

**United States  
Arctic Research Commission**



**Report on  
Goals and Objectives  
for  
Arctic Research  
2005**



## A MESSAGE FROM THE CHAIR

The Arctic Research and Policy Act of 1984 (as amended) directs the United States Arctic Research Commission to publish its Report on Goals and Objectives for Arctic Research every two years to guide the Interagency Arctic Research Policy Committee, and thus, the member Federal Agencies, as they prepare their revision of the National Arctic Research Plan. This report for the year 2005 reflects the best judgment of the Commission based upon information gathered at our formal meetings, from other Arctic research community meetings, plus our interaction with Arctic scientists, the indigenous people of Alaska, the State of Alaska, Federal agencies and interested citizens.

The Commission continues to review the research programs the United States and other nations with Arctic interests. We have attempted to synthesize them into a focused set of goals that meet federal, state, local and native research needs in order to understand and respond to the changes being observed in the Arctic. At the same time we have tried to be sensitive to the dynamics of the Arctic which are affecting the international as well as the national landscape of politics, economics, sociology, security and the environment. Because these dynamics are far reaching and diverse, completed on their own schedule, the recommendations in this report may not exactly coincide with the research priorities articulated in the President's budget that must at times be sensitive to requirements outside the Commission's purview.

During the past 15 years since the end of the Cold War, the Commission has been most pleased to participate in the world's growing interest in all aspects of the Arctic. Most recently our country's focus on Arctic research has increased significantly. This, in turn, has resulted in numerous advancements that will enable additional research and greatly increase our understanding of the least studied and most poorly understood area on Earth in the years ahead. Examples of these are:

The highly successful data collection efforts of the SHEBA Program.

The stunning revelations of the history and current state of the Arctic ocean gained from the SCICEX Program, and the continuing contributions from accommodation cruises by US Navy submarines.

The establishment of the Study of Environmental ARctic CHange (SEARCH) Program.

The impact of the Arctic Research Logistics Program at NSF as a vital adjunct to more cost-effective research.

Continuous upgrades at the Toolik Lake and Barrow Arctic Science Center research facilities in Alaska and the several facilities in Greenland.

The continuation of NOAA's Arctic Research Initiative.

The development and steady growth in contributions from the International Arctic Research Center at the University of Alaska.

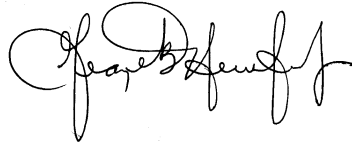
The continued availability of the US Coast Guard research icebreaker *Healy*, WAGB 20.

The success of international efforts, such as the AMORE and ACEX expeditions, that collected data in the central Arctic basin using multiple icebreakers and special platforms, both of which were unprecedented achievements.

But as we advance in our ability to conduct research and broaden our knowledge, we find unanswered questions. In response, we are compelled to continue to study the Arctic, perhaps more intensively now than ever. Specifically:

1. The Arctic Ocean is undergoing rapid change. Is it the result of man-induced global climate change or part of a natural cycle? Can we exploit these changes in the Arctic Ocean for our benefit? What is the potential impact of these ocean changes on the rest of the world?
2. The permafrost that underlies roughly 80% of the State of Alaska is decreasing. What engineering developments will mitigate the degradation of the State's infrastructure? Can we stimulate more research in this neglected area of potentially severe impact on the roads, bridges, utilities, buildings, and runways of Alaska?
3. The Bering Sea fishery provides 50% of the table fish for our nation but its ecology is changing. Why? What are the possible consequences of the changes? What are the social and economic impacts?
4. As climate changes so do the habitats and ranges of animals and plants. What is happening to the terrestrial ecology of the Arctic? What will be the effects on human activities such as subsistence hunting, forestry and agriculture?
5. The availability of public services in remote and harsh Alaskan conditions is limited. Can applied research solve the needs for telecommunications, health care delivery, education, efficient electric power, water and waste disposal – all of which are easily met in the other 49 states?

The trend in Arctic warming, accelerating since our last *Report on Goals and Objectives for Arctic Research* published in 2003, makes a compelling argument for continuing relevant, cost effective research at all levels - from basic through applied engineering. Though the Arctic is harsh, remote and complex, the fact that nine out of ten people on Earth live on the continents that border the Arctic Ocean strongly urges that our research have a "northern focus". We believe the goals and objectives recommended in this report again show the way toward needed accomplishments in Arctic research.



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# **ARCTIC RESEARCH AND POLICY ACT OF 1984 AMENDED 1990**

Finding, among other facts, that "Arctic research expands knowledge which can enhance the lives of Arctic residents, increase opportunities for international cooperation, and facilitate the formulation of national policy for the Arctic," the United States Congress passed the Arctic Research and Policy Act in July 1984 (Public Law 98-373), and amended it in October 1990 (Public Law 101-609).

The main purposes of the Act are:

**To establish national policy, goals and priorities to provide a federal program plan for basic and applied scientific and engineering research in the Arctic;**

**To establish an Arctic Research Commission to promote Arctic research and to recommend Arctic Research policy and priorities;**

**To establish an Interagency Arctic Research Policy Committee to develop with the Commission a national Arctic Research policy and to prepare a five-year plan to implement that policy;**

**To designate the National Science Foundation as the lead agency responsible for implementing Arctic Research policy.**

The Act assigns specific duties to the Commission and the Interagency Committee, and specifies procedures for the development of the five-year Arctic Research Plan and its periodic revision. The Commission reports to the President and to the Congress and consists of seven voting members appointed by the US President. By law, four are from academic or research institutions, two from private industry undertaking Arctic resource development, and one from among indigenous residents of the US Arctic. The Director of the National Science Foundation serves as a nonvoting *ex-officio* member.

**U.S. Arctic Research Commission  
TDD 703-306-0090  
<http://www.arctic.gov>**

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## **A SUMMARY OF THE COMMISSION'S FINDINGS AND RECOMMENDATIONS**

**The Arctic Research Commission strongly supports the Interagency SEARCH program and encourages it to grow into a fully developed program with a common research agenda and an integrated budget approach.**

**The Arctic Research Commission congratulates IASC on the inception of their program on the study of Arctic change and encourages US researchers to collaborate and coordinate**

**The Commission recommends an international program to promote the recovery and/or re-establishment of the most important hydrometeorological monitoring stations for systematic detection of contemporary and future environmental change.**

**The Commission applauds and encourages these planning activities related to the Bering Sea and its watershed and recommends a Bering Sea Ecosystem Summit.**

**The Arctic Research Commission supports immediate expansion of the BERPAC program to include annual research cruises and appropriate support for related research both within NOAA and through extramural funding paths.**

**The Arctic Research Commission supports the implementation of the third focused, interagency program to coordinate and emphasize research on health concerns in the Arctic and to build links to the health research programs of other Arctic nations.**

**The Commission supports the continuation and expansion of the NIOSH program for reduction of injury and death in Alaska's important industries.**

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

**The Commission Recommends the implementation of the recommendations in the *Report on Climate Change, Permafrost and Impacts on Civil Infrastructure*.**

**The Commission recommends that the Department of the Interior and the National Geospatial-Intelligence Agency take steps to acquire and make available precise geospatial data for maps of the US Arctic.**

**The Arctic Research Commission recommends that Federal agencies immediately commence a comprehensive program of research on oil in ice base on the Commission's **Special Report** *Advancing Oil Spill Response in Ice-Covered Waters*, (USARC Special Report 04-1).**

**The Arctic Research Commission recommends that the affected agencies include new research funding in their requests for re-authorization of OPA 90.**

**The Commission recommends an accelerated program of applied research on issues in the Bering Sea region with an emphasis on the fishing industry.**

**The Arctic Research Commission recommends an expansion of the research base for the development of value-added products and recommends that the State of Alaska support this particularly important need.**

**The Commission commends the Department of Energy for the establishment of this center and suggests that its mandate be broadened beyond the confines of the Office of Oil and Gas to include such topics as renewables and conservation.**

**The Arctic Research Commission supports the current efforts in distance education and telemedicine and supports further efforts to improve the provision of these services.**

**The Commission supports the continuation of the work of the CITF.**

**The Commission also notes the commendable efforts of the Arctic Research Consortium of the United States (ARCUS) in education.**

**The Commission supports efforts by Arctic researchers to make their results available to interested citizens.**

**The Commission approves of the NSF Office of Polar Program's efforts to involve teachers in Arctic Research and urges its continuation and expansion.**

**The Commission is pleased that the cadre of new Arctic researchers currently in training is growing and encourages the NSF and NOAA to continue the good work they are accomplishing.**

**The Commission supports the NSF's Rural Systemic Initiative in Alaska.**

**The Arctic Research Commission is pleased that the National Science Foundation's regular support for research aboard HEALY. Other Federal Agencies including NOAA, MMS, FWS and others have research needs which require icebreaking research vessels such as ecosystem research in the Bering Sea in winter. The Commission recommends that these agencies become involved in HEALY scheduling and operations through the AICC.**

**The Commission recommends that the National Science Foundation fund the final design and construction of the Alaska Regional Research Vessel at the earliest opportunity.**

**The Commission supports the continued declassification of bathymetric, ice and other oceanographic data collected in the Arctic Ocean as appropriate.**

**The Commission supports the effort to produce the Ice Atlas.**



## **INTRODUCTION**

The United States is an Arctic nation. Since the purchase of Alaska in 1867, the United States has been bounded by the Arctic Ocean and the Bering Sea and been bordered by Arctic Russia and Arctic Canada. As a consequence of the national presence in the Arctic, we have both opportunities and responsibilities in the region. It is the purpose of this report to indicate the potential for research efforts to address Arctic and indeed global questions through studies carried out in and around the Arctic region.

### ***NATIONAL SECURITY***

For many years, the Arctic was a place for confrontation with adversaries of the United States. With the end of the Cold War these tensions have been eased but there remain important national security concerns in the region. Our northern border is unmanned and insecure. In the past there was little attention paid to the security of this vacant and mostly wilderness border. With current concerns for homeland security, the enormous coastline of Alaska (fifty percent of the entire US coastline) becomes a potential opening for unwanted intrusions into the United States. At the same time, the role of the US Arctic in missile defense strategies has developed. The installations under construction in Alaska on the edges of the Arctic region require an advanced state of knowledge about the environmental conditions where they will be required to perform their sophisticated functions. The effects of permafrost, sub-arctic climate, auroral activity and many other unique features of the region will play a role in the functioning of these technologically advanced defense systems.

At the same time the Arctic is changing. Changes in the world's climate are leading to changes in the Arctic Ocean. These changes bear implications for the role of the US Navy in the region. The material changes in ships, aircraft and other systems require forethought as these changes have very similar time scales. A ship takes about ten years from the beginning of the design effort to initial operations at sea and predictions of changing conditions on ten year time scales are substantial. Planning for new Navy responses in the Arctic should be undertaken now and research efforts to improve and refine predictions of changing conditions and to characterize the environment in which the Navy will be expected to function must also be active now.

### ***RESOURCES***

The Arctic region is rich in resources particularly in the US Arctic, Canada and Russia. Russia, for example, has the largest continental shelf of any nation with many geological similarities to the petroleum bearing regions on Alaska's North Slope and in the western Canadian Arctic. Alaska contains the majority of US proven coal reserves. In addition to large potentials for energy exploitation in the Arctic, mineral products of great value also abound in the region. The Red Dog Mine in the Alaskan Arctic is the largest lead-zinc producer in the world and recent diamond discoveries in the Siberian and Canadian Shields have overtaken African producers as well. But the resource potential in the US Arctic suffers from a serious lack of exploration, identification, understanding and evaluation. These

surveys are essential if the nation is to take the fullest advantage of our own natural resources. Environmentally sound exploitation of these resources requires research into the potential for new and cleaner extractive processes with reduced environmental effects. This knowledge is essential for effective regulation of these resource industries.

At the same time, living and renewable resources from the Arctic affect lives throughout the nation and the world. Alaskan waters produce more than half of the nation's table fish and Alaskan forests are major producers of timber products for both domestic use and international trade. It is essential that these resources be harvested in sustainable ways which will assure that they are available for future generations. Research in both their individual behavior and the ecosystems in which they are embedded is essential for prudent and sustainable management.

### ***SOCIAL AND ECONOMIC ISSUES***

The US Arctic is rich in natural resources. The exploitation of these resources brings value to the nation and employment and wealth to the population of the region. But these activities are new to the local residents, especially the indigenous population, and bring with them new phenomena of social and economic change. The wise stewardship of these resources requires a depth of understanding of the environments from which they are taken that can only come from careful and penetrating research. The difficulties which might be caused by inappropriate and unsustainable use of these resources can be avoided and the populations affected can be protected but only in the presence of careful study and broad application of the essential products of research. Sustainable and environmentally sound use of fisheries, forests and mineral and energy resources can't be achieved without a thorough understanding of the social organizations within which they exist.

### ***GLOBAL CHANGE***

At the same time that new ventures are seeking to use the natural resources of the North, changes in the environment are taking place which have major effects on the residents of the Arctic and are reflected globally. Atmospheric and oceanic processes in the Arctic are changing. Model studies suggest that climate change will be largest and earliest in the Arctic. At the same time, the residents of the Arctic live closer to and in more intimate contact with the natural environment than in any other part of the nation. Climate change is already upon us in the Arctic. Beaches are eroding and permafrost is becoming destabilized. Sea level is rising and sea ice is melting earlier and re-freezing later leaving longer periods of open water and resulting in excess erosion on beaches; beaches where most of the country's Arctic population live. Because of the retreat of sea ice along the coasts of Alaska, the indigenous subsistence whalers are facing increasing challenges to their lifestyle.

### ***THE ARCTIC OCEAN AND THE BERING SEA***

The Arctic Ocean is the least well known ocean on the planet. We know more about the topography of the planets Venus and Mars than we do about the bathymetry of the Arctic

Ocean. Recent developments in Arctic Ocean research facilities have allowed us to get a first glimpse of the changes taking place in the Arctic Ocean in real time. We now know that the penetration of warmer, saltier Atlantic Ocean water into the Arctic basin through the Fram Strait between Svalbard and Greenland has accelerated in the last decade bringing in more warm water, eroding the cold halocline and threatening the stability of the sea ice. Changes farther south in the Greenland-Iceland-Norwegian Seas (the GIN Seas) are causing changes in the character of the production of cold deep water at the start of the global ocean “conveyor belt” which drives the entire circulation of the deep ocean and the chemistry and biology of both the deep and shallow ocean around the globe. Research in the region is essential if we are to understand changes in climate and ocean circulation which affect the entire planet and all of its people.

### ***CIVIL INFRASTRUCTURE***

As climate changes and as new economic activities occur in the North, civil infrastructure in the form of airports, pipelines, roads, ports, bridges, buildings and water/waste water facilities begin to suffer from the effects of the Arctic climate and the changes taking place. The Arctic Research Commission has outlined the scope of this problem and the research efforts necessary to cope with these changes. In addition, the Commission has held hearings in Alaska which have illustrated the needs for new information which forms the basis for civil infrastructure. The Commission has encouraged the creation of new building codes appropriate for the Arctic. Similarly, new technologies, standards and practices in water and waste water, heating, ventilation, energy and air conditioning and many other systems appropriate for the region are required. The Commission notes that these and other applied research topics have been neglected by Federal agencies and that more efforts will be required in the future.

### ***RUSSIA***

The Russian Federation exercises dominion over the largest land mass in the Arctic. The opportunities for cooperation and collaboration with Russia in the Arctic are extensive and hold great potential for advances in knowledge. At the same time, economic conditions in Russia have starved their research apparatus of resources to the point that serious shrinkage appears to be underway. This presents an opportunity for the US to build cooperative relationships with Russian scientists in the Arctic. Some steps have already been taken.

Stemming from a 2003 Memorandum of Understanding for World Ocean and Polar Regions Studies between NOAA and the Russian Academy of Sciences, a 45-day collaborative US – Russian Federation oceanographic expedition took place in summer 2004. (For more information see <http://www.arctic.noaa.gov/aro/russian-american/>.) This was the first cruise of Russian-American Long-term Census of the Arctic (RUSALCA) funded in the U.S. through the NOAA Arctic Research Initiative. The cruise took place on the Russian ice-strengthened (not ice-breaking) research ship, the R/V *Khromov*. The cruise objectives support the SEARCH Program, the NOAA Ocean Exploration Program and the Arctic Ocean Census of Marine Life, and included sampling and instrument deployment in both U.S. and

Russian territorial waters of the northern Bering and Chukchi Seas. The NSF's RAISE Program, atmospheric monitoring programs by NSF, NOAA and EPA, and the BERPAC Program are ongoing projects of great potential but the dedication of resources by the federal government to these programs has not kept pace with research needs. Others, particularly the European Union and especially Germany have supplanted the United States leadership in collaborative research activities in Arctic Russia.

River flow data collected by Roshydromet can be used to estimate the frequency and severity of the annual spring floods in Russian rivers. These estimates are, in turn, vital for understanding the probability and magnitude of re-mobilization events which can disperse the serious contamination of the Russian environment caused by many years of poor practices. These contaminants, if mobilized into the Russian rivers will enter the Arctic Ocean and circulate in relatively rapid fashion throughout the marine environments of all of the Arctic nations. With several billion curies of Sr<sup>90</sup> and Cs<sup>137</sup> loose in the Russian landmass these are not trivial concerns.

### ***INTERNATIONAL COOPERATION***

The Arctic is an important arena of international cooperation. There have been a number of icebreaker expeditions to the vicinity of North Pole in the last decade and a half, and each has been an international expedition with at least two ships from different nations. Similarly, circumarctic cooperation in organizations such as the Arctic Council, the International Arctic Science Committee, the Arctic Ocean Science Board, the International Union for Circumpolar Health and the International Arctic Social Science Association coordinate research activities and promote communications among the international Arctic research community. Given the necessity for collaboration in facilities and the requirement that the Arctic be studied as a complete system, international cooperation is essential and flourishing. In a similar fashion to our cooperation with Russia, however, budget support for our international cooperation are often notably less than many of our collaborators. Perhaps the most notable weakness in international cooperation is the low level of our collaboration with our Canadian neighbors.

As the Arctic Ocean becomes more accessible and researchers exploit the accessibility to better understand the ocean, the Arctic Research Commission has stimulated the National Geospatial Agency to construct a system to warn of hazards to navigation in the Arctic Ocean and to prevent mutual interference between maritime interests and the research community. Current efforts to make this internet-based system truly pan-Arctic are underway through the offices of the International Hydrographic Office (IHO).

### ***RESEARCH FACILITIES***

Research facilities in the Arctic and their continuing support are crucial for research. The lack of infrastructure in the Arctic makes dedicated facilities essential. The advent of the Coast Guard's research icebreaker HEALY has opened a new era in Arctic research by the United States. The outstanding success of the AMORE expedition to the Gakkel Ridge in the



Arctic Ocean in concert with the Alfred Wegener Institute's icebreaker, POLARSTERN, demonstrated that the US is a new contributing partner in Arctic Ocean research. The Shelf Basin Initiative (SBI) Program funded largely by the National Science Foundation and NOAA has relied on HEALY for research support and mobility. Now our European colleagues with collaborating US scientists have conducted a scientific drilling program in the Arctic ice - an unprecedented feat of technological expertise. The results of this program are revolutionizing our understanding of the nature of the Arctic Basin in the past and, in particular, changes in climate near the pole in the past - changes which will allow us to understand past epochs of warm climate which may predict the future of our planet. This capability combined with the occasional opportunities to make measurements from US Navy nuclear submarines operating under the Arctic pack ice has allowed the US to move into the forefront of marine research but much remains to be done. The ability to conduct systematic geophysical surveys and sea ice measurements has been notably diminished by the end of the SCICEX "dedicated" cruises. These measurements must be continued and new autonomous facilities will be required to conduct these surveys.

The availability of the Coast Guard's HEALY does not finish the task of providing oceangoing research capacity for the region. The University of Alaska, with the blessings of the University National Oceanographic Laboratory System and the Federal Oceanographic Fleet Committee, have proposed the Alaska Regional Research Vessel, an ice strengthened replacement for ALPHA HELIX, a ship in its thirties and fast approaching the end of its useful life. This new vessel, capable of operations in light ice, near the margins of the ice pack, is essential for the study of marine ecology, fisheries oceanography, environmental contamination, marine geology and geophysics and coastal processes in the Bering Sea and those parts of the Beaufort and Chukchi Seas with seasonal open water or light pack ice not requiring the massive capabilities of HEALY. On the other hand, changes in budget priorities now threaten the nation's icebreaker capability and careful and thoughtful action will be required to preserve our polar research support system. It is particularly important that proponents of Arctic research work closely with our colleagues working in the Antarctic to ensure a successful system of icebreaker operations for research.

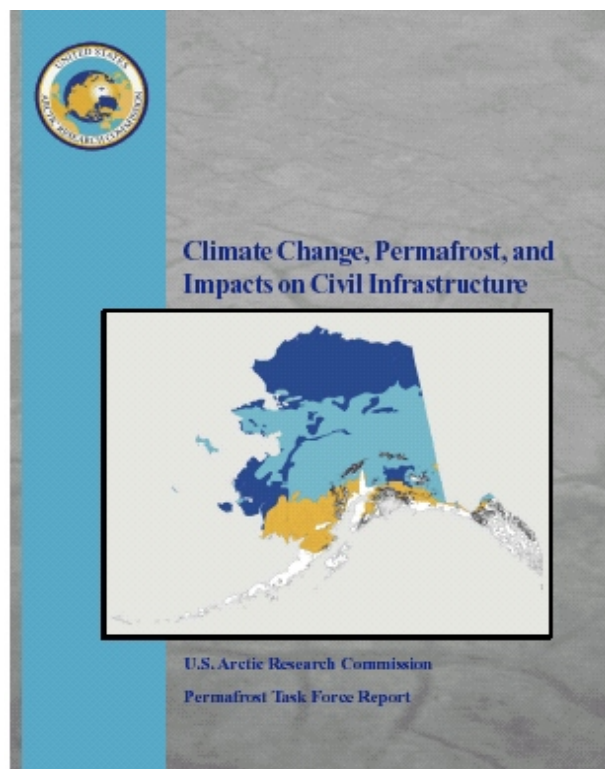
While physical facilities are essential, high quality analytical instrumentation is similarly crucial. Samples collected in the Arctic need to be analyzed as soon as possible and by specialists close to the environments and processes being studied. The expectation that high quality analytical facilities in distant laboratories, working on other high priority research, are adequate for these purposes is incorrect and will not contribute to the level of new knowledge necessary for research in the region. High quality analytical instrumentation close to the primary researchers is often neglected, but essential to capacity building for Arctic research.



## RECENT DEVELOPMENTS

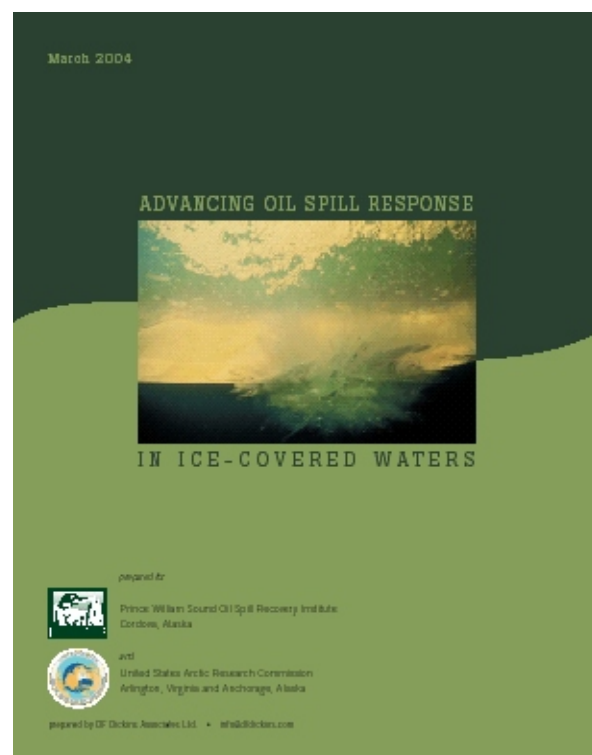
### *CLIMATE CHANGE, PERMAFROST, AND IMPACTS ON CIVIL INFRASTRUCTURE*

In the past year several new developments have occurred which should inspire the research community to new efforts. Early in 2004 Arctic Research Commission published the Report on *Climate Change, Permafrost, and Impacts on Civil Infrastructure*, USARC Special Report 03-1. This report was compiled by a special Commission Task Force to bring together projections of climate change with the effects of this change on the civil infrastructure upon which northern residents depend. The report contains a list of essential research initiatives recommended to federal and state agencies for further study. While these initiatives lie in our major program recommendation on civil infrastructure, the detailed recommendations should be consulted in the report which is available on the Commission's web site at <[www.arctic.gov](http://www.arctic.gov)>.



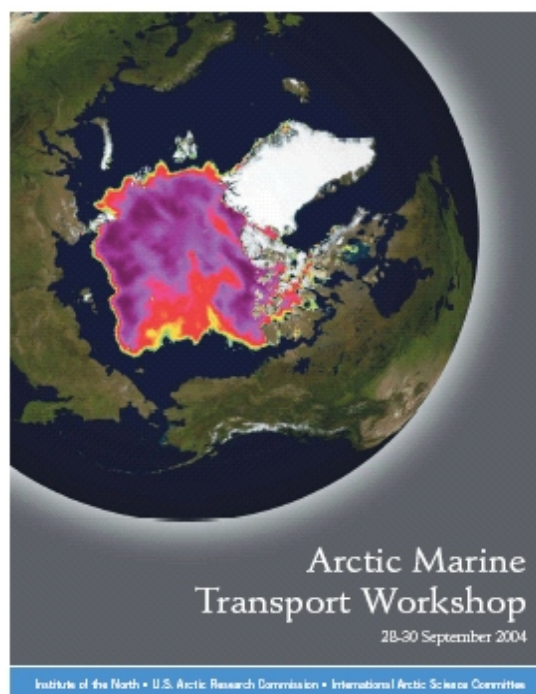
### *ADVANCING OIL SPILL RESPONSE IN ICE-COVERED WATERS*

Later in 2004 the Commission in concert with the Prince William Sound Oil Spill Recovery Institute in Alaska published *Advancing Oil Spill Response in Ice-Covered Waters*, USARC Special Report 04-1, also available on our web site. This report points out the unknowns in the behavior of oil released into an environment containing sea ice. Such a scenario is a clear possibility as petroleum exploration and development continues in the northern regions of both North America and Russia. Conventional methods using booms and skimmers are unlikely to be successful in heavy sea ice and new technologies, methods and understanding are required. This report also contains a detailed research agenda.



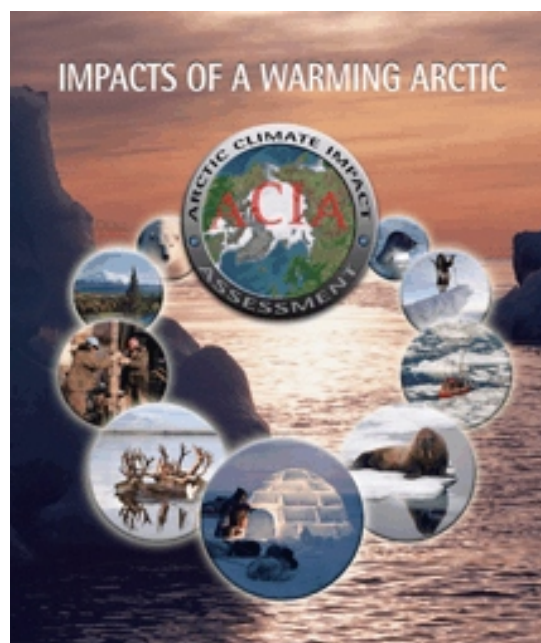
## ARCTIC MARINE TRANSPORT WORKSHOP

In September of 2004 the Arctic Research Commission in collaboration with the Institute of the North and the International Arctic Science Committee conducted an experts workshop on marine transportation in the Arctic at the Scott Polar Research Institute at Cambridge University. The report of this workshop is available on the Commission's web site at <[www.arctic.gov](http://www.arctic.gov)>. It is clear from the results of the Arctic Climate Impact Assessment (ACIA, see below) that ice conditions in the Arctic Ocean are changing now and that further reductions in sea ice coverage can be expected to affect the opportunities for marine transport in the north polar region.



## THE ARCTIC CLIMATE IMPACT ASSESSMENT

Late in 2004 the first products of the Arctic Climate Impact Assessment (ACIA) were introduced to the public. This project was initiated by the International Arctic Science Committee (IASC) and subsequently adopted by the Arctic Council as a major initiative. The results are the product of many authors from throughout the international Arctic research community. The research agenda is being compiled as this project moves to completion in early 2005. Preliminary reports of the ACIA recommendations indicate that we must be prepared to increase the level and intensity of our investigations and to construct a monitoring and detection program which will provide the long term measurements necessary for our efforts to understand the processes governing climate in the Arctic and to detect the kinds of change and their relative rates in the Arctic and their effects on the world climate system. The report entitled *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* can be viewed on the web site of the Arctic Council's Arctic Monitoring and Assessment Program at <<http://www.amap.no/acia>>



The research agendas in these documents should be considered as supplemental to this edition of the Commission's *Report on Goals and Objectives for Arctic Research*.

## *THE INTERNATIONAL POLAR YEAR*

The international Arctic research community is organizing a new International Polar Year (IPY) to take place in 2007-2008. This will be a continuation of the series which began with the first IPY in 1882-83 and continued with the second in 1932-33 and the IGY of 1957-58. The US is participating in the planning through the US Committee on the IPY <<http://dels.nas.edu/us-ipy/>> organized by the NAS/NRC Polar Research Board in coordination with the International office of the IPY <<http://www.ipy.org/>>.

The IPY will be an international program of coordinated, interdisciplinary scientific research and observations in the Earth's polar regions to explore new scientific frontiers, to deepen our understanding of polar processes and their global linkages, to increase our ability to detect changes, to attract and develop the next generation of polar scientists, engineers and logistics experts and to capture the interest of schoolchildren, the public and decision-makers. The Commission encourages those agencies and organizations planning for the IPY. We expect that great strides will be made in both our understanding of the polar regions and our ability to observe polar climate systems to understand change in these most sensitive parts of the planet.





## **MAJOR RESEARCH PROGRAM RECOMMENDATIONS**

This edition of the Arctic Research Commission's Report on Goals and Priorities for Arctic Research focuses on five Major Interagency Projects: Climate Change, The Bering Sea, Arctic Health and Infrastructure Research and Resource Assment. These projects run the gamut between basic and applied research. The Arctic Research Commission believes that there must be a continuous flow of ideas and priorities between basic and applied research.

### ***STUDIES OF THE ARCTIC REGION AND GLOBAL CHANGE***

Global change, particularly climate change, is expected to have its most pronounced effects in the Arctic. A significant amount of data has already been gathered on such phenomena as the thinning of Arctic Ocean sea ice (Rothrock et al., 1999, Rothrock & Zhang, 2005) and reductions in its extent, the reduction of the thickness of the distal parts of the Greenland ice cap (Krabill et al., 2000) and changes in the circulation of the Arctic Ocean (Morison et al., 1998). These and other data strongly suggest that rapid and important changes are occurring in the Arctic environment. The albedo of snow-covered sea ice is the highest of any natural surface and the albedo of open sea water is the lowest. Thus, changes in sea ice cover caused by climate change have a dynamic and profound effect on the energy balance of the region. In addition, melting of glacial ice adds to the volume of the ocean, raising sea level and affecting coastal communities in a variety of serious ways. Reductions in sea ice cover will affect the productivity and probably the community structure of the marine flora and fauna of the Arctic seas reaching up to the highest trophic levels such as birds, seals, sea lions, walrus, whales and polar bears.

Model studies indicate that temperature changes induced by increases in atmospheric carbon dioxide and other greenhouse gases will be several times greater in the Arctic than elsewhere on the planet. Such changes will modify the hydrologic regime of the Arctic including changes in precipitation, river runoff, permafrost and the mass balance of glaciers. The impacts on Arctic soils and their plant and animal communities may be profound. Studies already underway indicate an increase in the rate of carbon release to the atmosphere in the form of methane and carbon dioxide, two gases with major impacts on the radiative balance of the atmosphere. If the Arctic has a positive feedback on climate warming, the results will be to amplify warming everywhere on the planet.

The earth is a fragile planet and, because it is our home, we may not conduct experiments on it which might have serious consequences for its habitability. Our only approach to understanding the complex phenomena of climate change is to learn as much as we can about the processes causing and responding to these changes, to apply our growing computational capabilities to model studies, and especially to study diligently the record of climate change in the past. Recent insights derived from the study of the climate record in the Greenland ice cap have shown that our previous ideas of slow steady change at the end of the last ice age were wrong and that climate change can occur in rapid transitions from one climate state to another. Other studies of fossil climate records in lake sediments have been used to test the predictions of numerical models for climate during the most recent ice age and have shown them to



require further refinement. Without the ability to experiment on the planetary systems which sustain us, we must rely on the record of the experiments that nature has conducted in the past to test and refine our understanding and our ability to predict the future. The cause of these phenomena and the question of their relationship to potential permanent changes in the climate of the Arctic region is of vital importance both to residents of the Arctic and as early indicators of change for the rest of the planet.

But, it is also clear that environmental change is always with us. There are few recent changes in climate that compare with the difference between summer and winter regimes in the Arctic. Because of these stupendous changes in temperature, precipitation, wind, light and other annually varying environmental properties subtle changes on longer time scales are not easy to detect. Processes such as the North Atlantic Oscillation which appear to have episodic time scales of the order of a decade have been causing climate changes for many centuries. Other changes with similar time scales indicate that the circulation patterns in the surface waters of the Arctic Ocean change regimes on similar time scales. It is essential that we understand the current changes in the Arctic environment and that we seek to separate those which represent oscillations about a stable state from those which indicate that the Arctic may be undergoing significant, long-term changes in its climate regime. To do so requires a broad based attack on the question which seeks to understand the particular mechanisms of environmental change. The Arctic is an apt place for this study as changes in environment are magnified by the extremes of the natural cycle. The common observable boundaries in the Arctic (such as the edge of the polar ice pack, the marginal permafrost zone and the tree line) are particularly sensitive to these changes. The movements of these boundaries are not only sensitive indicators of environmental change but also have major effects of the lives of Arctic residents, particularly on native people endeavoring to continue their subsistence lifestyle in the face of major cultural and material stresses.

Environmental change has important consequences for human activity in the Arctic. As climate changes the means by which life goes on in the Arctic will also change. In particular, the physical infrastructure will sense these changes. Roads, bridges, buildings and other aspects of civil infrastructure will react to changes in the environment. These changes will affect human activities in many ways including local energy consumption, housing design and construction, transportation, water and waste water management and subsistence activities. These in turn will lead to changes in the social milieu which depends on interactions between people living in the Arctic and on the stresses imposed on their lives by the Arctic environment.

At its meeting in March, 2000 the Interagency Arctic Research Policy Committee (IARPC) agreed to organize an interagency program of research on the Study of Environmental Arctic Rapid Change (SEARCH). The emphasis of the SEARCH project is on those changes occurring rapidly enough to be evident today in climate and oceanographic data -- changes which are affecting Arctic ecosystems and the modes of living of Arctic residents now.

The SEARCH program has drawn on many agencies and on a broad spectrum of Arctic researchers in constructing its program. The Commission strongly recommends that the



Office of Management and Budget consider the SEARCH program in a unified manner recognizing the interdependence of the research programs of each of the agencies. Similarly, the Congress must consider budget requests for the SEARCH program in the light of the effects of budget decisions for each of the agencies individually on the efforts of the program as a whole. This will be a difficult task but we have already begun to make progress. The Office of Management and Budget is gathering data on SEARCH programs from all Federal Agencies and we will have a unified view of funding for SEARCH in the President's Budget Request for Fiscal Year 2006 to be submitted in February 2005. We believe that an integrated rather than a piecemeal approach is essential for success.

**The Arctic Research Commission strongly supports the Interagency SEARCH program and encourages it to grow into a fully developed program with a common research agenda and an integrated budget approach.**

The International Arctic Science Committee (IASC) has considered the US initiative in studies of Arctic change and has instituted a new international program called the International Study of Arctic Change (ISAC). This new international effort will allow for programs in the IASC member nations to leverage their participation by gaining access to the full array of observations and measurements conducted in a coordinated manner by ISAC.

**The Arctic Research Commission congratulates IASC on the inception of their program on the study of Arctic change and encourages US researchers to collaborate and coordinate with their international colleagues.**

Physical, chemical, cultural, and socioeconomic data resources are required to understand the current state of the pan-Arctic system and to monitor its progression to a potentially new and unprecedented state in the face of economic development and rapid environmental change. A sound knowledge base is essential to both environmental management and can be an important vehicle for international cooperation and diplomacy.

A progressive loss of hydro-meteorological monitoring networks has occurred over the last two decades across major portions of the Arctic – in particular throughout Russia and Canada. The dynamics of station losses are a complex patchwork over both space and time. In North America the land area monitored for discharge declined from 60% down to 51% between 1986 and 1999. For some Russian provincial monitoring offices losses in the number of stations from 1986 to 1999 totaled from 25% to nearly 80% with higher rates of loss for the Arctic. Similar figures exist for Canada, varying from 30% to 70% loss. The US faces similar threats as evidenced by temporary decommissioning of the USGS discharge monitoring station located at Pilot Station, AK, on the Yukon River. Such losses and lack of adequate coverage occurs at precisely the time when assessments from scientists show a consistent and high sensitivity of the pan-Arctic region to global environmental change. Links of the freshwater cycle to ocean circulation and hence planetary heat balance have been postulated and thus are of enormous US strategic importance. Understanding the pan-Arctic system will be seriously compromised without a long-term commitment of resources to collect the requisite data sets for model calibration and validation.

**The Commission recommends an international program to promote the recovery and/or re-establishment of the most important hydrometeorological monitoring stations for systematic detection of contemporary and future environmental change.**

***STUDIES OF THE BERING SEA REGION***

Alaska leads all states in the amount of fish and shellfish landed with nearly five billion pounds per year. Louisiana with around one billion pounds is its nearest competitor. Alaska also led all states in the value of landings with a value of almost one billion dollars followed again by Louisiana at around three hundred million. More than half of the table fish and shellfish consumed in the United States come from the Bering Sea. Dutch Harbor-Unalaska is the leading US port in terms of tonnage landed. In addition to its commercial value, the Bering Sea is home to an array of animal life including sea birds, whales, walrus, seals and sea lions unprecedented in the rest of the nation. The inhabitants of the Bering Sea region include Inuit, Aleut and Yupik people who have lived by and from the Bering Sea for millenia.

The health of the Bering Sea ecosystem is of vital importance to the United States, to the State of Alaska and to the residents of the region. Changes in the ecology of the Bering Sea have major impacts not only on fisheries but on the everyday lives of thousands of people who rely on it for their sustenance. Human activity has had its impact in the region but it is not the sole, nor perhaps the most important cause of many of these changes. Changes in climate, in ocean circulation, in weather patterns and the behavior of sea ice in fall and spring are all major actors on the Bering Sea stage. The Arctic Research Commission is concerned that our knowledge of the Bering Sea is not sufficient to support the important decisions which must be made for the safe and effective management of the resources of the region.

PICES Report 27 (December 2004)  
PICES-GLOBEC International Program on Climate Change and Carrying Capacity

The Second International Workshop to Develop a Marine Ecosystem Model of the North Pacific Ocean including Pelagic Fishes was held at the Frontier Research System for Global Change in Yokohama, Japan, from March 3 to 6, 2003. The workshop was convened to build upon the results of three earlier marine ecosystem model workshops. The first was the NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) Workshop, held in Nemuro, Japan, in January 2000, to develop a marine ecosystem model based on lower trophic levels. Next was the MODEL Workshop, which took place in Hakodate, Japan during the PICES Ninth Annual Meeting in October 2000, to look at viable strategies for linking lower trophic level models to higher trophic models of the North Pacific ecosystem at regional and basin scales. The third was the NEMURO.FISH (NEMURO For Including Saury and Herring) Workshop, held in Nemuro, January 2002, in which a higher trophic level bioenergetic model for fish was linked with the lower trophic level NEMURO model.

<[http://www.pices.int/publications/scientific\\_reports/Report27/Rep\\_27\\_default.aspx](http://www.pices.int/publications/scientific_reports/Report27/Rep_27_default.aspx)>

In the 1997 version of the US Arctic Research Plan, a new initiative was introduced entitled, “Beringian Systems Studies” (USARP-97, p. 11-18). This initiative was directed toward the following Goals and Objectives:

- Assess the magnitude of changes in the Beringian system as a consequence of global change;
- Assess and predict the consequences of these changes on the physical, biological and socioeconomic systems in the region and determine the cumulative impacts of these changes on the region including assessment of past impacts;
- Promote studies addressing the modern socioeconomic conditions of Beringia’s rural residents and in particular problems of environmental quality, education and human health;
- Increase baseline documentation and synthesis on Beringian paleoenvironments and landscape history and distributions of marine and terrestrial flora and fauna for use in global change modeling;
- Develop baseline documentation of cultural, biological and linguistic variation in historical and modern times, and inventory and assess the status of these resources;
- Develop integrated syntheses of human-environmental interactions with regional and global perspectives;
- Establish baseline documentation on contaminants and their pathways in Beringian food chains and their environmental, health and economic impacts;

Report 29 (December 2004)

Report of the Study Group on “Ecosystem-Based Management Science and its application to the North Pacific”

Summaries of each country’s approach to ecosystem-based management (EBM) are provided, and in reviewing these summaries, it is immediately obvious that EBM challenges are different between China, Japan and Korea *vs.* Russia, Canada and the United States. The greater coastal populations in the former three countries, coupled with their much longer history of full exploitation of most harvestable renewable resources, meant that EBM is, initially at least, focused on (1) minimizing existing impacts, (2) rebuilding depleted stocks to more acceptable levels, and (3) in near-shore areas in particular, minimizing widespread impacts in the marine environment from land runoff from both industrial and urban developments. In contrast, in the latter three countries, human coastal populations and development were generally much less, with fishing impacts and offshore oil and gas development and transport identified as the major impacts. In many instances, relatively unimpacted, pristine habitat and biological communities still existed, and so the challenges there were often how to maintain them while permitting appropriate new economic activity to occur.

<[http://www.pices.int/publications/scientific\\_reports/Report29/Rep\\_29\\_default.aspx](http://www.pices.int/publications/scientific_reports/Report29/Rep_29_default.aspx)>

- Develop modeling capabilities and relate the results of regional Beringian studies to larger global patterns of climatic and environmental change; and
- Develop coordination and infrastructure by enhancing regional research centers, by promoting the spread of scientific knowledge and by encouraging cooperative and international research and education programs that include representation of northern residents and communities.

The Commission still sees substantial gaps in this current state of affairs with regard to Bering Sea studies. Fisheries management has progressed from single species management through management with regard to endangered and threatened species. The North Pacific Fisheries Management Council (NPFMC) has done an outstanding job of managing the fisheries in this region. It is clear that the NPFMC has made it a priority to listen to the advice of their Scientific and Statistical Committee (SSC) on the sustainability of the fishery and that all participants in the regional fishery have been committed to wise use of their resource.

The North Pacific Marine Science Organization (PICES) and the NOAA Coastal Ocean Program have studied the Bering Sea Ecosystem (See the sidebars). These reports represent the foundation for a new understanding of the behavior of biological resources in this complex environment.

The Magnusson-Stevens Fisheries Conservation and Management Act has mandated that fisheries management move to an ecosystem based model. This requires that management create rules and regulations for the utilization of any species taking into consideration interactions with all other species in the ecosystem affected. In February 2005, the SSC of the NPFMC sponsored a one-day workshop on multi-species models, which should help with the integration of various approaches. The Commission encourages more of these exchanges between scientists and managers. At the same time, managers will need to include in their deliberations consideration of the variability of environmental parameters affecting the ecosystem. This, in turn, requires a powerful research program including long term monitoring of both environmental variables and species abundances and behavior and process studies to illuminate the interactions between environmental variables and the ecosystem as well as interactions between species of interest. Although resources are not currently sufficient for this

The Southeast Bering Sea Ecosystem:  
Implications for Marine Resource Management  
(March 2004)

NOAA COASTAL OCEAN PROGRAM  
Decision Analysis Series No. 24

Southeast Bering Sea Carrying Capacity (SEBSCC, 1996–2002) was a NOAA Coastal Ocean Program project that investigated the marine ecosystem of the southeastern Bering Sea. SEBSCC was co-managed by the University of Alaska Fairbanks, NOAA Alaska Fisheries Science Center, and NOAA Pacific Marine Environmental Laboratory. Project goals were to understand the changing physical environment and its relationship to the biota of the region, to relate that understanding to natural variations in year-class strength of walleye pollock (*Theragra chalcogramma*), and to improve the flow of ecosystem information to fishery managers.

<[http://www.pmel.noaa.gov/pubs/PDF/mack2658/\\_mack2658\\_executive\\_summary.pdf](http://www.pmel.noaa.gov/pubs/PDF/mack2658/_mack2658_executive_summary.pdf)>

task, the Commission continues to support an expanded program of ecosystem research in the region. In particular, the construction of the Alaska Regional Research Vessel is vitally important for research access to the region.

The Commission has drawn two lessons from our overview of Bering Sea ecosystem studies. First, there appears to be a lack of integration between basic oceanographic data collection and analysis and studies of population effects at higher trophic levels such as marine mammals, birds and fish. Each project appears to see the Bering Sea ecosystem from its own perspective but only rarely integrates the observations of others into a complete picture.

The second lesson drawn from our examination of Bering Sea research is the absence of emphasis on the ability to predict changes in the Bering Sea system, particularly in the population dynamics of the higher trophic levels. Management decisions are generally based on records of past behavior in the system but the ability of the system to see ahead, to produce scenarios reflecting changes, to act to preempt negative effects before they occur and to avoid crisis management, are still not in evidence. Scientists and managers are always reluctant to engage in prediction. There are many pitfalls in predicting natural systems not the least of which is the high potential costs of incorrect predictions. Nevertheless, careful and concise predictions with carefully stated confidence limits are essential for the effective management of our interaction with the Bering Sea ecosystem.

In order to build predictive capacity two approaches are useful. The first is to conduct predictions testable by historical data, *i.e.*, use the data from the past to predict more recent years and compare the predictions to the actual data. This approach allows continual refinement of the predictive system and can indicate the limits of reliability of predictions of the future. The second approach is to study intensively the processes linking the various phenomena occurring in the system. This approach requires abundant detailed study and provides guidance to modeling and predicting the behavior of the system by characterizing the essential links in need of further study. The use of these two approaches in tandem, empirical modeling guiding detailed study and detailed study improving the empirical models by emphasizing the data most useful for predictions is the most effective means for predicting complex systems. While such systems are common in many fields of science, they appear to have been avoided by the programs studying the Bering Sea. They need to be applied, improved and implemented.

The planning and construction of the SEARCH program discussed above has built a model for interagency cooperation in the study of important Arctic research questions. The Arctic Research Commission believes that the study of the Bering Sea requires an equivalent interagency program which can produce predictions of the important changes in the Bering Sea based upon an integrated application of the research tools of all the relevant agencies acting in concert. While the study of change in the Bering Sea is currently an element of the SEARCH program known as the Bering Sea System (BEST) program, the Commission believes that the importance of the Bering Sea system to the resident populations, to other users of Bering Sea resources and to the nation's economy justifies a stand-alone interagency program which can

command the attention of all contributing agencies and lead to assurances that critical parts of the study do not fail for lack of visibility during the budget process.

The Science Plan for the North Pacific Research Board (NPRB) has been completed by the National Research Council. The plan includes studies of the North Pacific Ocean, the Bering Sea and the Arctic Ocean. The science planning for the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSI) is underway with the assistance of the National Research Council with completion expected in late 2005. IARPC has organized an interagency program for the study of the Bering Sea and some research planning has already begun. Given the advanced state of planning for these important programs The Arctic Research Commission believes that the time has come for a summit meeting on Bering Sea Ecosystem Research. The purpose of such a meeting is not to hear the views of stakeholders but to bring together State and Federal leaders in all aspects of Bering Sea ecosystem research to discuss the overlaps and gaps in research activities, to divide the responsibilities and tasks for the various aspects of the study of the Bering Sea and to map out a campaign of action for the future.

**The Commission applauds and encourages these planning activities related to the Bering Sea and its watershed and recommends a Bering Sea Ecosystem Summit be convened.**

In order to fully understand the Bering Sea, studies must be carried out on the western side of the basin which will require the active participation of Russian scientists. Such a program exists in the Department of the Interior. This program, known as BERPAC, has conducted sporadic cruises in recent years in various parts of the Bering and Chukchi Seas with Russian collaborators often using Russian research vessels. This program offers an outstanding opportunity for increasing our understanding of the Western Bering Sea. Funding for a reinvigorated BERPAC program has recently been made available through NOAA.

**The Arctic Research Commission supports immediate expansion of the BERPAC program to include annual research cruises and appropriate support for related research both within NOAA and through extramural funding paths.**

### ***RESEARCH ON THE HEALTH OF ARCTIC RESIDENTS***

The questions surrounding environmental health effects in the Arctic are many and varied. Potential sources of effects on human health include radionuclides, heavy metals and Persistent Organic Pollutants. Residents of the Arctic are concerned that contaminants are transported to the region from industrial sources in developed and developing nations farther south and that they are entering the food chain causing effects on both wildlife and humans, especially on those engaged in subsistence hunting and fishing. Research is needed to identify the abundances of these contaminants throughout the environment and in humans, especially the young. Arctic residents need guidance on coping with these problems and it is the responsibility of the research community to supply them with the information they need to live safe and healthy lives. Substantial research progress is being made through programs such as NOAA's Arctic Initiative, research on PCBs and mercury by the EPA and NSF's Contaminants Program, but much remains to be accomplished.

While environmental health concerns play an important role in our deliberations, they do not (at least not yet) constitute the major causes of morbidity and mortality in the US Arctic. Infectious diseases, chronic diseases such as diabetes, cancer, heart attack and stroke as well as health problems such as alcoholism, drug use and suicide are the most frequent causes of ill health and death in Arctic populations. These must also be studied with an eye toward relieving the Arctic population of as much of this sad burden as possible. Such a program falls predominantly within the purview of the National Institutes of Health and the Indian Health Service. Collaboration with health officials in the State of Alaska is essential as is coordination with local organizations and native groups. The Arctic Council will also focus on sustainable development in the Arctic, a focus which will include studies of health concerns in the North.

The health of Arctic residents depends on many factors. It is clear that life in the Arctic, particularly in small communities, is affected by the complexities of the provision of the essential infrastructures of community life. The Arctic environment requires an approach to housing, water, waste-water, energy and transportation systems far more difficult than those of temperate regions. This country can put a man on the moon but, as yet, cannot find a cost effective way to dispose of human waste in a cold, remote environment. While the State of Alaska has made substantial progress in improving sanitation in the villages, these problems must be addressed by the application of the best technologies and practices available.

At the same time, the relative obscurity of these problems in the larger context of US engineering research must be overcome. Partners are available and willing to attack these problems. The Commission has opened discussions with the American Society of Civil Engineers on how they can assist in developing new initiatives in Arctic infrastructure. The Denali Commission was established in 1998 to attack the problems of rural infrastructure in Alaska. The Arctic Council's Program on Sustainable Development has a new program on Arctic Infrastructure. These initiatives should be used to bring the considerable talents and abilities of the US engineering community to bear on those systems directly affecting health in the Arctic.

At the IARPC Staff Retreat in May, 2000, it was agreed that IARPC would consider the planning of an interagency program of studies on Arctic health. Lead agencies would be somewhat different from those most involved in the SEARCH and Bering Sea programs. The National Institutes of Health, the Centers for Disease Control, the Public Health Service, and the Indian Health Service will be the most prominent participants with applied engineering research and environmental measurements programs in other agencies contributing as noted above.

**The Arctic Research Commission supports the implementation of the third focused, interagency program to coordinate and emphasize research on health concerns in the Arctic and to build links to the health research programs of other Arctic nations.**

The Arctic Research Commission takes special note that the National Institute of Occupational Safety and Health has established a research unit in Anchorage, Alaska to examine occupational injuries. Substantial progress has resulted from this program especially in

reducing injuries and fatalities in such dangerous occupations as fishing and helicopter lumbering. This unsung program has already saved many lives and stands to realize further advances in safety and protection of workers in the most dangerous occupations.

**The Commission supports the continuation and expansion of the NIOSH program for reduction of injury and death in Alaska's important industries.**

### ***RESEARCH ON CIVIL INFRASTRUCTURE***

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 US Army's Cold Regions Research and Engineering Laboratory (CRREL) and the University of Alaska to bring the nation's most able cold climate engineering talent to bear on these problems. CRREL is recognized around the world as an international center of excellence in Arctic engineering.

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

Because of the high priority placed on studies of both climate change and civil infrastructure the Commission empaneled a Task Force of experts to produce a report entitled *Climate Change, Permafrost, and Impacts on Civil Infrastructure*. This report on the effects of climate change on civil infrastructure indicates that climate change may have profound effects on structures such as roads, bridges, airport runways and even homes, which are vital to life in our Arctic region. The research recommendations included in this report demand action. The time to identify our vulnerabilities and to take preventive and moderating action is now, when the effects of climate change are just beginning to make themselves felt.

**The Commission Recommends the implementation of the recommendations in the *Report on Climate Change, Permafrost and Impacts on Civil Infrastructure*.**

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 as well as enhancing safety. In collaboration with the National Geospatial-Intelligence Agency (formerly the National Imagery and Mapping Agency, NIMA) 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 US Arctic region at high precision (1m x 1m x 1m) does not exist and is critically needed for such continuing activities as resource identification, safety, natural hazards evaluation, engineering applications, navigation, search and rescue, combating emergencies and many others.

**The Commission recommends that the Department of the Interior and the National Geospatial-Intelligence Agency take steps to acquire and make available precise geospatial data for maps of the US Arctic.**

### ***RESEARCH ON NATURAL RESOURCES***

The US Arctic is a vital source of renewable and non-renewable resources. The extraction of these resources requires high levels of technological innovation. At the same time, the environmentally sound use of these resources require industry to limit the environmental damage cause by resource utilization on to be prepared for the restoration of site after their resources have been exhausted.

Over 66% of the land in the State of Alaska is managed by the Federal government. Federal agencies play an important role in identifying options and promoting the development of innovative technologies for resource exploration; extraction of oil, gas, and minerals; long distance energy transmission; fisheries; and marine transportation, usually as regulators and sometimes as owners of the resources in question. An integrated approach to the study of all those issues involving Arctic resources is required.

The development of oil resources in the Arctic, particularly the US and Canadian Arctic, are proceeding currently. Offshore drilling and production activities have occurred in both US and Canadian waters. In addition, the possibilities for marine transport of Arctic oil are growing. The Commission has been informed of Canadian interest in shipping oil from their Arctic region by sea from the MacKenzie delta region to ports in the Pacific.

The Arctic Research Commission has been briefed on the special research needs for the response to oil spills in ice covered waters. In particular, the Commission has consulted with Alaska Clean Seas and Environment Canada on their research efforts and the gaps in our knowledge of oil in sea ice. Alaska Clean Seas has, for example, reported that there is no vessel capable of an adequate response to an oil spill in ice covered waters in the US Arctic. The only ships capable of responding to such an event are US Coast Guard icebreakers HEALY, POLAR SEA and POLAR STAR and these ships are generally either operating in the Antarctic or stationed in Seattle, unless by chance, performing specific tasks in the Arctic. Alaska Clean Seas also indicated that it was likely that burning was the method of choice for the disposal of oil in ice. They also stated that the use of emulsion breaking chemicals was generally prohibited as they are considered flammable. Since this restriction is in conflict with their use (to promote burning) there appears to be a need to revise this prohibition. In April of 2000 an International Oil and Ice Symposium was held in Anchorage and Prudhoe Bay, Alaska. The Commission recommended a comprehensive attack by agencies participating in the interagency oil spill response program on these problems in its 1997, 1999, 2001 and 2003 Reports, but NO ACTION has been forthcoming.

The Commission's highest priority is to develop an oil spill prevention and response capability, including innovative containment and cleanup operations in ice-infested waters and on permafrost terrain. Three types of research are needed: a) applied work to perfect *in situ* burning techniques in ice covered seas, b) more basic and applied research to identify and develop alternatives to combustion on land, and c) policy analysis and associated information transfer activities related to the testing and acceptance of new pollution abatement processes. To achieve this goal the Commission in collaboration with the Prince William Sound Oil Spill Recovery Institute sponsored the preparation of a report entitled *Advancing Oil Spill Response in Ice-Covered Waters*, (USARC Special Report 04-1). This report collates the research which must be undertaken in order to provide the technical understanding and best practices for dealing with an oil spill in ice covered waters. Such a spill is inevitable. We cannot tell when or where, but it is clear that a spill in ice will occur. It is incumbent on us all to be prepared to minimize the damage caused by such a spill and to remove as much of the oil as possible by the most effective means. The well being and livelihood of Arctic residents and the protection of the Arctic Ocean's ecosystem are vital interests which require us to be prepared.

**The Arctic Research Commission recommends that Federal agencies immediately commence a comprehensive program of research on oil in ice based on the Commission's Special Report *Advancing Oil Spill Response in Ice-Covered Waters*, (USARC Special Report 04-1).**

The Commission also notes that the Oil Pollution Act of 1990 (OPA 90) contained funds for research on oil spills but that provisions were only made for research funding through 1995. When this provision lapsed, OPA 90 sponsored research on oil spills ceased. OPA 90 is now before the Congress for re-authorization. Research on oil in ice would be notably strengthened if the re-authorization included a renewed provision of funds for research on the topic and, in particular, on oil in ice. At the same time, oil spills in high latitude waters are also a danger. Given the severity of temperature, wind strength and remoteness of locales such as the Bering Sea, more research is needed to prepare for releases of oil in these regions as well.

**The Arctic Research Commission recommends that the affected agencies include new research funding in their requests for re-authorization of OPA 90.**

## OTHER RESEARCH PRIORITIES

### *APPLIED RESEARCH IN FISHERIES*

The exploitation of the resources of the Bering Sea region are conducted in a rigorous climatic regime under difficult and often dangerous conditions. The technologies employed in these activities are in need of research to improve the success of resource extraction activities, to reduce the environmental impacts of these activities and to provide for the safety and welfare of workers and residents in the region. Research on effective fishing techniques, on the development of new products, on the improvement of current products, on the use of harvesting byproducts and the reduction of effluents are all vital to sustaining the fishing industry in the Bering Sea region. As the Arctic region becomes more accessible, research on the development of ports, factories, navigation and search-and-rescue facilities are similarly needed with an additional emphasis on the impacts of all of these activities on socio-economic activities in the region.

**The Commission recommends an accelerated program of applied research on issues in the Bering Sea region with an emphasis on the fishing industry.**

### *RESEARCH ON VALUE ADDED PRODUCTS*

The development of value added products derived from the extraction of both petroleum and non-petroleum resources also requires an accelerated research approach. We have already discussed applied research in fisheries. Similar advances are needed in such other industries as timber and mineral use. New and improved products, produced in the North not only increase the value of the resource but also retain more of the economic benefits of the resource industries in the region where new economic activity is vitally needed.

**The Arctic Research Commission recommends an expansion of the research base for the development of value-added products and recommends that the State of Alaska support this particularly important need.**

### *RESEARCH ON TECHNOLOGIES FOR REMOTE COMMUNITIES*

The technologies developed to cope with the problems of living in the Arctic are often valuable for other communities with a similar distribution of rural residents. The use of such technologies as distance education and telemedicine are not by any means restricted to the Arctic, nor are water, waste-water and energy technologies developed for small, remote communities. Rural regions throughout the rest of the world can profitably employ these techniques and developers may find much broader markets for these products than expected from a purely Arctic perspective. In order to achieve expanded developments, research must continue to supply the new technologies for continued growth.

The Commission notes with pleasure the establishment of the Department of Energy's Arctic Energy Office in Fairbanks. This program will lead to improvements in energy supply for the region and will support and encourage the development of important new technologies for rural energy supply.

**The Commission commends the Department of Energy for the establishment of this center and suggests that its mandate be broadened beyond the confines of the Office of Oil and Gas to include such topics as renewables and conservation.**

***RESEARCH ON COMMUNICATIONS TECHNOLOGIES AND THEIR APPLICATIONS***

The Arctic includes some of the most remote settlements in the modern world. Communication technology provides the potential to bring the delivery of services to these remote settlements. In particular, distance education and telemedicine are valuable providers of services to remote settlements that can not otherwise be supported. Distance education can bring the educational resources of the world to the most distant villages. Telemedicine has the potential to provide expert medical care to patients in an emergency or to those who are unable to go to a medical facility to consult with a physician and can support local medical personnel by supplementing and supporting their efforts in medical care. The Commission is pleased to see the expanded efforts in these two vital fields which are currently underway and notes that these technologies are not only valuable in the Arctic but represent a potential economic base for Alaskans in providing technology for remote settlements all over the world.

**The Arctic Research Commission supports the current efforts in distance education and telemedicine and supports further efforts to improve the provision of these services.**

The Commission has supported and commends the Arctic Council for the establishment of the Circumpolar Infrastructure Task Force (CITF). The work of the CITF in collaboration with the Institute of the North and the International Arctic Science Committee on both air and sea transportation in the Arctic is vital for the nation's future.

**The Commission supports the continuation of the work of the CITF.**

## EDUCATION

The Commission's priorities for education can be divided into three parts: (1) General scientific and technological literacy; (2) Education of professional researchers; and (3) Education of Arctic residents, particularly native peoples, about scientific advances in understanding the Arctic. The Arctic Research Commission lacks a direct mandate for action in general education, but notes the role of the NSF Directorate for Education and Human Resources in this vital task.

**The Commission also notes the commendable efforts of the Arctic Research Consortium of the United States (ARCUS) in education.**

### *GENERAL SCIENTIFIC AND TECHNOLOGICAL LITERACY*

Better education of the citizenry, particularly in science and technology, is a continuing national priority. In this modern, technologically complex world the education of the nation is essential if democracy is going to cope with the increasingly technical nature of public debate on such matters as environmental protection, ozone depletion, nuclear waste disposal and many others. The Arctic is a particularly important topic for educational activities as it is considered by many to be both remote and exotic. For example, a very large proportion of the population is unaware that an ocean exists at the top of the world. The relationship of events and processes in the Arctic to the well being of the entire nation is very poorly if at all understood.

**The Commission supports efforts by Arctic researchers to make their results available to interested citizens.**

### *TEACHERS LEARNING ABOUT THE ARCTIC AND ARCTIC RESEARCH*

The Commission is pleased to note the work of the Office of Polar Programs at the National Science Foundation enabling the involvement of teachers in research activities in the Arctic for research experiences during their summer recess. The result is that teachers gain a new understanding of the modes of research, the importance of the Arctic, and an excitement which can only result from actually participating in the research endeavor. This enthusiasm is then transmitted to all the student influenced by these teachers over the ensuing years with the result that research in the Arctic is understood and appreciated by a growing number of citizens.

**The Commission approves of the NSF Office of Polar Program's efforts to involve teachers in Arctic Research and urges its continuation and expansion.**

### *EDUCATION OF PROFESSIONAL RESEARCHERS*

In the past the Commission has noted the slow growth in the number of young scientists and engineers with Arctic expertise in our nation. In recent years the rapid growth in the Arctic research account at the National Science Foundation has afforded many new opportunities for graduate education in the Arctic as have recent developments at NOAA.

**The Commission is pleased that the cadre of new Arctic researchers currently in training is growing and encourages the NSF and NOAA to continue the good work they are accomplishing.**

***EDUCATION OF AND BY ARCTIC RESIDENTS***

The Arctic is characterized by small, remote communities. The provision of adequate educational opportunities is difficult and the financial base for the support of education is usually small, and smallest in the most remote communities. The support of education in these communities is a serious problem. The National Science Foundation is providing support for rural education in Alaska through its Rural Systemic Initiative. This effort combined with advances in the technology of distance education have the potential for dramatic improvements if the provision of education and hence the potential for economic improvements in Alaska's rural communities and the upward mobility of their youth.

**The Commission supports the NSF's Rural Systemic Initiative in Alaska.**

The education of Arctic residents, particularly native people, about scientific advances in understanding the Arctic is vital to the continued success of Arctic research. Citizens of the Arctic, particularly the native people, experience the research endeavor more directly than most. Indeed, they are often subjects of the research effort and, if not, their fragile support systems for food, water, shelter, health, energy and transportation are often the subject of study. It is incumbent upon Arctic researchers to become directly involved with these communities in order to inform and involve the Arctic citizenry in the mutual benefits of our increasing knowledge.

At the same time it is essential that the scientific community absorb the vital and hard-won knowledge that only many years and even generations of residence in the Arctic can produce. The absorption of traditional knowledge into the scientific endeavor serves to sharpen the focus of the research effort and to bring into the research system the observations and experience of the native community.

## RESEARCH INFRASTRUCTURE

Arctic research responsive to national needs requires responsible management and adequate support services. Because of the extremely high cost of support systems in the Arctic environment, coordination of logistic services and cooperation in their use are essential in achieving maximum cost effectiveness.

### *LOGISTIC SUPPORT*

The Commission is pleased to note the continuing efforts by the National Science Foundation to upgrade and improve research facilities in the Arctic. Their collaboration with the Barrow Arctic Science Consortium in improving facilities and services at Barrow and the establishment of the Barrow Environmental Observatory are laudable efforts which the Commission hopes will continue to grow and prosper. The establishment of a cooperative agreement with the University of Alaska for support and expansion of the research facilities at Toolik Lake is similarly a positive step in the support of the basic infrastructure of research in the region. The establishment of a year-round research facility at the summit of the Greenland ice cap in the facilities constructed for the Greenland Ice Sampling Program is especially noteworthy. This is the first US Arctic facility which approaches the level of difficulty readily assumed for Antarctic research. Winter access is difficult to

impossible and the environment is extreme. The Commission commends the National Science Foundation for their efforts in establishing Summit as a permanent research facility. It is, however, notable that the National Science Foundation is called upon to shoulder the entire burden of these facilities without financial aid or participation from other agencies of the Federal Government.

The Commission has encouraged cooperative use of US military logistic capabilities to support civilian research in the Arctic. Following the successful Arctic science cruise of the Navy's nuclear submarine USS *Pargo* in the summer of 1993, the National Science Foundation, the US Geological Survey, the National Oceanic and Atmospheric Administration, the Office of Naval Research, the Director, Submarine Warfare Division in the Office of the Chief of Naval Operations, and the Commanders of the Atlantic and Pacific Submarine Forces signed an

The Arctic Research Commission is concerned that the ice breaking capabilities of the US are in serious decline. The operating costs, the deferred maintenance and the plans for major repair/refit or replacement of the POLAR Class icebreakers are measured in units of \$100,000,000 and appropriate budgetary provisions appear to be lacking. The continued ability to operate in the polar oceans is crucial to US polar research and leadership in an international arena with a rapidly growing pool of competitors. Because the Polar regions are the natural homeland of the indigenous people of the North, strategically important for many reasons including homeland security, national security, resource exploration and environmental protection, and crucial for our studies of climate change, the fate of the US icebreaker fleet and the future of our ability to continue to operate in ice covered seas are a major concern for the community of Arctic researchers and Arctic Research Commission.

historic, multi-agency Memorandum of Agreement (MOA) for continuing use of submarines of opportunity for scientific studies of the Arctic Ocean.

The Program resulting from this initial demonstration cruise and the MOA was called the Science Ice Exercise (SCICEX) Program and resulted in valuable extended research cruises in 1995, '96, '97, '98 and '99. Unfortunately, changes in the number and configuration of the US Navy's submarine fleet have ended the opportunity for annual "dedicated" cruises with civilian scientists aboard Navy nuclear submarines in the Arctic.

The Arctic Research Commission has initiated the study of new ways to approach the Arctic Ocean with the capabilities which can replace those lost with the end of the "dedicated" cruises. Other cruise opportunities referred to by the Navy and the research community as "opportunity" and "accommodation" cruises may, from time to time, become available on US submarines (For details see *Arctic Science from Submarines - A Report Based on the SCICEX 2000 Workshop, et al.*, 1999). To this date, three such accommodation cruises have taken place.

The Commission has also opened discussions with the Royal Navy on the use of their nuclear submarines and has begun exploring the availability and capabilities of Swedish and German submarine with "Air Independent Power" systems which carry both fuel and oxidizer for extended operations while submerged. With the advent of HEALY, requirements for deep sampling and surface operations from a submersible platform have subsided. It became clear in the latter days of the SCICEX dedicated cruises that submerged operations were the most appropriate use of the submarine's capabilities. This has led to discussions of the capabilities of unmanned or autonomous vehicles for survey research in the Arctic. Discussions continue on all of these fronts as well as continuing discussions with the Navy about the possibilities for another "dedicated" cruise to the Arctic.

**The Commission recommends that dedicated cruises be periodically conducted as a National priority because of their synoptic value, speed of collection as co-registered data sets and their value to the submarine force.**

The NSF is now supporting an Internet site for logistics information called the Arctic Logistics Information Access Service (ALIAS, <http://www.nsf.gov/od/opp/arctic/logistic/start.htm/>). This web site is expanding rapidly and is becoming an important reference for researchers seeking Arctic logistics information.

The NSF's Arctic Science Section has made great strides in coordination with the US Coast Guard on the utilization of Coast Guard icebreakers and the design and construction of science facilities aboard HEALY, the Coast Guard's icebreaking research vessel. NSF and the Coast Guard has engaged the University National Oceanographic Laboratory System (UNOLS) to operate the Arctic Icebreaker Coordinating Committee (AICC) to build a communications and cooperation bridge between the US academic oceanography community and the Coast Guard's design, construction and operating teams. Now that HEALY's rugged capabilities have been demonstrated, the AICC continues to oversee execution of and improvements in research operations and forms a focal point for expeditionary planning.



**The Arctic Research Commission is pleased that the National Science Foundation's regular support for research aboard HEALY. Other Federal Agencies including NOAA, MMS, FWS and others have research needs which require icebreaking research vessels such as ecosystem research in the Bering Sea in winter. The Commission recommends that these agencies become involved in HEALY scheduling and operations through the AICC.**

### ***ALASKA REGIONAL RESEARCH VESSEL***

The Alaska Regional Research Vessel (ARRV) has been approved by the University National Oceanographic Laboratory System (UNOLS) and leads the list of new vessels recommended for procurement in the report on the UNOLS research vessel fleet by the Federal Oceanographic Fleet Committee. The design studies and model tests conducted by the University of Alaska and the Woods Hole Oceanographic Institution with support from the National Science Foundation indicate that this ship will be an extremely vital and more capable replacement for ALPHA HELIX, the University of Alaska's current research vessel which is over thirty years old.

**The Commission recommends that the National Science Foundation fund the final design and construction of the Alaska Regional Research Vessel at the earliest opportunity.**

### ***BASC FACILITIES AT BARROW***

The Barrow Arctic Science Consortium (BASC) is planning the construction of a new Global Change Research Facility to replace the ageing infrastructure left from the Navy Arctic Research Laboratory (NARL). This new facility will provide modern and efficient facilities for Arctic researchers working in Barrow and be a locus of support and assistance working in more distant locations. The Commission applauds the efforts of BASC in bringing about the construction of this facility.

### ***CEON***

The National Science Foundation has tasked researchers at Michigan State University with the construction of the *Circumarctic Environmental Observatories Network* (CEON). The goals of this web based information system is, "*To strengthen the capacity for emerging monitoring, research and policy needs at high northern latitudes by making data available that is adequate and suitable for answering and addressing a series of well-defined key scientific questions and uncertainties.*" The results of this effort, based on the latest technology in Geographical Information Systems, are outstanding and readers are directed to the CEON Web site at <<http://www.ceoninfo.org>>.

### ***ENGINEERING RESEARCH***

The Commission has not made any special recommendations for logistics support for engineering research. Nevertheless, these needs are present and are not necessarily appropriate for the logistics facilities available for basic research. Studies on such topics as road and airstrip construction, housing technology, corrosion under Arctic conditions, construction

techniques in cold climates, coating technology and permafrost engineering require special facilities.

### ***DATA AND INFORMATION***

In 1997 the Commission identified and negotiated the declassification of Arctic bathymetry data collected by US Navy submarines between the inception of nuclear submarine operations in the Arctic and 1988. These data were released for public use in early 1998 and formed the basis for a revised and much improved International Bathymetric Chart of the Arctic Ocean, (IBCAO) the first such chart based on a comprehensive data set. The Commission is pleased that these data are now accessible to the research community through the GEBCO web site at <<http://www.ngdc.noaa.gov/mgg/gebco/gebco.html>> and believes that, along with unclassified data gathered by the SCICEX program, (also available from the national data center) this will permit new insights into many branches of marine and earth science in the Arctic. In late 2003 the Commission again facilitated the release of bathymetry data from nineteen additional submarine cruises in the Arctic from 1988 to 1992.

**The Commission supports the continued declassification of bathymetric, ice draft and other oceanographic data collected in the Arctic Ocean as appropriate.**

The Commission's Deputy Executive Director, Dr. Lawson Brigham, in collaboration with Dr. John Walsh at the IARC are beginning work on the compilation of sea ice extent model data into an international *Ice Atlas*. The Commission looks forward to the production of this useful tome which should be a valuable asset for Arctic researchers and practitioners throughout the Arctic.

**The Commission supports the effort to produce the Ice Atlas.**

## INTERNATIONAL COORDINATION

International cooperation is an integral component of many scientific endeavors in the Arctic, linked to, and often inseparable from, the normal process of research planning and execution. The Commission is charged with advising the President and Congress on Arctic Research policy and priorities, and with recommending the means for developing international scientific cooperation. Scientific cooperation among the circumpolar nations, as well as among other countries with scientific activities in northern latitudes, is accelerating. Quite generally, the increasing number of international bilateral and multilateral agreements for Arctic research (now about 450) signals the rising importance and breadth of both governmental and non-governmental international collaboration.

The Government of Japan has developed an interest in the Arctic region which has led them to a cooperative project with the University of Alaska entitled the International Arctic Research Center (IARC). IARC is now fully established, supported and operating. It will continue to make notable advances in Arctic research.

The US and Denmark have had a long and successful logistical cooperation in support of research in Greenland. The support of ski equipped C-130 Hercules aircraft of the New York Air National Guard has been a mainstay of research in Greenland. The National Science Foundation has recently negotiated a new research agreement with Greenland/Denmark for continuing research activities in Greenland. In September 1998, the International Arctic Science Committee (IASC) held an informal meeting of "Arctic Operators" in Tromsø, Norway. At this meeting, logistics providers in the Arctic formed the Forum of Arctic Research Operators (FARO) to work on the means for sharing information on logistics opportunities in the Arctic. FARO has since met in Tromsø, Cambridge, Iqualuit, Groningen, Kiruna and Reykjavik in successive years.

The Arctic Research Commission has been engaged in a discussion of logistics opportunities with the Canadian government through an annual meeting between the Commission and the Canadian Polar Continental Shelf Project. These meetings are the result of a framework agreement between Canadian Prime Minister Chretien and US President Clinton. The first of these meetings was held in April in Cambridge, UK and has been continued by meetings in at Arctic Science Summit Weeks in Iqualuit, Groningen, Kiruna and Reykjavik, Research using Canadian facilities presents a timely and cost effective means to expand both the efforts of US researchers in the Arctic and their Canadian colleagues.

Research in collaboration with our Russian colleagues is growing and the Commission encourages this process. Difficulties in conducting Arctic research in collaboration with colleagues at major institutions in European Russia are surmountable by diligent efforts on both sides. Obstacles to research in the Russian Far Eastern Region are, however, much larger. The Commission has received a considerable amount of information on these difficulties and considers them a serious threat to research collaboration which is, in fact, in the interests of both nations. Communications with political entities in the Russian Far East are difficult and some means to alleviate these problems would make an important contribution to progress and research and in understanding the challenges of living in the Arctic. Collaboration with Russian colleagues represents an opportunity for the International Arctic Research Center.

Article 76 of the United Nations Convention on the Law of the Sea contains a provision for national claims to extensions of their continental shelf under a group of complicated formulae. The chief requirement for a successful claim to an extended continental shelf is bathymetric data showing the 2500 meter depth contour and the transition between continental slope and continental rise. The Commission has been working with our neighboring Arctic nations, Canada and Greenland/Denmark to both provide data from US archives and to seek new data collection.

## RECOMMENDATIONS FOR AGENCIES

1. The Interagency Arctic Research Policy Committee (IARPC). The Commission is pleased to note the initiative by IARPC to organize and support planning for integrated, interagency research programs including SEARCH, Bering Sea and Arctic Health. The response of IARPC to the Commission's recommendations is heartening and the Commission wishes to commend the participating agencies and their staffs for their commitment. The Commission expects continued progress and cooperation in bringing the Bering Sea and Arctic Health initiatives forward.
2. The National Science Foundation (NSF). The NSF has made great strides in their support for Arctic Research. Funding has grown as has the enthusiasm with which Arctic research is considered inside the Foundation. The Commission encourages continued cooperation and growth.
3. The Department of Defense (DOD). A number of activities fall under the Department of Defense. Chief among these is the SCICEX Program of the Department of the Navy. The 109th Airlift Wing of the New York Air National Guard provides LC-130 support for both Arctic and Antarctic research operations. The Commission encourages the Department of Defense to continue to provide support for Arctic research and environmental studies and to communicate with the Commission on any new programs

Global climate change poses new challenges for defense agencies. Changes in the Arctic are occurring sooner and faster than elsewhere. In addition, the water-ice boundary which characterizes many Arctic environments creates the need for systems and facilities which can operate in environments where ice is a frequent and even a constant obstacle. These environmental challenges require new thinking by defense planners. The Commission recommends that the Department of Defense support workshops and other studies focused on climate change and the consequent changes in the battle space environment.

A. Department of the Navy. The level of interest in Arctic research at the Office of Naval Research (ONR) is extremely low. IN 2002 ONR cancelled its High Latitude Dynamics Program and no longer has a focus for Arctic research. Recent developments, however, suggest that changes in the climate of the Arctic may result in new requirements roles and missions for the Navy in the Arctic (See Commission Special Report 02-1). The Commission believes that these changes in the Arctic environment require an increase in research levels in the Arctic in order to maintain the national security in the region. The knowledge base created and maintained by research in the region may be of vital national interest in the future, particularly as access to the Arctic Ocean improves; a fact made likely through the observed thinning and retreat of Arctic sea ice. Rapid environmental changes in the region dictate mission changes, and thus, suggest that research efforts based on Navy needs should be substantially increased.

The Office of Naval Research has long been the prime contributor (1) to the development of ocean research instrumentation and (2) to the advancement of basic ocean acoustic research. The recent demise of the High Latitude Dynamics has ended these important activities which are critical not only for the Navy of the future but for the nation. The Commission

recommends the Office of Naval Research re-establish its High Latitude Dynamics Program as a critical adjunct to National Security.

With this in mind, the Commission commends the efforts of the Navy in carrying out the SCICEX dedicated cruises. The Commission notes the substantial effort made by the Navy to support this program in the face of shrinking resources and facilities. These expeditions into the Arctic Ocean aboard operational fast attack nuclear submarines showed an extraordinary interest in the support of science by the Navy. The retirement of the last of the Sturgeon Class submarines and the difficulties in finding resources for future dedicated cruises are of great concern to the Commission. The Commission recommends that the Navy continue to explore with the scientific community the means to continue this invaluable access to the Arctic Ocean.

In 1998 the SCICEX Program collected swath bathymetric data in the Arctic for the first time from a submarine. This instrument known as the Seafloor Characterization And Mapping Pods (SCAMP) has been made possible by the enthusiastic support of the National Science Foundation's Office of Polar Programs. This data collected by SCAMP will be of great value for students of the region from many disciplines. The regions surveyed in 1998 and 1999 comprise only a moderate fraction of the area of the deep water portion of the Arctic Ocean. The value of these data is indicated by the importance attached to it by the international community in connection with the revision of the International Bathymetric Chart of the Arctic Ocean (IBCAO). Navy data more than doubled the data base available for the next IBCAO update. The means to continue gathering swath bathymetry with the SCAMP system should be identified for the future. Navy nuclear submarines are the preferred platform for these investigations and the Commission continues to explore these possibilities but other opportunities may also emerge. Under the current Memorandum of Agreement between the participating agencies, the SCICEX Program will continue with "opportunity cruises" using occasional time slots provided during other Navy Arctic deployments. While these opportunity cruises will not allow for scientist "rider" or the installation of specialized equipment, they are valuable and will offer the opportunity to observe many characteristics of the Arctic environment. The Commission wishes to express our gratitude for the opportunities past and future provided by the Navy for study of the Arctic Ocean from Navy nuclear submarines.

A corollary issue is the declassification of archived bathymetry data collected on previous operations. These data are a valuable resource for the research community. A continuing program has been established to bring these data out from the classified realm respecting the security concerns which may surround the collection of this data.

As a further indication of the high degree of cooperation demonstrated by the Navy and the utility of Navy nuclear submarines for research in the Arctic Ocean, the Commission notes the attempt to carry out a test of the submarine as a receiving ship for seismic refraction measurements. The test, though not executed, remains precedent setting. The Commission encourages further investigation of this concept. Similar tests are needed to confirm the data collection methodology, for such data will be required for the US to prepare a claim under Article 76 of the UN Convention on the Law of the Sea when ratified by the US Senate.

In the 108<sup>th</sup> Congress the Senate Committee of Foreign Relations forwarded to the full Senate a letter of advice and consent to the UN Convention on the Law of the Sea (UNCLOS).

Unfortunately the full Senate failed to take action on this matter. The US Arctic Research Commission along with the Commission on Ocean Policy, the Department of State, the Department of Defense and an array of experts recommended that UNCLOS be ratified and that the United States move to participate in this international program. Chief among the opportunities provided by accession to UNCLOS is the opportunity to present a claim to extended limits to the continental margin of the United States based on the provisions of UNCLOS Article 76. Part of the data required for our national claim will be extensive bathymetric mapping of our continental margin. While the collection of this data is relatively simple in other parts of the US borderland, the continuing presence of sea ice in the Arctic makes systematic mapping extremely difficult from surface ships. A nuclear submarine, however, carrying the Sea Floor Characterization and Mapping Pods developed for the SCICEX Program can accomplish this data collection rapidly and systematically. The Commission continues to work to obtain permission, scheduling and financial support for this critical mission of national importance.

B. Department of the Army. The Army Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH is a national center of excellence in Arctic science and engineering research. In the current climate of budget stringency the pressure on Army labs is growing. The Commission wishes to be on record in support of the vital resource that is CRREL. Serious reductions at CRREL might be helpful in the short term but clearly would be a detriment to the national well being over the long term. The Commission encourages continued support for CRREL. The Commission is also pleased to note the continuing cooperation between the University of Alaska and CRREL which brings the essential experience and talent of CRREL researchers to bear on the infrastructure needs of the State of Alaska.

#### 4. The Department of Commerce

A. The National Oceanographic and Atmospheric Administration (NOAA). NOAA has been the leading US agency for Arctic Monitoring and Assessment Program (AMAP). In this role, NOAA has supplied both staff efforts and funding to the AMAP. These efforts have been largely conducted on a goodwill basis without organized programs or a satisfactory funding base. NOAA deserves great credit for these efforts. The Commission commends and supports their efforts. Recently the NOAA Office of Ocean Exploration has sponsored cruises aboard HEALY mapping the Arctic continental margin and studying the ocean floor. The Commission applauds NOAA's accelerating activities in the Arctic.

NOAA along with the Navy operates the National Ice Center. This center provides ice imagery and mapping for the national and international polar community. As climate change effects the Arctic regions, the ability to predict ice conditions grows ever more important, urgent and time sensitive. These essential services depend largely on satellite imagery. The imminent projected end of the current RADARSAT and the changes planned for the distribution of images from the next generation of RADARSAT instruments will, if not modified, have serious effects on the National Ice Center's ability to provide detailed images, maps and forecasts of polar ice conditions. The Commission recommends that NOAA move immediately to ensure that the National Ice Center receives and adequate supply of high resolution, synthetic aperture radar images.

NOAA operates a suite of National Data Centers including the National Snow and Ice Data Center, the National Oceanographic Data Center, the National Geophysical Data Center and the National Climate Data Center. These data centers are charged with the responsibility for data rescue in the Former Soviet Union. The Commission recommends that the national data centers continue and expand their efforts to collect data vital to our understanding of the Arctic, especially the dispersal of contaminants in the region.

5. The Environmental Protection Agency (EPA). The native residents of the Arctic live in a close relationship their environment (roughly 50% of their annual caloric intake comes from native plant and animal species). The stresses of village life and their vast and ancient store of traditional knowledge of the Arctic environment make their continued well being a matter of great concern. At the same time, the Arctic native community is probably more closely coupled to their environment and to new stresses introduced by human activity and natural variations than any other community in the United States. This suggests that, although their numbers are small relative to the rest of the nation, they are in the front lines of environmental susceptibility. The results of the AMAP study indicate that there is still much to learn about contaminant stressors in the Arctic. The interagency program on Arctic Health recommended above will require serious efforts by EPA if questions concerning environmental health are to adequately attacked. As the Arctic Health Program goes forward, the Arctic Research Commission encourages EPA to play a major role.

There are important efforts in the Arctic sponsored by the EPA's Office of International Programs. EPA's Office of International Activities (OIA) has supported the study of contaminants in umbilical cord blood samples from Arctic residents and projects to assess and reduce sources of Mercury and polychlorinated biphenyls (PCBs). The Commission commends EPA-OIA for their efforts and urges support for there activation and expansion.

6. The Department of State. The Department of State is responsible for the negotiation and operation of our international agreements in the Arctic. The Department seeks input from the IARPC agencies and others through the Arctic Policy Working Group which meets monthly with the Polar Affairs Section at State. Matters concerning US participation in the Arctic Council are the principal topics for discussion at these meetings. The United States finished a two year term as Chair of the Arctic Council in 2002. Hard work by the State Department and close cooperation, particularly with the *ad hoc* working group organized in the State of Alaska resulted in a successful two years. The Commission commends the efforts of the *ad hoc* Alaska working group and State Department.

It appears likely that the US will soon accede to the UN Convention on the Law of the Sea (UNCLOS). When the US does so, the Nation will have ten years to submit a claim for "submerged extensions" of the US continental margins under the requirements of UNCLOS Article 76. While there are some gaps in the data necessary for maximizing our claim in the temperate and tropical seas, these bathymetric gaps are relatively easy to fill in. There is, however, virtually no data in the Arctic Ocean north of Alaska, where ironically the prospects of fossil fuel resources are considered quite high. The US Arctic Research Commission in collaboration with Arctic Ocean researchers and the Interagency *ad hoc* Committee on Article 76, has created a plan for the conduct of the necessary surveys. The Navy has indicated to us that they are able and interested in conducting these surveys but that no submarine asset is



currently assigned or available for this task. The operational Navy has indicated that they will be happy to carry out the necessary surveys if directed to do so by the National Command Authority. The Government of the United States needs to consider the value of an extended Article 76 claim in the Arctic and, assuming a claim is considered in the national interest, direct the Navy to include this survey effort in its mission planning activity as a requirement. The State Department should convey to the National Command Authority as a national priority that the Navy should be directed to include an Article 76 survey in its operational plans.

The Commission also notes that the Department of State is encouraging nuclear fuel reprocessing activities in Russia in spite of the very poor environmental record of such processing facilities as Mayak and Tomsk. The Commission suggests that this decision be reconsidered.

## 7. The Department of Homeland Security.

A. The United States Coast Guard (USCG). The US Coast Guard is the principal provider of research time on icebreakers for US scientists not collaborating with other nations. The communication and understanding between the scientific community which will be using HEALY and Coast Guard ship operators has substantially improved. The Arctic Icebreaker Coordinating Committee (AICC) is proactive and has resulted in substantial improvements in the design of research facilities aboard HEALY. The need for liaison and coordination has now changed from the construction of the ship to the planning and scheduling of effective research operations. The Commission is gratified that the Coast Guard has been willing to work closely with the AICC drawing upon the US academic community's substantial level of experience in oceanographic operations generally and in Arctic studies in particular.

There is a substantial dearth of knowledge about oil spills in Arctic conditions. The Commission's Report *Advancing Oil Spill Response in Ice-Covered Waters* (USARC Special Report 04-1) has recommended a substantial research program on the behavior of oil in ice infested waters. In addition, the Commission has had substantial discussions on the subject with the Oil Spill Recovery Institute. The Commission, in collaboration with the Alaska Clean Seas Association and others, has recommended test burns in the Arctic Ocean to study the variety of questions associated with this highly effective method of disposing of oil on the sea. The Commission recommends that the Coast Guard in cooperation with the EPA, OSRI, the State of Alaska and others commence such a program soon, before the question is made imperative by an accident in the Arctic. The Commission also notes that the only US vessels capable of responding to an oil spill in the presence of substantial sea ice coverage are the Coast Guard icebreakers. The Commission is concerned that there is inadequate contingency planning for a spill in the Arctic ice off the north slope of Alaska and recommends that the Coast Guard make adequate preparation for such a spill. We also note our comments above on the re-authorization of OPA 90 and our recommendation that research funding be restored with an emphasis on oil in ice.

## 8. The Department of Transportation

A. The Federal Aviation Administration (FAA). The FAA is the principal sponsor of the CAPSTONE Project which is enabling aircraft traffic control and enhancing safe air operations

in the remote regions of Arctic Alaska. The Arctic Research Commission applauds the FAA's efforts to implement the CAPSTONE Project and recommends that they also work with Commissioners and others to support the Arctic Council's Civil Infrastructure Task Force (CITF) in their international efforts to unify and improve transportation infrastructure in the north.

9. The National Aeronautics and Space Administration (NASA). The Commission has been briefed on the Programs undertaken by NASA in the Arctic or having a substantial component in the Arctic. These programs are clearly of a high caliber but, we feel, inadequately described to the research community. The Commission recommends that NASA carry out a program of outreach to the Arctic Research Community to publicize these programs and to encourage broader participation. NASA is always at risk for the engineering side of their programs to overwhelm scientific uses and needs. The Commission believes that by broadening the participation of the research community in their programs, NASA can benefit from the resulting community support.

The Commission notes with particular interest the participation of NASA in the planning for the SEARCH Program. Clearly, remote sensing data with its broad area coverage and frequent collection of data will be essential for this and other coordinated studies in the region. We urge NASA to continue its interagency communication and coordination efforts with a particular emphasis on planning for the Bering Sea Study recommended above by the Commission.

The Commission also notes that NASA supports the Alaska Synthetic Aperture Radar Facility at the University of Alaska Fairbanks. The Commission supports these efforts and looks forward to their continuation and expansion.

Images of the polar region from satellite borne synthetic aperture radar (SAR) are unique in their ability to image sea ice at very high resolution while being able to penetrate cloud cover without difficulty. Canadian plans for the next generation of their RADARSAT satellites, which are the principal providers of this data, is of great concern. The commercialization of RADARSAT images at very high prices and the end of the current policy of free distribution of a portion of the RADARSAT data stream to the US in compensation for the launch of the first satellite will make their availability extremely difficult. In addition, the US National Ice Center (NIC) may not be funded at a level sufficient to maintain its current level of image acquisition. The Commission urges NASA and NOAA to negotiate actively with RADARSAT to continue the current level of availability of images at the NIC. In addition, the Commission recommends that NASA endeavor to negotiate a two tiered pricing structure where older data and images, which have lost most of their timeliness and hence their commercial value, be made available to researchers at a substantially reduced price.

10. The National Institutes of Health (NIH). The Commission has recommended a comprehensive, inter-agency 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 (see comments above on the efforts of the State of Alaska). 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.

#### 11. The Department of the Interior.

A. The United States Geological Survey (USGS). 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 (~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 Congress has recently restored funds for these studies. The Arctic Research Commission recommends 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 Commission has also noted above its concerns for Alaska public lands resource evaluation and for the lack of precise geospatial data in Alaska. The Commission recommends that the USGS in collaboration with the National Geospatial-Intelligence Agency (formerly NIMA) take immediate action to procure/provide this essential data.

The USGS Water Resources Branch has recently reduced the number of hydrologic monitoring stations in the Arctic. Data from these stations are urgently needed for testing and improving the predictions of large-scale of fresh water runoff in the Arctic. Recent research has indicated that fresh water runoff into the Arctic Ocean is increasing. Fresh water runoff affects the stratification of the Arctic Ocean, the production of sea ice and the distribution of nutrients, tracers and contaminants brought to the Arctic Ocean from the land. The World Climate Research Program - Arctic Climate System Study maintains an Arctic Runoff Data Base for these purposes. The Commission recommends that the USGS rebuild a strong program of Arctic hydrologic measurements.

During the construction of the Trans Alaska Pipeline, USGS experts in the field of permafrost were crucial to planning for this massive infrastructure program. Now strong consideration is being given to construction of a new pipeline for the transmission of natural gas to the lower tier of states. This project will also require expertise in permafrost studies, expertise which has, for the most part, been lost by the USGS over the intervening years. At the same time, climate change is expected to de-stabilize permafrost through large areas in Alaska. To meet this challenge the Commission recommends that the USGS implement a new program in the study of permafrost in collaboration with academic and industry scientists as outlined in the Commission’s Report on *Climate Change, Permafrost and Impacts on Civil Infrastructure*.

B. The Fish and Wildlife Service. The Fish and Wildlife Service has been a stalwart in the work of the Arctic Council's working Group on the Conservation of Arctic Flora and Fauna (CAFF). The Commission recommends that other divisions of the Department follow the example of the Fish and Wildlife Service in their support of Arctic Council Activities.

C. The Minerals Managements Service (MMS). The MMS has responsibilities for offshore natural resources and, as a result, is a principal participant along with the State Department, USGS and NOAA in the preparation of a US claim under Article 76 of the UN Convention on the Law of the Sea. This provision allows nations to claim submerged extension of their continental margins for the purpose of the exploitation of resources on and under the sea bed. While data are somewhat more abundant and certainly easier to collect in the temperate and tropic waters under US jurisdiction, the state of knowledge about the Arctic is so limited that new efforts at bathymetric and geophysical measurements may be required for the US to submit a successful claim. The Commission is observing this process with great interest and stimulating it wherever and whenever we can and urges all agencies to contribute as possible to a successful US claim.

D. The North Slope Science Initiative (NSSI). The North Slope Science Initiative (NSSI) was established to develop a science based program that integrates inventory, monitoring, and research activities to support resource management decisions on the North Slope of Alaska. NSSI member organizations include: Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, National Marine Fisheries Service, Minerals Management Service, U.S. Geological Survey, Alaska Department of Natural Resources, Alaska Department of Fish and Game, Arctic Slope Regional Corporation, and the North Slope Borough. These agencies represent the principal government agencies at the regional, State, and Federal levels with management responsibilities for lands, fish, and wildlife on the North Slope. The Commission is supportive of the work of the NSSI and expects that it can become a DOI contributor to the Interagency SEARCH Program.

12. The Department of Energy (DOE). The energy needs of Arctic villages in Alaska are extreme. Poor transportation to remote villages, small communities unable to take advantage of the economies of scale usually associated with municipal energy systems, a mixed economy with only modest cash flow and the lack of a sophisticated technical infrastructure all make the provision of adequate energy resources in the Arctic difficult. The Commission notes the activities of the DOE in developing fuel cell technology. Fuel cells may become a principal source of energy at appropriate scales but the Commission is concerned about cost/benefit ratios and encourages further development of small scale appropriate technology systems for village energy systems in the north.

The Commission notes with pleasure the establishment of the Arctic Energy Office in Fairbanks. This program will lead to improvements in energy supply for the region and will support and encourage the development of important new technologies for rural energy supply. As the Commission has pointed out on many occasions, the supply of appropriately scaled village technology for Alaska's remote communities also leads to opportunities for the production of these systems for users in small, remote communities all over the world. We view the Arctic Energy Office as both a service to Arctic communities and an inspiration for commercial development of these technologies for more widespread use. The development of

world wide markets for these system will help to bring their costs down and their availability within reach for small communities.

The Commission has long held serious concerns about radioisotope contamination in Russia derived from atmospheric nuclear weapon testing and nuclear fuel reprocessing systems. While national concern focuses on the security of the remaining stockpile of Russian nuclear weapons, the reprocessing cycle which produces the basic fissile material for these weapons has had a far greater actual (as opposed to potential) effect on the environment and the people living in it. The Commission encourages the DOE to continue its interaction with the Russian nuclear power infrastructure and to consider potential environmental remediation, restoration or at least sequestration efforts pointed toward the Russian fuel reprocessing system. The Commission also notes that the Department of State is encouraging reprocessing activities in Russia in spite of the very poor environmental record of such processing facilities as Mayak and Tomsk. The Commission suggest that this decision be reconsidered.

The Commission fully supports the activities in the Arctic under the DOE's Atmospheric Radiation Measurement (ARM) Program. The ARM Program is an important research effort and is also an outstanding example of close cooperation between researchers and native communities and stands as an example for other research programs.



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