and GK-12 programs, as well as Arctic Research and Education and Geosciences Education. Strong international partnerships in educational activities have developed in association with research programs in both polar regions. In the Arctic, such partnerships include U.S. collaboration with groups from Russia, Greenland, Iceland, Canada, Denmark, Norway, Sweden, and Finland. In the Antarctic, partnerships include U.S. collaborations with many nations that participate in the Scientific Committee on Antarctic Research (SCAR).

OPP sponsored a workshop in June 2004 (www.ldeo.columbia.edu/~mkt/PolarED_Web.htm) to bring together educators, researchers, media and museum outreach experts, agency representatives, and others to discuss effective mechanisms to conduct education and outreach in support of the IPY. The workshop highlighted many of the education and outreach efforts that have already been supported by NSF, including Teachers Experiencing Antarctica and the Arctic (TEA), Teachers and Researchers Exploring and Collaborating (TREC), Antarctic Artists and Writers Program, various journalists in the field, museum exhibits, and Research Experiences for Undergraduates (REU). The NSF Education and Human Resources Directorate (EHR) has been a key partner with OPP in many of these efforts and will play a key role in developing educational programs for IPY. The NSF Office of Legislative and Public Affairs will develop an agency-wide outreach effort and will provide coordination for multiagency outreach.

EHR plans to build on the fascination of students with the remote polar regions to enhance their interest in science and engineering careers with the aid of educational materials developed in connection with IPY research. Other agencies, such as NASA and NOAA, have robust polar research and education programs interested in supporting IPY efforts. NSF is developing the foundation for international and interagency partnerships to bring together support and expertise from the community of researchers and educators. Another area where NSF can have a significant IPY impact is in research on distance education, both in terms of technology and in terms of the science of learning as it applies to different cultures. The aim of these efforts is to develop highly visible, long-lived education and outreach products for IPY research and to provide opportunities for educating the next generation of polar researchers, the public, and policy makers.

Data Management

Archival and distribution functions for data required for support of Arctic and Antarctic IPY research are distributed among all the U.S. national data centers. These data are held in global archives at the National Climatic Data Center (NCDC) (climatology and meteorology), at the National Oceanographic Data Center (oceanography), at the National Geophysical Data Center (seismology, geomagnetism, marine geology and geophysics, solar and ionospheric studies, ecosystems, topography, and paleoclimatology), and at the National Center for Atmospheric Research (upper atmosphere and ionospheric studies). For example, data sets for a vast array of cryosphere-specific variables in the Arctic (sea ice, snow cover, permafrost, etc.) are archived and distributed through the National Snow and Ice Data Center (NSIDC) and the World Data Center for Glaciology in Boulder, Colorado (<http://www.ngdc.noaa.gov/wdc/>). These also include satellite-derived measurements, in situ observations, and ancillary information from the Antarctic and the Arctic that have been supported by NASA, NOAA, and NSF. NOAA/NESDIS/NCDC in Asheville, NC, holds the global satellite data archives for polar-orbiting satellites.

For data management, a new focus on “Virtual Observatories” is being developed and promoted by the “Electronic Geophysical initiative Year” (<http://www.eGY.org>). As more researchers provide their data on individual or institutional web or FTP sites, rather than submitting to data centers, the current “push data” approach (where the data must be submitted to the National and World Data Centers System) is now becoming more difficult to implement. Therefore, the worldwide data management community is focusing on providing more effective access to globally distributed data sets via the “pull data” concept. The eGY group and the ICSU World Data Centers Panel are working toward a convergence of data centers into “data clearinghouses,” while the Virtual Observatories are developing a network of interconnected data holdings and retrieving/visualizing software that constitutes the worldwide “data fabric.” NSF is supporting the concept of Virtual Observatories as a means of managing relevant data for IPY.

Other Areas of IPY Research

In addition to large-scale projects such as those mentioned above, NSF plans to support IPY activities that address the ICSU and NAS guidelines in a broad spectrum of areas, particularly

research that addresses opportunities in the social sciences, systematic and biotic diversity surveys (e.g., the ongoing Census of Marine Life), implementation of observing systems, and research in the Southern Ocean on the transport and fate of nutrients and carbon.

One example of research in the social sciences is the study of endangered languages in Arctic cultures, where we have the opportunity to create a legacy of knowledge that will inform future generations of scholars while at the same time strengthening local cultures. The Documenting Endangered Languages (DEL) program is a multi-year funding partnership between NSF and the National Endowment for the Humanities (NEH) to support projects to develop and advance knowledge concerning endangered human languages. This program is made urgent by the imminent death of an estimated half of the 6,000–7,000 currently used human languages. Working with the SBE Linguistics Program, the OPP Arctic Social Sciences Program has identified DEL as a natural IPY project. The unfortunate situation of the estimated 52 Arctic indigenous languages is no exception to the international prognosis. Following the first DEL Announcement of Opportunity, over 10% of the proposals were to research Arctic languages, and the DEL Management Group anticipates that over 10% of the recommended proposals will be for research in the Arctic region. NSF and NEH have agreed to funding for DEL for three years, with an evaluation and possibility for renewal in 2008, during the IPY. The IPY provides an opportunity to bring publicity and resources to the pressing issue of endangered languages in the Arctic.

With regard to the implementation of observing systems, the National Ocean Partnership Program, through the Ocean-US office, is pursuing the establishment of an Integrated Ocean Observatory System (IOOS). The IOOS is planned to include three “Regional Associations” in Alaska, including the Chukchi Sea and North Slope, Bering Sea, and northeast Pacific. NSF is working with the National Oceanic and Atmospheric Administration and local groups to identify and support these regional associations. NSF is working with the research community in Barrow, Alaska, to develop a plan for a major observatory to be located in that community, with an emphasis on research that contributes to SEARCH and other high-priority Arctic programs. To enable the IOOS and to provide for a new generation of polar research, NSF is committed to supporting work in developing and

deploying novel instrumentation. New work is especially needed in chemical and biological sensors (for example, for studies of nutrients and plankton). In addition, a new set of platforms must be developed for making and transmitting observations from under the ice pack, including both gliders and autonomous underwater vehicles. Finally, NSF will be deploying the first shore-based polar observatory off Palmer Station in January 2006 and is confident that this experience will be invaluable in planning other polar coastal observatories.

Logistics Support

Arctic and Antarctic Research Support and Logistics are supported through logistics contracts and other agreements. These support contracts provide a flexible mechanism that is capable of supporting a wide range of potential science and educational activities. NSF also works with the U.S. Coast Guard, NOAA, the University–National Oceanographic Laboratory System (UNOLS), the Canadian Coast Guard, and others to provide shipboard facilities for marine research in both polar regions. Other support is available in the Arctic through a cooperative agreement with the Barrow Arctic Science Consortium (BASC) in Barrow, Alaska, to provide research support and logistics for researchers working on the North Slope of Alaska and a cooperative agreement with the Institute of Arctic Biology at the University of Alaska Fairbanks to support operation of the Toolik Field Station, an NSF LTER site. Cooperation with other national polar research programs offers an avenue for supporting international projects.

One aspect of logistics support that is being explored is the feasibility of supporting year-round research or extending the research season at more locations in the polar regions than are now set up to do so. (South Pole, McMurdo, Palmer, and Summit are staffed for year-round research, plus there are remote sensors operating year-round at a variety of locations.) Year-round research and research in remote areas is complicated and expensive to execute, yet it is necessary to provide adequate spatial and temporal coverage to address research questions. Evolving technology has made it possible to collect many measurements remotely through instrumentation or the use of remotely operated vehicles. There are many improvements to be made to the technology to ensure consistency of data collection under extreme conditions and make use of renewable

energy sources. Sensors could be integrated into a network that uploads data via satellites in real time. Upgrades and improvements of existing infrastructure include improvements in the information technology infrastructure at research hubs such as Barrow, Alaska; development of unmanned sensor networks in the Arctic and Antarctic; development of remote power for sensors, particularly using renewable resources; and improvements in field research facilities (e.g., laboratory space and equipment, living quarters, communications, and safety).

2.1.2 Department of Energy

DOE is planning to support the IPY in a variety of important ways through the Atmospheric Radiation Measurement Program and the Climate Change Prediction Program.

Atmospheric Radiation Measurement Program

The ARM Program will continue its year-round operation at the North Slope of Alaska (NSA) site. This site is providing data about cloud and radiative processes at high latitudes. These data are being used to refine models and parameterizations as they relate to the Arctic. The NSA site is centered at Barrow and extends to the south to the vicinity of Atqasuk and to the east to Oliktok Point. DOE will also support IPY-related proposals to conduct experiments using either the NSA site and/or the ARM Mobile Facility.

Climate Change Prediction Program

The CCPP will continue research to develop coupled climate models. The CCPP is developing ocean and sea ice models that are components of the Community Climate System Model (CCSM). In addition to coupled climate simulations, researchers apply the ocean and sea ice models to a variety of ocean and sea ice problems, including eddy-resolving ocean simulations, studies of the thermohaline circulation, and polar ice feedbacks. CCPP also supports analyses of the causes and consequences of biases in the mean climate and circulation of the Arctic.

2.1.3 National Oceanic and Atmospheric Administration

NOAA will be supporting the IPY through programs involving exploration, observations, prediction and modeling, and data, outreach, and decision support.

Ocean Exploration in Polar Regions

NOAA's Office of Ocean Exploration (OE) plans to support multiple projects in both the Arctic and Antarctic in conjunction with the IPY. OE expects to solicit specific projects for the IPY via Federal Register announcements in calendar years 2005, 2006, and 2007. Ocean Exploration, together with the Arctic Research Office of NOAA and the Russian Academy of Sciences, will facilitate an expedition to the Pacific Arctic in 2008, as part of the ongoing RUSALCA (Russian–American Long-term Census of the Arctic) program.

Causes and Impacts of Recent Changes in the Pacific Arctic

Unprecedented minima of sea ice area have occurred in the Pacific Arctic during the three most recent summers. Summer 2003 and 2004 brought record forest fires and drought to eastern Siberia and Alaska after a decade of warm spring-time temperature anomalies. In surrounding seas there has been a northward shift of ice-dependent marine animals, with pelagic species such as pollock favored over bottom-feeding flatfish. Many Pacific Arctic changes are continuing, despite the observation that climate indices such as the Arctic Oscillation were negative or neutral for six of the last nine years. The Pacific Arctic may be having a larger role in shaping the persistence of Arctic change than has previously been recognized. NOAA will work with its partners to carry out expeditions in this area to gather observations about ecosystem indicators of climate change and to set up systems to monitor these changes in the environment over space and time.

International Arctic System for Observing the Atmosphere

A system of strategically located, long-term Atmospheric Observatories will be developed around the Arctic to carry out both routine measurements made at meteorological stations and intensive measurements at the surface and through the depth of the atmosphere. Measured quantities can include solar radiation, aerosols, air chemistry, trace gases, cloud properties, water vapor, ozone, temperatures, winds, precipitation, surface albedo, and stratospheric properties. The Atmospheric Observatory partnership includes the United States, Canada, Russia, Norway, Finland, and China.

Polar Stratospheric Ozone Depletion Observations

As a part of the International Geophysical Year

in 1957, column ozone measurements were initiated at South Pole, Antarctica, using Dobson spectrometers. In 1985 the annual stratospheric ozone depletion over Antarctica—the “Antarctic Ozone Hole”—was identified. In less than five years it was proven that the ozone hole was caused by human-emitted fluorochlorocarbons (CFCs), and the ozone hole has become a globally recognized “poster child” for showing how humans can cause global-scale changes.

The Arctic stratospheric ozone changes, though lesser in magnitude than the Antarctic ozone hole, are by no means of lesser importance. Key studies will be undertaken in the Arctic to monitor these changes.

Short-term Arctic Predictability

The STAP study will explore the variability and associated predictability of weather, sea ice, ocean wave, and land surface processes in the Arctic region in the 3- to 90-day time range, with special emphasis on improving forecast guidance for high-impact events in the 3- to 14-day lead time range.

Advances in Satellite Products and Their Use in Numerical Weather Prediction

Spatially comprehensive observations of the atmosphere in the data-sparse polar regions significantly and positively impact high-latitude numerical weather predictions. In addition, errors in model forecasts for the high latitudes often propagate to the mid-latitudes, implying that improvements to high-latitude forecasts will result in better mid-latitude forecasts. These findings provide the motivation to improve our ability to measure the state of the polar regions with satellites and to expand the use of these data in numerical weather prediction systems.

Arctic Climate Modeling

The general goal of this project is to improve predictions of the Arctic environment on time scales ranging from seasonal to climate change. Thus, NOAA's research will focus on analyzing and modeling the physical processes and teleconnections between the Arctic and the rest of the globe.

Arctic System Reanalysis

A concerted effort during the IPY to construct pan-Arctic atmosphere–ocean–ice–land data sets, and to assimilate and enhance these with a high-resolution (coupled) reanalysis system optimized for the Arctic region, will provide researchers with

an unprecedented description of the Arctic environment over the past several decades. The operational analysis system (post-2008), expected to be a legacy of this activity, would provide constantly updated depictions of the Arctic environment and would foster improved short- and medium-range weather forecasts as well as seasonal climate outlooks. Improved understanding of Arctic climate processes resulting from the development of the ASR will lead to better global climate models, in turn reducing uncertainty in projected future climate states of the Arctic. The ASR will also serve as a vehicle for diagnostic evaluation of ongoing changes in the Arctic system.

NOAA's Data, Information, and Change Detection Strategy for the IPY

NOAA's fundamental data management responsibilities will be to securely archive IPY data sets and ensure that these and other relevant polar data are easily accessible for current and future users. NOAA will utilize the existing World Data Center (WDC) System and NOAA National Data Centers (NNDC) to serve as a clearinghouse and facilitator for data-management issues and will work with IPY participants to ensure that ICSU/WMO IPY Data Committee guidelines are followed. NOAA will also ensure that international standards such as the Open Archival Information System Reference Model and the ISO19115 metadata standards are met.

NOAA intends to build and maintain a pan-Arctic view of climate variability and change that will serve decision makers with information products. These range from baseline atlases against which future assessments can be carried out, to the Near Realtime Arctic Change Indicator web site, where information on the present state of Arctic ecosystems and climate is given in historical context.

Decision Support

The cornerstone of NOAA's Regional Climate Decision Support program for Alaska and the Arctic is to establish an integrated program spanning stakeholder-influenced research and development of decision support tools for the sustained delivery of customer services.

This includes establishing in Alaska a Regional Integrated Sciences and Assessment (RISA) and a Regional Climate Center (RCC) with formal liaisons to NOAA's National Weather Service and the State Climatologist Office to foster the growth of climate services.

2.1.4 Department of State and Department of Health and Human Services

Arctic Human Health Initiative

The AHHI will advance the joint research agenda of the Arctic Council, an eight-nation intergovernmental forum for sustainable development and environmental protection, in the areas of infectious disease monitoring, prevention, and response; the effects of anthropogenic pollution, UV radiation, and climate variability on human health; and telehealth innovations. Specifically, the leaders of these research programs will build on their years of circumpolar collaboration to extend the International Circumpolar Surveillance network of hospitals and public health facilities into Russia and include additional infectious diseases of concern, to continue monitoring contaminants in human blood and tissues to reveal temporal and spatial trends and to combine experiences from the rapidly expanding disciplines of biomarker research and molecular epidemiology with these monitoring programs, and to extend circumpolar cooperation on telehealth, particularly to Arctic regions in the Russian Federation. In addition, the AHHI will draw on the outstanding leadership of the Arctic Council member states' national and international research programs in the areas of human genomics, hypothermia/hibernation, and health impacts of climate change (including the spread of zoonotic and arboviral diseases in the Arctic).

The Fogarty International Center (FIC) of the National Institutes of Health (NIH), as the designated DHHS lead in the Arctic Council and the Interagency Arctic Research Policy Committee (IARPC), plans to collaborate with other NIH institutes and DHHS agencies to pursue these priorities as well as to actively explore other opportunities for trans-NIH and interagency collaboration (e.g., with NSF, NASA, etc.), such as mental health. For example, FIC is working with the National Institute of Mental Health (NIMH), the Substance Abuse and Mental Health Services Administration (SAMHSA), and others to plan a symposium focusing on suicide prevention in the Arctic as part of the next conference of the International Association of Suicide Prevention, which will take place in Durban, South Africa, in September 2005. It is expected that the outcomes of the symposium will provide input for the 13th International Congress on Circumpolar Health, to be held in

Novosibirsk, Russia, in June 2006 as a “Gateway to IPY.”

The AHHI steering group, led by the U.S. Centers for Disease Control and Prevention, will work with the International Union for Circumpolar Health (IUCH), the FIC, and other partners to develop a program of outreach and public education focused on the promotion of good health for Arctic residents and better integration of the findings of Arctic health research. The IUCH will make its triennial congress in 2006 available to facilitate IPY health activities and its congress in 2009 to underscore the health legacy of IPY.

2.1.5 U.S. Geological Survey

The U.S. Geological Survey serves the U.S. by providing reliable scientific information to:

- Describe and understand the earth;
- Minimize loss of life and property from natural disasters;
- Manage water, biological, energy, and mineral resources; and
- Enhance and protect our quality of life.

The USGS intends to participate in the IPY through extension and enhancement of programmatic activities in research, assessment, and monitoring in the polar regions that support the scientific mission of the organization and address the themes and goals of the IPY. These activities span biology, geology, hydrology, geography, and information sciences and will include five themes: status, change, global linkages, new frontiers, and unique vantage point.

Theme 1. Status

- Research and monitoring of status and distribution of fish, wildlife, and vegetation;
- Determination of species at risk;
- Permafrost evaluation, including assessment of thermal regime, organic carbon characteristics, and distribution;
- Evaluation of hydrologic inputs, including the influence of large river deltas, snow- and water-borne contaminants, and freshwater inputs; and
- Evaluation of surficial and geochemical processes in understanding the changing polar environment.

Theme 2. Change

- Integrated monitoring for assessing regional changes in carbon cycle of Arctic watersheds;
- Extension of current ground and satellite-

based monitoring of glaciers and icecaps for volumetric changes and monitoring of thermal changes in permafrost;

- Reconstruction of past climate and evaluation of current changes from sediment and ice cores;
- Monitoring and assessment of changes in rates of coastal erosion and surficial process; and
- Evaluation of changes in the status and distribution of circumpolar vegetation, fish, and wildlife (including invasive species) and freshwater discharges in the Arctic.

Theme 3. Global Linkages

- Evaluation of the nature of Arctic and boreal hydrologic interactions and the relationships between climate and plant growth, productivity, permafrost depth, and resulting effects on nutrient availability and heat source and sinks; and
- Evaluation of the potential for methane hydrate decomposition in a regime of Arctic warming.

Theme 4. New Frontiers

- Development of a micro-seismicity array in the Antarctic South Pole quiet sector for high-resolution studies of the earth’s interior;
- Establishment of an absolute geomagnetic observatory at South Pole for long-term time series observations of variations in the earth’s magnetic field; and
- Studies of extremophile interactions in polar geochemical and nutrient cycles.

Theme 5. Unique Vantage Point

- Establishment or extension of permanent monitoring infrastructure for permafrost, global seismicity, and geomagnetic activity;
- Assessment of energy resources in the circum-Arctic area, including oil, gas, coalbed methane, and methane hydrates; and
- Production of geospatial data to include high-resolution mapping and digital aerial photography and the structuring of all data in a geospatially referenced knowledge management system as an element of the USGS’s Natural Science Network.

2.1.6 National Aeronautics and Space Administration

NASA’s contributions to IPY likely will involve ongoing activities (operating satellites, continuing

ground networks, scientific research, and communication/education/outreach), some episodic activities (satellite snapshots and field campaigns), new efforts related to the development and deployment of suborbital capabilities (aircraft and unmanned aerial vehicles), and coordination of remote sensing observations with in situ measurements supported both by NASA and other agencies, primarily the National Science Foundation. New opportunities associated with the President's Vision for Space Exploration initiative are also likely, particularly related to human-robotic interactions and concepts of operations in polar regions as analogs for planetary settings. In addition, NASA plans to land the first openly competed Mars "scout" mission (PHOENIX) near the north polar ice cap of the planet Mars during the IPY as part of its ongoing campaign to understand the potential habitability of Mars as well as the polar climate on the red planet. Furthermore, NASA is also interested in the polar regions of the Moon as potential human exploration sites and will be undertaking orbital reconnaissance of these regions using a new array of remote sensing instruments as part of the 2008 Lunar Reconnaissance Orbiter (LRO) Mission in 2008–2010, during the IPY. These planetary polar activities naturally dovetail with those being planned and coordinated by other Federal agencies and offer unique opportunities for investigating the unique aspects of Earth's polar regions during the IPY in a comparative planetary framework.

Currently, NASA operates 20 satellites that collect information about the polar regions. The Ice Cloud and Land Elevation Satellite (ICESat) was specifically designed to measure changes in the elevation of Earth's great ice sheets and the ice sheet processes that are manifest in the surface topography in unprecedented detail. In addition, the mission has revealed new information about recent thickness characteristics of sea ice in the entire Arctic and Antarctic regions. Upcoming Earth orbital missions such as Cloudsat and Calipso will provide three-dimensional information on the structure of Earth's atmosphere, and, as with all near-polar-orbiting satellites, coverage will be at a maximum in the polar regions. Other polar aspects of the Earth system, such as storage and fluxes of freshwater and carbon, ocean biology, land cover and land use change, etc., are also being addressed by ongoing missions and scientific research.

NASA has demonstrated success in the past in developing comprehensive polar observations through international collaborations with the

Canadian Space Agency (CSA) to carry out the Antarctic Mapping Mission and the Arctic Snapshot of Arctic sea ice characteristics at very high spatial resolution using microwave remote sensing methods (i.e., SAR). NASA expects to continue to develop these international efforts through a coordination of activities with its colleagues at space agencies in other countries.

NASA is also implementing polar-oriented missions that reach beyond Earth, including the PHOENIX Mission that will land near Mars's North Pole in 2008, the Lunar Reconnaissance Orbiter that will map lunar polar regions for the first time starting in 2008, and the Mars Reconnaissance Orbiter (MRO) that will explore Martian polar regions in three dimensions from Mars orbit. Polar analogs in Mars exploration are vital; for instance, scientists have used Earth's polar regions to simulate aspects of Mars for over 30 years. As an example, the Dry Valleys of Antarctica are the best "Mars analog" known on Earth, in terms of basic physical processes. The ASTEP Program (astrobiology) uses polar activities in Antarctic, Axel Heiberg, Svalbard, and Siberia, and in the future potentially Iceland.

NASA efforts for the IPY are envisioned to focus on:

- Understanding of polar feedbacks in the Earth system;
- Development of a "snapshot" of the polar regions to serve as a baseline for future generations of observations, requiring coordination with international and industry partners;
- Ongoing satellite missions, including ICESat, Cloudsat/Calipso;
- New airborne surveys targeted at measuring land-ice elevation changes and thickness characteristics;
- Comprehensive observations of polar atmospheric composition, dynamics, and thermodynamics;
- Utilization of polar regions as a stepping stone to exploring planetary environments, with emphasis on Mars and the Moon;
- Understanding the poles of other planets and similarities and differences to those on Earth; and
- A sustained public engagement through a suite of communication, education, and outreach efforts to allow individuals around the globe to explore science of the poles and life on Earth.

NASA continues to study Earth as a system through the unique sampling capability afforded

by remote sensing. During the IPY and beyond, NASA will continue to develop this capability to understand polar processes, the role of the polar regions in Earth's environment, and the nature of poles on other planets in our solar system. Developing and coordinating new scientific initiatives and opportunities associated with the President's Vision for Space Exploration with other Federal agencies (NSF, USGS, and NOAA, for example) within the framework afforded by the IPY are important aspects of NASA's involvement.

2.1.7 U.S. Department of Agriculture

The U.S. Department of Agriculture plans to continue its mission-related activities in the Alaska region. The Agricultural Research Service (ARS) will continue its work towards preserving Alaskan plant diversity by preserving and archiving high-latitude plant germplasm through traditional seed collocation and modern molecular methods. The U.S. Forest Service, through the Pacific Northwest Research Station, is responsible for managing the Alaskan boreal forest and will continue its commitment in support of the Bonanza Creek LTER, which takes place at the Bonanza Creek Experimental Forest. The Natural Resources Conservation Service (NRCS) will continue to provide assistance to State, Native Alaska, and private landowners through the USDA Farm Bill. The Forest Service and NRCS will continue their joint activities in permafrost and wetland soil research. The Cooperative State Research, Education and Extension Service will continue its educational support for the University of Alaska, which is the Alaska land-grant institution. CSREES will also continue its extension activities through the Alaska extension services and experimental research stations. CSREES is currently contributing to the interagency Study of Environmental Arctic Change (SEARCH) by providing resources to a joint solicitation with NASA for proposals on land use and land cover change. SEARCH is one of the primary activities of NSF for the IPY, and the USDA will continue to work with the interagency working group of SEARCH to promote joint interests in Alaska.

2.1.8 Smithsonian Institution

The Smithsonian is prepared to engage in a variety of research, education, and outreach programs in support of the IPY. Some of the following

plans—all of which have been developed with interagency collaboration—are already underway; others need further discussion and are offered here as ideas for consideration.

Of all U.S. governmental agencies, the Smithsonian probably has the longest record of association with IPY activities, because of its critical role in the first U.S. IPY field expeditions of 1881–1884, in caring for its collections, and in publishing many of its proceedings. Hence SI participation in IPY 2007–2008 will include both historical and contemporary dimensions.

The SI contribution will be based on the institution's time-tested strengths: the research of its scientific personnel, the special value of its museum collections as national treasures, and its broad public outreach program, coupled with the unique position of Smithsonian museums on the National Mall and their special attraction to the general public and the nation.

On the scientific side, the SI is already playing the leading role in framing the U.S. sociocultural and Native studies programs based on staff expertise through the National Museum of Natural History's Arctic Studies Center (ASC) and the value of its ethnological collections. An ASC Arctic ethnologist is playing a key role in planning the IPY 2007–2008 social and cultural agenda as a member of both the U.S. National IPY Committee and the main ICSU–WMO Joint Committee for the International Polar Year. The ASC will continue its leading role in the social and cultural planning through its meetings, symposia, publications, exhibits, coordination activities, and other means.

Smithsonian scholars are also active in other fields of Arctic and Antarctic research, particularly in biology, paleontology, ocean, and astrophysics studies that will be included in the Smithsonian's IPY program. SI also curates the U.S. National Antarctic Meteorite collection.

The Smithsonian offered to organize and host a national IPY symposium at the beginning of the IPY 2007–2008 activities, with the participation of the leading SI scientists and representatives of other agencies and research institutions.

SI is eager to offer its Arctic and Antarctic collections (ethnological, botanical, zoological, mineral, films and archival materials, etc.) and to facilitate all types of IPY collection research as its contribution to the interagency IPY 2007–2008 program. Of particular value are the ethnological and biological collections from Barrow, Alaska, Ellesmere Island (Greeley Expedition), and Ungava Bay, Arctic Canada, from the first IPY 1881–1884

expeditions, as well as scientific instrument collections and records of the early IPY stations, as well as its the instrument collections from the IGY at the Air and Space Museum.

SI offers its space and personnel resources to serve as the key IPY interagency hub for education, outreach, and public communication during 2007–2008 (and even earlier), through its museum programs, outreach, and exhibit ventures.

The following are proposed IPY events for the National Mall:

- The first event will be the opening of the new Smithsonian exhibit, *Arctic: A Friend Acting Strangely* (October 2005), focused on the current impacts and science of Arctic environmental change. This exhibit has been produced with financial support from NOAA and NSF and will be a part of the National Museum of Natural History's "Global Links" Exhibition Program.
- SI proposes organizing a national IPY symposium at the beginning of the IPY period (2007–2008).
- As part of this symposium, SI will organize a small exhibit on the history of the early U.S. IPY efforts based on its collections, instruments, and photographic and documentary records. SI invites other agencies to join resources in exhibiting objects or graphic materials related to their own contributions to the U.S. IPY efforts.
- The major Smithsonian public contribution could be a much larger exhibit, such as *Science at the Poles: IPY 2007–2008*, to publicize its preliminary results and major accomplishments. This might take place in early or mid-2010 and, as a major public venture,

would have to be supported by substantial agency contributions.

2.1.9 Environmental Protection Agency

EPA plans to support other agencies' IPY efforts through its Environmental Monitoring and Assessment Program (EMAP) and its involvement in the Global Earth Observation System of Systems (GEOSS). For 15 years, EMAP has developed cost-effective and policy-relevant sampling approaches for freshwater and marine resources. EPA has supported monitoring of coastal resources in south-central and southeastern Alaska, as well as freshwater monitoring in central Alaska. The State of Alaska has submitted an IPY "Expression of Intent" for Arctic and Bering Sea Coastal Assessments. EPA will give non-budgetary support to this proposal. Other agencies also may wish to support this effort and perhaps support a larger potential effort of developing a circum-Arctic or even circumpolar coastal monitoring program, using EMAP approaches, to obtain baseline conditions. This larger effort could be done in the context of IPY 2007–2008.

EPA is involved in GEOSS as a data collector, integrator, and user. Also, EPA is co-chair of the GEO Secretariat's User Requirements and Outreach Subgroup. EPA is interested in how the ocean observing network is expected to be included under GEOSS and how all the other earth observations overlap with IPY. EPA looks forward to collaborating with other agencies in GEOSS activities related to the IPY.

2.2 *The Study of Environmental Arctic Change*

2.2.1 *Introduction*

The following discussion is drawn in part from the Science Plan for the Study of Environmental Arctic Change (SEARCH) program, a research program sponsored by the Interagency Arctic Research Policy Committee. The Science Plan was prepared by the former SEARCH Project Office, Polar Science Center, Applied Physics Laboratory, University of Washington, Seattle.

In addition to U.S. SEARCH efforts, the International Study of Arctic Change (ISAC)—the international umbrella for SEARCH—has led to first discussions of coordination of research on environmental change in the Arctic among many interested nations. The International Polar Year 2007–2008 (IPY) offers an opportunity to consolidate and expand existing studies and implement a network or system of measurements that is driven by the needs identified within the scientific community as well as by stakeholders and planners.

As discussed in detail in the SEARCH Science Plan, observed changes in the atmosphere, in the oceans, and on land in the Arctic are affecting virtually every part of the Arctic and now have potential impacts, both direct and indirect, on human society. These changes include a decline in sea-level atmospheric pressure [typically a 2-mb decrease in multiyear averages (Steele and Boyd 1998) over the Arctic with a peak change of 4 mb near the center of the basin (Walsh et al. 1996), or on the order of one standard deviation in AO Index]. Other observed environmental changes include:

- Reduced sea ice extent [3% per decade (Parkinson et al. 1999)] and thickness [–42% in the last 25 years (Rothrock et al. 1999)].
- Shift in the balance between Atlantic and Pacific waters and changes in salinity and temperature (e.g. Morison et al. 2000). The revealing changes in upper ocean temperatures and salinities are five times the RMS variability in the 1970s and exceed extreme values measured in the corresponding locations in the previous 50 years (EWG 1997, Steele and Boyd 1998).
- Sea level rise in the Russian Arctic. There are 2- to 20-cm increases in sea level in the Russian marginal seas over a 50-year period, with interannual variations on the same order (Pavlov 2001). Proshutinsky et al. (2001) argue that

this is driven by changes in atmospheric forcing of the barotropic circulation.

- Permafrost warming (0.5°C) and thawing in the intermittent permafrost region of Alaska (Osterkamp and Romanovsky 1999) and warming and thawing of permafrost in the Russian Arctic (Pavlov 1994) since the late 1980s.
- Decreasing permafrost temperatures in eastern Canada (Wang and Allard 1995).
- Below-average Northern Hemisphere snow cover in recent years by reductions in spring snow cover since the mid-1980s (Robinson et al. 1993, 1995).
- Decreasing mass of small Arctic glaciers (Dyurgerov and Meier 1997, Dowdeswell et al. 1997).
- Drying trend, increased forest fires (Oechel and Vourlitis 1996, Stocks 1991), and southern pest infestations in Alaska.
- Long-term increase in river runoff (Petersen et al. 2003).
- Large increase in Bering Sea jellyfish populations. According to Brodeur et al. (1999) the biomass of large jellyfish in the Bering Sea has soared in the 1990s.
- Whale migrations shifting with decreased ice extent (Tynan and DeMaster 1997, Treacy 1998).
- Increase in Barents Sea cod size with temperature increases (Bogstad and Gjosaeter 1994, Brander 1994).
- More terrestrial plant growth. According to the SEARCH Science Plan, studies point to increased plant growth (Mynemi et al. 1997), northward advances of the tree line (D'Arrigo et al. 1987, Nicholls et al. 1996), increased fire frequency (Oechel and Vourlitis 1996, Stocks 1991), and thawing and warming of permafrost (Pavlov 1994, Osterkamp and Romanovsky 1996, 1999).

Because of the interplay of natural and human-caused factors, we do not know if the recent complex of changes is part of a pattern of natural variability or the beginning of a long-term shift. We also do not know what climate and ecosystem processes may be involved or what the long-term impacts may be. We do know that environmental changes in the Arctic can affect other global systems in major ways, mainly by changing the amount of solar radiation reflected from the earth's surface (snow and ice reflect energy that is absorbed by earth and open water) and by reduc-

ing the global thermohaline circulation by capping the subarctic seas with fresh water and melted sea ice flowing from the Arctic Ocean.

2.2.2 Arctic Oscillation

SEARCH scientists hypothesize, and statistical analysis and modeling studies tend to confirm, that many of the changes listed in Section 2.2.1 are related to a strengthening of the atmospheric polar vortex [e.g., SEARCH Science Plan 2001, Morison et al. 2000, Zhang et al. 1998, 2000, Maslowski et al. 2000] as characterized, for example, by the Arctic Oscillation (AO), which is a natural mode of atmospheric variation. The strengthened west-to-east motion of the atmosphere associated with an increased AO brings more warm air to the Greenland Sea, Scandinavia, and Russia.

The cause for the 1990s increase in the AO is an important research question. Some modeling studies (Fyfe et al. 1999, Shindell et al. 1999) suggest the AO is strengthened by the anthropogenic (human-caused) rise in greenhouse gases, but the recent changes are larger and earlier than these models suggest. Therefore, while anthropogenic climate change may explain part of the observed environmental changes, a significant part of the change is likely an extreme example of natural variability. This large-scale pattern of change interacts with more localized natural and anthropogenic factors to change the climate at any one location. We do not know if the recent complex of changes is part of a cyclic pattern of natural variability or the beginning of a long-term shift. We also do not know if these changes can themselves reinforce or slow environmental change.

2.2.3 Goals

SEARCH is a broad, interdisciplinary, multi-scale interagency program with a core goal of understanding the complex of recent and ongoing intertwined changes, with a view toward prediction. In addition to understanding how changes in the Arctic are interrelated, SEARCH will investigate the links between Arctic change and global processes and will assess the impacts that Arctic change may have throughout the Northern Hemisphere. SEARCH will evaluate the possibility that changes in the Arctic can anticipate changes elsewhere on the globe.

To be most effective in understanding the Arctic's many systems and their interplay, many resources and kinds of expertise must be brought

together. SEARCH is the first interagency effort to combine funding sources, disciplines and knowledge from across the United States and around the world to address an issue of this type. The effort is designed to bring researchers together to share knowledge and learn from one another. It is unique, given the complexity of the Arctic environment.

2.2.4 Critical Science Questions

The recent changes in the Arctic are complex, but a key idea of SEARCH is that many of the changes can be thought of as an interrelated complex of pan-Arctic change related to the atmospheric circulation of the whole Northern Hemisphere (SEARCH Science Plan). As discussed above, it is relatively straightforward to argue that a strengthened polar vortex can drive the observed complex of change through the effect of wind stress and the transport of heat and moisture. A critical question is to what extent the response of the Arctic can in turn affect the Northern Hemisphere atmospheric circulation through effects on albedo or the freshwater cycle and global thermohaline circulation (SEARCH Science Plan). Based on observations by the indigenous populations of the Arctic, which bear much in common with the scientific observations, it seems certain that the complex of change has ecological and social dimensions as well (SEARCH Science Plan). For example, people who depend on sea ice for transportation and subsistence gathering report firsthand the effects of decreases in ice extent. The SEARCH program will test these hypotheses in order to understand the changes seen to date, track the changes into the future, and help society to adjust to future changes. Science questions related to these hypotheses will guide the efforts of SEARCH. For example:

- Are the changes seen in recent decades in the Arctic climate system consistent with natural variability, or are such changes at least partially attributable to human activity?
- What is the interplay among atmospheric circulation, ozone loss, and UV radiation?
- Can climate changes in the Arctic be predicted or assigned a probability?
- How will hemispheric or global climate affect or be affected by changes in the Arctic (atmosphere, ocean, land surface, and hydrology)?
- How will seasonal weather patterns in the Arctic and mid-latitudes be affected by changes in the Arctic?
- What are the likely effects and consequences of environmental Arctic change on the health

and well-being of Arctic residents?

- What are the likely effects and consequences of environmental Arctic change on ecosystems and key species of the Arctic?
- How might Arctic-driven environmental changes affect societies and U.S. national security?

2.2.5 Major Activities

The changes of the last few years come at a time when many of the large-scale observing systems of the past have declined or been eliminated. For example, the large-scale hydrographic surveys and the ice camps maintained by the Soviet Union for many years have stopped (EWG 1997). Many of the weather stations in the United States, Canada, and Russia have been eliminated. Therefore, according to the SEARCH Science Plan, a major emphasis of SEARCH is developing a long-term, large-scale program of observations, the related analysis and modeling, and activities to apply what is learned. SEARCH includes four major types of activities:

- A long-term observational program to detect and track the environmental changes;
- A modeling program to synthesize observations, test ideas about the coupling between the different environmental changes observed, and predict their future course;
- Studies to test hypotheses about critical forcing and feedback processes; and
- An application component to understand the impact of the physical changes on ecosystems and societies and to distinguish between climate-related changes and changes due to other factors such as resource utilization, pollution, economic development, and population growth.

To achieve the goals of SEARCH, the agencies supporting it will invest not only in the four areas described above, but also in “infrastructure” activities such as:

- Development of new observing technologies;
- Creation of new computer-based models;
- Management and rescue of environmental data; and
- Construction and maintenance of field facilities.

2.2.6 Observation and Modeling

There is a need for the deployment of a comprehensive and sustained Arctic environmental

observing system. This system will require remote and in situ systems focused on land, sea, air, and ice. It must provide the critical information on the physical and biotic environment needed to meet the needs of SEARCH. The observing system must be strongly coupled to modeling and data assimilation efforts to ensure that the system’s data are useful and used. This comprehensive system must evolve to meet new requirements, comply with new strategies, and incorporate new technologies. Once new observing technologies have been developed and proven in the field, a pathway will be needed to make these technologies operational. This pathway must include consideration of funding requirements, data quality and continuity, and data application.

The observing system and models will provide useful information at different geographic scales from local to regional to global. The use of satellite-based remote sensing is critical for providing the large-scale overview and finer-scale information when possible. Locally intensive observations will rely more heavily on in situ observations. Whenever possible, these should be made with autonomous sensors or samplers. Continuous use of in situ data for calibration or validation of remotely sensed data is essential and will require a multiagency approach.

2.2.7 Summary of Agency Participation

Each participating agency will contribute to SEARCH in ways consistent with its mandates, strategies, and scientific capabilities. Each will undertake specific parts of SEARCH and share data, information, and understanding to achieve the overall SEARCH goals. Results from SEARCH and other programs will provide the scientific underpinning for Arctic regional and global assessments of climate variability and change and associated impacts. Table 2 describes the major types of activity that each agency expects to undertake to support SEARCH.

2.2.8 Resource Requirements for Continuing Implementation of SEARCH

The SEARCH program is planned as a long-term effort to document and understand environmental change and associated impacts. Given this long-term perspective, SEARCH can be successful even though all activities do not begin at the same

Table 2. Agency activity areas.

National Science Foundation	Environmental processes research and observation, model development, observing technology development, social sciences research, Native-led observatories
National Aeronautics and Space Administration	Space-based and airborne measurements of atmospheric and land/ocean surface processes; model-based research
Department of Commerce/National Oceanic and Atmospheric Administration	Sustained in situ ocean and atmospheric observations, data- and model-based analyses, forecast services, impact assessments
Department of Defense/Office of Naval Research, Cold Regions Research and Engineering Laboratory	Research and technology development leading to predictive capability for environmental conditions that affect defense operations
Department of Energy/Atmospheric Radiation Measurement Program—North Slope of Alaska/Adjacent Arctic Ocean ARM Climate Research Facility	Research on atmospheric processes, quantification of surface radiation budgets, environmental modeling
Department of the Interior/Bureau of Land Management, Fish and Wildlife Service, National Park Service, U.S. Geological Survey, Minerals Management Service	Use of protected and managed land areas for long-term terrestrial in situ observations; assessment of impacts of environmental change on glaciers, vegetation, fish, and wildlife; development of best management practices
Department of Agriculture/Agricultural Research Service, Natural Resource Conservation Service, Forest Service	Impacts of high-latitude environmental change on plant germplasm, agricultural pests, soil quality, and boreal forests; assessments of environmental change on agricultural potential and forest resources.
Smithsonian Institution	Research to understand current and past responses of society to environmental change, and development of interagency outreach program
Department of Homeland Security/U.S. Coast Guard	Logistics support for ocean and sea ice research and observations
All	Integrated modeling and/or assessment efforts, joint studies, collaborative publications

time. Agency planning processes are complex and require coordination. Over the next several years the participating agencies will further define their individual roles in SEARCH and seek to obtain the resources needed to implement those roles.

2.2.9 Interagency Management of the SEARCH Program

From its inception the Interagency Working Group (IWG) of the Interagency Arctic Research Policy Committee has been responsible for developing the SEARCH program within the agencies. The responsibilities of the IWG are to:

- Approve membership and “terms of reference” for the Science Steering Committee (SSC);
- Review and approve science and science implementation plans prepared by the SSC and its subsidiary bodies;
- Solicit science advice from the SSC and develop responsive programs and plans;

- Discuss and coordinate agency plans for budget requests to support activities related to SEARCH and provide appropriate inter-agency assistance;
- Review agency activities that address SEARCH hypotheses and science questions and coordinate agency activities;
- Facilitate international efforts needed to address the SEARCH science questions;
- Identify opportunities for and promote coordination of development and use of facilities needed for SEARCH;
- Identify, encourage, and support activities to integrate and synthesize the results of science supported by SEARCH funds; and
- Identify, encourage, and support outreach and education activities based on the results of activities supported by SEARCH funds.

The SEARCH SSC will continue to provide scientific planning. In particular, it will develop the scientific bases for the thematic programs to be implemented under SEARCH and will be instrumental in devising means for synthesizing and

integrating the diverse information that SEARCH will generate. The SSC will provide scientific liaison to international science groups and aid the IWG's efforts to achieve international implementation mechanisms.

To provide guidance from different perspectives and to open a channel for community and stakeholder input during this period of SEARCH evolution and implementation, the SEARCH SSC organized an implementation workshop that was held May 23–25, 2005, in Lansdowne, Virginia. Preparation for the discussions during the workshop was guided by white papers prepared by the three SEARCH panels: Observing Change, Understanding Change, and Responding to Change.

The position papers were circulated widely to provide opportunities for the community at large to express their views on the next steps of SEARCH implementation.

A report of this SEARCH Implementation Workshop has been prepared (<http://www.arcus.org/search/meetings/2005/siw/index.php>). At the time of publication of this revision to the U.S. Arctic Research Plan (July 2005), the SEARCH Implementation Workshop report is under review by the SEARCH Interagency Program Management Committee (IPMC, formerly Interagency Working Group) of the Interagency Arctic Research Policy Committee.

2.3 Developing a Research Plan for a Sustainable Bering Sea

The Bering Sea, located between the Aleutian Archipelago and Bering Strait, is a marginal sea that connects the North Pacific to the Arctic Ocean. The Bering Sea region is productive and ecologically diverse. Its multiple habitats are ideal as homes to a rich variety of biological resources.

The ecological riches of the Bering Sea have attracted and supported aboriginal cultures for millennia. Today, Bering Sea resources continue to support the economic survival, subsistence, and cultural foundation for Alaska Natives. In addition, the Bering Sea commercial fishery is a key economic force in the region. About 50% of all fisheries landings in the United States in 1998 came from the Bering Sea (see <http://www.pmel.noaa.gov/foci/overview.html>). Walleye pollock comprise much of the fish landings. Bristol Bay supports the world's largest sockeye salmon fishery, and snow crab landings represent the largest crustacean fishery in the U.S.

2.3.1 Changes in the Bering Sea

The Bering Sea is a seasonally ice-covered, subarctic sea located at the southern extreme of seasonal sea ice cover, and thus it is likely to be exceptionally sensitive to variations in climate that impact the extent and duration of sea ice. Sea ice is a forcing mechanism that influences the temperature and salinity of the water column, its hydrographic structure, and the availability of light for photosynthesis. As such, sea ice potentially affects the timing, amount, and fate of primary production, the survival of larval fish, and the spatial distribution of fish and their predators. Thus, changes in the dynamics of sea ice, if they occur, can have profound influences on the ability of a region to support diverse ecological communities and fisheries.

Recent and rapid changes in the physical and biological characteristics of the Bering Sea have raised concerns (Overland et al. 2004). Changes in the abundance of salmon, crab, and groundfish may result in significant economic impacts. Continuing declines in some populations of marine birds and pinnipeds have prompted protective measures such as fish trawling closures around critical feeding areas used by the endangered Steller's sea lion. There have been unexplained blooms of phytoplankton never before recorded

in the Bering Sea, and between 1989 and 2000 an exponential increase in the biomass of large gelatinous zooplankton occurred, which has since collapsed (Hunt et al. 2002).

There is a clear need to better understand the causal relationships between climate, primary and secondary production, and the population dynamics of upper-trophic-level organisms. Greater understanding about how these factors influence each other is vital for determining the relative roles of climate variability and fishery harvests in structuring the Bering Sea ecosystem and for understanding the region's resiliency in the face of change.

2.3.2 Arctic Research Commission Charge

The Arctic Research Commission, in its 2001 and 2003 Reports to Congress (<http://www.arctic.gov>), targeted integrated research and assessment of the Bering Sea as key research priorities. The Commission observed that concern about the Bering Sea has engendered large and intense research synthesis and planning efforts. These efforts share a commitment by scientists from diverse disciplines and organizations to come together to define the most important research needs and to share research results. Significant research efforts have produced important results. The Commission concluded:

- Greater integration of key Bering Sea research programs is required.
- Current research has not enabled managers to predict ecological responses to management decisions implemented within the Bering Sea region.
- An integrated research program and a concerted effort are required to synthesize existing and new information for an integrated assessment.

2.3.3 Enhancing Research

Continued research is critical to better elucidate the mechanisms and processes of change in the Bering Sea as well as the Arctic. To meet the needs for an integrated assessment in the Bering Sea, Federal partners will develop a strategic plan to clarify and connect scientific questions to management needs.

Since natural ecosystems, science, and man-

agement are all dynamic processes, an iterative approach will be used to ensure linkages among decisions that need to be made, new knowledge that will be obtained, and ongoing changes that will influence outcomes. The importance of this process was reflected by the Polar Research Board of the National Research Council of the National Academy of Sciences, which published a study on the Bering Sea ecosystem that included a set of recommendations emphasizing the vital link between science and management, including:

- Adopting a broad ecosystem perspective for scientific research and resource management;
- Adopting an adaptive management approach for Bering Sea resources;
- Evaluating how well management and research institutions are able to address emerging problems;
- Providing appropriate management solutions; and
- Developing research programs to help policy makers solve short- and long-term ecological problems.

Components of Strategic Integrated Research

The Bering Sea Research Strategy includes five key components, each of which influences the others in an iterative framework. They include:

- Definition of a sustainable Bering Sea: Based on dialogue among interested parties, key concerns, common interests, and desired outcomes from management actions will be determined. In this process the essential characteristics of the Bering Sea are defined. This will provide the necessary framework around which to structure integrated assessments. Interviews were conducted with Federal and state officials and commercial and environmental interests.
- Conceptual synthesis: Existing data will be integrated to identify potential relationships among forcing functions, ecosystem changes, sources of stress, and ecological end points of concern identified in the goals. The process is interactive, iterative, and interdisciplinary, and it addresses the influences of multiple natural and human stressors on ecological and human systems. The purpose is to learn more from existing data, generate multiple working hypotheses about likely causal relationships, and define essential research needs.
- Research plans: Based on the conceptual synthesis, research questions will be refined and further research designed to produce

integrated research and assessments. The expected outcome is a dynamic research plan available to Federal agencies and others that capitalizes on existing research efforts and defines new research within a structured framework for integrating research activity and interpreting results.

- Research implementation: New research will be initiated to evaluate predictive relationships among natural and human influences on key values to be sustained. The research will investigate processes, trends, and effects, as well as monitor the impacts of management decisions. New information is fed back into goal setting, synthesis, and planning for re-evaluating goals, refining conceptual models, and developing updated research plans.
- Ecological forecasting: To be useful to living-resource managers, the results of research must lead to the ability to provide forecasts of future ecological states. Research will be conducted to build coupled physical–biological models and to develop science-based products that provide value to resource managers. A long-term goal of this research is to specify an ecological forecasting system that could be used in an operational setting for resource management.

The strategy is intended to be dynamic and to involve interplay among research findings and environmental observations, desired management outcomes, goal setting, and new insights that lead to new research. Strategy development will progress concurrently with ongoing research. The outcome over the next several years is expected to include conceptual synthesis and a first-stage integrated assessment and research plan.

2.3.4 Bering Ecosystem Study

The goal of the Bering Ecosystem Study (BEST) Program is to develop a fundamental understanding of how climate change will affect the marine ecosystems of the eastern Bering Sea, the continued use of its resources, and the economic, social, and cultural sustainability of the people who depend on it.

A BEST Implementation Plan outlines the first phase of a ten-year research program focused on the marine ecosystems of the eastern Bering Sea and the people dependent on its resources. To improve understanding of the variables and processes shaping all aspects of the Bering Sea, from physical forcing (atmosphere and ocean) to food

web responses including fish, seabirds, marine mammals, and humans, fundamental research in the physical, natural, and social sciences, appropriate for funding by the National Science Foundation (NSF), will be linked to studies funded by other agencies with interests in this important region. The BEST Science Plan (www.arcus.org/Bering/science_plan.html) outlines a broad range of questions important for understanding how climate variability could influence the ecosystems of the eastern Bering Sea and their ability to sustain the goods and services required by people. Social scientists developed a parallel Science Plan, *Sustaining the Bering Sea* (www.arcus.org/Bering/hbest/index.html), which outlines a community-based research program focused on the needs of the residents of Bering Sea communities to understand how climate variability will affect their future. These two initially separate programs have now been integrated into a single program that will study the ecosystem as a whole, including the social implications of climate change and the roles of people in the system.

The BEST program will bring together physical, biological, and fisheries oceanographers; ecologists; climatologists; archeologists; and social scientists in a highly integrated and interdisciplinary program. The work will draw on regional historical data sets derived from modern oceanographic programs over the last several decades, longer-term instrumental and written records, and knowledge of ecological change recorded by the multigenerational observations of local populations. BEST will develop the next generation of conceptual and numerical models needed to link ecological and physical change and provide better strategies to anticipate and ameliorate climate-induced impacts on subsistence and commercial resource users.

The study of ecosystem changes in the eastern

Bering Sea will involve the investigation of a full suite of variables and processes that are linked ecologically but divided by the research mandates of different agencies and organizations. The BEST program must therefore be capable of integrating a variety of complementary research efforts to develop a unified understanding. Collaborations among scientists funded through NSF, NOAA, NASA, NPRB, BASIS, AOOS, USGS, and USFWS will be required to accomplish an end-to-end understanding of the eastern Bering Sea ecosystem and its users. In the face of the rapid ecosystem changes underway, this understanding is essential to sustain the rich marine resources of the eastern Bering Sea and the people and cultures dependent on their harvest.

Planning for a comprehensive study of the eastern Bering Sea began in September 2002 with a Planning Workshop in Laguna Beach, California. Workshop participants agreed unanimously that there was an urgent need to improve our understanding of the linkages between climate variability and the responses of the ecosystems of the Bering Sea, as detailed in the Workshop Report (<http://www.arcus.org/Bering>).

In March 2003, a second planning workshop was convened in Seattle, Washington, to develop a Science Plan for the Bering Ecosystem Study (BEST) Program (<http://www.arcus.org/Bering/index.html>).

In March 2004, a workshop was convened in Anchorage, Alaska, with Bering Sea residents and social scientists to outline possible goals of a social science plan for the Bering Sea. This workshop led to the development of the social science component of BEST, now integrated into this implementation plan.

In May 2005, an Implementation Workshop was held in Victoria, British Columbia.

2.4 Arctic Health Research

The Arctic Research Commission has recommended:

“...a comprehensive, interagency study of Arctic Health. NIH has agreed to be the focal point for this effort focused primarily on the environmental health questions outlined by the Arctic Monitoring and Assessment Program and on the study of incidences and trends in the major causes of morbidity and mortality in the Arctic. NIH should lead this effort with the assistance of other agencies, especially EPA and NOAA. The potential effects of anthropogenic contaminants such as persistent organic pollutants, heavy metals and radionuclides are a growing concern in the Arctic. The effects of both communicable diseases such as tuberculosis, systemic diseases such as diabetes and cancer and external causes of illness and death such as alcoholism and accident likewise have profound effects in the Arctic. The Commission eagerly awaits the organization of this multi-agency effort under the leadership of the NIH Fogarty Center” (*Report on Goals and Objectives for Arctic Research*, U.S. Arctic Research Commission, 2005).

The Arctic Research Commission also expressed interest that such a plan address health concerns from two standpoints: What are the health concerns that people of the Arctic worry about, such as pollution? What are the actual causes of morbidity and mortality in the Arctic?

2.4.1 Epidemiology and Health Surveillance

Research Goal: To understand the epidemiologic parameters of diseases important to Arctic residents, providing data that will inform and guide programs to prevent, diagnose, and treat such diseases, ranging from acute infectious illnesses to chronic conditions dependent on diet and life-style. The Centers for Disease Control and Prevention has been the lead in these activities.

Infectious Diseases

Centers for Disease Control and Prevention's Arctic Investigations Program. AIP, based in Anchorage, Alaska, is a division of the National Center for Infectious Diseases. Its mission is prevention and control of infectious diseases with a focus on diseases of high incidence and concern among the indigenous populations of the Arctic and subarctic and emerging and re-emerging infectious diseases. CDC's long-term plan, “Pre-

venting Emerging Infectious Diseases: A Strategy for the 21st Century,” focuses on four goals:

- Strengthening surveillance and response nationally and internationally;
- Supporting research to understand and combat infectious diseases threats;
- Enhancing public health epidemiologic and laboratory capacity in the U.S. and internationally; and
- Working with partners in public health to implement, support, and evaluate disease prevention activities.

The plan targets certain high-priority categories of emerging infectious disease problems and special groups of peoples who are at risk for antimicrobial resistance, food- and water-borne diseases, vector-borne and zoonotic diseases, diseases transmitted through blood transfusions or blood products, chronic diseases caused by infectious agents, vaccine development and use, people with impaired host defenses, diseases of pregnant women and newborns, and diseases of travelers, immigrants, and refugees.

For the 2006–2010 planning period, the Arctic Investigations Program will target vaccine preventable diseases, antimicrobial resistance, chronic diseases caused by infectious agents, and bioterrorism response.

National Institute of General Medical Sciences. The NIGMS, through a partnership with the Indian Health Service, is supporting a project carried out by the Alaska Native Tribal Health Consortium. The study, funded in part by the National Institute of Allergy and Infectious Diseases, is determining the prevalence and serotype of chronic hepatitis B, which may aid in understanding modes of communication of the disease.

Occupational Injuries and Disabilities

National Institute for Occupational Safety and Health. The CDC's NIOSH, Alaska Field Station, in collaboration with the Indian Health Service, the State of Alaska, the Alaska Native Tribal Health Consortium, and the Alaska Native Health Board, will continue studies on the epidemiology, risk factors, and prevention strategies for occupational injuries in Alaskan communities. Using surveillance and analysis as information for action, injury prevention partnerships have helped contribute to a 61% decline in occupational deaths in Alaska from 1990 through 2004. The Alaska Field Station

has focused recent work through two initiatives in Arctic research:

- **Fishing industry:** The commercial fishing industry contributes high numbers of fatal and severe non-fatal injuries. NIOSH is examining vessel stability and the deck environment surrounding the deployment and retrieval systems of fishing equipment (including the use of cranes, winches, lines, nets, crab pots, and crab pot launchers) from a mechanical and safety engineering perspective.
- **Aviation safety:** Since 2000, the U.S. Congress has supported a Federal initiative to reduce aviation-related injuries and fatalities and to promote aviation safety in cooperation with the air transportation industry in Alaska, through a partnership of four Federal agencies: the Federal Aviation Administration, the National Transportation Safety Board, the National Weather Service, and NIOSH. A large survey of the air taxi industry and a study examining the roles of fatigue and inexperience in aircraft crashes have been completed, and the results have recently been published. The information from these studies is enriching discussions with the industry about how best to implement changes to prevent crashes in Alaska. This concerted effort involves collaboration between government agencies, industry, and NGOs applying research findings to develop higher voluntary standards of practice and improved training and supervision regimes. The goal is to reduce the number of aircraft accidents and injuries in Alaska by at least 50% by the end of 2009.

In addition, the Alaska Field Station will collaborate in the integrated surveillance system for disease and injury in the Arctic, linking to the International Circumpolar Surveillance system.

National Institute of General Medical Sciences. For rural, subsistence, or working class families, disabilities can have profound effects on entire families. The NIGMS, through a partnership with the Indian Health Service, is supporting a study that examines the prevalence of disabilities in Alaskan communities.

Chronic Diseases

Centers for Disease Control and Prevention's National Center for Environmental Health. The Health Studies Branch of the National Center for Environmental Health is monitoring selected persistent organic pollutants (POPs) and heavy metals

in maternal blood and urine samples and in umbilical cord blood in Alaska Natives. The POP levels in these samples will be related to pregnancy outcome (e.g., full-term live birth, miscarriage, birth defects) and to the rate of infectious diseases in the infant's first year of life. The Health Studies Branch plans to continue enrolling women and their infants indefinitely and expects to add regional hospitals and health consortia from across Alaska. A newsletter is being developed to update study participants about the study's progress.

Another study examines the relationship between environmental exposures and breast cancer. Pregnancy history, dietary history, and other relevant risk factors are being analyzed, and laboratory analyses of blood and tissue for POPs and other analytes is underway. Aggregate results will be reported to Alaska Native health consortia and study subjects.

2.4.2 Biomedical and Behavioral Research

Research Goal: To uncover new knowledge that will help prevent, detect, diagnose, and treat disease and disability, thus improving people's health and saving lives. The spectrum of research includes basic through applied and clinical research, with the ultimate goal of translating research results into interventions and communicating research findings to patients and their families, health care providers, and the general public. The National Institutes of Health has been the lead in these activities.

Infectious Diseases

National Institute of Allergy and Infectious Diseases. The NIAID promotes the development of vaccines, diagnostic tests, and drug therapies to prevent and control infectious disease.

Hepatitis: Researchers supported by NIAID are investigating the relationships between hepatitis C virus replication, evolution, and disease progression in Alaska Natives. Complete histories of the patients, including their estimated date of infection and alcohol history, are being obtained. Blood and liver specimens are being collected both retrospectively and prospectively in order to examine levels of and variation in the virus and to compare these with disease progression. This study of a well-defined Alaska Native population may lead to many key answers regarding the natural history of hepatitis C and may impact its future

treatment worldwide.

National Institute on Drug Abuse. Since 1994, the NIDA has been funding basic and applied research at the University of Alaska Anchorage on drug abuse and related conditions in the Alaska Native population. Several of these research projects have produced data on the co-morbidity of sexually transmitted diseases in Alaska Native drug users, as well as other relationships to HIV risk, alcohol use, and unemployment.

Chronic Diseases

National Institute of Environmental Health Sciences. The NIEHS supports research programs to define and understand the effects of environmental chemicals and other factors on human health. In the Arctic, one important factor is that of persistent chemicals, specifically chlorinated aromatics, being transported to cold regions and remaining there because of the “sink” effect of low temperatures.

The NIEHS continues to have a small grant program that attempts to assess health effects from these contaminants. One program seeks to define dietary risks and benefits in Alaskan villages from bio-accumulated chemicals in traditional foods. Another focuses on the mechanism of effects of PCB compounds in children and on methods to assess damage to development. Other studies look for metabolic changes that might affect toxic impacts so that preventive and treatment modalities can be developed. Toxicogenomic studies are likewise attempting to understand variability in response to such exposures.

National Heart, Lung, and Blood Institute. A study supported by NHLBI is a working partnership between the Native-owned corporation that manages the health care of the Alaska Natives of Norton Sound and investigators from the Strong Heart Study, a 14-year study of cardiovascular disease in American Indians. These Native villages are remote and isolated, and the traditional lifestyle is being eroded by mechanization and a westernized diet. There has been relatively little outside genetic influence, and the Alaska Natives, like the American Indians of the lower 48 states, are beginning to show a marked increase in the prevalence of atherosclerosis and coronary artery disease.

The aims of the initial five-year \$7.8 million study, begun in FY 2000, were to document cardiovascular disease (CVD) and associated risk factors among 1,214 Alaska Natives who are members of approximately 40 families. This family-based,

cross-sectional study will add a longitudinal component to document recognized and emerging risk factors for CVD through analyses of morbidity and mortality surveillance data. The investigators will assay contemporary samples and serum specimens, which have been stored at the CDC office in Anchorage for 10–20 years prior to this study, for specific markers of inflammation and serologic responses to infection. In addition, the project will use genome-wide scan data from families to complete a linkage study of CVD risk factors. This is the first project to identify and map genes that contribute to the risk of cardiovascular disease in this unique and understudied population.

The NHLBI and the Canadian Institutes of Health Research (CIHR) co-sponsored a Working Group meeting in July 2004 entitled “Research with Arctic Peoples: Unique Research Opportunities in Heart, Lung, Blood and Sleep Disorders” to address three objectives related to research with Arctic peoples. The meeting was international in scope, with investigators from Greenland, Iceland, and Russia, as well as Canada and the U.S. The meeting concluded with a list of ten recommendations covering research priorities, barriers and solutions to Arctic research, and international comparisons. The report of the meeting is available at <http://www.nhlbi.nih.gov/meetings/workshops/arcticpeoples.htm>.

Additional discussions have been held between NHLBI and CIHR staff regarding potential joint activities. Several collaborative research opportunities are under consideration.

National Institute of Alcohol Abuse and Alcoholism. The goal of the NIAAA is to identify the causes and consequences of abusive and chronic alcohol consumption and to develop effective treatment and prevention strategies for adverse consequences of drinking. Over the next five years, NIAAA plans to continue the following studies in the Arctic region:

- **Prevention:** This study will determine the effect of alcohol availability and other control policies on alcohol-related consequences in Arctic communities.
- **Genetics and Environment:** This study will address individual variations in behavioral responses to alcohol that are directly linked to the influence of inheritance and environment, including the role of extended periods of darkness in responsiveness, the role of adaptive mechanisms of prolonged stress, the impact of corticosteroid activation on health and survival, and differences in expression

between men and women.

- **Treatment:** This study will test the efficacy of pharmacological adjuncts to alcoholism treatment in Alaska Native populations.

National Institute on Drug Abuse. The NIDA is supporting a study investigating stigmas and barriers to receiving treatment for drug abuse, mental health disorders, and HIV/STDs among Alaska Natives. The project will make significant contributions to health services research in the Arctic and other frontier and rural areas, leading to a better understanding of rural health problems and their solutions. NIDA plans to include studies of a previously overlooked problem—rural run-away youth—a group at extreme risk for substance abuse, mental health disorders, and infectious diseases, as well as violence and other forms of abuse. Another NIDA research grant is developing a community trial to prevent inhalant use in Alaska.

National Institute of Diabetes and Digestive and Kidney Diseases. The Nonalcoholic Steatohepatitis Clinical Research Network (NASH CRN) is a multicenter collaborative effort of clinical centers and a data coordinating center, supported by the NIDDK, which is intended to accelerate clinical research and progress in understanding the pathogenesis of NASH, defining its natural history, and developing safe and effective means of treatment. A comprehensive database for two clinical trials (one in pediatrics and one in adults) has been started. Ancillary studies are currently under development. Research to date suggests differences in epidemiology among different racial and ethnic groups; therefore, efforts to include a diverse participant population are critical. The University of Washington is the major referral clinic for liver disease for Alaska, Washington, Montana, and Idaho. A large proportion of the patients are Asian or from the Pacific Islands, Hispanic, or Native American. The university also serves the entire Alaska Native population, making the institution uniquely positioned to enroll NASH patients of Alaska Native ancestry as well.

National Institute of General Medical Sciences. The NIGMS, through a partnership with the Indian Health Service, is supporting two projects carried out by the Alaska Native Tribal Health Consortium regarding nutrition:

- The Alaska Native diet and assessment of the nutrition of subsistence foods; and
- Maternal nutrition during pregnancy among Alaska Natives.

National Institute of Dental and Craniofacial

Research. The NIDCR, in collaboration with the NIGMS and the Indian Health Service, is focusing on children's oral health, specifically on community intervention to reduce toddler obesity and caries. American Indian youth experience the highest rates of childhood obesity and early childhood caries in the U.S. population. At the same time, obesity is a major risk factor for type 2 diabetes, which is now occurring in American Indian youth as well as adults. The greatest dietary shift over the last 20 years has been the replacement of water, milk, and juice with soft drinks and other sugared beverages, coinciding with increases in energy consumption and leading to childhood obesity and early childhood caries. Researchers working with the Northwest Tribal Health Research Center are testing whether community and family-based interventions can alter patterns of recreational drink consumption in expectant mothers and their offspring and extend the length of breastfeeding, and whether such behavioral changes can impact childhood obesity and caries. If successful, the intervention will have great significance for the many tribal communities, including those in northern regions, facing similar issues.

National Cancer Institute. The NCI is supporting several research projects related to Arctic health:

- **Alaska Native Tumor Registry:** The Alaska Native Tumor Registry was initiated in 1974 through a collaboration between the NCI and the CDC, using procedures developed by NCI's Surveillance, Epidemiology and End Results (SEER) Program. Subsequently, the Alaska Native Medical Center became a partner in the program through the Indian Health Service, with technical assistance provided by the University of New Mexico. Accurate information on the unique cancer patterns occurring in this population is useful for provider education and training, program planning, studies of cancer etiology, evaluation of screening programs, and the development of interventions to improve patient care and programs for cancer prevention and risk reduction. The registry is participating in several research projects, including a study examining the relationship between breast cancer and exposure to environmental organochlorines among Alaska Native women and the Nicotine Research and Tobacco Control Program.
- **Network for Cancer Control Research among American Indian and Alaska Native Popula-**

tions: This network of researchers, established through NCI's Surveillance Research Program in 1990, developed a National Strategic Plan for Cancer Prevention and Control Research in 1992. The NCI shares support for network meetings with the Mayo Comprehensive Cancer Center. The web address is <http://mayoresearch.mayo.edu/mayo/research/cancercenter/nativenetwork.cfm>.

- **Tobacco and Health Disparities Research Network:** Tobacco is the leading cause of preventable illness and death in the U.S. Unfortunately, certain groups, including racial/ethnic minorities, women, youth, blue-collar and service workers, and those of low socioeconomic status, remain at high risk for tobacco use and exposure and suffer disproportionately from tobacco-related illnesses and death. To answer remaining questions about the causal mechanisms underlying disparities, NCI's Tobacco Control Research Branch is developing and implementing the Tobacco and Health Disparities Research Network. The network is a unique endeavor that aims to advance the science in understanding the etiology, prevention, and treatment of tobacco use and nicotine addiction among underserved populations in the U.S. (including Alaska Natives) and to translate that knowledge into practice and inform public policy.

National Institute of Neurological Disorders and Stroke. The NINDS anticipates funding a cooperative agreement that will support the development of a state-wide, population-based Alaska Native Stroke Registry at the Alaska Native Medical Center. It will create a model registry to conduct research on the epidemiology and management of stroke among Alaska Natives, support research strategies to reduce the burden of stroke in the population, and strengthen the research capabilities of the faculty at the Alaska Native Medical Center. The primary goals of the Alaska Native Stroke Registry are to:

- Define the natural history and clinical course of stroke among Alaska Natives, including incidence and prevalence, risk factors, clinical management, and health outcomes such as residual physical disability and mortality;
- Develop research programs to prevent stroke and improve the quality of care provided to Alaska Natives to minimize stroke sequelae; and
- Enhance opportunities for multidisciplinary

research collaborations between the Alaska Native Medical Center and institutions with established programs in stroke research.

National Institute of Child Health and Human Development. The mission of the NICHD is to ensure that every person is born healthy and wanted; that women suffer no harmful effects from reproductive processes; that all children have the chance to achieve their full potential for healthy and productive lives, free from disease or disability; and to ensure the health, productivity, independence, and well-being of all people through optimal rehabilitation.

- **SIDS and Prenatal Alcohol Exposure:** Since 2003, the NICHD, in partnership with the National Institute of Alcohol Abuse and Alcoholism, has funded a network of community-linked studies to investigate the role of prenatal alcohol exposure in the risk for sudden infant death syndrome (SIDS) and adverse pregnancy outcomes, such as stillbirth and fetal alcohol syndrome (FAS). The long-term goal of the network is to decrease fetal and infant mortality and improve child health in these communities. The clinical sites will be working with Northern Plains Indian communities and populations in the Western Cape of South Africa. Although these sites do not involve Alaska Native communities and populations in the Arctic, study findings may have potential relevance to these groups.
- **Other relevant research priorities:** Aside from SIDS, aspects and outcomes of other significant ongoing research activities of the NICHD may have relevance for Arctic health research, even if these activities currently do not target populations in the Arctic. These include the impact of environmental factors on fetal and newborn health and development; interaction between nutrition/food and environmental exposures; fetal exposure and origins of obesity and diabetes; and all matters related to nutrition and health and development. In addition, there may be opportunities to undertake vaccine-related research with indigenous populations of the Arctic region.

2.4.3 Information: Acquisition, Assembly, and Dissemination

Research Goal: To develop a responsive system for handling health information transfer in the Arctic, ranging from telemedicine systems utilized in

health care delivery, to an Internet-based health information network for researchers and the general populace, especially Native and other populations (such as the Circumpolar Health Information Center).

National Library of Medicine. In the fall of 2000, the NLM committed to developing an Arctic health web site to help organize and disseminate pertinent information regarding health issues in the Arctic, including the health effects related to the bioaccumulation of toxins in the environment. This web site, located at <http://www.arctichealth.org>, includes health information related to the indigenous populations of the U.S. Arctic, a database of information about research projects going on in Alaska, and health-related information relevant to very cold climates as well as much local Alaska information. Goals for the web site include working with indigenous peoples of the Arctic to collect and organize information on traditional medicine that may otherwise not be accessible to non-Native scientists, collecting and organizing information that may not yet be digital, and serving as a focal point for linkages with other Arctic countries for information dissemination. NLM is working with the Consortium Library and the Institute for Circumpolar Health Sciences, both at the University of Alaska Anchorage, to maintain and develop this web site.

National Institute of General Medical Sciences. The NIGMS, through a partnership with the Indian Health Service, is supporting several projects carried out by the Alaska Native Tribal Health Consortium. One applied study investigates the degree of concordance of diagnosis of effects of telemedicine versus live diagnosis. This study is significant because of the challenges of delivering health care to rural Alaska.

National Institute of Mental Health. Since 1986, the NIMH has supported the American Indian and Alaskan Mental Health Research Center. This center conducts research and promotes research training and leadership development appropriate for Native communities, disseminates research findings to communities and practitioners, and aids organizations in developing skills to conduct mental health research. The center has initiated activities in the following areas:

- **Treatment:** Working with the Cook Inlet Tribal Council, the nonprofit arm of the Cook Inlet Region Corporation, a web-based manual is being developed to address the continuum of care needed for Alaskans with alcohol, drug, and mental disorders. Care programs address

the range of needs from the homeless to women at risk of having their children taken away for abuse or neglect.

- **Health Services:** A research evaluation to examine factors associated with success in disseminating the State-of-Alaska-funded rural human services program for serious emotional problems or disturbances.

In addition, in partnership with the Indian Health Services, SAMHSA, the Canadian Institutes of Health Research, and Health Canada, NIMH is undertaking follow-on collaborative activities identified as priorities during a joint conference, held in September 2005, to address the issue of suicide prevention in indigenous populations in the U.S. and its territories and Canada.

National Cancer Institute. With support from the NCI, the Network for Cancer Control Research and the Mayo Comprehensive Cancer Center established the Native CIRCLE, a clearinghouse for research-based information and resources. Many useful, culturally sensitive materials, including school curricula, videos, pamphlets, and survey instruments, are catalogued and made available to researchers and communities for application in the areas of smoking prevention, cancer screening, and dietary change. The web address is <http://mayoresearch.mayo.edu/mayo/research/cancercenter/native.cfm>.

National Institute of Child Health and Human Development. The NICHD is working with American Indian and Alaska Native communities to identify and develop outreach programs that increase the awareness and reduce the risk of sudden infant death syndrome (SIDS) among American Indian and Alaska Native infants. The outreach programs will provide a vehicle for health care professionals and other outreach workers to interact with community leaders, including small group discussions with public health nurses, community health representatives, elders, and other caregivers of infants. Some of the issues and strategies to be discussed include:

- Developing a community-owned project;
- Incorporating the indigenous culture and traditions, such as encouraging the use of cradle boards and using talking circles;
- Involving elders in educating young parents;
- Using public health nurses, community health representatives, and home visiting programs such as Healthy Start;
- Focusing education on women's health, pre- and post-pregnancy; and
- Focusing on alcohol and smoking issues.

The NICHD plans to use information gleaned from previous meetings with community leaders and discussion groups to develop materials, coalitions, and an infrastructure that the communities can use when developing and conducting outreach programs. As a result of these interactions, representatives from the tribes and individual communities may tailor informative action plans for community-driven SIDS risk reduction strategies that meet the unique needs of their local community members.

National Institute of Diabetes and Digestive and Kidney Diseases. The NIDDK, via its National Diabetes Education Program, promotes a public awareness campaign: “*Move-IT! Reduce your Risk of Diabetes.*” This campaign is targeted to Native youth to encourage physical activity in order to reduce their risk of type 2 diabetes.

National Institute of Dental and Craniofacial Research. The NIDCR-supported Northwest/Alaska Center to Reduce Oral Health Disparity, located at the University of Washington, focuses on reducing socio-cultural barriers to improve oral health of vulnerable children in the Pacific Rim, including the northern regions of Alaska. The project seeks to better understand information regarding feeding practices and to develop culturally appropriate communications methods that will ultimately assist in the design of an appropriate web-based tool (EthnoDent) to improve the cultural competence of dentists who serve such populations as Native American and Alaska Natives.

National Center for Research Resources. To educate and inform the Alaskan public about health science research so they can make healthier lifestyle choices, NCRP, through its Science Education Partnership Awards (SEPA) program, supports the Imaginarium’s Health Outreach Caravan, which forms partnerships with the scientific, public health, educational, and cultural communities; develops mobile, hands-on, interactive, and culturally appropriate health-related programs; and develops a Health Science Teen Volunteer Corps across remote, culturally unique regions of Alaska to facilitate linkages among biomedical scientists, village elders, and local community and school programs. The program is designed to stimulate Alaskan students’ interest in science, particularly those students in remote rural areas of Alaska who are traditionally under-represented in the science professions. Ancillary activities in addition to the Teen Volunteer Corps will include teacher professional development and health fair festivals.

Fogarty International Center. The FIC is work-

ing with the National Institute of Mental Health, the Substance Abuse and Mental Health Services Administration, and others to undertake follow-on collaborative activities identified as priorities during an international symposium focusing on suicide prevention in the Arctic, held in September 2005. The discussions and recommendations are expected to provide input for the 13th International Congress on Circumpolar Health, to be held in Novosibirsk, Russia, in June 2006 as a “Gateway to IPY.”

2.4.4 Infrastructure and Capacity Building

Research Goal: To build up the capacity of Arctic institutions and organizations for competitive participation in the research enterprise (i.e., their ability to obtain research grants) through training and support of facilities or center-type grants.

National Heart, Lung, and Blood Institute. The NHLBI will continue to develop the research capacity of Alaska Native organizations and individuals through the existing Genetics of Coronary Artery Disease in Alaska Natives (GOCADAN) study and other potential funding awards currently under review. The goal will be to establish grant funding for one or more Alaska Native organizations. In addition, any grants funded in Alaska by NHLBI will be strongly encouraged to recruit and train staff from within the study population and to utilize the NIH’s minority supplement mechanisms to support training for one or more promising Native students in biomedical research.

National Cancer Institute. The NCI continues to support several training programs in the area of Arctic health:

- **Native American Student Research Program:** **Community-based Cancer Control:** This research and training program for American Indian and Alaska Native graduate and post-doctoral students is a collaboration between the Indian Health Service, Oregon Health Sciences University, and the tribe-operated Northwest Portland Area Indian Health Board.
- **Education for Healthcare Providers of Alaska Natives: Palliative Care:** Cancer is now the leading cause of death for Alaska Natives, surpassing trauma and infectious diseases, which were leading causes of death for many years. Given that the majority of basic primary care for Alaska Natives is provided by village-based workers and community health aides, whose training and experience is primarily in

primary and acute care, health care providers are often ill-prepared to provide palliative care to patients nearing the end of life. This program is designed to address educational needs related to system-wide implementation of a comprehensive, integrated, and culturally sensitive palliative care program for Alaska Natives. A well-trained palliative care team will become the core trainers once the program is implemented.

National Institute on Aging. The Native Elder Research Center/Resource Center for Minority Aging Research, supported by the NIA, provides an administrative structure, supported by a comprehensive array of unique programs, that directs and coordinates a culturally relevant, scientifically meritorious research career development program targeting American Indians and Alaska Natives. This project also is designed to augment already active partnerships with these communities to ensure continuous access to and involvement of elders, their families, and local systems of care in the aging research process. It is housed within the Division of American Indian and Alaska Native Programs of the Department of Psychiatry, School of Medicine, at the University of Colorado Health Sciences Center.

National Institute of Nursing Research. The NINR has expanded its activity in infrastructure and capacity building in the Arctic through its Centers Program. Specifically, in FY 2004 the University of Washington's Center for Women's Health and Gender Research formalized its collaborative relationship with the University of Alaska Anchorage's School of Nursing. The University of Alaska is now a part of the Research Development and Partnership Core at the Center.

National Institute of Neurological Disorders and Stroke. The NINDS, along with the National Institute of Mental Health and the National Center for Research Resources, is collaborating in the joint sponsorship of the Alaskan Basic Neuroscience Program at the University of Alaska Fairbanks. This program is intended to establish, expand, and enhance competitive research programs in basic neuroscience at minority institutions. It is expected also to facilitate the development of collaborative research and to stimulate the active participation of Alaska Native students. The research projects will examine themes of interest to Alaskan peoples, including circadian rhythms, hibernation mechanisms, and neural development and repair.

National Center for Research Resources. The

NCCR continues to develop Alaska's research capacity through funding from the two components of the Institutional Development Award (IDeA) program: the Centers of Biomedical Research Excellence (COBRE) award and the IDeA Networks of Biomedical Research Excellence (INBRE).

The University of Alaska's Center for Alaska Native Health Research (CANHR), funded through COBRE, has enrolled 777 participants in Yup'ik villages and will continue to enroll new participants for community-based epidemiological studies of biological and environmental variables in metabolic disorders and obesity. The center's cultural behavioral core will continue to disseminate key information to participating villages, with Yup'ik research assistants trained to give presentations using the Yup'ik language and culturally attuned symbols and concepts. In addition, the center will exploit enhanced cyberinfrastructure supported by NCCR to form networks with senior investigators outside of the state, creating a broad and strong foundation for future growth and productivity.

The INBRE award to the University of Alaska provides support to build a network that will broaden and strengthen capacity and performance in biomedical research by supporting faculty and providing research opportunities that will expose undergraduate students within the state to promote careers in biomedical research. The research efforts focus on environmental health, with an additional focus on molecular toxicology of subsistence species and on infectious agents, including zoonotic diseases. The INBRE award also supports an outreach program for smaller Alaska colleges, hospitals, and health corporations to attract students and faculty and engage them in INBRE research projects. The ultimate goal of the INBRE program is to enhance science knowledge of the Alaskan workforce and expand the undergraduate student pipeline into health careers, with particular attention to Alaska Native students.

Fogarty International Center. The FIC is soliciting grant applications for its new International Collaborative Trauma and Injury Research Training Program. This program, co-funded by seven NIH partners, the CDC's National Center for Injury Prevention and Control, the Pan American Health Organization, and the World Health Organization (WHO), aims to raise awareness of the human and economic costs caused by trauma and injury, which are leading causes of death and disability globally, particularly in the Arctic. Training will

build skills and knowledge on how to address most effectively this challenge across the range of basic to applied science, the epidemiology of risk factors, acute care and survival, rehabilitation, and long-term mental health consequences.

Substance Abuse and Mental Health Services Administration. The mission of SAMHSA is to build resilience and facilitate recovery for people with or at risk for substance abuse and mental illness. SAMHSA works in collaboration with the states, national and local community-based and faith-based organizations, and public and private sector providers. Although SAMHSA does not conduct research per se, it supports numerous activities relevant to capacity development in Alaska:

- Fetal Alcohol Spectrum Disorders Center for Excellence: This center coordinates activities to ensure that advances in both science and practice are synthesized and efficiently disseminated to the field. The center's mandates include the study of innovative clinical interventions, identification of communities with exemplary comprehensive systems of care, provision of technical assistance and training to individuals in service systems, and development of innovative techniques to prevent alcohol use by women in childbearing years.
- Circles of Care Program: This SAMHSA program provides grants for tribes and urban Indian communities to plan, design, and assess culturally specific mental health service system models for American Indian and Alaska Native children and their families.
- Child Mental Health Initiative: This cooperative agreement provides grants to states, political subdivisions, and tribes or tribal organizations to develop community-based systems of care for children (and their families) with serious emotional disturbances.
- Screening, Brief Intervention, Referral and Treatment (SBIRT): This five-year discretionary grant program is designed to assist states, territories, and tribes in expanding the continuum of care available for treatment of substance use disorders. The Cook Inlet Tribal Council, Inc., of Anchorage is one of seven SBIRT grantees.
- Co-Occurring State Incentive Grants (COSIG): Alaska has committed to improving the identification and treatment of individuals with co-occurring disorders through a diverse service delivery system of improved screening, assessment, treatment, and training. In fulfill-

ment of a state action plan for integrating mental health and substance abuse services, this effort will be accomplished through a five-year COSIG grant (awarded in 2003) to Alaska to support infrastructure development, focusing on staffing competency, credentialing, and licensure; financial planning and reimbursement; and information sharing and data collection.

- Targeted Capacity Expansion (TCE) Program: This grant program expands treatment opportunities and capacity in local communities experiencing serious, emerging drug problems and in communities that propose innovative solutions to substance abuse treatment needs not previously met. Specialized initiatives emphasize strengthened services for youth, adolescents, and minority communities, particularly in rural areas, and support services for persons in recovery (e.g., from methamphetamine and other emerging drugs), in particular those addressing the twin issues of substance abuse and HIV/AIDS. Alaskan grant recipients have included the Yukon Kuskokwim Health Corp., the Copper River Native Association, the Fairbanks Native Association, and the Cook Inlet Tribal Council.
- Access to Recovery Program (ATR): SAMHSA's signature treatment services program is a state-run voucher program for substance abuse clinical treatment and/or recovery support services. ATR is designed to expand capacity by increasing the number and types of providers, including faith-based providers; allow recovery to be pursued through many different and personal pathways; and require grantees to manage performance, based on outcomes that demonstrate patient successes. While Alaska is not a current ATR grantee, it will be eligible to apply again in FY 06 when the program is proposed for expansion to allow seven additional awards to be made.

Health Resources and Services Administration. The HRSA works to expand access to high-quality, culturally competent health care and to improve health outcomes among Alaska's minority communities through the National Health Service Corps and support of community health centers. The agency also enhances direct medical care in Alaska through the use of telehealth technology and promotion of the Health Disparities Collaborative approach to disease management through

HRSA-funded community health centers.

In addition, an HRSA grant to the Alaska Psychiatric Institute (API), Alaska's state psychiatric hospital, provides funds for API to work with the Alaska Federal Health Care Access Network to extend the clinical infrastructure of API to rural/remote areas of Alaska and integrate behavioral health services with primary care and Native health clinics through the use of telemedicine.

As part of a quality improvement effort associated with its community health centers in Alaska, the HRSA supports health disparity collaborative activities, which focus on specific topic areas.

Examples include the following centers:

- Anchorage Neighborhood Health, Anchorage: Diabetes and Depression
- Eastern Aleutian Tribes, Anchorage: Depression and Cardiovascular Health
- Edgar Nollner Health Center, Galena: Diabetes and Cardiovascular Health
- Illiuk Family and Health Services, Unalaska: Diabetes and Cardiovascular Health
- Interior Community Health Center, Talkeetna: Diabetes and Depression.

2.4.5 *International Circumpolar Collaborations*

Research Goal: To promote the collaborative efforts of scientists across the eight circumpolar nations to facilitate comparison of environmental monitoring results, disease rates, development of new approaches, and dissemination of best practices and care. This will lead to a more comprehensive understanding of the effects of environmental pollution, climate change, and cultural impacts on Arctic populations.

In September 2004, the National Institutes of Health (NIH) and the Canadian Institutes of Health Research (CIHR) signed a letter of intent to strengthen research cooperation on health issues of priority to American Indians, Alaska Natives, Canadian First Nations, Métis, and Inuits of the U.S. and Canada. The agreement builds on an earlier one, signed in May 2002, between the U.S. Department of Health and Human Services and Health Canada (equivalent to the Ministry of Health), which recognized common objectives of improving the health status of First Nation and Inuit peoples in Canada and American Indians and Alaska Natives in the U.S. and sharing knowledge to improve approaches to Native peoples' health issues. Together, these agreements represent significant institutional support for collaborative

projects focusing on indigenous peoples of the North through the CDC, the NIH, the Indian Health Service, and several health organizations in Canada.

National Cancer Institute. The NCI is engaged in a binational collaboration with Canada on the cancer burden in Native populations. In the U.S., cancer is the second leading cause of death for American Indians and the leading cause of death for Alaska Natives. In Canada, cancer is the third leading cause of death, following injuries/poisonings and cardiovascular disease. The First Nations and Inuit population of Canada experience health disparities similar to those of American Indians and Alaska Natives in the U.S. (i.e., a gap of 6.4 years and 4.7 years in life expectancy, respectively, compared to the general population). The purpose of the project is to assemble and analyze cancer surveillance data on the Native populations in the U.S. and Canada—culturally and genetically related but exposed to different health care and social environments—into a profile of North American cancer surveillance and cancer burden that could lead to improved understanding of risk factors and effective preventive interventions. The Alaska Native Tumor Registry described in Section 2.4.2 will play an important role in this collaborative project.

Centers for Disease Control and Prevention's Arctic Investigations Program. The Anchorage-based AIP coordinates the International Circumpolar Surveillance (ICS) system, which links existing public health laboratories and facilities in Arctic countries to address emerging infectious diseases. This initiative follows the CDC's Global Disease Strategy: "Protecting the Nation's Health in an Era of Globalization," which defines CDC's global health priorities in six areas:

- International outbreak assistance;
- A global approach to disease surveillance;
- Applied research on diseases of global importance;
- Application of proven public health tools;
- Global initiatives for disease control; and
- Public health training and capacity building.

For the 2006–2010 planning period, AIP will continue to develop public health partnerships for the international circumpolar surveillance of invasive bacterial diseases (those caused by *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, and Group A and B streptococcus) in the U.S. Arctic (Alaska), northern Canada, Greenland, Iceland, Norway, Finland, and Sweden. This network of networks provides data

for tracking the emergence of antimicrobial resistance and the impact of programs for prevention of invasive bacterial diseases. During this planning period, opportunities will be explored to initiate surveillance of tuberculosis, hepatitis B, and HIV and to extend the surveillance system to include northern regions and oblasts of the Russian Federation. In addition, ICS will expand its scope to include integrated surveillance of non-infectious diseases and injuries in the Arctic region.

National Institute of Allergy and Infectious Diseases. The NIAID has established the Population Genetic Analysis Program: Immunity to Vaccination/Infection. An Icelandic company, deCode Genetics, a component of this program, was awarded a contract to conduct research on genetic polymorphisms in candidate immune response genes, including those for transcription factors, cytokines, chemokines, and adhesion and co-stimulatory molecules, in an Icelandic population. Approximately 500–1,000 cases and an equal number of controls will be enrolled in Iceland under that country's human subject protection rules.

National Institute of Alcohol Abuse and Alcoholism. Working with local communities and in collaboration with other Federal agencies, the NIAAA is supporting a study of maternal drinking and Fetal Alcohol Spectrum Disorders (FASD), which will advance understanding of the roles of environment, culture, and general intellectual functioning in the phenotype of FASD by comparing neuropsychological tests and brain imaging studies of children in the U.S., Helsinki, and Moscow. The project also will develop a core team of expert diagnosticians at all consortium sites.

National Institute on Aging. The NIA supports research in international Arctic health through its Age, Gene/Environment Susceptibility Study (AGES), an intramural project carried out in collaboration with the Icelandic Heart Association's Reykjavik Study. The collaboration is a study of genetic susceptibility and gene/environment interaction as these contribute to traits and phenotypes common to old age. The study uses a well-

characterized, homogenous, longitudinal population sample from the Icelandic Reykjavik Study. This allows the use of mid-life data in conjunction with old-age measurements to determine phenotypes of interest for genotyping—a tremendous advantage, since diseases of old age are known to change risk factors and biomarkers. AGES focuses on traits from four biologic systems reflecting the multi-system effects of aging:

- **Neurocognitive:** cognition, dementia, depression, neurosensory (vision, hearing, balance);
- **Cardiovascular:** atherosclerosis, arterial distensibility, ventricular and valvular disease;
- **Musculoskeletal:** spine and hip osteoporosis, hip osteoarthritis, strength and function; and
- **Metabolism and body composition:** obesity, sarcopenia, and hyperglycemia/diabetes.

The AGES Study has enrolled about 5,100 subjects (including 1,000 people ages 80 or older) as of July 2005. The enrollees include persons with diverse physical and cognitive function, a large proportion of whom meet suggested criteria for frailty.

U.S. Civilian Research and Development Foundation. The NIH, together with NSF and the U.S. Department of State, will continue to support collaborative research projects, some of which are relevant to the Arctic, between U.S. scientists and their counterparts in the former Soviet Union through the U.S. Civilian Research and Development Foundation (CRDF) and its Cooperative Grants Program. During the period 2006–2010, one project in particular is relevant to Arctic health:

- “Spectrum of Mitochondrial DNA Mutations in Leber's Hereditary Optic Neuropathy in Russia/Siberia”: This project, carried out by collaborators at the Institute of Cytology and Genetics in Novosibirsk and University of California Irvine, focuses on the study of the genetics of migrating populations from northern Russia and the lower Arctic. The study will provide additional and precise information relevant to genetic epidemiology of mitochondrial disease and natural DNA variation, in an evolutionary context, in this part of the world.

2.5 *Research on Resource Evaluation*

In its 2003 *Report on Goals and Objectives for Arctic Research*, the Arctic Research Commission provided the following statement and recommendation:

“The Alaska National Interest Lands Conservation Act of 1980 (ANILCA §1010) directs the Secretary of the Interior to “assess the oil, gas, and other mineral potential on all public lands in the State of Alaska in order to expand the data base with respect to the mineral potential of such lands.” The Department of the Interior conducted and published several of these assessments. However, for the last several years the program has not added to the information on the resources on Alaska public lands. The environmentally sound and sustainable use of the resources on the vast area of federal lands in Alaska (about 66% of the State’s area) is essential for both the state and the nation. Resource exploitation provides the nation with needed materials and energy while providing expanded economic opportunities for the population of the State.

The Arctic Research Commission requests that the Department of the Interior resume its resource evaluation activities and cooperate with the other Federal Agencies, the State of Alaska and institutional partners to provide widely available and comprehensive coverage of all federal lands in Alaska.”

The Department of the Interior has continued to assess the energy and minerals of Alaska, and its bureaus have published numerous reports on this subject. However, with the renewed interest in information on the oil, gas, and other mineral potential on public lands in the State of Alaska, the Department of the Interior will initiate discussions with Interior bureaus and other departments to determine the feasibility of resuming publication of an annual report on these topics. IARPC expects to work with the Department of the Interior to develop this initiative in the context of funding that is made available during the period of this revision to the U.S. Arctic Research Plan (2006–2010).

2.6 Research on Civil Infrastructure

In its 2003 *Report on Goals and Objectives for Arctic Research*, the Arctic Research Commission provided the following statement and recommendations:

“Understanding climate change in the Arctic is an important goal, as the SEARCH Program has recognized. It is at least equally important, however, to begin the task of finding ways to cope with the effects of climate change, particularly on Arctic infrastructure. The effects of infrastructure problems on human life in the Arctic are particularly noted above in the section on Arctic Health. These difficulties are compounded by climate change. The destabilization of structures by changes in permafrost, changes in coastal communities caused by changing in sea level and in the frequency and strength of storm induced wave action, changes in weather patterns requiring changes in aircraft operation and many others require a strong commitment to engineering research in the Arctic. The Commission is encouraged by arrangements between the U.S. Army’s Cold Regions Research and Engineering Laboratory (CRREL) and the University of Alaska to bring the nation’s most able engineering talent to bear on these problems. CRREL is recognized around the world as an international treasure of expertise in Arctic engineering.

The Commission recommends continuing support for the U.S. Army Cold Regions Research and Engineering Laboratory and encourages their participation in infrastructure research in Alaska.

Accurate and precise geospatial (map) data are essential for many purposes including air navigation, wilderness travel, and mineral and energy exploitation. Similarly, they are fundamental requirements for the effective construction of civil infrastructure projects. The Department of the Interior through its USGS Geospatial Data Clearinghouse provides geospatial data and, in particular, digital elevation models based on a variety of measurement techniques, primarily observations from aircraft and spacecraft. Complete coverage of the 48 contiguous

states has been available for years. Full coverage of the U.S. Arctic region at high precision (1m × 1m × 1m) does not exist and is critically needed.

The Commission recommends that the Department of the Interior take steps to acquire and make available precise geospatial data for maps of the U.S. Arctic.”

The USGS has initiated the National Map Program in Alaska through the Alaska Geographic Data Committee’s (AGDC) Alaska Digital Ortho-Imagery Initiative. The AGDC comprises over 45 Federal, state, local government, university, and nongovernmental institutions, including private industry. The AGDC developed a set of technical requirements and a strategic plan with required funding and timelines that would provide high-resolution ortho-imagery and high-resolution DEMS for the entire state. Work on the AGDC initiative was formally begun in FY 02 with the acquisition of interferometric synthetic aperture radar (IFSAR) imagery (for DEM production) and high-resolution color aerial photography for the Northeast Study Area of the National Petroleum Reserve of Alaska. DOI invested approximately \$1 million in FY 02 for this pilot study through USGS contracts with private industry, supplemented with funding from the BLM.

In FY 03 the USGS and BLM expanded the coverage over NPR–A. The strategy is to focus the work on areas of the state where high-resolution data are required to support priority DOI and AGDC members’ planning and management needs. IARPC and the Department of the Interior will work to develop this program in the context of funding that is made available during the period of this revision to the U.S. Arctic Research Plan (2006–2010). IARPC also will encourage continuing support for the U.S. Army Cold Regions Research and Engineering Laboratory’s participation in infrastructure research in Alaska.