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INTERNATIONAL POLAR YEAR

JOINT HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

AND THE

COMMITTEE ON FOREIGN RELATIONS

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

SEPTEMBER 26, 2006

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ONE HUNDRED NINTH CONGRESS

SECOND SESSION

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INTERNATIONAL POLAR YEAR

TUESDAY, SEPTEMBER 26, 2006

U.S. SENATE, COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, MEETING JOINTLY WITH THE COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The Committees met, pursuant to notice, at 3:30 p.m. in room SR–253, Russell Senate Office Building, Hon. Ted Stevens, Chairman of the Committee on Commerce, Science, and Transportation, presiding.

OPENING STATEMENT OF HON. TED STEVENS, U.S. SENATOR FROM ALASKA

Chairman STEVENS. My apologies for being late. Gentlemen, I do appreciate your being here. And we have had some questions from the press concerning why we're holding this hearing. I hope it will become apparent to them very quickly.

And I'm delighted that Senator Murkowski has joined in this hearing. It is a joint hearing, with the Foreign Relations Committee and our Commerce Committee. You're the first Senator who was ever born in Alaska. So——

Senator MURKOWSKI. That's right.

Chairman STEVENS.—you're unique.

As we all know, the Earth is changing, and these changes are happening in the polar regions faster than anywhere else in the world. The upcoming International Polar Year will be a critical opportunity for the world's science community to come together and study the climactic changes and impacts on the Arctic and Antarctic.

We feel we have a vested interest, as Alaskans, in the findings of this IPY, because many of us—many of our people live above the Arctic Circle, and those who don't, live in the polar region anyway.

The research that will be done will, we hope, enable us to make informed decisions on where we build schools, when and where subsistence hunts take place, and what to do to prepare for winter storms, or to, most importantly, determine what has to be done to help people who have already been affected by the changes that have taken place so far.

Now, this third IPY aims to involve not only young graduate students, but K–12 students and indigenous people of the Arctic. It's my hope that the IPY will have a lasting impact, like that of the International Geophysical Year that took place almost 50 years ago.

I look forward to the testimony you all are going to present today. Again, I'm sorry to be late. It's been sort of a strange day.

Do you have a statement, Senator?

STATEMENT OF HON. LISA MURKOWSKI,
U.S. SENATOR FROM ALASKA

Senator MURKOWSKI. Thank you.

I want to thank you, Senator Stevens, for agreeing to hold this hearing—as you note, a joint hearing with the Foreign Relations Committee today.

You know, this is a pretty significant consideration, when we think of the international nature of IPY and, kind of, the interrelating or overlapping interests among so many different committees here in the Senate. So, again, I'm appreciative to have this opportunity with you today.

Understanding the polar regions is obviously very important to us in Alaska. The fact that you have two-thirds of the Alaska delegation in attendance today should bear evidence to that.

I would also like to note that Alaska will serve as the host of the 2008 Conference of the Standing Committee of Parliamentarians of the Arctic region. This is more commonly referred to as the Arctic Parliamentarians. I've had the pleasure of participating in this group as the U.S. Representative now for 2 years, and I can report that each of the delegates that I serve with is very much excited about the upcoming IPY. In fact—and the fact that the 2008 Conference comes on the tail end of IPY will give Alaska and the United States an opportunity to demonstrate all that has been, and is being, advanced through IPY.

But, just as the interest from the Arctic Parliamentarians demonstrates, IPY isn't just about Alaska. It isn't just about the United States. This is truly an international effort, and that's what really makes it exciting—an international effort involving researchers, from over 60 countries, whose projects and data gathered over the next few years will have a—truly global impact.

We're fortunate to have a talented group of scientists and polar-region experts with us today from all over the country, each of whom will play a key role in making IPY a success for the United States and for the rest of the world, and I want to thank all of you who have agreed to be with us today. I know several of you have come from extremely long distances, whether it's from the north or whether it's from Europe. So, thank you. We appreciate your close attention to this.

With that, Senator Stevens, I'm prepared to move on to the first panel.

Chairman STEVENS. Yes, thank you very much.

We have two panels, and roughly, I think, about an hour and a half-plus clearance from the floor, so again, we're delighted that you all would come and join us.

And our first panel—our first witness will be Mead Treadwell, Chairman of the Arctic Research Commission. Mead, it's nice to see you here today, we appreciate your coming.

STATEMENT OF MEAD TREADWELL, CHAIR,
U.S. ARCTIC RESEARCH COMMISSION

Mr. TREADWELL. Thank you, Senator Stevens, Senator Murkowski.

On behalf of the Arctic Research Commission, thank you for holding this hearing. The more people who know about the exciting research going on in the polar regions during the International Polar Year, the more likely we are to see the legacy of a strong polar science program.

Today, I'd like to address actions Congress may want to make, this session, that could make the IPY more successful. And I'll also speak to the legacies of IPY that Congress may want to help foster, which could mean a robust Arctic Research Program for years to come.

The successful IPY will do more than gather vast knowledge in the next 2 years. With IPY, we should establish long-term monitoring networks and other science infrastructure, including the ship- and land-based research platforms and remote sensing technologies, to keep the knowledge coming. And within the government itself, IPY will help us focus on our goals in the Arctic, in science and in policy. The Commission believes we must use IPY to craft a more coordinated and sustainable long-term Arctic Research Program.

Mr. Chairman, Senator Murkowski, when I was designated chair by the President, there were two immediate calendar items that the Arctic Research Commission faces. First is the kickoff for IPY, next March. It is—we're committed to making this a successful broadening and strengthening of Arctic science in many places and many disciplines. It's cooperation across disciplines, between the poles, around the world, and will be involved in outreach, as Senator Murkowski has suggested many times. And with the Congress and within the Executive Branch, we're encouraging a level of funding and participation appropriate to this Nation's leadership in polar research.

The second calendar item that we've got is, we owe you a *Goals Report* in January, and that *Goals Report,* which helps—is really the first draft of the Arctic Research Program, which the Interagency Arctic Research Policy Committee then vets and finalizes into an Arctic Research Program. And that committee is chaired by my colleague Dr. Bement, to my left. We are hoping that that plan next year looks at the long-term research and infrastructure needs that we have, and that that can be a legacy of IPY.

Congress can work to make IPY a rousing success several different ways. First is getting the word out. We encourage you to have more hearings as IPY progresses. I've heard Senator Murkowski tell the science community several times, that we must share the excitement of exploration in polar regions. This is a risky and adventurous frontier with great rewards from solving its mysteries. We encourage you, in Congress, to visit the field during IPY to see the scientific work firsthand. IPY research will help human health, energy security, safer, sounder homes, and assist in sustaining traditional cultures in the north.

Second, we're hopeful enough funds and encouragement will be provided to the other agencies to make sure we're able to fulfill our

commitments. The Administration's current proposal for $62 million funding from NSF should be approved by Congress this year. It remains to be seen what the President and NSF will propose for next year, but if we're to move beyond fragmented and leveraged funding for IPY, that number should be significantly greater and should take into account the long-term need for monitoring and data management.

Two agencies under the purview of the Senate Commerce Committee, NOAA and NASA, could play a pivotal role in IPY. Mr. Chairman, I should say I was appointed by the President, and we're team players with the Administration, but, at the same time, based on statute, legislative intent, and our oath to support it, we're obliged to tell you in the Congress where the Arctic Program funding request may not effectively meet the Arctic—the Nation's Arctic Research Plan.

The Commission is sad that NOAA has recently eliminated its Arctic office, reducing the visibility of its Arctic Research Program, and just prior to the IPY. It has also had significant budget reductions this year. But, nevertheless, there is a lot of work being done at NOAA in the Arctic. And those are detailed in my written testimony, and we can answer specifics and questions.

At NASA, the pressure on the Earth Science budget is also well documented. Much of NASA's current Earth-sensing infrastructure is in polar orbits, meaning the coverage of the Arctic and the Antarctic is robust, but, therefore, at greater risk, with delays and cancellations of key remote-sensing systems.

Japan's cooperation with the United States on Arctic research could be much more productive if work being done at the International Arctic Research Center in Fairbanks had greater NASA participation. And Congress could help make that happen.

Further, this is a great time for Congress to stress to agencies that they identify their role in Arctic research and integrate their work with other agencies. And I'm glad to say that we're working closely with IARPC staff and the staff of OMB to make sure that you get what the law calls for, which is a unified Arctic research budget when the President's budget is submitted.

The Arctic research budget has grown significantly in recent years. It's now approaching $400 million a year and has significant work going on in a variety of areas. At least 15 Federal agencies support this work, and the program benefits from important partnerships with the State of Alaska, our Arctic neighbors, the European community, Korea, China, and Japan.

Last, Congress may want to encourage a discussion about U.S. Arctic policy during IPY. The last time U.S. Government agencies sat down to comprehensively review Arctic policy was in 1994. And while the Presidential statement that survives that process is in force today, much has changed. We know much more about Arctic climate, and the change has brought imperatives in security, housing, infrastructure, transportation, and research.

Recently, just this afternoon, the House held a hearing on a National Research Council study on icebreakers which called for the construction of two new Polar Class icebreakers. And that also requires a policy consideration.

The Commission is working hard on issues, in terms of mapping of the Arctic Ocean floor, which relate to Article 76 of the Law of the Sea. And what we learned through Arctic cooperation, whether through the Northern Forum, the Arctic Council, or by other mechanisms, is that there are opportunities for common development, common protection, and common exploration. The long-held goal of using the Arctic Ocean as a regular shipping route may be upon us soon, and other nations have recently held public examinations of their goals in the Arctic. And it's appropriate for us to do the same.

Let me conclude by saying that our *Goals Report,* which will be delivered to you in January, will look at the infrastructure issues, the long-term legacies of Arctic research that's necessary. You'll hear about icebreakers, research vessels, submarines, satellites, and autonomous vehicles—underwater, in the air. There are a number of tremendous things happening and developing in improving Arctic research, but there's one key infrastructure legacy at the top of everyone's list. The U.S. will soon launch an Arctic Observing Network that must, and will, be one of the key legacies of IPY. It'll be a network of networks, actually, that will collect data in as close to realtime with standards of measurement across the Arctic. While the observation capabilities the U.S. supports in the field today may be enough to declare that we have the Arctic Observing Network going, the process of designing an improved system, identifying gaps, setting standards, and managing data has yet to take place. We urge the Congress to pay close attention as this process begins.

As our explorers head to the field, I've heard Senator Murkowski say, several times, that it's up to them to share the excitement with the public. When I speak to kids about Arctic exploration, we've got lots to discuss. NASA's animation of receding ice cover, as seen from satellites in space, prompts a discussion not only of climate change and shipping routes, but whether the robot that took the picture had rockets in his shoes. Alaskans used to landing at runway 6 at Ted Stevens International Airport in Anchorage learned that it's now runway 7, because the magnetic North Pole is constantly moving, and taking the Aurora Borealis with it. Reports of mid-ocean ridge spreading in the Arctic Ocean bottom have forced instructors to rewrite the textbook on plate tectonics, and recent coring near the North Pole has revealed organic rift sediments that could likely serve as source material for oil and gas deposits around the Arctic margin. And if you get no further than the freezers at the Institute of Arctic Biology at Fairbanks, you'll meet a number of sleeping ground squirrels. And what we've learned about them and hibernation may help in the fight against cancer.

Mr. Chairman, there is much going on, and knowing about it stimulates further curiosity, further interest in exploration, and this discussion surely is to be continued.

Thank you very much.

[The prepared statement of Mr. Treadwell follows:]

PREPARED STATEMENT OF MEAD TREADWELL, CHAIR,
U.S. ARCTIC RESEARCH COMMISSION

Mr. Chairman and Members of the Committees:

On behalf of the U.S. Arctic Research Commission, thank you for holding this hearing. The more people know about the exciting research going on in the Polar Regions during the International Polar Year, the more likely we are to see the legacy of a strong polar science program.

Today, I would like to address actions Congress may want to make this session that could make the International Polar Year more successful.

I will also speak to the legacies of IPY the Congress may want to help foster, which could mean a robust Arctic research program for years to come.

A successful IPY will do more than gather vast knowledge in the next 2 years. With IPY, we should establish long-term monitoring networks and other science infrastructure, including the ship- and land-based research platforms as well as remote sensing technologies, to keep the knowledge coming.

Within the government itself, IPY will help us focus on our goals in the Arctic—in science and in policy. The Commission believe we must use IPY to craft a more coordinated and sustainable long-term Arctic research program.

Background on the U.S. Arctic Research Commission

I have had the honor of serving on the U.S. Arctic Research Commission since 2001, and as Chair for less than 2 months. Six other Commissioners, whose names are listed on the cover of this testimony, also serve. This Commission, Mr. Chairman, reports to you in the Congress and to the President, on goals and priorities for the U.S. Arctic Research Program. With our counterpart, the Interagency Arctic Research Policy Committee, (IARPC), we work to see those goals accomplished. Much of that work is building cooperation—among U.S. agencies, universities, the State of Alaska, the private sector, indigenous and other Arctic residents, and other nations.

Two immediate calendar items face the Commission.

First is the kickoff for the International Polar Year. Within the Commission, we're committed to making this a successful broadening and strengthening of Arctic science in many places and many disciplines. It is cooperation—across disciplines, between the poles, around the world. We will participate in outreach. With the Congress and within the Executive Branch, we're encouraging a level of funding and participation in IPY appropriate to the Nation's leadership in polar research.

Our Commission's second calendar item is a *Goals Report* due for delivery to the Congress and the President in late January, as specified by law. In formulating that *Goals Report,* Commissioners are focused on how we can ensure that the excitement of IPY results in long-term, sustainable legacies in Arctic research.

The International Polar Year

The first International Polar Year was in 1882–1883. The last International Polar Year, in 1932–1933, helped inspire the first International Geophysical Year fifty years ago, in 1957–1958. The excitement surrounding this event was palpable, and while I recall little of my reading in second grade, I do remember an article in "My Weekly Reader."

Last time around, IPY and its global counterpart, the International Geophysical Year, happened as the world entered the atomic age . . . the jet age . . . the space age . . . and soon, the digital age. The excitement of exploration—the assault on the unknown—was contagious. This time, we hope for a similar epidemic—a continuing thirst for knowledge.

Whatever we gain in knowledge this time around, this IPY has important differences. Like never before, the IPY will involve the people who live in the Arctic. *Political barriers* that existed during the Cold War are behind us, and Arctic cooperation is strong. *Physical access barriers* are disappearing, not just with receding ice, but also with improved technology and navigation, at sea and in the air. *Communication barriers* to exploration and data collection have disappeared, with the availability of fiber networks and low-earth orbiting communications networks like Iridium phone and data systems that allow polar research to be conducted, literally, from afar. *Barriers in scientific disciplines,* and those between "western science" and traditional knowledge, are also fading. That trend suggests that the knowledge we get, in the end, will itself be more whole.

Thus, we begin this IPY with the prospect that its real legacy will be a connected Arctic—one that will continue to reveal itself, know itself, and share its mysteries.

Immediate Actions the Congress May Take in Support of IPY

There are two ways the Congress can help make the IPY a rousing success.

First is getting the word out. We encourage you to have more hearings, as IPY progresses. I have heard Senator Murkowski tell the science community, several times; we must share the excitement of exploration in the polar regions. This is a risky and adventurous frontier, with great rewards from solving its mysteries.

We encourage Members of the Congress to visit the field during the International Polar Year, to see the science firsthand, and to understand the value of what we're learning. Understanding the Earth's processes—and man's impact—is just the start. IPY research will help human health, energy security, safer, sounder homes, and will increase culture sustainability.

We believe the U.S. will be well represented in IPY if appropriate funding is provided in several agency budgets. The Administration's current proposal for $62 million funding from NSF should be approved by the Congress this year. It remains to be seen what the President and NSF will propose for next year. If we are to move beyond fragmented and leveraged funding for IPY, that number should be significantly greater, and should take into account the long-term need for monitoring and data management.

Second, we're hopeful that enough funds and encouragement will be provided to other agencies to make sure we are able to fulfill our commitments. Two agencies under the purview of the Senate Commerce Committee—NOAA and NASA—could play a pivotal role.

Mr. Chairman, I was appointed by the President, and we are team players with the Administration. At the same time, based on statue, legislative intent, and our oath to support it, we are obliged to tell you and the Congress where the Arctic program funding requests may not effectively meet the Nation's Arctic Research Plan.

NOAA has recently reduced its office, by eliminating the Arctic Program, and just prior to the IPY. Nevertheless, NOAA has a lot of work to do. Through negotiations on Capitol Hill in 1996, the Arctic Research Commission convinced Congress to establish an Arctic Research Initiative (ARI) within the budget of NOAA with the understanding that the ARI would be institutionalized as part of NOAA's annual budget request. Instead, the ARI, which provides funds for extramural research through a competitive process that is managed by CIFAR (the Cooperative Institute for Arctic Research), has been zeroed out in the past 2 years. Additionally, the Joint Russian-American Long Term Census of the Arctic (RUSCALA), the result of the Memorandum of Understanding between NOAA and the Russian Academy of Sciences in 2003, is an on-going collaboration between U.S. and Russian scientists in the northern Bering and Chukchi Sea. Funds are needed for this program to make awards for proposals already competitively selected and approved by NOAA for work beginning in FY07 for the next major Russian-American cruise in 2008. Without the requisite commitments to such research infrastructure—so critical to mobilize—in light of the upcoming IPY, it will be difficult to ensure a strong U.S. presence in the initiative.

NOAA funds sought for Arctic research in the coming year must support further construction of the Barrow Global Climate Change Research Facility. Funds provided must also support NOAA's leadership of the Arctic Council's Arctic Monitoring and Assessment Program, and NOAA's participation in the development of integrated monitoring networks. To make these things happen, the Arctic program of that agency—recently downgraded—needs more visibility and support.

At NASA, the pressure on the Earth Science budget is well documented. Much of NASA's current Earth sensing infrastructure is in polar orbits, meaning that coverage of the Arctic and the Antarctic is robust, but therefore at greater risk with delays and cancellations of key remote sensing systems. Japan's cooperation with the United States on Arctic research could be much more productive if the work being done at the International Arctic Research Center in Fairbanks had greater NASA participation. Congress can help make this happen.

Within our government, it is important to encourage each appropriate agency of the U.S. Government to participate in IPY. Further, this is a great time for Congress to stress to agencies that they identify their role in Arctic research and integrate their work with other agencies.

Toward that end, Congress has called for an integrated Arctic research budget from Federal agencies since 1984, to be delivered in enough time for your analysis and ours from the Commission. The data call made this year, done only after Senator Murkowski's request, lacked input from several key agencies. I'm happy to report that the Commission, IARPC staff, and the staff of OMB are working together to solve this problem. We will try again this year to see that the budget presented to Congress in January clearly shows what we're up to during the IPY. And even though the requirement is in the law, we are helped in this process when Congress asks for the information.

The Commission believes that knowing what we're doing—across the board—can promote much stronger cooperation.

What we have learned so far is that our Nation's commitment to Arctic research has grown significantly in recent years. IARPC reports that the U.S. Arctic Research Program, with expenditures approaching $400 million a year, has significant work going on in a broad variety of areas. At least fifteen Federal agencies support this work, and the U.S. program benefits from important partnerships with the State of Alaska, our Arctic neighbors, the European Community, Korea, China, and Japan.

The Commission, for much of the last decade, has worked to focus the U.S. Arctic Research Program on five key questions:

- What is the changing climate of the Arctic, and how will it affect the rest of the world?
- What processes govern the world's richest fishery in the Bering Sea?
- What can be learned to enhance the health of Arctic residents?
- What are the vast resources of the Arctic that we own in common?
- What changes to Arctic infrastructure must we make in response to changing climate?

To answer these questions, the research community has responded with a set of integrated science programs, some of which are reflected in budgets sent to Congress, and some of which exist as less formal initiatives combining contributions from many sources.

- SEARCH, the Study of Environmental Arctic Change, is the Nation's integrated look at climate and environmental change in the region. Funding is led by NSF, but agency contributions come from a number of sources. Leadership exists both in the academic community and in the government.
- BEST, the Bering Ecosystem Study, is a part of SEARCH. It focuses on the Bering Sea, and is just getting started under NSF's leadership. The work of the North Pacific Research Board is adding greatly to the capabilities of this science plan.
- Arctic Health studies are coming together through a U.S. initiative at the Arctic Council. Dr. Alan Parkinson, speaking here today, can tell you how NIH and CDC are bringing a broad base together to address very important questions, from contaminants in the food chain to dealing with the high alcohol and suicide problems in the Arctic populations.
- The U.S. Geological Survey has taken the lead in the Resource Assessment program called for in the U.S. Arctic Research plan. Other agencies should join, and the Commission is formulating specific recommendations in that area.
- Infrastructure Research has no specific agency leader today, and we hope yet for integration. Candidates to participate in an integrated infrastructure research program include the Army Corps of Engineers, the Department of Transportation, the Department of Housing and Urban Development, the U.S. Department of Energy, and the U.S. Geological Survey. The Commission will be working with IARPC to bring this about.

Lastly, Congress may want to encourage a discussion about U.S. Arctic policy during IPY. The last time U.S. Government agencies sat down to comprehensively review Arctic policy was in 1994. While the Presidential statement that survives that process is in force today, much has changed. We know much more about Arctic climate—and the change has brought imperatives in security, housing, infrastructure, transportation, and research.

The world is looking to the Arctic much more now for its energy security. The Commission has recommended that new support for oil spill research programs, focusing both on prevention, detection, and response, become a national priority.

Even as the Senate considers the Law of the Sea Treaty, the Commission believes we should move forward with the mapping of the Arctic Ocean floor which other nations have begun to claim under Article 76. Congress could help make the submarine platforms available to do it more quickly.

What we've learned through Arctic cooperation, whether through the Northern Forum, the Arctic Council, or by other mechanisms, is that there are opportunities for common development, common protection, common exploration. The long-held goal of using the Arctic Ocean as a regular shipping route may soon be upon us. Other nations have recently held public examinations of their goals in the Arctic, and it is appropriate for the U.S. to do the same.

An IPY Legacy: Monitoring and Other Infrastructure

At the U.S. Arctic Research Program, we believe the legacy of IPY should be long-term, sustainable infrastructure for Arctic research.

As our past and present Commissioners deliberate with the science community on what research infrastructure is needed in the 21st century, there are a wide variety of needs.

Just this afternoon, a House Committee was briefed on a new National Academy study on the Nation's needs for an icebreaker fleet.

In our upcoming *Goals Report,* you will hear much from us about icebreakers, research vessels, submarines, satellites, and autonomous vehicles under water and in the air.

The Bering Strait has been described as the "choke point" of the Arctic and yet support for oceanographic moorings (that monitor currents, temperature, salinity, various measures of productivity, and nutrient status) in both Russian and American waters are funded on a year-by-year basis and at present, hinges in part on funding for the Alaska Ocean Observing System (AOOS). As an integral part of the Arctic Observing Network, long-term support for the yearly recovery and deployment of moorings in the Bering Strait is an essential part of our IPY legacy and key to understanding how change will affect storm events in our coastal communities, marine mammal and fisheries resources so important to our citizens, as well as evolving transportation needs in the Arctic.

We must sustain onshore research platforms in the Arctic, such as the Barrow Global Climate Change Research Facility, or Toolik Lake in the Brooks Range, or our cooperative facilities in Greenland, Russia, or Svalbard.

Outside the Arctic, researchers rely on communications networks, supercomputers, ice core repositories, carbon-14 dating laboratories in Florida, and the National Ice Center here in Suitland, Maryland.

Mr. Chairman, there is hardly a member of the Senate who does not represent facilities—and researchers—participating in the important work of Arctic research.

But there is one key infrastructure legacy that is on the top of everyone's list. The United States will soon launch an Arctic Observing Network that must and will be one of the key legacies of IPY. It will be a "network of networks" actually, that will collect data, in as close to real time, with standards of measurement, across the Arctic. The ambition of such a network—nurtured by the very effective international cooperation which produced the Arctic Climate Impact Assessment 2 years ago in the Arctic Council—is strong.

In the next few years, new technologies will bring datasets we collect once a year to us in real time. Hydrology, humidity, temperature, rainfall, winds, atmospheric gas composition, radiation, ozone, ice thickness, currents, salinity—information collected by many agencies in many places—will be more prolific, more immediate, and most important, more organized.

While the observation capabilities the U.S. supports in the field today may be enough to declare that we have the AON going, the process of designing an improved system, identifying gaps, setting standards, and managing data has yet to take place. We urge the Congress to pay close attention as this process begins.

On so many key issues today, the Arctic is a bellwether for the globe. With suitable support, this could be an excellent and early working system of the networks envisioned as part of the Global Earth Observing System of Systems (GEOSS). It supports the goals, as my fellow Commissioner Dr. Charles Vorosmarty wrote, of the American Competitiveness Initiative.

> "Mobilizing and harmonizing major land, water, air, and space-based observing systems across the pan-Arctic would also be an important vehicle to entrain the U.S. private sector, stimulating innovation through technology along the lines of the American Competitiveness Initiative. The use of miniaturized, state-of-the-art sensors provides an interesting focal point private sector engagement. Training the next generation of scientists and engineers also provides critical long-term support to the ACI.
>
> "*What Congress could do:* Call for an assessment (through the National Academies Polar Research Board) of U.S. science and technology capabilities in this realm with the express aim of uniting academic, agency and private sector partners; stimulate private investment in instrumentation, data broadcast technologies, supercomputing, new mathematical and statistical approaches; commit to make appropriate instrumentation purchases . . ."

Exploration Under IPY: the Human Legacy

As our explorers head to the field, I've heard Senator Murkowski say several times, it is up to them to share the excitement with the public.

When I speak to kids about Arctic exploration, we've got lots to discuss. NASA's animation of receding ice cover, as seen from satellites in space, prompts a discussion not only of climate change and shipping routes, but whether the robot that took the picture had rockets in his shoes.

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If you get no further than the freezers at the Institute of Arctic Biology at Fairbanks, you will meet a number of sleeping ground squirrels. What we've learned about them may help in the fight against cancer.

Mr. Chairman, there is much going on, and knowing about it stimulates further curiosity, further interest in exploration. This discussion, surely, is to be continued . . .

Thank you very much.

Chairman STEVENS. Thank you, Mead. It's going to be a stimulating period, there's no question about that.

Our next witness is Dr. Arden Bement, Director of the National Science Foundation.

Doctor, it's nice to have you with us again.

STATEMENT OF DR. ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. BEMENT. Thank you, Chairman Stevens and Senator Murkowski, for the opportunity to testify on the upcoming International Polar Year and how NSF and our sister agencies are addressing this important opportunity.

Fifty years ago, the Third International Polar Year and International Geophysical Year entranced American's youth and galvanized America's innovative powers. That effort left a permanent legacy ranging from scientific Earth satellites to the development of a generation of world-class scientists and engineers whose interest in research was piqued by news coverage of polar research. NSF has equally high aspirations for the upcoming International Polar Year. We intend to create a legacy of infrastructure and data for future generations of scientists. We also intend to expand international cooperation. And, finally, we hope to engage the public in polar discovery and help attract and educate the next generation of scientists and engineers.

The impacts of climate change on northern peoples—and, more generally, on ecosystems and polar environments—strongly motivate a broader focus than that of the last IPY. Thus, NSF will emphasize three scientific themes, coupled with education and outreach activities.

The extremes of polar environments provide unique opportunities to advance our understanding of how organisms adapt to climate extremes, how they have evolved, at the genomic level, and how gene expression depends on the physical environment. The development of a circum-Arctic Observing Network, or AON, will provide the missing data essential to faithfully model and predict Arctic climate change. Multinational investigations of changes in the Earth's great ice sheets will improve our understanding of how these affect global conditions, including global sea level.

NSF's Office of Polar Programs and the Director for Education and Human Resources have already funded nine truly outstanding and creative projects in education and public outreach that will launch our IPY efforts in great style. The second round of projects will be funded early next year.

To fulfill the IPY leadership role assigned to NSF by OSTP, we are cooperating with other Federal agencies. NSF and NASA are working to coordinate ground-based and space-based observations in order to provide a comprehensive body of benchmark data. NASA has initiated discussions with space agencies around the world to bring the worldwide satellite fleet to bear on this effort.

A circum-Arctic system requires active collaboration with countries around the Arctic Rim. NSF has already developed strong links with Norway, Sweden, Germany, and Russia to bring their activities to bear on AON. We are working actively with the European Polar Board and the Canadian officials to build IPY partnerships.

In response to the recommendations of the Arctic Research Commission, NSF is now working closely with the Northern Pacific Research Board. We are aligning our Bering Sea Ecosystems Program with NPRB's related studies and with NOAA's long-term Bering Sea fisheries management activity. Through these combined efforts, we aim to understand the response of the Bering Sea ecosystem, the most productive fishery in the U.S., to environmental change; most notably, to reductions in seasonal sea ice.

Barrow was a key station in the first IPY, and we anticipate it will be, again. U.S. contributions to an Arctic Observing Network activity are expected to include Barrow's new Global Climate Change Research facility, and investments to improve a safe and effective year-round research capability to the University of Alaska's Toolik Field Station.

NSF places high priority on securing funding to build a new ice-strengthened ship to serve research needs in the waters around Alaska. Subject to appropriations in Fiscal Year 2007, construction will begin during the IPY. Designated the Alaska Regional Research Vessel, the ship will conduct scientific research cruises year-round in waters of the Gulf of Alaska and southern Bering Sea, and, in the summer, as far north as the Chukchi and the Beaufort Seas, during minimal ice cover.

Chairman Stevens and Chairwoman Murkowski, earlier I mentioned the educational legacy created by IPY 50 years ago. The current IPY effort has even greater potential. By linking the public's fascination with things polar to outreach into museums, homes, and classrooms that conveys the excitement of research and discovery, we can attract a new generation of Americans into science and engineering careers, while contributing to a more informed public.

Thank you both, again, for providing an opportunity to highlight NSF's role in the upcoming International Polar Year, and I would be pleased to answer any of your questions.

Thank you.

[The prepared statement of Dr. Bement follows:]

PREPARED STATEMENT OF DR. ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Thank you, Mr. Chairman, for the opportunity to testify before the Committee concerning the upcoming International Polar Year (IPY) and on how the National Science Foundation (NSF) and our sister agencies are addressing this important opportunity. Our job is to enable U.S. scientists and educators to realize these opportunities, opportunities that members of today's distinguished panel will be speaking to in more detail.

We intend for the International Polar Year period—which has been declared by the International Council of Science (ICSU) and the U.S. National Academies (NAS) to be from March 2007 through March 2009—to explore new frontiers in polar sciences; improve our understanding of the critical role of the Earth's polar regions in global processes; create a legacy of infrastructure and data for future generations of scientists; expand international cooperation; engage the public in polar discovery; and help attract and educate the next generation of scientists and engineers.

Fifty years ago, the Third International Polar Year and International Geophysical Year (IPY–3/IGY) entranced America's youth and galvanized America's innovative powers in ways that created a legacy that lives on today. That legacy ranges from scientific Earth satellites to the development of a generation of world-class scientists and engineers who drove our knowledge-based economy forward for the next half-century.

Advances in instrumentation and technology, the realization that polar regions are critical in the changing global climate system, and linkages among international research organizations offer opportunities for breakthrough developments both in fundamental disciplinary science and in science for policy during IPY. In addition, the impacts of climate change on northern communities, and more generally, on ecosystems in polar environments strongly motivate a broader focus than the last IPY had. The NSF tradition of linking research and education offers the further opportunity to engage America's youth in this period of discovery and awaken them to the excitement of a career in science and engineering.

In his introduction to the "American Competitiveness Initiative, Leading the World in Innovation," President George Bush stated that a "well-educated and skilled work force is the bedrock of America's competitiveness." U.S. institutions of higher learning remain the envy of the world, but the global economy has greatly increased the competition for the best and brightest students. America must ensure that its best and brightest young people give appropriate consideration to careers in science and engineering and that they take advantage of the fact that ours is the most open educational system in the world. NSF, its sister agencies, and IPY have a key role to play in achieving this goal.

NSF has been tasked by the White House Office of Science and Technology Policy to provide leadership for the U.S. in IPY. And, the agency is poised to do exactly that, both domestically and on the broad international stage. We have worked closely with our colleagues in other Federal agencies and with the NAS to that end over the last two and a half years. Back in July 2004, I was pleased to be invited to deliver the keynote address at a meeting organized by the three Presidents of the NAS that was devoted to IPY planning. With your permission, I would like to enter my remarks for the record. As I said then, and I quote:

> Both the National Academy of Sciences and the International Council of Science have made a compelling case for why we should launch an international polar year in 2007. NSF is in full agreement. In the polar regions, we are discerning the outlines of environmental change, from sea ice extent, retreating glaciers, shifting patterns in flora and fauna, to environmental observations by Arctic natives.
>
> What is more, such change—whether environmental, biological, or social—has implications for the rest of the globe. Polar change ripples across the planet on a spectrum of time scales, through the atmosphere, oceans, and living systems.
>
> We do not yet fully understand the causes of what we are observing. Now is the time to change this, for new tools make possible the needed observations and synthesis. They range from satellites to ships to sensors, and from genomics to nanotechnology, information technology, and advances in remote and robotic technologies.

The NAS subsequently conducted a year-long study to develop a Vision for the International Polar Year, one that would take advantage of the broad expertise of the U.S. scientific community; position the U.S. for world leadership in IPY; and most importantly, create a long-term legacy that would not otherwise exist. This Vision is providing a framework for IPY planning among the Federal agencies. It was

developed under the leadership of Dr. Mary Albert of the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire, and I believe my colleague on the panel, Dr. Robin Bell, will outline its recommendations in more detail. Robin chairs the NAS/National Research Council (NRC) Polar Research Board that oversaw the work of Mary's committee. They both have earned our continuing gratitude and congratulations.

In exercising NSF's leadership role, I also convened several meetings of the policy-level officials to discuss IPY planning. These activities resulted in a report we provided to the Congress last year and a number of agencies have taken the opportunity to update their sections of the report for this hearing. With your permission, Mr. Chairman, I would like to submit a copy for the record and mention a few highlights.

NASA is holding discussions with space agencies around the world to organize a coordinated program to map the polar regions using today's sophisticated satellites. NSF and NASA are working together to coordinate space- and ground-based observations in order to provide future generations of scientists and others with a comprehensive body of benchmarked data. These data will greatly increase our ability to discern change on a regional basis—a basis that relates directly to the different environments in which people work and live.

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and NSF are developing atmospheric, land and ocean-based environmental monitoring capabilities that will be key components of the planned circum-Arctic Observing Network (AON), which will significantly enhance our observing capability in the Arctic Region beyond that currently available. Data from this AON will enable the U.S. multi-agency program SEARCH—the Study of Environmental Arctic Change—developed under the Interagency Arctic Research Policy Committee to get a handle on Arctic environmental change. We discuss specific U.S. investments later.

Here, too, the NAS have helped significantly with an NSF-funded study of how best to implement AON. A circum-Arctic system requires active contributions from countries around the Arctic rim. We have already developed strong links for coordination with the $30-million European program called DAMOCLES; have initiated discussions with our Canadian colleagues; and have joined with Norway, Sweden, Germany, and Russia in establishing an office in St. Petersburg to assist with linking Russian activities to AON. NOAA has led an effort to build U.S.-Russian Federation collaboration in ocean and polar region studies, as highlighted by the Russian American Long Term Census of the Arctic RUSALCA program. This will be a key U.S.-Russian component of the IPY. NOAA, in collaboration with NSF, also leads the U.S. participation in the IPY International Arctic System for Observing the Atmosphere, which began as a grass roots international activity under the IPY umbrella that now has the potential to provide the climate component of AON.

Responding to the recommendations of the Arctic Research Commission's Goals Report, which I'm sure Mr. Treadwell will mention in more detail, NSF is now working closely with the Northern Pacific Research Board (NPRB) to align our Bering Sea Ecosystem Program (BEST) with NPRB's related studies, as well as NOAA's long-term Bering Sea fisheries management activity. Through these combined efforts we aim to understand the response of the Bering Sea ecosystem, the most productive fishery in the U.S., to environmental change, most notably, reductions in seasonal sea ice.

I would like to note that plans have been underway for several years for construction of a new ice-strengthened ship that would serve research needs in the waters around Alaska. NSF has assigned high priority to securing funding to build this ship, and subject to appropriation of funding in Fiscal Year 2007, construction will begin during the IPY. Designated the Alaska Regional Research Vessel (ARRV), it would likely be operated by a university as a UNOLS vessel. It would replace the *Alpha Helix,* and like that ship, it would conduct research cruises year round in waters of the Gulf of Alaska and southern Bering Sea. And in the summer, the ARRV would travel as far north as the Chukchi and Beaufort Seas during minimum ice cover.

Additional IPY efforts by NOAA, NASA and other sister agencies are described in the attached document entitled, "*The International Polar Years 2007–2009*."

NSF's Office of Polar Programs (OPP) and the Directorate for Education and Human Resources (EHR) combined to jumpstart IPY preparations by committing $12 million from their FY06 appropriations to a special IPY proposal solicitation. The solicitation drew a very strong response from U.S. scholars; taken together the proposals requested over $150 million in the four focus areas (three science areas and education).

We chose to focus on areas that, for one reason or another, needed extra lead time for preparation and that would represent a good start toward realizing the NAS/NRC Vision. The NSF merit review of the education proposals was completed just a few days ago, and the results exemplify the creativity and the enthusiasm of our educators and scientists. I expect to be able to announce the results from the three research areas by the end of October. Meanwhile, the Program Officers overseeing the merit review process tell me the quality of the proposals is outstanding.

Building on this excellent FY06 start, NSF Program Officers from the Agency's disciplinary directorates are working with OPP to formulate how best to respond to IPY opportunities in FY07 and FY08. On the basis of their work, the Administration requested $62 million in FY07. And, I'm very happy that both Houses of Congress have signaled their agreement with our IPY agenda.

The strong partnership created with EHR in developing the FY06 solicitation is the very first legacy of IPY; it will ensure an effective outreach and education effort throughout the upcoming 2 years and well into the future. A strong partnership with the NSF's Office of International Science and Engineering (OISE) is enabling rapid development of new international links, as well as a strengthening of existing ones.

IPY planning by the Biological and Social, Behavioral, and Economic Sciences Directorates and studies by the NAS/NRC have identified an exciting group of leading-edge research subjects in biology and the social sciences, ones that with strong IPY support and focus could create 21st century legacies. The Geosciences Directorate and OPP have a long history of joint cooperation for proposals, and IPY provides a strong basis for developing new partnerships in key focus areas such as climate studies. The Mathematical and Physical Sciences Directorate and OPP have an outstanding partnership in astrophysics at the South Pole, another excellent IPY building block. Thus, there is great potential for creating legacies through research achievements, a new generation of American scientists and engineers, and new networks of international collaborations.

The aforementioned solicitation identified three science themes and a strong education focus as key investment areas for special emphasis during FY06. These themes will be developed further during FY07 and FY08. A cross-directorate working group is evaluating the extent to which the original focus areas will have been addressed by the FY06 solicitation, and how they can be broadened to address more of the Vision developed by the NAS. NSF and the Office of Management and Budget will soon discuss how to address these focus areas in the FY08 budget request to Congress.

The first of these research themes addresses climate change in the Arctic by contributing to building the circum-Arctic Observing Network (AON) that I mentioned earlier. This program was organized under the direction of the U.S. Interagency Arctic Research Policy Committee chaired by the NSF Director and involves partnership with NOAA, NASA, DOI, DOE, NIH, DOD, USDA, and the Smithsonian Institution.

During the past few decades, the Arctic has experienced significant environmental changes that could have broad-reaching consequences for human and animal populations in the form of impacts on local ecosystems, as well as on global climate. One example is that winter sea and river ice—for centuries used by northern communities to facilitate hunting and transportation and more recently for industrial development—have become useable for shorter and shorter periods with less predictability. Warmer winter temperature minimums have lead to the spread of pests. For example, Spruce Bark Beetles once thrived only in the lower 48 U.S. states, but now have become a threat to more northerly communities by killing large stands of forest and increasing the risk of significant fire damage to communities and habitats. But new opportunities are also emerging. For example, significantly reduced summer sea-ice minimums might mean that the Arctic finally becomes the summer sea-transportation route once sought by early explorers.

The AON will provide a network of observations that will facilitate this understanding of the profound change that is occurring in the Arctic in a global context. To achieve this goal, Cyberinfrastructure (CI) will need to be developed to provide interoperability between the various elements of the observing network, seamless broadband communications capabilities at the poles, data storage and archive capabilities, and timely access to data—particularly for input into large-scale coupled models. This initiative will not only support the Foundation's broader CI interests, it also supports the broader Administration goal of developing a Global Earth Observing System (GEOS). The Chairman need not be reminded that Barrow was a key station in the first IPY, and we anticipate it will be again. U.S. contributions to a pan-Arctic AON activity are expected to include Barrow's new Global Climate

Change Research facility and investments to provide a safe and effective year-round research capability to the University of Alaska's Toolik Field Station.

A second broad theme addresses research on what we're calling "Life in the Cold and Dark." Relatively recent developments in instrumentation and technology offer the opportunity to study the mechanisms by which organisms adapt to the climate extremes they face in polar environments, how they have evolved at the genomic level and how gene expression depends on the physical environment. A recent NAS report, "*Frontiers in Polar Biology in the Genomics Era*," outlines the opportunities and challenges, and describes the ecological relevance and research benefits of these tools of modern biology. The Life in the Cold and Dark theme also encompasses research on the interactions between living and physical systems at all levels and brings together researchers trained in the biological and social sciences.

The last International Polar Year in 1957–1958 focused almost entirely on physical science but IPY 2007–2009 will be different. Many northern languages are now spoken by only small numbers of elderly people and NSF will partner with the National Endowments for the Humanities in the U.S. and with Canada and other countries in sponsoring work to document those endangered languages in Alaska and throughout the Arctic.

NSF-supported research also will address issues associated with environmental change that are of critical importance to people living in the North. These studies, sponsored jointly by NSF and NIH, will seek to determine not only what causes change and predicting it more accurately, but also how change allows infectious diseases to move into new areas where vulnerability is high because the people and wildlife will not have developed resistance to the novel pathogens that will be moving into these regions.

The third broad theme addresses changes in the Earth's great ice sheets, changes that could have profound impacts on global conditions including global sea level. Recent data indicate that the Greenland Ice Sheet is thinning at the edges but thickening at the center. Some ice streams draining the West Antarctic Ice Sheet have slowed while at least one other is accelerating. Relatively small changes in the mass balance of these ice sheets can raise global sea level significantly while complete loss of the West Antarctic Ice Sheet would raise global sea level by over five meters. Furthermore, a combination of ground-based, airborne, and satellite observations shows that surface melt water can penetrate the ice sheet at thicknesses of a kilometer and accelerate flow beyond previously suspected rates. Research supported by NSF, NASA and other agencies under this theme will combine with work supported by many other countries to develop a much more complete understanding of the behavior of these ice sheets and how changes in this behavior might evolve. The theme will also address further studies of ice sheet changes that occurred over geological time and the causes and effects of those changes.

The overall scientific impact of IPY will only become apparent through synthesis activity that brings together results from disparate research groups addressing different aspects of these broad themes. NSF recognizes the critical importance of funding workshops and related activities to that end, and will do so well beyond the end of the two-year IPY period.

The education focus has the potential to create a legacy for the decades, one that will benefit the Nation as well as the science and engineering community more specifically. By linking the public's fascination with things polar to outreach that conveys the excitement of research and discovery, we hope to attract a new generation of Americans into S&E careers while contributing to a more informed public.

With the jumpstart provided by the EHR/OPP FY06 solicitation, NSF will enter the IPY period well-placed to make major impacts during the ensuing two-year period. A multi-year outreach and education strategy will have substantially greater impact than one limited to a single year, while the international collaborations that can greatly enhance the reach and impact of NSF-supported research will also hinge on continued support.

While our outreach and education strategy will be focused on U.S. students, parents and families, we recognize that IPY also brings the opportunity to demonstrate to them how research and understanding can result when people from many nations work together on problems of global interest. The many international scientist-to-scientist collaborations now under development will help us carry that story to our public and to others around the world.

Indeed, part of the IPY impact will be the enduring partnerships established among scientists in the over 30 countries that have signaled their intention to provide funding for IPY activity. Countries around the world have seized on the 50 year anniversary of IPY–3/IGY to create a new legacy of scientific understanding and a new generation of scientists and engineers. We understand that Canada has committed $150 million over 6 years to its IPY effort, Korea—$150 million, Japan—$460

million for a new icebreaker, and China—$60 million for infrastructure and research. Among the EU commitments, one exceeds $30 million for a project closely linked to the U.S. IPY centerpiece addressing climate change in the Arctic.

The 1957–1958 International Polar Year culminated in an international meeting in Washington, called by the State Department, to frame what became the Antarctic Treaty. As President Nixon noted in 1970, ". . . the Antarctic is the only continent where science serves as the principal expression of national policy and interest." The State Department plans to host the annual meeting of the Antarctic Treaty Consultative Parties in 2009, which will spotlight the historic diplomatic achievement by the Treaty Parties 50 years ago. We expect this new IPY to create a further legacy of international partnerships in the interest of advancing scientific research and understanding.

The U.S. research community is poised to provide worldwide leadership throughout IPY, and NSF is committed to enabling that to the best of our ability.

Chairman STEVENS. Thank you, Doctor Bement. I'm sure we're going to see a lot of each other in the years ahead here now, but this is a very important function we're going to commence.

Our next witness is Vice Admiral Robert Papp, the Chief of Staff of the U.S. Coast Guard.

Admiral?

STATEMENT OF VICE ADMIRAL ROBERT PAPP, CHIEF OF STAFF, U.S. COAST GUARD

Admiral PAPP. Thank you, Mr. Chairman. Good afternoon. And, Senator Murkowski, good afternoon to you, as well. Thank you for including the Coast Guard in this hearing this afternoon. It's my pleasure today to discuss the Coast Guard's role in the International Polar Year.

I'd like to submit my full statement for the record and follow on with just a few brief comments.

Chairman STEVENS. Yes, all statements will be printed in full in the record. I noticed the others have abbreviated theirs, too, but we appreciate your courtesy.

Admiral PAPP. Thank you, sir.

The Coast Guard's committed to providing support to the scientific community during the IPY to make it a success. We've always maintained a presence in the Arctic, since 1867, when President Andrew Johnson dispatched one of our cutters to research and chart the waters of the Alaska coastline, while, at the same time, enforcing United States sovereignty and laws, and ensuring the safety of Americans in that newly acquired territory.

Coast Guard missions to support safety, security, and stewardship, as well as sovereignty in the Arctic and Antarctic, have been continuous and sustained over the decades. And in 1964, President Lyndon Johnson directed the Coast Guard to become the sole agency with responsibility for Federal icebreaking resources. That role was reaffirmed in 1990 by a Presidential declaration, and then validated recently in the Coast Guard Roles and Missions Study of 1999. Put simply, the United States Coast Guard has the authority, the experience, and the capabilities to support and sustain operations in the polar regions.

Now, in terms of capabilities, 50 years ago four Wind-Class Coast Guard icebreakers supported the U.S. efforts in the Third International Polar Year and International Geophysical Year. Coast Guard icebreakers also participated in the first Operation Deep Freeze, in 1956, which established U.S. presence on the Antarctic

continent. Today, one heavy icebreaker, the POLAR SEA, remains to support the U.S. Antarctic program resupply effort. Her sister ship, POLAR STAR, is in caretaker status, and would take up to 18 months to reactivate. One medium Coast Guard polar icebreaker, HEALY, remains to provide scientific and icebreaking support in the Arctic.

The Coast Guard is committed to working with the science community and other Federal agencies to provide the support needed to make the upcoming IPY a success. In accordance with our existing Memorandum of Agreement, we'll support the National Science Foundation and other agencies, as requested and as funded.

Thank you for the opportunity to testify before you today, and I'd be delighted to answer your questions.

[The prepared statement of Admiral Papp follows:]

PREPARED STATEMENT OF VICE ADMIRAL ROBERT PAPP,
CHIEF OF STAFF, U.S. COAST GUARD

Introduction

Good afternoon Chairman Stevens, Chairman Lugar, Senator Inouye, Senator Biden, and distinguished Members of the Committees. It is my pleasure to appear before you today to discuss the Coast Guard's role in the International Polar Year (IPY). The International Council of Science (ICSU) and the U.S. National Academies have stated that the goals of the International Polar Year (March 2007 through March 2009) are: to explore new frontiers in polar sciences; improve our understanding of the critical role of the Earth's polar regions in global processes; create a legacy of infrastructure and data for future generations of scientists; expand international cooperation; engage the public in polar discovery; and help attract and educate the next generation of scientists and engineers.

Fifty years ago, four Wind Class Coast Guard icebreakers supported U.S. efforts in the Third International Polar Year and International Geophysical Year. Coast Guard polar icebreakers also participated in the first Operation Deep Freeze in 1956, which established a stable U.S. presence on the Antarctic continent by forging a path through the challenging Antarctic ice belt, allowing a U.S. naval task force to establish permanent bases at McMurdo and the South Pole. Today, one heavy Coast Guard polar icebreaker, the Cutter POLAR SEA, remains to support the U.S. Antarctic Program re-supply effort; the other heavy polar icebreaker, the Cutter POLAR STAR is in caretaker status and could be available for use with approximately 18 months advance notice, due to extensive maintenance requirements. In the Arctic Region in 1957, the U.S. Coast Guard successfully sent the Cutters STORIS, BRAMBLE, and SPAR through the Northwest Passage to determine the feasibility of an emergency Defense Early Warning (DEW) line shipping support route. Today, one medium Coast Guard polar icebreaker, the Cutter HEALY, remains to provide science and icebreaking support in the Arctic.

Since 1956, the Coast Guard has been a regular presence in the polar regions. Significant historical events have been the catalyst that influenced national polar policy decisions. These events have included: the purchase of Alaska; World War II; the Cold War; the 1956–1957 International Geophysical Year; the Antarctic Treaty; and the oil crises of the 1970s. In addition to the planned IPY events, recent focus on issues such as the 1982 Law of the Sea Convention, increasing world-wide demand for natural resources, changing shipping patterns driven by a global economy, recent severe ice conditions in the Antarctic, and changes in Arctic sea ice have fueled U.S. debate on national polar policies and associated resource needs.

These recent and developing polar issues, coupled with U.S. interests in both polar regions, demand heightened awareness of our national polar missions. In particular, the United States must consider the increasing international initiatives in the Arctic. Thus far, the Arctic has witnessed a growing foreign polar presence in and more frequent and assertive international claims on the Arctic.

The National Science Foundation (NSF) has been tasked by the White House to provide leadership for the U.S. in the IPY. As the Federal agency charged with providing all U.S. polar icebreaker needs, the Coast Guard is committed to working with the NSF, the science community, and other Federal agencies to provide the support needed to make the upcoming IPY a success. The NSF and other Federal agencies have had general discussions with the Coast Guard about using polar ice-

breakers for the upcoming IPY, but have not made any specific requests outside of annually planned polar icebreaker activities in the Arctic and Antarctic.

Coast Guard Polar Icebreakers

The Coast Guard polar icebreaker fleet currently consists of the cutters POLAR SEA, POLAR STAR and HEALY. The POLAR SEA and POLAR STAR were built and commissioned in the 1970s and are nearly thirty years in age. The HEALY was commissioned in 1999 and has been actively supporting annual Arctic research deployments ever since. Unlike the older Polar class ships, HEALY was designed from the keel up as a science platform, with due consideration of Coast Guard multi-mission capabilities as well. Due to the harsh and remote polar environment and operating procedures for polar icebreakers, all of these vessels require durable marine engineering features in order to withstand years of colliding with sea ice (typically having the characteristics of concrete, found twenty feet thick or more, and at temperatures as low as negative 60°F). The unique environment in which polar icebreakers operate, coupled with their significant operating requirements, make the vessels inherently costly to operate and maintain.

Conclusion

The Coast Guard is committed to working with the science community and other Federal agencies to provide the support needed to make the upcoming IPY a success. In accordance with our existing Memorandum of Agreement (MOA), we will support the National Science Foundation, and other agencies' IPY efforts as requested and as funded. Thank you for the opportunity to testify before you today. I will be happy to answer any questions you may have.

Chairman STEVENS. Thank you very much, Admiral.

Mead, you say that there's already mapping going on, on the floor of the Arctic Ocean?

Mr. TREADWELL. Yes, sir. In fact, the mission that the HEALY was doing when the two crew members were killed this summer was a mapping mission. The Appropriations Committee has provided for that, for a couple of years now.

We actually believe that the United States should develop an overall mapping plan for the extended Outer Continental Shelf, and we're glad to be participating in a workgroup that the Department of State has had on developing this proposal.

The idea of having a claim available for—U.S. claim, under Article 76, Law of the Sea, is one of the drivers. A scientific driver is that it—while you've got the platforms out there, you're learning much, much more, as well.

We believe it's important to have the robust icebreaker platforms for this work, and, also, we've recommended reinstating the use of submarine platforms also to support this work.

Chairman STEVENS. Admiral, we're all familiar with the loss of your people up there, and we do express our regret about that. Is this—is Mead right? Were they part of a mapping program up there?

Admiral PAPP. Yes, sir, that's what they were involved in. They had to terminate that early, as you know, and return, to deal with the deaths of the crew members, and then return to home port for—to, sort of, recalibrate the crew. When that will be rescheduled, a continuation of that project, remains uncertain, at this time.

Chairman STEVENS. How expensive is that program of mapping, at this time?

Admiral PAPP. I'm not sure how much that program costs, sir. We get the money to operate the ship and take it out on the missions. NSF provides us the funding for that. And I'm not sure what the cost of that program is.

Chairman STEVENS. Now, have we outlined mapping the whole part of the Arctic adjacent to our State—Arctic Ocean adjacent to our State?

Admiral PAPP. I don't know that, sir. We've been dealing in parts of that. I think probably NSF has a better handle on that than we do.

Chairman STEVENS. What do you know about it, Dr. Bement?

Dr. BEMENT. Yes. Senator, there are cartographic activities under the AON initiative, and in order to do the whole survey of the Arctic Ocean, that would be a multi-year activity that wouldn't be completed during IPY, but there would be a good start. And that would be an important area of research to sustain in the years after IPY.

Chairman STEVENS. Well, let me apologize for my ignorance, but I would assume that could have been done digitally by the equipment we have. Do we have to have divers to do that? Admiral?

Dr. BEMENT. Well, I can't answer, on the operational aspects of how that would be done.

Admiral PAPP. No, sir, we don't have—the only reason we carry divers on our icebreakers is for emergency procedures. If there's something wrong, they become fouled in the ice, or if there are equipment problems, we can put down divers to inspect the hull, or, at times, if we have equipment—for instance, if we're using a remotely operated vehicle to do some sort of work underneath the ice, if there are some problems with the equipment, we can put our divers down for that. But the divers are provided only for emergency circumstances.

Chairman STEVENS. Mead—my last question—you assume that there's going to be some cooperation in preparing a proposed plan for this IPY, as it affects the Arctic, in general, and our state, in particular, as far as Federal agencies are concerned?

Dr. BEMENT. Yes, sir. We do have an updated plan. It's updated, as of September 18. And it includes activities in the Fiscal Year 2007 request. And we'd be glad to present that, for the record.*

Chairman STEVENS. I'd be pleased to have it. Have you made submissions on that, Mead?

Mr. TREADWELL. If you're talking to me—addressing me, Senator, the Arctic Research Commission, every other year, publishes a *Goals Report*. That *Goals Report* is referred to the Congress and the President, and then the Interagency Arctic Research Policy Committee takes that report and revises the 5-year Arctic Research Plan. The United States Arctic Research Program, we hope, basically runs against the plan that the IARPC prepares.

In my written testimony, Senator, I referred to five key goals that were in our last *Goals Report* that were in the plan, two of which are very good programs underway, the SEARCH program and the BEST program, which is just getting started. You'll hear, from Dr. Parkinson later this afternoon, about the first, really, interagency initiative on health. And we're seeing some gaps in the others. But I can say, just as an affirmative answer to your question, we are hoping that by the time we bring a *Goals Report* back

*The information can be found at *http://www.nsf.gov/od/opp/ipy/ipy_rept_us_fed_agency_planning.pdf*.

to the Congress this winter, that that will stimulate a discussion of legacies of IPY throughout the Government.

Chairman STEVENS. Well, when did you submit the last *Goals Report*?

Mr. TREADWELL. The last *Goals Report* was submitted probably the end of January 2005.

Chairman STEVENS. Thank you.

Senator Murkowski?

Senator MURKOWSKI. Thank you.

Admiral, I just want to make sure that I understand the situation with the icebreakers. You say the POLAR STAR is in this caretaker status. So, for purposes of this upcoming IPY, we can assume that it will not be available for any research that might be associated. Is that correct?

Admiral PAPP. We have no plan for it to be available, Senator. It's laid up right now, and our estimate is it would take probably up to 18 months to reactivate the ship, at a cost of probably about, roughly, $25 million.

Senator MURKOWSKI. And then, the POLAR SEA is the one that will be available down in the Antarctic. So, would that be available at all in the Arctic regions, or is that exclusively down south?

Admiral PAPP. POLAR SEA's mission tasking is going to be for the Antarctic resupply mission, and she has had some money put into her to extend her anywhere from about 4 to 8 years. We did the sustainment repairs that we would—that I was talking about for the POLAR STAR. We accomplished that on POLAR SEA. That should keep her running at least 4 to 8 more years. And we envision her primarily used for the Antarctic resupply mission.

Senator MURKOWSKI. So then, for any IPY activities in the northern region, what we're looking at as the only available icebreaker, then, is the HEALY? And will they be able to handle anything that comes to them, as directed by NSF?

Admiral PAPP. Yes, ma'am. That's the standard operation for the HEALY, is the Arctic operations in support of NSF. HEALY's back in port now, will be going through some minor repairs and a drydocking in the upcoming months, and then we'll prepare it for the next season, and she will be devoted solely to the support of NSF and the IPY.

Senator MURKOWSKI. OK, thank you.

Doctor, in your testimony—and both you and Mr. Treadwell both spoke to the legacy of IPY, and this is something that—I really look forward, Mead, to the report coming out, and further discussion about the specifics of the legacy and how we make this happen, because it's one of those things—we do great research, we have great things happening, but, at the end of the International Polar Year, everyone's done and goes off on their respective ways. We want to know that the legacy is in place, whether it's through the socioeconomic effect on some of our indigenous people, infrastructure, whether it's roads or facilities. We want to see that. And, Doctor, you've spoken to the educational legacy and an effort underway now to do an education and public outreach. What types of programs is NSF looking at right now for purposes of funding? And what kind of prioritization do you go through for that?

Dr. BEMENT. Well, we give this very high priority. I can talk about what NSF has currently funded, but I should also point out that we're coordinating activities with other Federal agencies, so that's—the overall effort will be larger than what I'll represent. And I should also point out that this is also international in scope, so our international partners are also involved. In fact, almost all the grants that we have issued to date have strong international participation. But we issued nine grants, based on a current solicitation this year, to jumpstart public outreach and education four are in the area of informal education that would involve museums, the media, bringing the experience of polar research into the classroom and into the home. Three of them are in formal education, at the graduate and undergraduate level, that deal with the development of new courses and also involving broadening participation of minorities. Two of them are in the K–12 area and will involve students and teachers actually working with researchers in both the Arctic and the Antarctic. And some of this work will be brought to bear on teacher training, teacher involvement, broadly. And so, we think that is a good spectrum of activities to begin with, but I should point out we'll be doing a second solicitation next year, and we expect to have an additional spectrum of activities that will deal with both public outreach and education.

Senator MURKOWSKI. What efforts will be made to make sure that you are working with the Alaskan native community?

Dr. BEMENT. Almost everything that we do in Alaska, from a research point of view, and also from the social studies point of view, will involve Native Alaskans. I should mention another project that we have with the National Endowment for the Humanities, which is focused on capturing endangered languages. There are about 52 native languages in Alaska, and half of those will disappear in another year or two. So, we're working very actively—in fact, I think we have a grant with the University of Alaska in Anchorage—to help not only document those languages, but understand the culture and the history that's embedded in those languages.

Senator MURKOWSKI. Well, we recognize that we have some challenges in education, the traditional education, particularly out in some of our remote areas, and to know that you can make science come alive, that you can make languages come alive by the kids being the researchers, the kids being the scientists. I mean, I think we've got some opportunity here to help you, but to also help so many in our State.

It has been mentioned, certainly by Mead, and by you, as well, the reality of multiple agencies, and then you throw in over 60 different countries that you're dealing with. Can you let me know how we're doing, in terms of the interagency cooperation? Is it working? What do we need to be doing to make it flow better, if it's not flowing well?

Dr. BEMENT. Well, today we've had several high-level meetings. One meeting at the policy level was held last year. And it was during those meetings that we began to formulate the identification of all the activities that each of the agencies are going to be engaged in and begin cross-correlating, through interagency cooperation, to see that we get highest leverage of those activities, especially to—with regard to the two major activities identified by the Arctic Re-

search Commission—namely, the AON, the Arctic Observing Network, and also the Bering Ecological Study, of the Bering Sea. Those two are very critical. And its not only important that we get a good start during IPY, but we also advocate for sustainability of those activities so that they become stronger over time.

Senator MURKOWSKI. Again, going to that legacy concept that everyone's talking about.

Mr. Treadwell, you had mentioned in your testimony some of this fragmented funding and some of the issues associated with that. We certainly look forward to this unified Arctic research budget. I think that will certainly help. I think getting this *Goals Report,* as it comes due, is going to be—going to be very important for all of us. But as far as the funding issues that you have mentioned, you have—perhaps it's just politically correct language, but in your testimony, you say, "a level of funding and participation appropriate to the Nation's leadership in polar research." Do you have any idea what you figure the appropriate level might be?

Mr. TREADWELL. Well, Senator Murkowski, I don't have a specific number in mind. I don't think the Commission has discussed a specific number. And, in fact, if you track the number that IARPC has collated for Arctic research over the past several years, the Arctic research budget level of the Government has grown, it's now approaching $400 million.

Where we're concerned—and, as I mentioned in my testimony—we're concerned that some of the goals that were adopted last time, after our *Goals Report* two years ago, haven't been funded as yet, and also that some of the programs—I mean, there is a general concern in the science community that NOAA, by closing its Arctic office, so to speak, is moving in the wrong direction.

Senator MURKOWSKI. Is NOAA's perspective, if you will, that it's a funding issue, and it's not for lack of interest in the Office of Arctic Research?

Mr. TREADWELL. I don't think it's for lack of interest. I mean, the jobs that NOAA has taken on are tremendous. They basically coordinate the international work on the AMAP program through the Arctic Council, the monitoring program. They are responsible for this mapping project that we talked about, all of the funding for the Barrow Climate Change Research Facility that—you know, I expect you to be involved in a ribbon-cutting for that sometime this spring—is coming through NOAA. The—NOAA is responsible for the—I believe it's the RUSCALA program, but—the U.S./Russian cooperation on studies in the Bering Sea, which is a very important window, given the access problems that all of our researchers have with Russia. And to have all of these NOAA responsibilities that they've taken on, and they're appropriately taking on, at the same time to see the budget reductions, is just a difficulty.

Senator MURKOWSKI. Well, then how do we get these agencies, whether they're NOAA or whether it's NASA, to get excited about what we've got going with the potential for IPY so that they are able to move forward with those goals that have been set out?

Mr. TREADWELL. I think we can both ask.

Senator MURKOWSKI. We'll keep asking.

You mentioned the kickoff for the International Polar Year for March 2007. And, Doctor, this might also be a question for you. Do

we have anything planned for the kickoff? Is there anything that we're looking at doing? Should we be focusing on that right now? That's coming up soon.

Dr. BEMENT. The one thing that we're trying to schedule, at the present time, is a White House event on or at the time of the beginning of IPY, which will be next March. We would also like to have major events both at the—in the Arctic and the Antarctic, and certainly in Alaska. We would like to be involved in a kickoff in Alaska.

I should also mention, going back to the Barrow Global Climate Change Research Facility, we recognize the importance of that facility to support researchers who are going to be doing research in that area, especially in connection with AON, and their greatest need is going to be for cyberinfrastructure and also for communications and data management tools, because the amount of data that's going to be generated in the Arctic is going to be enormous, especially in Alaska. So, we have put in change orders during the construction of the building to incorporate cabling and other facilities, so that at the time we put in the cyberinfrastructure and also broadband communications, the building will be fully equipped for that.

Senator MURKOWSKI. Well, we've been given a copy of a picture here of the Army Signal Corps building, built for the first IPY, in Barrow, in 1888.

Dr. BEMENT. Yes.

Senator MURKOWSKI. Hopefully it looks better than what we've——

Dr. BEMENT. No, that has been——

Senator MURKOWSKI.—were able to produce in 1888.

Dr. BEMENT.—has been fully renovated, and I've been in that building.

Senator MURKOWSKI. Yes. Well——

Mead, one last question for you. You raised the issue that we really haven't updated our Arctic policy in over a decade now, a decade-plus, and it's an issue that I have been trying to raise to a level here where we can have a discussion about Arctic policy. But, oftentimes, I get looked at by other Senators or other colleagues and say, "Well, I'm from Alabama, or Arkansas, or Iowa. Why do I care about Arctic policy?" And I think what is happening—we're on the verge of pushing forward with IPY—is an awareness that the issues in the Arctic are not just isolated to the north, and then, of course, down to the south, in the Antarctic. So, I'm hopeful that one of the things that we will accomplish with this IPY is an understanding as to this—you talk about the connectedness of the Arctic, I think we also need to look to the connectedness of the Arctic to the rest of the world. And if you want to just take a minute and speak to that——

Mr. TREADWELL. Well——

Senator MURKOWSKI.—I'd appreciate your thoughts.

Mr. TREADWELL.—since 1994, the last time the Arctic policy interagency process produced that kind of a document, a Presidential Decision document, it was just at the beginning of the Arctic Council process. In fact, the Arctic Council hadn't been formed, as yet. We had the beginnings of circumpolar cooperation with the

Arctic Environmental Protection Strategy. And, since then, we've had a robust Arctic Council process, a robust northern forum process. The kinds of activities in this whole panoply of research activities with IPY will reflect not just geophysical science, which is extremely important, but also the social science that you talked about. So, we have a much more developed Arctic community.

The change in the Arctic since then—that statement really did not address climate change, it didn't address the opportunities or the problems of climate change in the Arctic, and the opportunities are numerous. It's not just climate change, but technology, which is going to make the Arctic Ocean much more accessible. And if you think about it, an accessible Arctic Ocean that has changes in boundaries coming with—Article 76 of the Law of the Sea Treaty, has varying claims. The Russians have claimed 45 percent of the Arctic Ocean under that, that hasn't been adjudicated, as yet. It's important for the United States to sit down and assess what it is. And I can think of no better time, the Commission can think of no better time, than during this IPY process to chew on these policy issues at the same time.

So, with that, coming out of the other end we may find more important commitments to science, the legacies that we've talked about. You have a very tough policy decision on the platforms, including the icebreakers, which—the report that just came out this afternoon, issues of how much the United States wants to promote transportation in the Arctic Ocean. And these are the kinds of things that should be considered.

Senator MURKOWSKI. Doctor?

Dr. BEMENT. Yes, if I may address your question. NSF supports about 20 long-term ecological research sites, which include Lake Toolik, Bonanza Creek in Alaska, but are distributed across the United States, all the way to Puerto Rico. And the purpose of these ecological research sites is to look at ecological change, especially with regard to climate change and other changes in the environment. Those sites, collectively, will be able to determine how the changes in the Arctic will ripple through the U.S. over time. Admittedly, the changes are most dramatic and most easily seen in the Antarctic, not only with regard to the flora and the fauna, but also with regard to insect infestations, as you're well aware of, the spruce bark beetle. But also the spread of infectious diseases and the response of people who have not normally been exposed to these types of diseases, as warming occurs, as these viruses and so forth move north.

So, all these things are part of our ongoing study involving the ecology.

Senator MURKOWSKI. Mr. Chairman, I could probably spend the rest of the afternoon with these three, but I know that we have an equally distinguished second panel, so I'm done with my questions.

Thank you.

Chairman STEVENS. Thank you very much.

Staff just gave me this. This is a planning document from the Office of the IPY. And it lists studies for—related earth, land, people, oceans, ice, atmosphere, space, and education, and outreach. I mention it, because I had a personal letter from my old friend, the Di-

rector of the International Arctic Research Center in Fairbanks, at the university. And I'll print the whole letter in the record.

[The information referred to follows:]

INTERNATIONAL ARCTIC RESEARCH CENTER—UNIVERSITY OF ALASKA FAIRBANKS

Fairbanks, AK, September 14, 2006

Hon. TED STEVENS,
Chairman,
Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

Dear Ted:

The idea of an International Polar Year (IPY) started as a celebration of the 50th anniversary of the International Geophysical Year (IGY) (1957–58), which was the largest geoscience enterprise in history at that time. Sydney Chapman, who was my professor during my Ph.D. student days, was the President of the IGY, and I am one of the few "survivors" (still active) of that event. By working alongside Professor Chapman during that period, I learned what it took to make the IGY successful. Government support was necessarily easy.

From the beginning of the preparations for IPY, I have voiced my opinion that the 2007 IPY is a rare opportunity for polar researchers to demonstrate publicly that they are *combining* their talents for studying a few crucial problems of the present global warming, which is one of the major concerns of the people of the world. In this way, we would gain a better understanding of climate change and also the support of the people.

To be specific in terms of science, Arctic researchers should work together in distinguishing between natural components and manmade components in the present climate change; this is one of the most difficult scientific problems. I am not saying that because this is precisely what IARC is working toward but because, without succeeding in this work, it is not possible to reduce uncertainty of climate change prediction.

I believe that the IPY needs a few, focused projects. Unfortunately, the present trend appears to be that individual Arctic scientists want to satisfy their own curiosity by expecting special funding for the IPY. Such projects are undoubtedly important, too, but we would lose the rare opportunity for combining many talents in pursuit of specific and focused programs.

When I expressed this opinion recently, one of the most respected climatologists, John Walsh, who is Chief Scientist of IARC, called it "excellent," saying that my written opinion saved him the time of writing the opinion himself.

With best regards,

SYUN AKASOFU,
Director.

Chairman STEVENS. But Dr. Akasofu says this, "I believe that the IPY needs a few focused projects. Unfortunately, the present trend appears to be that individual Arctic scientists want to satisfy their own curiosity by expecting special funding for the IPY. Such projects are undoubtedly important, too, but we would lose a rare opportunity for combining many talents in pursuit of specific and focused programs."

What do the three of you think about that comment?

Dr. Bement?

Dr. BEMENT. Well, I have a high regard for Dr. Akasofu. We do communicate. I would remind him, however, that all of our projects are merit-reviewed. We pick the best of the best. And he happens to be one of them, in the work that he's doing at IARC. So, I think that the statement is a bit extreme, but we do pay attention to those details.

Chairman STEVENS. Well, do we need some special—some broad-gauge projects that encompass a series of studies, or are we going to just pick individual studies, as we can afford them?

Dr. BEMENT. Senator, we have some of both, and I think you'll hear, in the next panel, some of the activities that we are funding at the University of Alaska at Fairbanks that are focused and involve multiple investigators. And those investigators are collaborating with other investigators throughout the United States. The broader-gauged programs that are interagency and multinational tend to be the Arctic Observing Network and the Bering Ecology—Ecological Study.

Chairman STEVENS. Well, we're going to be very interested in this. And it does get subjective. Before I came here, I had a visit with—from three members of the Alaskan Native community from the West Coast, three separate villages. And they wanted to know what we were going to do to try and deal with the causes of the change that they see, that many of them have great fear of today.

Dr. BEMENT. Yes.

Chairman STEVENS. We know that some of them have already been impacted by enormous waves and storm conditions. But they also see changes, in terms of the habits of the wildlife, of the growth of trees, and other plants in the Arctic area, and they see the permafrost thawing. So, they want some answers. And I'm not sure how the IPY is going to function into getting some of the answers to their questions—the people most affected by the change we know of, in terms of our country. And I think their questions are similar to those that would be in Siberia and others areas of the Arctic throughout the world. Are we going to find a way to try to do both, to look into the long-range science and, at the same time, try to get some answers for the people who are affected now?

Dr. BEMENT. The answer, Senator, is yes, we have involved Native Alaskans in our studies. I have personally talked with elders at Barrow. I understand their concerns. I understand the trauma of trying to adapt to change that they're facing, especially with regard to movement and hunting and whaling. The answers to some of those issues are not going to be short term, necessarily, but we are focused on dealing with climate change through our SEARCH programs. And, of course, that's what the AON is all about, in order to make those measurements on a regional basis. And we are also interested in the effects of ice sheet stability, on the possible climate change, as well as ocean rise, over time. We have a fair amount of data, working with NASA, on the recession of ice coverage in the Chukchi Sea and also in the Beaufort Sea, and we'll be able to continue to measure that over time. And that will affect the fetch of—caused by storms. It will contribute to coastal erosion. We understand some of those processes now. We'll be able to add more information as time goes on.

In addition to that, we are looking at the effects of extreme environments, especially the cold and the dark in the Arctic regions, on the ecology, as well as on life forms. And there are, in addition to that, social studies that will involve not only individuals, but also communities to examine the issues that have, with adaption to change among these—they used to be nomadic, they're less nomadic now—but, nevertheless, this is a community that has learned how to adapt, over time. And we have to maintain very close communication with that—with those native populations.

Chairman STEVENS. Well, thank you very much. We thank all—the three of you.

We're going to turn to the second panel now, if we may. It's Dr. Robin Bell, Dr. Buck Sharpton, Dr. Alan Parkinson, and Dr. Thomas Armstrong.

Thank you very much for coming, the first panel.

[Pause.]

Chairman STEVENS. Thank you very much. Our first witness in this panel is Dr. Robin Bell. She's Chairwoman of the Polar Research Board for the National Academy of Science, and Chairwoman of the USIPY Planning Committee.

Thank you for coming, Dr. Bell.

STATEMENT OF ROBIN E. BELL, PH.D., DOHERTY SENIOR RESEARCH SCIENTIST, LAMONT-DOHERTY EARTH OBSERVATORY, COLUMBIA UNIVERSITY; CHAIR, POLAR RESEARCH BOARD, U.S. NATIONAL COMMITTEE FOR INTERNATIONAL POLAR YEAR, DIVISION ON EARTH AND LIFE STUDIES, NATIONAL RESEARCH COUNCIL, THE NATIONAL ACADEMIES

Dr. BELL. Good afternoon, Senator Stevens and Senator Murkowski. Thank you very much for inviting me to speak about the International Polar Year, which I see as a scientific opportunity of a generation, for our Nation, for our society, and for our planet.

I'm a geophysicist at Columbia University Lamont-Doherty Earth Observatory, where I run major programs looking at the stability of ice sheets and looking at subglacial lakes. So, that's my passion, in terms of trying to understand our planet. And I've been active in planning for the International Polar Year, both nationally and internationally, since the inception of the idea.

You may wonder why—in this era of instant communications, why the scientific community has gotten excited about a strategy that was developed 100 years ago, when maps of both poles were empty, blank. We didn't even know if there was a continent in the middle of the Arctic Ocean. You wonder if we're arguing about what it looks like now; then, we still thought there might be a continent sitting on top of the North Pole. And our cutting-edge communication was the telegraph. But, even though the maps are much richer today, the scientific community is still motivated by our need to understand our planet, as a whole.

While environmental change and variability are part of the natural pattern on Earth, the environmental changes currently witnessed in the polar regions are generally much more pronounced than they are elsewhere in the world. The Arctic Ocean sea ice is thinning. The ice shelves in Antarctica, in some cases, are retreating and thinning. Glaciers are shrinking, and ecosystems, as you know, are changing. These changes have impacts locally and globally. Alaskan villages have been moved. Permafrost is thawing and undermining roads. Environmental change and rising sea level is really of impact globally, even though it's at the poles. So, that's one of the tremendous motivators, is the scientific community is very concerned and wants to understand what's causing the change in our planet.

Now, although we made tremendous progress in the last year in coloring in those maps—those last hundred years—there are still tremendous frontiers at the edges of scientific knowledge. The maps aren't blank anymore, but the frontiers and the unknowns have grown. They're no longer just spatial and geographic, but they're actually at the molecular and, still, at the continental scale. They're fundamental unknowns.

Through the planning process begun at the National Academy, we've identified five major challenges. The first is to assess the large-scale changes that are happening in the polar regions. The second is to conduct scientific exploration of these new frontiers, whether they're molecular or continental. Third is to observe the polar regions in-depth, with adequate knowledge, so we can look at what's causing the change. The fourth is to understand the human/environment dynamics in an environment where the interaction is very intimate. And, finally, we want to create a new connection between the science and the public.

And that's one of the major differences between this IPY and the earlier IPYs, is the recognition that the physical world and the biological world and the human society are intimately interrelated. The upcoming IPY is inherently not just about science, but science in support of human interests.

As you saw before, as you were holding up, Senator Stevens, this is the present international map of the 225 projects that highlights the geographic and discipline breadth of the IPY. And while this looks a little overwhelming, this represents 63 nations and 6,000 scientists. So, this is really the global view. And it's broken down so you can understand the breadth, both discipline-wise and geographically, of this International Polar Year. It provides an illustration of how their projects have crossed both poles, crossed the disciplines, and crossed the nations. Each cell is a major program with an international team of scientists working together and producing a tremendous multiplicative effect, far more than we would if it was simply funded through our classic national funding process.

The net result will be a huge leap forward in our understanding of polar processes—physical, biological, and social—and the global connections.

Planning's proceeding, as you've heard today, at a rapid pace with the official kickoff coming in March 2007. And there are a couple of potential requirements that must be met if it's going to meet the expectations. I think we need to see a broadening and deepening of participation of the agencies, increase in the level of funding, increase the coordination, nationally and internationally, and fostering the interdisciplinary work. How do we draw the linkages between these columns? These issues are things that must be addressed for a vibrant and successful International Polar Year.

In conclusion, I just want to address your questions about what the societal benefits of the International Polar Year are going to be.

Just as these science programs are multifaceted and multidisciplinary, so are the benefits. It will advance our fundamental understanding of our planet, from the polar ecosystems to subglacial terrains. It will improve our understanding of the processes of change and that complex double-edged sword of how society is influencing

change, and how change is influencing society, especially to the inhabitants of the North. It will inspire a new spirit of discovery across ages, and help us develop the next generation of leaders in science, engineering, education, industry, commerce, and, we hope, government.

At the international level, it'll show, again, even in the most difficult times, that science can be a powerful arena for international cooperation. Why should much of our Nation, who primarily live in the warmer part of our Earth, care about IPY? They think of the polar regions as being physically distinct, and they don't understand the critical links to the global climate system. I like to think of this simple experiment that you can do—or you can just do in your mind, I can do right now. Imagine holding an ice cube between your thumb and your forefinger. As you hold it, your finger starts to melt the ice cube, and you quickly feel the water dripping down across the ice cube and down your hand. That's what the poles are like. We know the poles are changing, but, as the poles change, it impacts the rest of our planet, the rest of the ice cube. We don't actually understand. And what we hope to understand is what's causing the warming fingers on our planet. But on our planet, the poles are causing the ocean currents to change—that's what's keeping Europe warmer, presently. And the sea ice is what modifies much of the climate as it reflects the solar energy back. Melting the ice sheet will raise sea levels, threaten coastal communities around the world. Polar regions are integral parts of the Earth system and will respond to, and drive, changes in the planet elsewhere.

So, from assessing large-scale environmental change to exploring the new frontiers, the International Polar Year is a scientific opportunity of a generation.

Thank you very much for your time, and I'm happy to address any questions you have.

[The prepared statement of Dr. Bell follows:]

PREPARED STATEMENT OF ROBIN E. BELL, PH.D., DOHERTY SENIOR RESEARCH SCIENTIST, LAMONT-DOHERTY EARTH OBSERVATORY, COLUMBIA UNIVERSITY; CHAIR, POLAR RESEARCH BOARD, U.S. NATIONAL COMMITTEE FOR INTERNATIONAL POLAR YEAR, DIVISION ON EARTH AND LIFE STUDIES, NATIONAL RESEARCH COUNCIL, THE NATIONAL ACADEMIES

Good afternoon. Thank you very much for inviting me to speak about International Polar Year 2007–2008. The International Polar Year (IPY) is the scientific opportunity of a generation for our Nation, for our society, and for our planet.

My name is Robin E. Bell, Ph.D. from Columbia University's Lamont-Doherty Earth Observatory, where I am a Doherty Senior Research Scientist. I am a geophysicist by training and at Columbia I lead major geophysical programs on the stability of ice sheets including subglacial lakes. I also direct Columbia's NSF sponsored ADVANCE program, aimed at recruiting and retaining women in science. I was the first woman to lead a major aerogeophysical program from the Antarctic continent, and this has been the focus of much of my research for the past two decades.

In addition to my research, I chair the National Research Council's Polar Research Board, which acts as the national coordinating committee for IPY. The Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine, chartered by Congress in 1863, to advise the government on matters of science and technology. I served as the Co-Chair of the International Council for Science's (ICSU) initial IPY Planning Group, and I currently serve as a member of the ICSU-World Meteorological Organization (WMO) Joint Committee for IPY, the main international planning group.

Today I will provide an overview of why IPY is happening and why it's important to us here in the United States. What has motivated more than 5,000 scientists from some 63 nations to decide to participate in a year devoted to polar studies and education? I'll highlight the major science questions that will be addressed, outline the role that U.S. scientists and science managers have been playing developing IPY, and conclude with thoughts on the many societal benefits that can result from the IPY.

In this era of instant communications and global connectivity, it might seem surprising that the global scientific community is so excited by a scientific strategy that was developed more than 100 years ago. Because it was indeed back in 1882–1883, that the idea of holding a focused, internationally-coordinated year of polar research—an International Polar Year—was first developed. At that point in history, the poles were blank white spaces on maps, and the cutting edge communications technology was the telegraph. The decision to coordinate with other nations rather than compete, and to focus on research to understand polar phenomena rather than acquisition of territory, was something new and exciting. That first IPY in 1882–1883 and subsequent ones in 1932–1933, and the International Geophysical Year (IGY) in 1957–1958, drew great minds and generated great leaders; these "international years" set a precedent of cooperation in science that, while innovative at the time, is considered the norm today.

Today's scientists are similarly motivated by society's need for integrated global knowledge. There is still a fundamental human need to push the limits of our understanding about polar phenomena. The polar regions are integral components of the Earth system. As the heat sinks of the climate system, they both respond to, and drive, changes elsewhere on the planet. While environmental change and variability are part of the natural pattern on Earth, the environmental changes currently witnessed in the polar regions are in many cases more pronounced than changes observed in the mid-latitudes or tropics. The Arctic sea ice cover is decreasing; some ice shelves in Antarctica are retreating and thinning; glaciers are shrinking; and ecosystems are changing, for instance, with plants flowering at earlier times. These changes are having human impacts: some Alaskan villages have been moved to higher ground in response to rising sea levels, and thawing of permafrost is undermining roads and buildings in northern communities around the world. We must understand the implications of environmental change for the future of our global society.

Although we've made tremendous progress in all science over the past 100 years, the polar regions are still at the frontiers of human knowledge. The maps aren't quite as blank, but the frontiers and unknowns have actually increased, and range from the molecular, to the ecological, to the continental. How is it that certain microbes can survive at minus 2 degrees Fahrenheit, that certain nematodes live even when ice forms in their cells, that polar fish species have evolved with an antifreeze protein in their blood? What will happen to the unique under-ice ecological communities of the Arctic, which are the base of the Arctic food web, as ice conditions change and new species arrive from southern waters? In just the last 10 years we discovered more than 150 subglacial lakes that exist under the ice in Antarctica. These range in size from something similar to the reflecting pool on the Mall to a lake the size of Lake Ontario. Why are these lakes important? They are thought to contain exotic ecosystems; the water in these lakes is part of the subglacial plumbing system that can be thought of as the lubricant that makes the ice sheet flow faster.

At its most fundamental level, IPY 2007–2008 is envisioned to be an intense, coordinated field campaign of polar observations, research, and analyses that will be multidisciplinary in scope and international in participation. IPY will provide a framework to undertake projects that normally could not be achieved by any single nation. It allows us to think beyond traditional borders—whether national borders or disciplinary constraints—toward a new level of integrated, cooperative science. A coordinated international approach maximizes both impact and cost effectiveness, and the international collaborations started today will build relationships and understanding that will bring long-term benefits. Within this context, IPY will seek to galvanize new and innovative observations and research, while at the same time building on and enhancing existing initiatives. IPY will serve as a mechanism to attract and develop a new generation of scientists and engineers with the versatility to tackle complex global issues.

In addition, IPY is clearly an opportunity to organize a range of education and outreach activities designed to excite and engage the public, with a presence in classrooms around the world, and in the media in varied and innovative formats. The IPY will use today's powerful research tools to better understand the key roles of the polar regions in global processes. Automatic observatories, satellite-based re-

mote sensing, autonomous vehicles, Internet, and genomics are just a few of the innovative approaches for studying previously inaccessible realms. IPY 2007–2008 will be fundamentally broader than past international years because it will explicitly incorporate multidisciplinary and interdisciplinary studies, including biological, ecological, and social science elements.

IPY 2007–2008 is an opportunity to deepen our understanding of the polar regions and their global linkages and impacts, and to communicate these insights to the public. IPY planners have identified five broad scientific challenges:

- Assess large-scale environmental change in the polar regions, with questions looking at both the physical and human dimensions of change and its impacts.
- Conduct scientific exploration of "new" frontiers, whether these are once inaccessible places beneath the ice sheet, or areas of inquiry that are now open because of advances in technology, such as how the tools of genomics now allow exploration of previously unanswerable questions about biological adaptation.
- Observe the polar regions in depth, with adequate coverage of the vast and challenging landscape, to provide a description of current conditions and allow for better future understanding of variability and change.
- Understand human-environmental dynamics in a region where the connections are intimate and where the impacts of change are clear.
- Create new connections between science and the public, using these regions that are inherently intriguing.

Previous IPY efforts were characterized by very top down planning and generally driven by the military. For example, under the oversight of Abraham Lincoln's son, Robert Todd Lincoln, then head of the Department of War, the U.S. participation in the first IPY in 1882–1883 was led by the Army. The science priorities for our upcoming IPY, on the other hand, emerged from grass roots planning, international scientific groups, U.S. agency input, and help from the U.S. National Academy of Sciences and National Academy of Engineering.

Beginning in 2002, the National Academies became involved in a serious dialog about whether there should be another International Polar Year (following in the tradition of the year held in 1882–1883, 1932–1933, and 1957–1958) and whether it would be advantageous to participate. We began talking with colleagues around the world to judge international interest, as well. Here in the U.S., the Chair of that first planning effort was Dr. Mary Albert of the Army's Cold Regions Research and Engineering Laboratory. She led a committee that sought wide input on whether the U.S. should participate in IPY and, if so, what we should hope to accomplish. The Committee led a series of web discussions, gave talks at numerous professional meetings, wrote an editorial for *Science* magazine (included as an attachment), met with agency leaders, hosted a multi-day workshop, and compiled contributions from 13 Federal agencies into an initial planning document. The report, "*A Vision for International Polar Year 2007–2008*" was released in 2004, and came to be the foundation for much of the international planning as well. (A summary of this report is attached to my testimony.) This early involvement put the U.S. in a leadership role in planning the IPY internationally.

One of the major differences between the first two IPYs and IGY and our upcoming IPY 2007–2008 is the recognition that the physical world, and the biological world, and human society are intimately interrelated. This upcoming IPY is inherently about not just science, but science in support of human interests. It includes work in engineering, medicine, sociology, and human-environment interactions. The so-called "honeycomb diagram" (attached) highlights some 225 large groupings of projects that illustrate the geographic and disciplinary breadth of IPY 2007–2008. Each cell represents a major program with many participating projects involving international teams of scientists. Working together, this research will produce a tremendous leap forward in our understanding of polar processes (physical, biological, and social) and their global connections.

Of the 225 projects, the U.S. plays a leadership role in 52 projects (20 percent) and is participating in 80 percent. Right now, everything is still conceptual—what will actually happen on the ground is still being determined, both here and in other nations. Significant planning efforts are occurring in each of the participating nations; in addition, there is an international IPY Programme Office, staffed by Dr. David Carlson and hosted in Cambridge, England, by the British Antarctic Survey. There is also an international planning committee, called the Joint Committee, of which I am a member, and subcommittees devoted to data management, observation systems, and education and outreach.

Although planning for IPY started with the scientific community, all the Federal agencies with cold regions responsibilities are having roles in implementation. When

the National Academies hosted a workshop to encourage agency coordination in 2004, 13 agencies participated. At the request of the White House, the National Science Foundation is serving as the lead Federal Agency. (In Alaska, the University of Alaska Fairbanks has stepped forward as the state-wide leader.) NSF has shown real leadership in its role, holding interagency planning meetings, creating a multi-agency website, and starting the process of soliciting proposals for the actual on-the-ground research and education and outreach activities. (In fact, last week NSF announced the first of the education and outreach activities to be funded, and these provide an excellent first glimpse at the kinds of exciting activities that will occur.)

The National Academies continues to provide coordination through the Polar Research Board, which acts as the U.S. National Committee for IPY. The Polar Research Board focuses on communication and coordination, in particular interacting with other nations and the international Programme Office, communicating what's happening in the U.S. science community, encouraging U.S. agencies to participate, and looking for ways to bring other partners into IPY. For instance, as part of its coordinating role, in early October, the Polar Research Board will host a meeting of the heads of IPY secretariats so that the staff working behind-the-scenes on IPY have an opportunity to coordinate.

Planning for IPY is advancing at a continued, rapid pace, with the official kick-off coming in March 2007. But there are some potential requirements that must be met if the IPY is to meet expectations.

1. Broaden and deepen the participation of the agencies. NSF is doing a stellar job leading and coordinating efforts, but other key agencies with polar interests remain less engaged.

2. Increase the level of funding. The programs outlined in the Vision document require a significant investment of funds both to NSF and other Federal agencies.

3. Enhance coordination nationally and internationally. Early IPYs were directed by the military. Today's grass-roots approach provides great flexibility and innovation, but frankly is more difficult to coordinate.

4. Foster multi-disciplinary work. While in the 1950's science was very discipline-based and that met the needs of the times, today's biggest scientific and societal challenges require a more complex, systems-based approach.

These issues must be addressed to ensure a vibrant and successful International Polar Year.

In conclusion, I want to think ahead about the societal benefits of the International Polar Year. Just as the IPY and the emerging science programs are multi-faceted and multi-disciplinary, the benefits of the IPY will be multifaceted and multidisciplinary. The IPY will advance our fundamental understanding of our planet—from polar ecosystems to subglacial terrains. The IPY will improve our understanding of the processes of change, and that complex double-edged sword of how society is influencing change, and how change is influencing society—especially the inhabitants of the north. The IPY will inspire a spirit of discovery across all ages, and help us develop the next generation of our Nation's leaders in science, engineering, education, industry, commerce, and government. At the international level, IPY will again show that even in the most difficult times, science can be an arena of international cooperation. IPY will foster the continued peaceful use of the polar regions, engage new partners in the global science community, and leverage precious scientific and logistical resources so that, in essence, we get more from our investments.

Why should the vast majority of us, who live in the warmer regions of the Earth, care about IPY? The polar regions, while physically distant, are critical links in the global climate system. Does this matter for the rest of the planet? Imagine holding an ice cube between your thumb and your forefinger. Beneath your fingers a pool of water forms quickly. The water will drip down your arms and down the ice cube. The changes at the end driven by the warmth of your fingers are transferred across the entire ice cube. The relationship between the poles to the rest of the globe are the same. The polar oceans play a critical role in maintaining ocean currents that keep coastal Europe much warmer than it would be otherwise, and the sea ice cover modifies Earth's surface temperature by reflecting solar energy. Melting ice sheets will raise sea levels, threatening coastal communities around the world. The polar regions are integral components of the Earth system that both respond to, and drive, changes elsewhere on the planet.

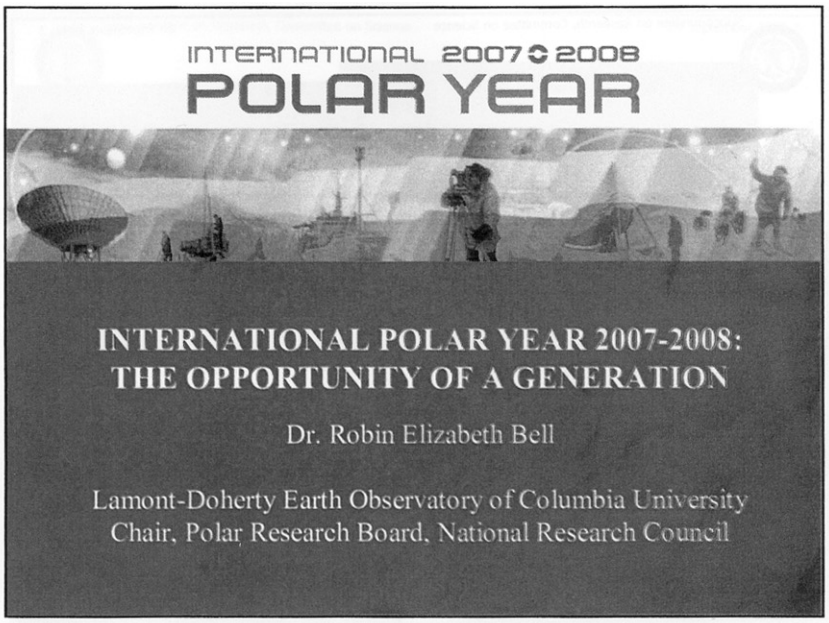
The polar regions also hold unique information of Earth's past climate history, and they are growing in economic and geopolitical importance. They are a unique

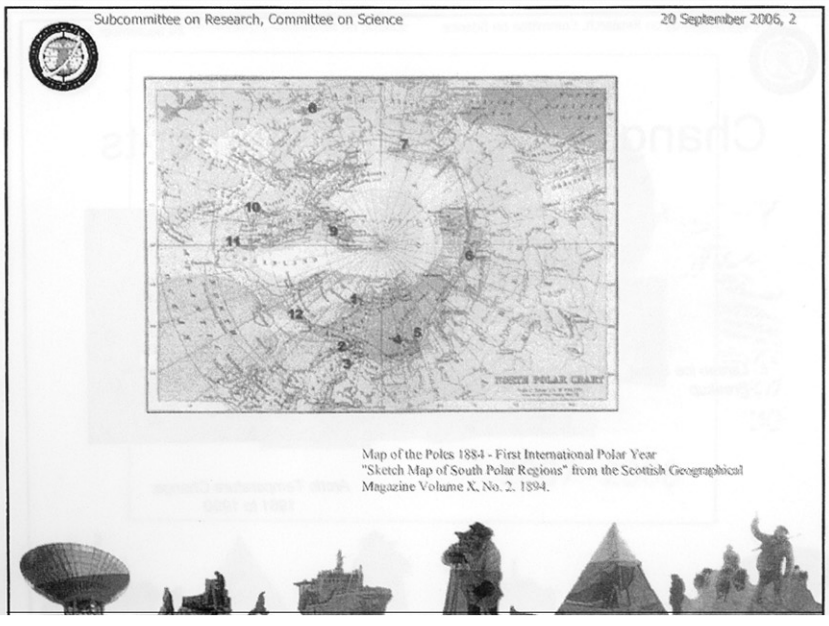
vantage point for studies that will help scientists understand environmental changes in the context of past changes, which in turn will help us make informed choices for our future. The exploration of new scientific frontiers in the polar regions also will lead to new discoveries, insights, and theories potentially important to all people.

In summary, International Polar Year 2007–2008 will leave us the following important legacies:

- an improved understanding of environmental status and change,
- more comprehensive data and the ability to understand trends in the future,
- improved observation systems to capture future environmental change,
- a continued spirit of exploration into new frontiers of science,
- a new and inspired generation of scientifically literate citizens and leaders,
- an enhanced level of international cooperation to address global scale issues.

Thank you for your time. I'd be happy to answer any questions.


INTERNATIONAL 2007 2008
POLAR YEAR
INTERNATIONAL POLAR YEAR 2007-2008:
THE OPPORTUNITY OF A GENERATION
Dr. Robin Elizabeth Bell
Lamont-Doherty Earth Observatory of Columbia University
Chair, Polar Research Board, National Research Council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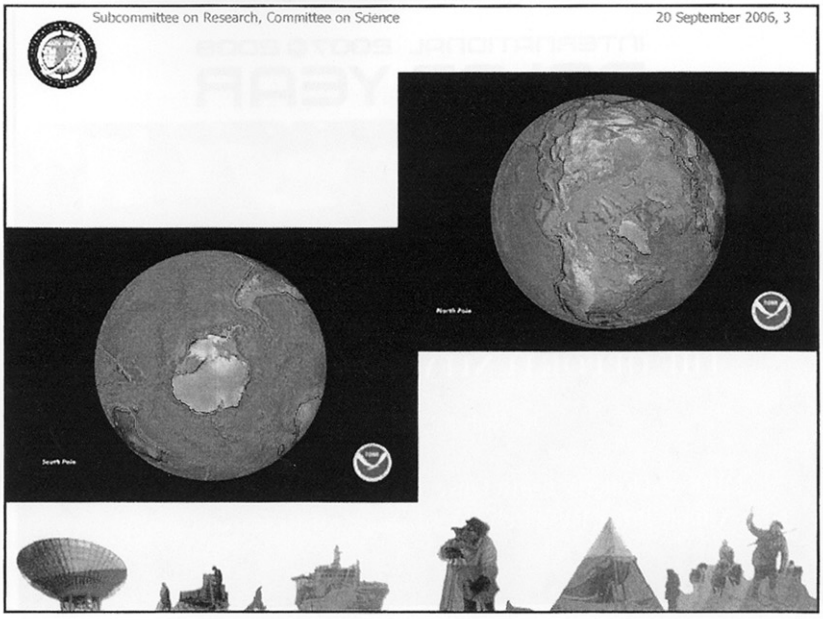
Map of the Poles 1884 - First International Polar Year
"Sketch Map of South Polar Regions" from the Scottish Geographical
Magazine Volume X, No. 2. 1894.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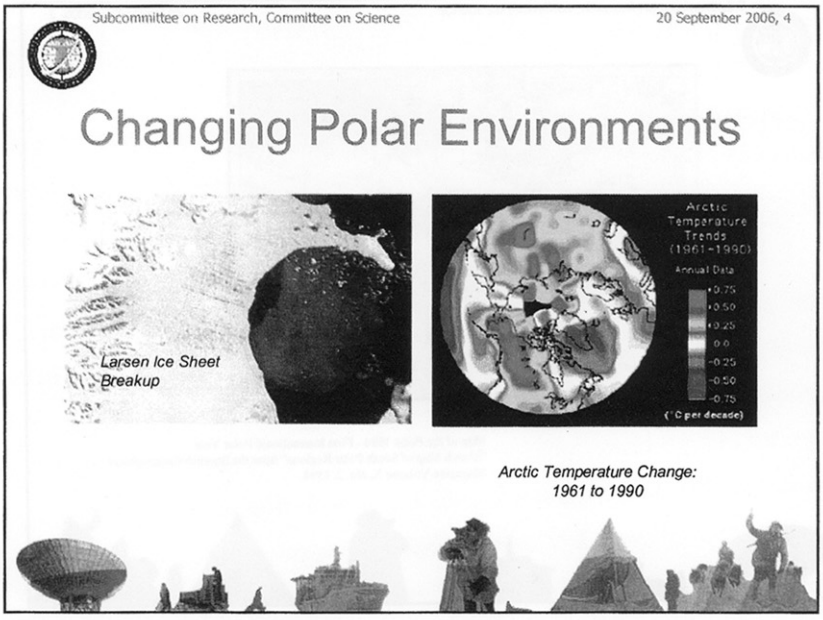
North Pole
South Pole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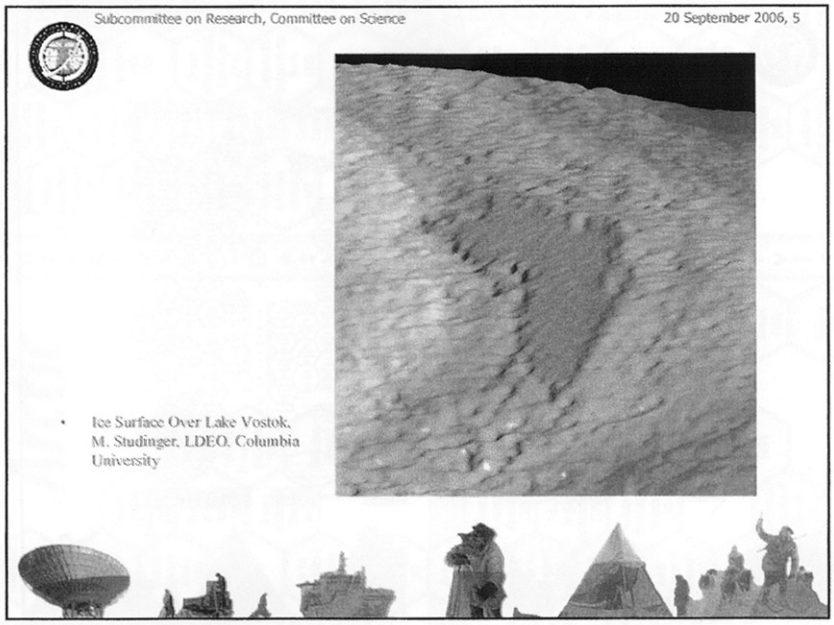
Changing Polar Environments
Larsen Ice Sheet Breakup
Arctic Temperature Trends (1961-1990)
Annual Data
+0.75
+0.50
+0.25
0.0
-0.25
-0.50
-0.75
(°C per decade)
Arctic Temperature Change: 1961 to 1990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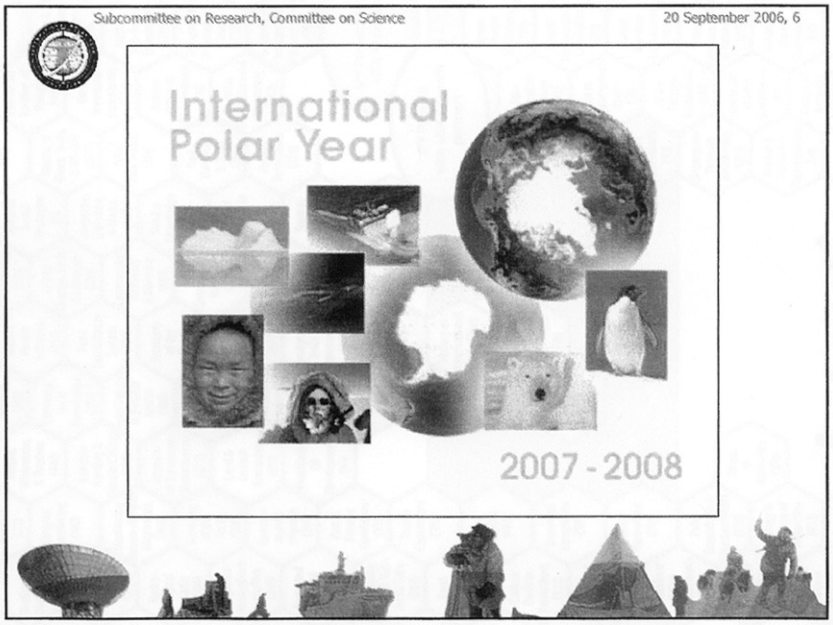
• Ice Surface Over Lake Vostok, M. Studinger, LDEO, Columbia University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International Polar Year
2007 - 2008

Earth
Land
People
Ocean
Ice
Atmosphere
Space
Education & Outreach
Arctic
Antarctic
Both
Integrated Data & Information Services
IPY PLANNING CHART
17 Sep 2006, Ver 4.2
IPY Projects led by USA Researchers

Science Magazine, March 5, 2004

THE INTERNATIONAL POLAR YEAR

by Mary R. Albert*

Change is ubiquitous in Earth's history, and evidence is clear that Earth's climate is changing rapidly now. The harbingers of change can be seen vividly in the polar regions. The Arctic ice cover is melting, ice shelves in Antarctica are crumbling, glaciers in temperate regions are disappearing, some ecosystems are changing, and permafrost thawing is causing the collapse of roads, buildings, and pipelines. Are we witnesses to an extreme in natural variability, the threshold of an abrupt change, or something more subtle? How will changes first seen in the polar regions affect us all?

Plans are under way for the International Polar Year (IPY) 2007–2008. Previous IPYs (1882–1883 and 1932–1933) and the International Geophysical Year (1957–1958) (which began as an IPY) produced unprecedented exploration and discoveries in many fields of research, and fundamentally changed how science was conducted in the polar regions. IPY 2007–2008 will benefit society by exploring new frontiers and increasing our understanding of the key roles of the polar regions in globally linked systems. Recent technological developments give us a new ability to investigate previously unexplored areas, using new tools and new ways of looking to understand once-unanswerable questions. Autonomous vehicles, genomics, and remote sensing instruments and networks are just a few of the technologies providing new tools for investigating previously inaccessible realms. The polar regions also continue to loom large in facilitating our understanding of the processes by which solar activity may seriously disturb Earth's space environment, affecting the performance of modern technologies deployed in space and on Earth. We believe that research is needed now, so that future generations may mitigate vulnerabilities and adapt to potential change.

Many important broad and interlinked research challenges exist today. To name just one example, how and why are the changes in polar regions occurring, and how can we predict and mitigate the outcome? Changes in ice mass are linked with regional and global environments, and atmospheric and oceanic processes; implementing polar observation systems would help document these changes. Clues for understanding how and why similar changes occurred in the past remain stored in polar earth and ice; sediment and ice coring would help us understand past changes. Polar changes are interlinked with the behavior and survival of ecosystems, from microbial life to large organisms, including humans; studies in polar biology are needed. Keys to fundamental discoveries for understanding change may spring from new modes of exploration that range from using autonomous underwater vehicles under the ice to the use of genomics for investigating adaptation; exploration reveals surprises. Communications technologies such as television and the Internet, combined with changes in the environment, are challenging traditional human lifestyles in our cold regions and elsewhere. Yet, these same technologies hold the potential for sharing ideas and experiences in both polar regions and for promoting global understanding; Internet-based efforts in global data collection, sharing, and education are needed.

Various international organizations and individual nations are actively planning for the IPY. The International Council for Science (ICSU) formed an international planning group to catalyze IPY development across national boundaries. The World Meteorological Organization also has identified IPY as a major new initiative. Other endorsements to date include the Scientific Committee on Antarctic Research, the International Arctic Science Committee, and the Arctic Council. Interested countries have begun to form national committees and develop a consensus regarding scientific themes that will form the backbone of the activities. In the United States, the Polar Research Board of the National Academies has formed a committee* to facilitate IPY planning.

In a world of much uncertainty and change, citizens turn to science for answers. The polar regions play an important role in providing these answers. A framework such as the IPY can provide the impetus to undertake projects that normally could not be achieved by any single nation, reaching beyond our traditional borders toward a new level of cooperative international science. Our vision for IPY 2007–2008 is that it will be the dawn of a new era in polar science, kicked off by an intense internationally coordinated campaign of activities. IPY 2007–2008 will address re-

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*Mary R. Albert is Chair of the U.S. Planning Committee for IPY 2007–2008.

*The U.S. National Committee to the IPY actively welcomes input from the science community (*www.us-ipy.org*).

search in both polar regions, which have strong linkages to the rest of the globe. It will be multi- and interdisciplinary in scope and truly international in participation. It will educate and excite the public, and help produce the next generation of engineers, scientists, and leaders.

Science Magazine, March 5, 2004

POLAR EXPLORATION—A YEAR TO REMEMBER AT THE ENDS OF THE EARTH

RESEARCHERS CHARTING A COURSE FOR AN INTERNATIONAL POLAR YEAR IN 2007–2008 ARE HOPING TO RECAPTURE THE GLORY OF A SIMILARLY AMBITIOUS VENTURE A HALF-CENTURY AGO

by Richard Stone and Gretchen Vogel

Cambridge, U.K. and Berlin

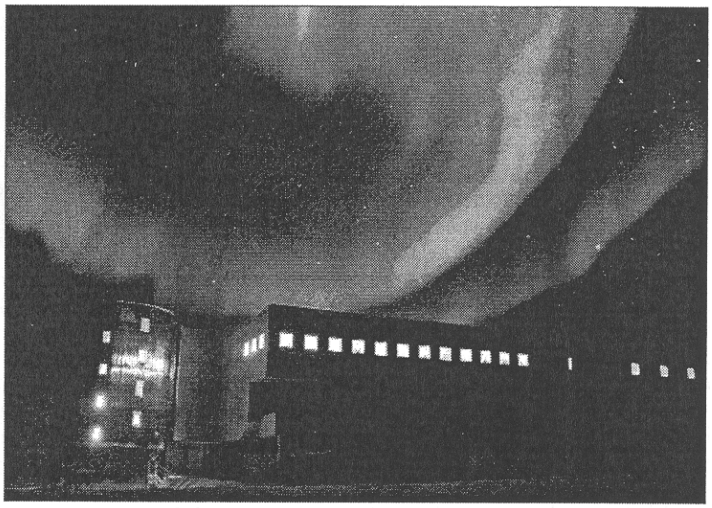
When Les Barclay and 20 intrepid fellow voyagers set out for Antarctica in November 1956, they knew they were embarking on the scientific adventure of a lifetime. After 5 weeks at sea, the radiophysicist and his colleagues on the International Geophysical Year (IGY) Antarctic Expedition put in at Halley Bay, then Britain's new toehold on the Antarctic Peninsula. They had lugged all the equipment they could possibly need there until the next ship called a year later. "We went down without recourse to any facilities back home," says Barclay.

For the next 2 years, he and counterparts across Antarctica and at the other end of Earth, in the High Arctic, made some of the first high-latitude measurements of the ionosphere and its most spectacular phenomenon, the aurora. Barclay also teamed with W. Roy Piggott to pioneer the use of radio waves for measuring the thickness of ice shelves, a technique that led to ground-penetrating radar. Other major finds of the $1 billion IGY of 1957–1958 include the discovery of the Van Allen radiation belts and radical new estimates of ice volume on Earth's surface. "We learned a tremendous amount about the world," says Barclay, who now runs a consulting firm in Chelmsford, U.K.

Nearly a half-century later, researchers are marshalling forces for another major assault on the poles. Under the auspices of the International Council of Scientific Unions (ICSU), the World Meteorological Organization (WMO), and more than a dozen other scientific groups, an ambitious plan is taking shape for an International Polar Year (IPY) to kick off during the Arctic spring of early 2007, and extend through the Antarctic fall of early 2008. "We want a real quantum jump in our understanding of how the poles work," says Chris Rapley, Director of the British Antarctic Survey and Chair of ICSU's IPY planning board.

Rapley and other organizers now face the daunting task of convincing countries to pitch in funding and logistical support beyond that already committed to ongoing polar programs. The overall investment could easily top $1 billion, organizers say, as dozens of countries sign up to multilateral agreements that will govern IPY projects.

The will be no shortage of ideas in search of funding, for unanswered questions of polar research are legion. IPY's planning board will try to winnow the field to a few major themes that promise to have deep scientific impact and broad public resonance. "One of the goals is to get people to realize that . . . the cold ends of the sphere we live on really do influence us," says ICSU IPY planning Vice Chair Robin Bell of Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York. And, like their predecessors, they intend to leave a lasting legacy. "We want to design a way to take the pulse of the poles in 2007 and 2008," Bell says, "but we also want to leave a heart monitor in place so we can continue to see what's going on."



Lighting the way. The U.S.'s Amundsen-Scott South Pole Station, under a brilliant aurora, will host a broad palette of research during the upcoming International Polar Year.

From Cape Horn to Sputnik

The Polar Year of 2007–2008 will follow in the footsteps of illustrious predecessors, each of which overhauled our understanding of global processes. The first IPY, in 1882–1883, was largely the brainchild of Karl Weyprecht, an Austrian naval lieutenant who commanded a ship during the Austro-Hungarian Arctic Expedition of 1872–1874. He argued that polar exploration required more than geographic discovery and called for the establishment of a network of research stations in the polar regions. The idea caught fire, and during the first Polar Year, 11 nations established 14 stations—two at Cape Horn and South Georgia Island in the South Atlantic and a dozen in the Arctic—to record data on everything from meteorology to terrestrial magnetism, and the aurora, findings that shaped later theories of the ionosphere. "It was the first big meteorological experiment," says Cornelia Lüdecke, a science historian at the University of Hamburg, Germany.

The second IPY took place 50 years later, in 1932–1933. Despite a global economic depression, 44 countries teamed up on nearly two dozen dedicated expeditions to the Arctic and the Southern Hemisphere, although like the previous IPY the effort did not reach as far south as Antarctica. Technology had come a long way: Telephone, aircraft, and radio sounding all were at the disposal of researchers. A major achievement was obtaining detailed measurements of the upper atmosphere, including the first maps of the jet stream.

Grand as those efforts were, they paled in comparison to the massive undertaking of 1957–1958. Lloyd Berkner of the Carnegie institution of Washington aired the IGY idea at a dinner party at the home of space physicist James Van Allen in the spring of 1950. The suggestion snowballed into one of the biggest global scientific undertakings ever. Still, it was the depths of the Cold War, and politics was never tar from the surface: The Soviet Union in 1956 announced that it would put the first satellite in orbit during the IGY (Sputnik duly went up the next year), and China withdrew from the effort after Taiwan was brought aboard. Antarctica was seen as a potential Cold War battleground, with countries laying claim to slices of the continent. An international research effort, some hoped, would ease tensions—and indeed, the IGY is credited with fostering the political climate for the Antarctic Treaty, in which signatories agreed to share the continent in the name of "peace and science." In all, roughly 80,000 scientists and support staff from 67 countries took part in the IGY.

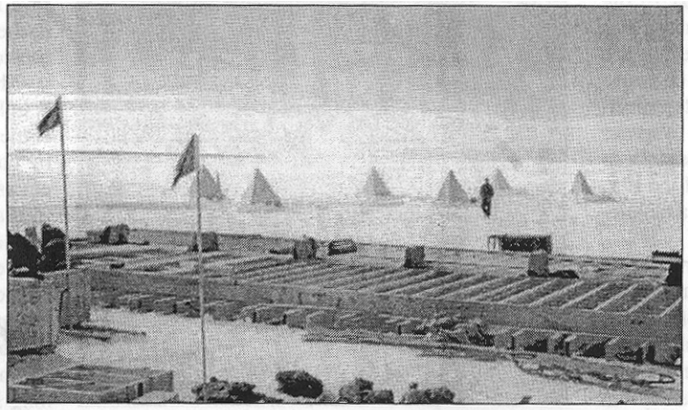
"It was a thrilling time," recalls David Limbert, who confesses that as a 29-year-old meteorologist he left several girlfriends in England to join the Royal Society's IGY advance team, dispatched in late 1955 to build the Halley Bay camp. "We were there as pump primers," he says. For the first several weeks he and the other expe-

dition members slept in tents as they built Halley beam by beam. Halley and many of the other few dozen Antarctic bases established during the IGY continue to produce world-class science. The IGY, says Rapley, "set the standard for what can be achieved."

The Next Frontier

The IGY will be a hard act to follow. But the half-century of polar science it ushered in has only deepened scientists' appreciation of the complexity and importance of polar processes. What happens at the poles is inextricably tied to patterns of cold and warmth, rainfall and drought. To have any hope of understanding what is happening to global climate today, and what might happen in the future, scientists need a better picture of conditions at the poles and how they interact with and influence ocean and air currents.

So far scientists have only the vaguest clues to how those interactions work. "We know the climate models don't get the polar regions right, and there is a lot of work going on to understand why that is," Rapley says. One puzzle, he notes, is that the models have largely failed to predict the dramatic melting of the Antarctic ice shelf And even state-of-the-art models vary widely in their predictions for the severity of the warming that might occur in the Arctic.



Roughing it. "The sleeping bags came in only one thickness," recalls David Limbert, part of the advance team that slept in tents while assembling the Halley Bay base in early 1956.

One challenge is that the polar regions seem to be reacting more dramatically than other latitudes to global climate changes. The three fastest-warming regions in the last 2 decades have been Alaska, Siberia, and parts of the Antarctic Ice Sheet, notes Rapley. But whether that is the start of a long-term trend or a normal fluctuation is unclear. Figuring this out "is directly related to our ability to collect data," Rapley says.

One likely project for the upcoming IPY will be updating an array of monitoring stations strung across the Russian Arctic during the IGY. In the last decade alone, many of those stations have fallen silent, depriving meteorologists of key data on temperature and rainfall, for example. According to the Russian Academy of Sciences, only 45 polar hydrometeorological stations were functioning in 2002, a two-thirds reduction over the past decade. Refurbishing the stations is a top priority, says Eduard Sarukhanian, WMO's IPY Coordinator. However, adds Rapley, "what we're keen to do is make sure that doesn't just focus on meteorology and hydrology but opens up new vistas on other research—from any field that people can convince us is worthwhile."

Opening new vistas may well be the driving theme of the IPY. "There are subglacial lakes and the spreading ridges under the Arctic that have never been explored," Bell says. And while biologists have barely begun to catalog life in polar oceans, there are hints that here, too, the frozen ends of Earth have a global influence.

One theory suggests that the Southern Ocean might have been a source of much of the biodiversity in the deep oceans worldwide. When the Antarctic continent broke away on its own, a girdle of swift-moving ocean currents formed around it, trapping species in the chilly waters of the Southern Ocean and forcing them to adapt to extreme conditions, Rapley explains. Those creatures, then, may have

hitched a ride to other oceans. Brigitte Hilbig of Ruhr University in Bochum, Germany, recently identified several worms in 5,000-meter-deep waters off Angola that are nearly identical to one first identified in the Southern Ocean, 5,000 kilometers away, suggesting that there may be important connections between the life forms of polar oceans and seabed habitats worldwide. To probe this further, Hilbig and colleagues have proposed taking a zoological and genetic census of the Southern Ocean as part of the IPY.

The Arctic waters, too, likely hold new surprises. An expedition in 2001 to the Gakkel Ridge, where the continental plates bearing Europe and North America are spreading apart, turned up much more hydrothermal activity than scientists expected, says Jörn Thiede of the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. As part of the IPY, he and his colleagues hope to send a remote-controlled sub to survey the region.

IPY organizers also hope to attract interest from astronomers who can use polar summers for uninterrupted views of the sun; medical researchers who study human responses to extreme conditions; and social and political scientists who could study the impact of Arctic warming on northern Russia, Canada, and other Arctic Rim nations.

In an initial call, organizers received nearly 150 proposals. "It's taking off like gangbusters," Rapley says. The ICSU committee and its partners will settle on a handful of flagship projects by autumn, he says. (Contributions are still welcome; see Editorial, p. 1437.) Rapley says that ICSU might try to coordinate three to five large-scale efforts, such as major transects across the poles or large-scale atmospheric or ocean surveys. He hopes the effort will inspire a wellspring of multinational projects around the globe organized by other scientists.

It's not yet clear whether such efforts will add up to the $1 billion infusion the last IGY enjoyed. Karl Erb, Director of the U.S. National Science Foundation's Office of Polar Programs, estimates that NSF might contribute up to $50 million in research funding and logistical support for IPY-specific activities, from its nearly $400 million annual budget. Given the formidable base that the field is building on, a smaller investment than that plowed into IGY could have just as profound an impact, argues Chad Dick of the Norwegian Polar Institute in Tromsø, Norway. The onus will be on organizers to choose projects with far-reaching payoffs. "If all we do is have a blast for 2 years and nothing changes in our ability to monitor the poles for the long term, we will have failed," he says. Considering the track record of the first two IPYs and the IGY, failure would appear to be only a remote possibility.

AN OTHERWORLDLY PLACE TO HUNT FOR OTHER WORLDS

by Gretchen Vogel

High on Antarctica's frozen desert, astronomers have found some of the best conditions on Earth for peering into space. The calm, cloudless skies above Dome C, 3233 meters above sea level in the middle of the main Antarctic ice sheet, make the isolated spot a stargazer's dream. The site is the location of the newest permanent year-round station in Antarctica, a joint French-Italian project called Concordia.

The main buildings, which will host 16 people over the 9-month winter and twice as many in summer, are expected to be finished by the Antarctic winter of 2005–2006, in ample time for the station to participate fully in the International Polar Year (IPY) to begin in 2007 (see main text).

Concordia, perched on an ice dome, should entice scientists from a range of disciplines. For example, researchers who use ice cores to decipher dues to past climates expect to look deep into the last Ice Age thanks to nearly 500,000 years of snow accumulation at Dome C. And as the third permanent station on the continent's interior, located more than 1,000 kilometers from its nearest neighbor, the United States' Amundsen-Scott South Pole Station, Concordia will help fill gaps in measurements of Earth's magnetic and gravitational fields and the continent's seismic activity.

New kid on the ice. Concordia is expected to become a hotbed for studies in astronomy, paleoclimatology, and the psychological stress of isolation.

Concordia is also set to rival the South Pole as a premier astronomical outpost. Although there are not yet any full-size telescopes at the site, measurements suggest it is an outstanding place for optical and near-infrared astronomy. The air can be so still, says Eric Fossat, an astronomer at the University of Nice in France, that smoke rings from tractors at the construction site often linger for tens of seconds before dissipating. The lack of wind and heat currents makes the atmosphere extremely clear, cutting down on the shimmer that disrupts Earth-based views of stars. Thus astronomers can look forward to some of the best "seeing" anywhere on Earth. "The indications are that the seeing may be absolutely extraordinarily good," says astronomer Tony Stark of the Harvard-Smithsonian Center for Astrophysics, who has worked extensively at the South Pole.

That quality, combined with the site's aridity and average ambient temperature of -50 °C, makes it a great spot for infrared astronomy—perhaps the best on Earth for searching for planets similar to our own, Fossat says. In the infrared, planets show up brighter and stars dimmer, allowing astronomers to discern planets more easily. And, he notes, there is half as much cloud cover as at the already impressively clear South Pole Station. Astronomers are still securing funding, but they hope to have the first telescope in place for the IPY in 2007. An array of telescopes could come further down the road.

Concordia may even help humans reach for the stars. To simulate the effects of long-duration space flight, researchers plan to study how staff members cope with the Antarctic winter (Science, 15 August 2003, p. 906). Fossat himself says he won't winter there. "I'm too old for that kind of sacrifice," he says. But with Concordia's astronomical attributes, don't expect any shortage of volunteers.

A Vision for International Polar Year 2007–2008 *

Environmental change and variability are part of the natural pattern on Earth. But environmental changes currently witnessed in the polar regions are, in many cases, more pronounced than changes observed in the mid-latitudes or tropics. The Arctic sea ice cover is decreasing; some ice shelves in Antarctica are retreating and thinning; glaciers are shrinking; and ecosystems are changing, for instance, with plants flowering at earlier times. These changes are having human impacts: some Alaskan villages have been moved to higher ground in response to rising sea levels, and thawing of permafrost is undermining roads and buildings in northern communities around the world.

Why should the vast majority of us, who live in the warmer regions of the Earth, care? The polar regions, while physically distant, are critical links in the global climate system. The polar oceans play a critical role in maintaining ocean currents that keep coastal Europe much warmer than it would be otherwise, and the sea ice cover modifies Earth's surface temperature by reflecting solar energy. These are just a few of many global connections. The polar regions also hold unique information

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* U.S. National Committee for the International Polar Year

of Earth's past climate history, and they are growing in economic and geopolitical importance. They are a unique vantage point for studies that will help scientists understand environmental changes in the context of past changes, which in turn will help us make informed choices for our future. The exploration of new scientific frontiers in the polar regions also will lead to new discoveries, insights, and theories potentially important to all people. To better understand these and other questions, nations around the world are making plans to participate in International Polar Year (IPY) 2007–2008.

IPY 2007–2008: Scope and Objectives

At its most fundamental level, IPY 2007–2008 is envisioned to be an intense, coordinated field campaign of polar observations, research, and analysis that will be multidisciplinary in scope and international in participation. IPY 2007–2008 will provide a framework and impetus to undertake projects that normally could not be achieved by any single nation. It allows us to think beyond traditional borders—whether national borders or disciplinary constraints—toward a new level of integrated, cooperative science. A coordinated international approach maximizes both impact and cost effectiveness, and the international collaborations started today will build relationships and understanding that will bring long-term benefits. Within this context, IPY will seek to galvanize new and innovative observations and research, while at the same time building on and enhancing existing relevant initiatives. IPY will serve as a mechanism to attract and develop a new generation of scientists and engineers with the versatility to tackle complex global issues. In addition, IPY is clearly an opportunity to organize an exciting range of education and outreach activities designed to excite and engage the public, with a presence in classrooms around the world and in the media in varied and innovative formats.

The IPY will use today's powerful research tools to better understand the key roles of the polar regions in global processes. Automatic observatories, satellite-based remote sensing, autonomous vehicles, Internet, and genomics are just a few of the innovative approaches for studying previously inaccessible realms. IPY 2007–2008 will be fundamentally broader than past International Years; because it will explicitly incorporate multi-disciplinary and inter-disciplinary studies, including biological, ecological, and social science elements. It will run from March 1, 2007 until March 1, 2009, to allow two field seasons of research in both the Arctic and the Antarctic.

What Will Happen During IPY?

During the window of IPY 2007–2008, scientists from many nations will join together in expeditions and research projects designed to meet the IPY objectives, coordinated at both the national and international levels. They will work both in the Arctic and the Antarctic, and in universities, laboratories, and observatories around the world. The specific research projects have not yet been selected, but we envision teams of researchers collecting coordinated measurements to compile a snapshot of environmental conditions, which can serve as a baseline for understanding future environmental change. There might be an effort to coordinate satellites to gather consistent data on ice extent. Ecologists might mount a massive effort to conduct a census of marine life so that we better understand population trends for important fisheries. Other groups might drill into the ocean floor in search of sediment cores with evidence of past environments. Multidisciplinary teams might document ecosystem changes in far northern communities where traditional subsistence foods are important to the local lifestyle, and try to understand how changes are affecting the people of those communities. The next year is very important to IPY planning, because it is time to sort through the many ideas that have been suggested and see which are best to pursue.

Who's Involved in the IPY?

Enthusiasm for IPY 2007–2008 is strong and growing. In barely more than a year, the science community has progressed from its earliest discussions of possibilities for new international science endeavors to serious planning of what an IPY might accomplish and what resources are needed. More than 25 nations have formally declared the intent to participate and many more have discussions in progress. Here in the United States, scientists have been presenting talks and holding open forums at professional meetings, and using an interactive website to brainstorm ideas where U.S. leadership might ensure significant contributions. A call to the science community for ideas about what science themes to pursue brought forward hundreds of ideas, and this input has been crucial in the IPY planning.

The U.S. Committee for the International Polar Year 2007–2008 was formed by the Polar Research Board of the National Academies to articulate a vision for U.S. participation in IPY 2007–2008, in coordination with and on behalf of our Nation's

scientific communities. The Committee has worked closely with the U.S. science community using a variety of mechanisms. It has worked with our international colleagues, especially the International Council for Science's IPY 2007–2008 Planning Group, to identify the important science themes and develop the detailed information needed to implement its many contributing activities.

When IPY 2007–2008 gets underway, it will involve far more than scientists. The hope is that many people—scout leaders, teachers, museum directors, filmmakers, journalists, parents, and students of all ages—will be involved. Some of the participation will be hands-on; other involvement will take full advantage of the tremendous opportunities for instantaneous communication offered by modern technologies.

What Should We Do To Make IPY a Success?

The Committee recommends the following actions for ensuring a successful IPY 2007–2008:

- The U.S. scientific community and agencies should use the IPY to initiate a sustained effort aimed at assessing large-scale environmental change and variability in the polar regions.
- The U.S. scientific community and agencies should include studies of coupled human-natural systems critical to societal, economic, and strategic interests in the IPY.
- The U.S. IPY effort should explore new scientific frontiers from the molecular to the planetary scale.
- The International Polar Year should be used as an opportunity to design and implement multi-disciplinary polar observing networks that will provide a long-term perspective.
- The United States should invest in critical infrastructure (both physical and human) and technology to guarantee that IPY 2007–2008 leaves enduring benefits for the Nation and for the residents of northern regions.
- The U.S. IPY program should excite and engage the public, with the goal of increasing understanding of the importance of polar regions in the global system and, at the same time, advance general science literacy in the Nation.
- The U.S. scientific community and agencies should participate as leaders in International Polar Year 2007–2008.

Scientific Challenges

IPY 2007–2008 is an opportunity to deepen our understanding of the physical, biological, and chemical processes in the polar regions and their global linkages and impacts, and to communicate these insights to the public. Five broad scientific challenges provide a framework for organizing IPY activities:

- Assessing large-scale environmental change in the polar regions, with questions looking at both the physical and human dimensions of change and its impacts.
- Conducting scientific exploration of "new" frontiers, whether these are once inaccessible places such as the seafloor, or areas of inquiry that are now open because of advances in technology, such as how the tools of genomics now allow exploration of previously unanswerable questions about biological adaptation.
- Observing the polar regions in depth, with adequate coverage of the vast and challenging landscape, to provide a description of current conditions, and allow for better future understanding of variability and change.
- Understanding human-environmental dynamics in a region where the connections are intimate, and where the impacts of change are clear.
- Creating new connections between science and the public, using these regions that are inherently intriguing.

Previous International Years

International Polar Year 2007–2008 is an ambitious program following in the footsteps of some past campaigns. There have been three similar programs over the last 125 years. During the first International Polar Year in 1882–1883, 12 countries launched 15 expeditions (13 in the Arctic and 2 in the Antarctic). As part of its contribution, the United States established our northernmost scientific station at Point Barrow, Alaska. The second International Polar Year in 1932–1933, even in the midst of the Great Depression, included participants from 40 nations, and brought advances in meteorology, atmospheric sciences, geomagnetism, and the "mapping" of ionospheric phenomena that advanced radioscience and technology. The United States established the first year-round research station inland from the Antarctic coast.

The International Geophysical Year (IGY) in 1957–1958, in which 67 nations participated, was conceived as an effort to use technology developed during World War II, such as rockets and radar, for scientific research. IGY brought many "firsts," such as the launch of the world's first satellites. IGY had a strong polar component, especially in the Antarctic: research stations were established and the experience in international collaboration, even in tense political times, led to ratification of the Antarctic Treaty in 1961. Each of these campaigns produced unprecedented exploration of Earth and space and led to discoveries in many fields of science. IPY 2007–2008 is expected to leave a similar legacy of accomplishments.

U.S. National Committee for the International Polar Year: Mary Albert, (Chair) ERDC Cold Regions Research and Engineering Laboratory; Robert Bindschadler, National Aeronautics and Space Administration—Goddard Space Flight Center; Cecilia Bitz, University of Washington; Jerry Bowen, CBS News; David Bromwich, The Ohio State University; Richard Glenn, Arctic Slope Regional Corporation; Jacqueline Grebmeier, University of Tennessee; John Kelley, University of Alaska Fairbanks; Igor Krupnik, Smithsonian Institution; Louis Lanzerotti, Bell Laboratories-Lucent Technologies; Peter Schlosser, Lamont-Doherty Earth Observatory of Columbia University; Philip Smith, McGeary & Smith; George Somero, Stanford University; Cristina Takacs-Vesbach, University of New Mexico; Gunter Weller, University of Alaska Fairbanks; Douglas Wiens, Washington University; Mahlon Kennicutt, (Ex-officio) Texas A&M University; Patrick Webber, (Ex-officio) Michigan State University; Terry Wilson, (Ex-officio) The Ohio State University; Sheldon Drobot, (Study Director) Polar Research Board; Chris Elfring, (Board Director) Polar Research Board; Kristen Averyt, (Christine Mirzayan Intern) Polar Research Board; and Rachael Shiflett, (Program Assistant), Polar Research Board.

This brief was prepared by the National Research Council based on the Committee's report. For more information, contact the Polar Research Board at 202–334–3479. *A Vision for International Polar Year 2007–2008* is available from the National Academies Press, 500 Fifth Street, NW, Washington, DC 20001; 800–624–6242 or 202–334–3313 (in the Washington area); *www.nap.edu*.

Chairman STEVENS. Thank you very much, and we thank you for coming. I did not know that was an international chart. I thank you for bringing that up. I will have some questions later. I do appreciate the charts and slides that you have brought with you. They're very informative.

Our next witness is Dr. Buck Sharpton. He's the Vice Chancellor for Research of the University of Alaska in Fairbanks.

Doctor, it's nice to have you with us.

STATEMENT OF DR. VIRGIL L. "BUCK" SHARPTON, VICE CHANCELLOR FOR RESEARCH, UNIVERSITY OF ALASKA (UA) FAIRBANKS; UA PRESIDENT'S PROFESSOR OF REMOTE SENSING

Dr. SHARPTON. Thank you, Chairman Stevens and Senator Murkowski, for the opportunity to be here today.

Fifty years ago, the world embarked on the most ambitious scientific program in history, the International Geophysical Year. This 18-month-long series of internationally coordinated observations returned untold dividends in the form of new scientific knowledge: discovery of the Van Allen radiation belts, sea-floor studies leading to the revolutionary theory of plate tectonics, the Antarctic Treaty, and many, many more. And our Nation derived other important benefits from this investment, as well. IGY expanded national research funding significantly and permanently, leading to tremendous payoffs in intellectual property and societal benefits throughout the latter half of the 20th century. IGY was also a much-needed opportunity for the United States to exhibit, on the global stage, its technological capabilities and political will to work equitably and openly with the international scientific community. We in-

vested heavily; and, as a result, the world has looked to the U.S. for scientific leadership ever since.

The upcoming IPY is a much-needed opportunity to reaffirm our place as world leaders in science and technology, to demonstrate that we are still committed to open international programs that advance scientific knowledge, and to invest wisely in activities that will inspire and train the next generation of U.S. scientists and engineers.

Often, when the term "polar" is used, people gravitate toward visions of Antarctica or the North Pole. Obviously, one does not need to look that far. "Polar," in United States terms, means Alaska and its people.

Alaskans are in the midst of change. We are in immediate need of IPY to more fully understand what's happening, and why, to be able to reliably forecast events to come, to identify how to hold on to our unique and valuable resources, such as indigenous languages and culture, and to make informed decisions to address the multitude of challenges before us.

The University of Alaska has been involved in IPY planning and implementation for the past 3 years. Over 75 percent of our research pertains to Alaska and the broader Arctic region, and over 25 percent of all the research and educational proposals endorsed by the IPY International Programme Office involve our researchers. I've attached a list of those to my written testimony.

Through our network of colleges across rural Alaska and ongoing research programs, we have gained valuable experience working with and for our Alaskan Native populations. This experience is essential in ensuring that the upcoming IPY addresses their issues, involves them as research partners and astute observers, not just subjects, and returns to them the results and rewards of these research activities.

Considerable financial resources will be needed if the United States is to take a leading role in IPY. Other nations have committed far more than ours, at least thus far. But we, at the University of Alaska, are not waiting for outside funds before we move forward. The University's president, Mark Hamilton, has committed $3.5 million to support 13 IPY postdoctoral fellows for 3 years. We look to these young scientists, five of whom come from other countries, to broaden our research capabilities and expand our connections around the world as we engage in IPY.

Eighteen months ago, we launched an IPY strategy that extends the research and educational opportunities afforded by IPY across all sectors of Alaskan society. Through awards from the State Department and NOAA's Cooperative Institute for Arctic Research, we have the resources to initiate this plan, the components of which are provided in my written testimony.

In conclusion, I would like to leave you with four recommendations for investments that would yield lasting returns to the Nation in our Nation's only Arctic State. Further details are included in my written testimony.

First, approve the National Science Foundation's budget to support IPY research and educational outreach.

Second, support the Arctic Observing Network.

Third, expand network connectivity infrastructure within Alaska, and from Alaska to the U.S. mainland, to acceptable national standards to promote economic growth and ensure equal opportunities for all the residents of our State.

And, finally, please help us acquire high-resolution digital imagery and elevation data for Alaska that meet national standards and are currently available for every State in our Nation except Alaska.

Thank you, again, for the opportunity to present this testimony today. And thank you very much for your interest in the International Polar Year.

[The prepared statement of Dr. Sharpton follows:]

PREPARED STATEMENT OF DR. VIRGIL L. "BUCK" SHARPTON, VICE CHANCELLOR FOR RESEARCH, UNIVERSITY OF ALASKA (UA) FAIRBANKS; UA PRESIDENT'S PROFESSOR OF REMOTE SENSING

Thank you Chairman Stevens, Chairman Lugar, Senator Murkowski and Members of both Senate Committees for the opportunity to be here today. In my capacity as Vice Chancellor for the University of Alaska in Fairbanks, I am responsible for developing and implementing the University's strategy for participating in activities of the upcoming 4th International Polar Year. As a researcher and educator, and now the Chief Research Officer of America's only Arctic University, I would like to share my perspectives on why IPY is important to Alaska and our Nation, how we have prepared ourselves to play key roles in these activities, and leave you with recommendations for valuable legacies that could result from IPY.

The upcoming IPY is staged to celebrate the 50th anniversary of the International Geophysical Year, IGY, held in 1957–1958. IGY was modeled on the two previous Polar Years, 1882–1883 and 1932–1933, where coordinated scientific studies were conducted to understand our planet's natural processes and cycles. IGY was originally planned to take place at the centennial celebration of the first Polar Year in 1982–1983, but instead was held 25 years earlier to take advantage of an unusually intense period of sunspot activity. Thus IGY came at a most critical time for our Nation and the world. During World War II and the early post-war era, technologies had been developed with the potential for unimaginable devastation. Ideological differences between the two multi-national superpowers heightened concerns that those technologies might some day be used as tools of aggression. IGY was an effort to develop peaceful uses of these post-war technologies in order to improve knowledge about our planet—particularly its polar regions—through an international campaign of coordinated scientific observations. IGY was a tremendous success; over 30,000 scientists from 67 countries took part in what was the largest and most ambitious scientific program ever attempted. Some of the scientific legacies left by this effort include:

- The discovery of the Van Allen radiation belts that ring the earth and affect communication and spacecraft operations;
- The charting of ocean depths and ocean currents;
- A mapping of the magnetic characteristics of the ocean floor that soon led to the revolutionary theory of plate tectonics;
- The first rigorous study of the Antarctic continent and its ice sheets;
- The Antarctic Treaty, making the whole continent a place of scientific research, free of national claims and international rivalry.

But there were other important benefits that our Nation derived from the investment we made in this program. IGY expanded national research investments significantly and permanently, leading to tremendous payoffs in intellectual property and societal benefits throughout the latter half of the 20th century. Furthermore, IGY was a much needed opportunity for the United States to exhibit, on the global stage, its technological capabilities and the political will to work equitably and openly with the international scientific community. We invested heavily and, as a result, the world has looked to the U.S. for scientific leadership ever since.

Now, on the eve of the 4th IPY, we face a different type of scientific challenge: the challenge to understand how our circumpolar regions are changing, and to develop reliable strategies for mitigating the negative impacts and optimizing the opportunities that accompany this change. You have undoubtedly heard testimony

from others on the various lines of evidence demonstrating that the Arctic is experiencing dramatic climate-induced changes: retreating sea ice, melting permafrost, and the migration of the Arctic tree line to higher elevations and latitudes, to name a few. And this is not just a regional issue affecting a relatively few Arctic inhabitants. The Polar Regions play key roles in the global climate system; therefore a more complete understanding of the Arctic and Antarctic is imperative if we are to improve global climate models.

In addition, many of the benefits our Nation derived from IGY, fifty years ago, apply today. The upcoming IPY is a much needed opportunity to reaffirm to the world our place as leaders in science and technology, to demonstrate that we are committed to open, international research programs that advance scientific knowledge, and to invest wisely in activities that will inspire and train the next generation of U.S. scientists and engineers.

Often, when the term "polar" is used, people gravitate toward visions of Antarctica or the North Pole, or exotic uninhabited places. Obviously, one does not need to look that far. Polar, in United States terms, means Alaska and its people.

Alaskans are in the midst of change; we are in immediate need of IPY to more fully understand what is happening and why, to be able to reliably forecast events to come, identify how to hold on to our unique and valuable resources such as indigenous languages and culture, and learn to make informed decisions so that we can address the multitude of challenges before us.

As Alaska's Research University, the Fairbanks campus as well as the University of Alaska's other campuses have been involved in IPY planning and implementation for the past 3 years. We are well prepared to play key roles in the upcoming activities. Over 75 percent of our research pertains to Alaska and the broader Arctic region. This commitment is reflected in the fact that over 25 percent of all the research and educational proposals endorsed by the IPY International Programme Office involve Fairbanks campus researchers. A list of the endorsed research projects is appended to this testimony.

Our field research stations, such as the Toolik Field Station on the North Slope, have been systematically gathering ecological and biological data for nearly half a century. Those sites will undoubtedly be important centers of IPY research. Through our network of colleges across rural Alaska, and ongoing research programs such as the Center for Alaska Native Health Research, we have gained valuable experience working with and for our Alaska Native populations. This experience is essential in ensuring that the upcoming IPY addresses their issues, involves them as research partners and astute observers—not just subjects—and returns to them the results and rewards of these research activities.

Considerable financial resources will be needed if the United States is to take a leading role in IPY. Other nations have committed far more than ours, at least thus far. But we at the University of Alaska are not waiting for outside funds before we move forward. The University's President Mark Hamilton has committed $3.5 million to support 13 IPY postdoctoral fellowships for 3 years. These young researchers were chosen from 180 applicants from around the world to work on IPY-related research projects at the 3 main campuses across the UA system: 9 at Fairbanks, 3 at Anchorage, and 1 in Juneau. We look to these young scientists—five of whom come from other countries—to broaden our research capabilities, and expand our connections around the world as we engage in the internationally coordinated research activities of IPY.

Eighteen months ago we launched an IPY strategy that included research coordination, educational outreach, community engagement, and public relations. We have taken steps to ensure that the research and educational opportunities afforded by IPY extend across all sectors of Alaska society. Through awards from the Department of State, Bureau of Educational and Cultural Affairs, and the NOAA Cooperative Institute for Arctic Research, we have the resources to initiate this plan which includes the following activities:

- The *IPY Education and Outreach Office* in conjunction with the University of the Arctic. UArctic is a cooperative network of educational institutions committed to higher education and research in the North. Its members share resources, facilities, and expertise to build post-secondary education programs that are relevant and accessible to northern students.
- Graduate and undergraduate research grants for student involvement in IPY research projects across the University system.
- A K–12 engagement plan built around two "contests" targeted toward K–12 students: the first is an IPY art contest where students from across Alaska submit works of art that capture the spirit of IPY. The best from each age group will be brought to Fairbanks for an awards ceremony and their art will be exhibited

at our *Museum of the North* during IPY. The second is a writing contest for high school students to submit their research papers on the benefits of past IPY activities to Alaska and the Arctic. Again, each age group will be judged and the winners will give presentations at one of the public functions during IPY.

- Implementation of the *Think Tank of the North*. This is a series of events that seeks to address critical issues facing the Arctic such as climate change impacts, development and mineral extraction issues, sustainable natural resource management, natural hazard mitigation, cultural impacts, and information technology infrastructure needs. The University will sponsor leading researchers, educators, and policymakers from around the world for week-long visits to brainstorm with our faculty and engage the public in open discussions.
- Planning for the *Ninth International Conference on Permafrost* to be held late June–early July 2008, in Fairbanks. Attendance at this event is expected to exceed 900 people.
- The *Helge Instad Memorial Symposium on Arctic Change* held September 8–10, 2006. More than 170 scientists from Alaska, Norway, Russia, Canada, and the lower 48 gathered at Fairbanks to commemorate the Norwegian explorer, scientist and author, who spent time with the Nunamiut (Eskimo) people of Anaktuvuk Pass, Alaska, and discuss common research areas across the Arctic countries. The symposium was co-sponsored by the Fairbanks campus and the Royal Norwegian Embassy and included a celebration officially naming Ingstad Mountain in Anaktuvuk Pass on September 10, 2006.
- A series of public presentations extending through the end of IPY, beginning with Jared Diamond (*Collapse: How Societies Choose to Fail or Succeed*) last March, Peter Smith (*The Martian Arctic*) June 27, and Dava Sobel (Latitude) March 19, 2007). Others will be selected during the next few months.
- Support for the *Arctic Institute of North America* to advance the study of the North American and circumpolar Arctic through the natural and social sciences, the arts and humanities and to acquire, preserve and disseminate information on the physical, environmental and social conditions in the North.

In conclusion, I would like to leave you with a few recommendations for legacy investments that would yield lasting returns to the Nation and our Nation's only Arctic state:

- Approve the National Science Foundation's budget to support IPY research and educational outreach. NSF is the ideal support organization to lead our Nation's IPY activities with its demonstrated commitment to polar research, and the development of a U.S. research community that is globally engaged. This is an investment that will pay huge scientific dividends, will strengthen our academic institutions, and gain the world's appreciation.
- Support the *Arctic Observing Network* (AON). The tight linkages between the physical, biological, and social systems in the Arctic, and the intensity of current and projected changes, call for a coordinated monitoring program that extends across the Arctic and provides long-term, multi-disciplinary observations. "Without such a program, it is very difficult to describe current conditions in the Arctic, let alone understand the changes that are underway or their connections to the rest of the Earth system." [1] AON would include satellites, terrestrial observatories, ocean buoys and moorings, weather stations, hydrologic monitoring stations, ecological sampling networks, Arctic residents, and other data sources, many of which already exist or are being planned. IPY offers an immediate opportunity for major progress.
- Expand network connectivity infrastructure within Alaska and from Alaska to the U.S. mainland to acceptable national standards. Currently, our main academic network connection to the outside world is OC–3. The current standard for large Internet Service Providers in the rest of the Nation is OC–192, which is 64 times faster than our connection. But this is just part of the problem. Our state is in desperate need of better high-speed connections between rural communities to ensure values that most U.S. citizens have grown accustomed to: educational opportunities, employment opportunities, and access to other information that could enrich their lives.
- Update high-resolution digital imagery and elevation data coverage for Alaska. These fundamental datasets are critically important in emergency response,

[1] *Toward an Integrated Arctic Observing Network,* Committee on Designing an Arctic Observing Network, National Research Council, ISBN: 0–309–10052–6, 128 pages, 8½ x 11, paperback, 2006.

wildfire behavior modeling, aviation safety, change detection, and making informed resource management decisions. Yet, the most recent program to acquire imagery and elevation data for Alaska was over 50 years ago. Alaska has changed and technologies have improved to the point that Alaska's maps are significantly below national standards. This year, Alaska's Governor Frank Murkowski and the State Legislature approved $2 million to initiate a Statewide Digital Mapping Initiative to "put some skin in the game." Some Federal assistance would assist us in bringing our maps up to national standards.

Thank you again for the opportunity to present this testimony today, and thank you for your interest in the International Polar Year. Please feel free to contact me if you have any additional questions.

Appendix: Endorsed IPY Projects With University of Alaska Participants

UA Faculty Member	Title
Igor Polyakov, UAF	Integrated Arctic Ocean Observing System
Hajo Eicken, Rolf Gradinger, Igor Dmitrenko, UAF	The Pan Arctic cluster for Climate forcing of the Arctic Marine Ecosystem
Sarah Fowell, UAF	The Bering Strait, Rapid Change, and Land Bridge Paleoecology
Katrin Iken, UAF	Impact of CLImate induced glacial melting on marine and terrestric COastal communities on a gradient along the Western Antarctic PENinsula (ClicOPEN)
JingFeng Wu, UAF	International Polar Year GEOTRACES: An international study of the biogeochemical cycles of Trace Elements and Isotopes in the Arctic and Southern Oceans
Matt Nolan, UAF	The dynamic response of Arctic glaciers to global warming
Virgil L. (Buck) Sharpton, UAF	International Polar Year (IPY) Data and Information Service (DIS) for Distributed Data Management
Vladimir Romanovsky, Larry Hinzman, Gary Kofinas, Matt Nolan, Tom Osterkamp, Chien Lu Ping, Buck Sharpton, Kenji Yoshikawa, Doug Kane, Donald (Skip) Walker, UAF	Permafrost Observatory Project: A Contribution to the Thermal State of Permafrost
Peter Schweitzer, Anne Sudkamp, UAF	International Congress of Arctic Social Sciences VI in Nuuk, 2007–2008
Bernard Coakley, Sarah Fowell, Leonard Johnson, UAF	Plate Tectonics and Polar Gateways in Earth History
Scott Bailey, UAF	Synchronized observations of Polar Mesospheric Clouds (PMC), Aurora, and other large-scale polar phenomena from the International Space Station (ISS) and ground sites
David Atkinson, UAF	Arctic Circum-Polar Coastal Observatory Network
Hajo Eicken, Jennifer Hutchings, Rudiger Gens, Rolf Gradinger, Mark Johnson, Virgil (Buck) Sharpton, UAF	The state of the Arctic sea ice cover: Physical and biological properties and processes in a changing environment
Douglas Kane, UAF	The Arctic Hydrological Cycle Monitoring, Modelling and Assessment Program
Jeffrey Welker, UA; Craig Lingle, UAF	The State and Fate of the Cryosphere
Martin Truffer, UAF	IPY in the Antarctic Peninsula—Ice and Climate
Ray Barnhardt, Oscar Kawagley, UAF	Circumpolar Center for Learning and Indigenous Knowledge Systems
Vladimir Romanovsky, UAF	Deep Permafrost Scientific Drilling
Gerd Wendler, Martha Shulski, UAF	Climate change in the Arctic with special emphasis on Alaska

Appendix: Endorsed IPY Projects With University of Alaska Participants—Continued

UA Faculty Member	Title
Russ R Hopcroft, UAF	Ecosystem West Greenland
Lawrence D. Kaplan, James Ruppert, Patrick Marlow, UAF	Glocalization—Language, Literature and Media among Inuit and Sami people
Matt Nolan, UAF	Bipolar Climate Machinery—A study of the interplay of northern and southern polar processes in driving and amplifying global climate as recorded in paleoclimate archives and their significance for the generation of realistic estimates of future climate and sea level development
Todd O'Hara, UAF	Polar bear (*Ursus maritimus*) circumpolar health assessment in relation to toxicants and climate change
Larry Hinzman, Vladimir Romanovsky, Igor Semiletov, Donald (Skip) Walker, UAF	Cold Land Processes in the Northern Hemisphere continents and their Coastal Zone: Regional and Global Climate and Societal-Ecosystem Linkages and Interactions
Donald (Skip) Walker, Andrew Balsar, Uma Bhatt, Keith Boggs, Brian Barnes, Rick Caulfield, Terry Chapin, Craig Dorman, Hajo Eicken, Brad Griffith, Tom Heinrichs, Larry Hinzman, John Kelly, Gary Kofinas, Hilmar Maier, Gary Michaelson, Corinne Munger, Matt Nolan, Chien-Lu Ping, Anupma Prakesh, Peter Prokein, Martha Raynolds, Vladimir Romanovsky, Mike Sfraga, Buck Sharpton, John Walsh, UAF	Greening of the Arctic: Circumpolar Biomass
Frank Willams, UAF	High Performance Computing and Mass Storage Resources for IPY Research Support
Gary Kofinas, Perry Barboza, Brad Griffith, Kris Hundertmark, Robert White, Greg Finstad, UAF	Starting the clock for the CARMA Network: Impacts on Human-Rangifer Systems in the Circumarctic
David Norton, Martin Robards, UAF	Sea Ice Knowledge and Use: Assessing Arctic Environmental and Social Change
Karen Perdue, UAF; Kathy Murray, Carl Hild, UAA	Arctic Human Health Initiative
Catherine F. Cahill, UAF	POLAR–AOD: a network to characterize the means, variability, and trends of the climate-forcing properties of aerosols in polar regions
Roger Hansen, Jeff Freymueller, UAF	Polar Earth Observing Network
Syndonia Bret-Harte, UAF	International Tundra Experiment (ITEX): impacts of long-term experimental warming and climate variability on tundra ecosystems
Martin Jeffries, UAF	The University of the Arctic: Providing Higher Education and Outreach Programs for the International Polar Year
Richard Collins, UAF	International Arctic Systems for Observing the Atmosphere
Larry Hinzman, UAF	The hydrological cycle of the Canadian Polar Regions: processes, parameterization, prediction and change
David Atkinson, UAF	Impacts of Surface Fluxes on Arctic Climate: Severe Storms, Effects on Coastal Processes and Relationships to Changing Climate
Richard Boone, UAF	Biodiversity of soil meso- and macro-fauna and latitudinal gradient impact assessment along the proposed Alaska gas pipeline
Richard Collins, UAF	The Structure and Evolution of the Polar Stratosphere and Mesosphere and Links to the Troposphere during IPY

Appendix: Endorsed IPY Projects With University of Alaska Participants—Continued

UA Faculty Member	Title
Shusun Li, Martin Jeffries, Kim Morris, UAF	Assessment of surface albedo feedback and the variability of surface radiation budget in the Arctic climate system using satellite and ground observations
Jack Kruse, UAA	The Political Economy of Northern Development
Dave McGuire, UAF	Arctic Biosphere-Atmosphere Coupling across multiple Scales
Martin Jeffries, UAF	Bering Sea Sub-Network of Community-Based Environmental Monitoring, Observation and Information Stations
Chien-Lu Ping, UAF	Response of Arctic and Subarctic soils in a changing Earth: dynamic and frontier studies
Martin Truffer, UAF	Remote sensing, monitoring, and forecast of surging glaciers' evolution with the investigation of modern fluctuations of surging glaciers of the Alaska, Svalbard and high elevated Asia glaciers
Stuart Chapin, UAF	Polar Disturbance and Ecosystem Services: Links between Climate and Human Well-being
Martin Jeffries, UAF	Consortium for coordination of Observation and Monitoring of the Arctic for Assessment and Research
Maribeth Murray, UAF	The Impacts of Oil and Gas Activity on Peoples in the Arctic Using a Multiple Securities Perspective
Martin Jeffries, UAF	Integrated Communication, Education and Evaluation
Rolf Gradinger, Russ Hopcroft, Bodil Bluhm, Falk Huettmann, Rob Cermak, John Kelley, Stephen Jewett, UAF; Oliver Hedgepeth, UA	Arctic Ocean Diversity (ArcOD)
Martin Truffer, Roman Motyka, UAF	Measurement and Attribution of recent Greenland Ice sheet chaNgeS (MARGINS)
Scott Goldsmith, UAA	The Economy of the North
Chien-Lu Ping, Vladimir Romanovsky, UAF	Carbon Pools in Permafrost Regions
Jack Kruse, UAA	Survey of Living Conditions in the Arctic, SLiCA—Remote Access Analysis System
Elena B. Sparrow, Donald A. (Skip) Walker, UAF	Biodiversity and Climate Induced Lifecycle Changes of Arctic Spiders
Gary Kofinas, Patty Gray, UAF	ANTLER Network Secretariat and Workshop Series
Peter Schweitzer, UAF	Moved by the State: Perspectives on Relocation and Resettlement in the Circumpolar North
Todd Sherman, Jean Flanagan Carlo, UAF	International Polar Year Arctic Nations Exhibition and Activities including Symposia, Seminars, Workshops, Residencies, Documentation and Event Coordination
Todd O'Hara, Alan Springer, UAF	MERSAM (MERcurySeabirdArticMonitoring)

Chairman STEVENS. Thank you very much, Doctor.

Our next witness is Dr. Alan Parkinson, the Deputy Director of the Arctic Investigation Program, Centers for Disease Control and Prevention, in Anchorage.

Doctor, nice to have you with us.

STATEMENT OF ALAN J. PARKINSON, PH.D., DEPUTY DIRECTOR, ARCTIC INVESTIGATIONS PROGRAM, CENTERS FOR DISEASE CONTROL AND PREVENTION, DEPARTMENT OF HEALTH AND HUMAN SERVICES

Dr. PARKINSON. Thank you very much, Chairman Stevens, Senator Murkowski. I'm very pleased to be here today to describe to you our national efforts to use the International Polar Year and the Arctic Human Health Initiative to increase the visibility of human health concerns of Arctic peoples.

Human health has not been a research theme of any previous Polar Year, so we see this event as an opportunity for the United States to take a leadership role in the International Polar Year by supporting human health research, disease prevention, and control activities that will improve the health and well-being of Arctic residents.

While much has been achieved since the last Polar Year, some 50 years ago, to improve the health of Arctic residents, life expectancy is shorter, and infant mortality rates are still higher among the indigenous Arctic residents. These health disparities can be resolved with greater understanding of their causes through research and by focused application of existing health strategies.

The rapid pace of change in the Arctic is presenting new challenges, as you heard earlier. Of particular concern are the potential health impacts of climate change, environmental pollutants, and economic development. The Arctic is unique in many aspects, but one particularly important aspect is the spirit of cross-border cooperation. And on issues of human health, the international cooperation is facilitated through the working groups of the International Union for Circumpolar Health and the Arctic Council. Nationally, the U.S. interagency cooperation on Arctic research is grounded in the Arctic Research and Policy Act of 1984, which established the Arctic Research Commission, which has emphasized human health as a special interagency focus area.

These international and national partnerships have led to the creation of the Arctic Human Health Initiative, which is an Arctic Council IPY Project which is being led by the U.S. Department of State, the CDC, and other U.S. interagencies and international partners. And the goal of this initiative is to use the Polar Year to really increase the public and political awareness of the human health concerns of Arctic peoples, and through international collaborative research, jointly develop strategies that will—which will improve the health and well-being of all Arctic residents.

The Arctic research programs of the CDC are focused on improving public health in Arctic communities. Programs currently are conducted by the National Center for Infectious Disease, the National Center for Environmental Health, the National Center for Chronic Disease Prevention and Health Promotion, and the National Institute of Occupational Safety and Health. And these programs are conducted with—in collaboration with partnerships with the State of Alaska Division of Public Health, the Alaska Native Tribal Health Consortium, regional tribal health corporations, the Indian Health Service, the National Institutes of Health, University of Alaska, and other state and local agencies.

The mission of the Arctic Investigations Program is prevention and control of infectious diseases among the residents of the Arctic and sub-Arctic. And we focus particularly on the elimination of the health disparities caused by infectious diseases that exist among indigenous populations of these regions. The National Center for Environmental Health is concluding studies of the levels of human exposure to environmental pollutants in the Arctic and the potential role of these contaminants as co-factors in breast cancer in Alaskan Natives. The National Center for Chronic Disease Prevention and Health Promotion is actually just beginning a study to generate new information on nicotine carcinogens in commercial and homemade chewing tobacco. And, of course, the Alaska Field Station of the National Institutes of Occupational Health and Safety is continuing studies aiming at decreasing the number of—and rate of work-related injuries among industries that face the extreme hazards of the Arctic environment.

In summary, the IPY presents us with a unique opportunity to focus political and public attention on the health concerns of Arctic communities and to develop collaborative international programs, research programs, that will address those concerns.

The improvements in the health status already achieved by Arctic peoples provide hope that, through concerted effort, clear vision, existing health challenges and disparities can be overcome. We believe that the U.S. leadership and scientific contributions of the International Polar Year and the Arctic Human Health Initiative are an important step in this direction.

Thank you for your attention, and I am happy to answer any questions.

[The prepared statement of Dr. Parkinson follows:]

PREPARED STATEMENT OF ALAN J. PARKINSON, PH.D., DEPUTY DIRECTOR, ARCTIC INVESTIGATIONS PROGRAM, CENTERS FOR DISEASE CONTROL AND PREVENTION, DEPARTMENT OF HEALTH AND HUMAN SERVICES

Good afternoon, Chairman Stevens, Chairman Lugar, and members of both Committees. I am Alan Parkinson Deputy Director of the Centers for Disease Control and Preventions, Arctic Investigations Program located in Anchorage, Alaska. I am pleased to be here today to describe our national efforts to use the International Polar Year (IPY) and the Arctic Human Health Initiative (AHHI) to increase the visibility and awareness of human health concerns of Arctic peoples and to coordinate at the national and international level research programs that will improve the health and well-being of Arctic residents. As you have heard from previous speakers, the IPY is an intensive one year multi-disciplinary program of collaborative international science, research, education, and communication focusing on the Arctic and Antarctic regions.

The years 2007–2008 will mark the 50th anniversary of the International Geophysical Year, and the third IPY. This event has been designated the 4th IPY by the National Academy of Science, International Council of Science, the World Meteorological Organization, the Arctic Council, and many other international organizations. This period of focused activity promises to "further our understanding of the physical and social process in polar regions, examine their globally-connected role in the climate system and establish research infrastructure for the future, and serve to attract and develop a new generation of scientists and engineers with the versatility to tackle complex global issues." U.S. activities during the IPY will focus on highlighting research, education, and public outreach efforts, and will be coordinated among Federal agencies and international partners that support research in Polar Regions. Human health has not been a research theme for any previous Polar Year and we see this event as an opportunity for the U.S. to take a leadership role in the IPY by supporting research activities that will address the human health con-

cerns of Arctic communities and set the stage for an integrated approach to Arctic human health research beyond 2009.

Human Health Concerns of Arctic Communities

Life expectancy in Arctic populations has greatly improved over the last 50 years. In 1950, the life expectancy for an Alaska Native, the indigenous people of Alaska, at birth was 47 years compared with 66 years for the general U.S. population. By 2000, the life expectancy for Alaska Natives had increased to 69.5 years, a gain of over 20 years. Much of this improvement can be attributed to health research and public health programs that have resulted in a reduction in morbidity and mortality from infectious diseases, such as tuberculosis, and the vaccine-preventable diseases of childhood. Reductions in infectious disease mortality for Alaska Natives have been especially dramatic. In 1950, 47 percent of deaths among Alaska Natives were due to infections, as compared with only 3 percent for non-Native Alaskans. By 1990, infectious diseases caused only 1.2 percent of the Alaska Native deaths, very similar to the 1 percent seen for non-Natives. [1]

Public health research has resulted in innovations such as the provision of safe water supplies, sewage disposal, development of community-based medical providers, that have contributed to improved care and access to care for injuries and illness. Research on the negative health effects of tobacco has lead to tobacco cessation and education programs. Mortality rates for heart disease and overall cancer rates are similar in Arctic indigenous residents in relation to overall rates for the U.S., Canada, and northern European countries, with some exceptions (*i.e.,* higher incidence of gastric, nasopharyngeal, renal cancers) not explained by known risk factors .

Despite improvements in these health indicators of Arctic residents, life expectancy is shorter and infant mortality rates are higher among indigenous Arctic residents in the U.S. Arctic, northern Canada, and Greenland when compared to Arctic residents of Nordic countries. For example, life expectancy for Alaska Natives still lags behind the general U.S. population which was 76.5 years in 2000. Similarly, indigenous residents of U.S. Arctic and Greenland have higher mortality rates for injury and suicide, and hospitalization rates for infants with pneumonia and respiratory infections; many of these health disparities can be eliminated through the focused application of existing public health strategies.

A common theme across the Arctic is the rapid pace of change and its impact on the health and well-being of Arctic peoples. Some of the major trends likely to affect the health status of Arctic peoples include economic changes, improved transportation and communications, environmental pollutants, and climate change.

Living conditions have and continue to change from an economy based on subsistence hunting and gathering to a cash-based economy. Across the circumpolar north there is increasing activity toward sustainable development via local resource development, and widening involvement in the global economy. The influence of such changes on the physical health of Arctic residents on the one hand have been positive, resulting in improved housing conditions, a more stable supply of food, increased access to more western goods, and decreases in morbidity and mortality from infectious diseases. But these changes in lifestyle brought on by the move away from traditional subsistence hunting and gathering, and the societal changes brought on by modernization, in general, have resulted in an increase in prevalence of chronic diseases such as diabetes, hypertension, obesity, and cardiovascular diseases. In addition, it is well known that child abuse, alcohol abuse, drug abuse, domestic violence, suicide, unintentional injury is also connected to rapid cultural change, loss of cultural identity and self esteem.

Globalization has meant improvements in the transportation infrastructure and communications technologies such as the Internet and telemedicine innovations. Many communities once isolated, are now linked to major cities by air transportation, and are only one airplane ride away from more densely populated urban centers. Consequently these communities are now vulnerable to the importation of new and emerging infectious diseases (such as influenza, SARS or SARS-like infectious diseases, antibiotic-resistant pathogens such as multi-drug resistant tuberculosis).

Environmental contaminants are a global problem. Contaminants such as mercury, other heavy metals, PCBs, DDT, dioxins and other organochlorines, mainly originate in the mid-latitude industrial and agricultural areas of the globe, but have migrated to the Arctic via atmospheric, river and ocean transport. Their subsequent

[1] Estimates on the proportion of mortality accounted for, by infectious diseases, are based on a catchment population size of 34,000 and 87,000 Alaska Natives, in 1950 and 1990, respectively. The estimated number of mortalities amongst Alaska Natives during these 2 years, was 575 and 565, respectively.

bio-magnification in the Arctic food webs, and appearance in subsistence foods such as fish, waterfowl, marine and land mammals, and the indigenous people who rely on these foods is of great concern to Arctic residents. Potential human health effects include damage to the developing brain, endocrine, and immune system. A new concern is the role of mercury on cardiovascular diseases. Ongoing research will identify the levels and human health effects of these contaminants in Arctic residents and will provide public health guidance on both the risks and benefits of consuming traditional foods.

The changing climate is affecting Arctic communities, and is bringing economic and health threats, as well as possible opportunities. The impacts of climate change on the health of Arctic residents will vary depending on factors such as age, socioeconomic status, lifestyle, culture, location, and capacity of the local health infrastructure systems to adapt. It is likely that the most vulnerable will be those living close to the land, living a traditional subsistence lifestyle in remote communities, those already facing health related changes. Direct health-related impacts, for example may include an increase in injuries, hypothermia, and frostbite related to travel, unpredictable ice and weather conditions, and heat stress in summer. Indirect impacts include the potential changes in vector borne diseases such as West Nile virus, zoonotic infectious diseases such as brucellosis, tularemia or echinococcosis, changes in access to safe water supplies, failure of the permafrost and damages to the sanitation infrastructure, and infrastructure in general (buildings, transportation, *etc.*) changes in the traditional food supply as the migration patterns of subsistence species change in response to changing habitats. Ongoing research will identify climate sensitive indicators that will allow the prediction of health impacts and the development of mitigation strategies.

The Arctic is unique in many aspects. It can be defined by population, a population that is sparsely scattered over a very large geographical area, by climate and latitude, by seasonal extremes of temperature, light and dark, and by its spirit and history of cross-border cooperation on issues of concern to Arctic communities.

International Cooperation on Arctic Human Health

There is a long history of international cooperation on many issues affecting Arctic communities including human health and human health research.

The International Union for Circumpolar Health (IUCH) (*www.iuch.org*) is an organization comprised of the memberships of the American Society for Circumpolar Health, the Canadian Society for Circumpolar Health, the Nordic Society for Arctic Medicine, the Siberian Branch of the Russian Academy of Medical Sciences, and the Danish/Greenlandic Society for Circumpolar Health. The IUCH promotes international cooperation, research, scientific information exchange, and education in the areas of Arctic Health Policy, Birth Defects & Genetics, Cancer, Diet & Heart, Environmental Health & Subsistence Food Security, Family Health, Fetal Alcohol Syndrome, Health Surveys, HIV/AIDS, STDs, Indigenous Peoples Health, Infectious Diseases, Injury Prevention, Occupational Safety & Health, Population-Based Planning, Tobacco & Health, and Women's Health.

The Arctic Council (*www.arctic-council.org*) is a ministerial forum for cooperation between governments and indigenous peoples to address concerns and challenges common to Arctic states. Members include: the U.S. (represented by the State Department), Canada, Greenland/Denmark, Iceland, Norway, Finland, Sweden, and the Russian Federation. Indigenous peoples are represented as Permanent Participants and include: Sámi Council, Aleut International, Inuit Circumpolar Conference, Russian Association Indigenous Peoples of the North, Arctic Athabaskan Council, and Indigenous Peoples Association. Current Arctic Council human health activities include monitoring the human health impact of anthropogenic pollutants, climate variability, infectious diseases, and the expansion and assessment of tele-health innovations in Arctic regions.

National Cooperation on Arctic Human Health

The U.S. Congress passed the Arctic Research and Policy Act, in July 1984, finding that "Arctic Research expands knowledge, which can enhance the lives of Arctic residents, increase opportunities for international cooperation and can facilitate national policy on Arctic Research." The Act established the Arctic Research Commission to promote and recommend research priorities. The Commission recommended an interagency program focusing on the health concerns of Arctic residents, and designated that the National Institutes of Health (NIH) lead this effort with assistance from other agencies. We look forward to partnering with our sister agency on this recommendation.

Arctic research programs of the Centers for Disease Control and Prevention (CDC) are focused on improving public health in Arctic communities. Programs are cur-

rently conducted by the National Center for Infectious Disease (NCID), the National Center for Environmental Health (NCEH), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), and the National Institute of Occupational Safety and Health (NIOSH). These programs are conducted in collaboration with the State of Alaska Division of Public Health, the Alaska Native Tribal Health Consortium, regional tribal health organizations, the Indian Health Service, the National Institutes of Health, and other state and local agencies and organizations.

The Arctic Investigations Program, located in Anchorage, Alaska, is one of three U.S.-based field stations operated by the NCID. The mission of AIP is the prevention and control of infectious diseases among residents of the Arctic and sub-Arctic, and in particular the elimination of health disparities caused by infectious disease that exist among the indigenous populations of these regions. The AIP has led efforts to eliminate Hepatitis A&B, and invasive diseases such as meningitis caused by *Haemophilus influenzae* type b, and pneumonia caused by *Streptococcus pneumoniae* in the U.S. Arctic. The Division of Environmental Hazards and Health Effects of the NCEH together with the Alaska Native Tribal Health Consortium and the AIP are concluding studies of the level of human exposure to environmental pollutants in the Arctic, and the potential role of environmental contaminants as cofactors in breast cancer in Alaska Natives. The NCCDPHP is beginning a study to generate new information on nicotine and carcinogen exposure in users of commercial and home-made chewing tobacco. The results will be used to generate public health messages for local tobacco control programs. The Alaska Field Station of the National Institutes of Occupational Safety and Health was established to decrease the number and rate of work-related injuries among industries that face extreme hazards due to the Arctic environment. Through research, outreach with industry and community partners, and active prevention activities has resulted in a 60 percent decrease in the number of occupational fatalities since 1990. These CDC Program accomplishments and plans are reported biennially in the *Interagency Arctic Research Policy Committee Report of U.S. Arctic Research* published by the National Science Foundation Office of Polar Programs.

The AHHI and the International Polar Year

The Arctic Human Health Initiative (AHHI) is an IPY Arctic Council project, led by the U.S. Department of State, and the CDC. The aim of AHHI is to increase public and political awareness and visibility of human health concerns of Arctic peoples, foster human health research, promote health strategies that will improve the health and well-being of all Arctic residents. The AHHI will coordinate IPY projects that focus on Arctic human health research and that will advance the joint circumpolar health research agendas of the Arctic Council and IUCH.

Priority IPY human health research needs of Arctic communities includes studies that include the assessment and mitigation of human health effects of:

- Anthropogenic pollution in Arctic regions.
- Oil, gas, and other sustainable development activities.
- Contaminants and zoonotic infectious diseases on subsistence species and the traditional food supply.
- Climate variability.
- Infectious diseases including tuberculosis, HIV/AIDS, hepatitis, vaccine-preventable diseases, and emerging infectious diseases such as Avian influenza.
- Chronic diseases such as cancer, cardiovascular diseases, obesity and diabetes.
- Behavioral health issues, such as suicide, interpersonal violence and substance abuse, and unintentional injuries.

Human health surveillance, monitoring and research networks allow the monitoring of diseases of concern in Arctic communities through the development of standardized study protocols, data collection, laboratory methods, and data analysis. These networks allow the monitoring of disease prevalence over time, the determination of risk factors for disease and evaluation and implementation of disease prevention and control strategies. For example, the CDC's AIP coordinates the International Circumpolar Surveillance (ICS) of infectious diseases, which links hospital clinical and public health laboratories and institutes in the U.S. Arctic, northern Canada, Greenland, Iceland, Norway, Finland, and northern Sweden for the purposes of monitoring invasive bacterial diseases that cause pneumonia, meningitis and blood stream infections. During the IPY this system will be expanded to include the monitoring of tuberculosis in Arctic countries, and include public health centers in 14 regions of northern Russian Federation.

As of September 15, 2006, there have been more than 1,145 Expressions of Interest and 222 full proposals endorsed by the IPY Joint Committee to undertake re-

search projects during the IPY. A full description of the AHHI (full proposal number 167) can be viewed at *www.ipy.org*. The proposal has been designated by the IPY Joint Committee as a coordinating proposal under which other human health related research proposals will be managed. To date, 13 Expressions of Intent and 8 full proposals from five of the eight Arctic countries have been clustered within the AHHI.

The AHHI will coordinate research projects through an International Steering Committee led by the CDC with representation from the International Union for Circumpolar Health, Arctic Council human health working groups, indigenous people's organizations, World Health Organization, the Fogarty International Center of the National Institutes of Health and other partners. The overall role of the Steering Committee will be to carry out the aim of AHHI, review and endorse proposals, identify research gaps, evaluate progress, facilitate reporting of research findings to the research community, communities at risk, policymakers and the general public, and guide the direction of human health research beyond IPY.

The IPY presents a unique opportunity to focus public and political attention on health concerns of Arctic communities and develop collaborative, international research programs that will address those concerns. The improvements in health status already achieved by Arctic peoples provide hope that through concerted effort and clear vision, existing health challenges and disparities can also be overcome. We believe that U.S. leadership and scientific contributions to the International Polar Year Arctic Human Health Initiative are an important step.

Thank you for the opportunity to share this information with you. I am happy to answer any questions.

Chairman STEVENS. Well, thank you very much, Dr. Parkinson. We will have some questions. I think you have a very interesting role in the Arctic right now.

Our last witness is Dr. Thomas Armstrong, Earth Surface Dynamics Program Coordinator for the USGS, in Reston, Virginia.

Doctor, it's nice to have you with us, too.

STATEMENT OF DR. THOMAS R. ARMSTRONG, PROGRAM COORDINATOR, EARTH SURFACE DYNAMICS, U.S. GEOLOGICAL SURVEY (USGS), DEPARTMENT OF THE INTERIOR

Dr. ARMSTRONG. Thank you, Senator Stevens and Senator Murkowski. Thank you for having me here today to talk to you about the issue of the U.S. Geological Survey's and the Department of the Interior's activities related to the International Polar Year.

My name is Thomas Armstrong, and I am the Program Coordinator for the Earth Surface Dynamics Program at USGS. I also represent the USGS and the Department of the Interior on the Arctic Monitoring and Assessment Program's Climate Working Group and activities related to the Arctic Climate Impact Assessment.

The USGS and other bureaus within DOI will participate in the IPY through extension and enhancement of our existing programmatic activities and research assessment and long-term monitoring in the polar regions that support the missions of our organizations and address the themes and goals of the IPY. These activities span the biologic, geologic, hydrologic, geographic, and information sciences. And some of the specific activities include the development of a satellite image atlas of glaciers of Asia, Alaska, and Iceland. Some of this work has already been completed. Some of this work is in press now, including the Atlas for Alaska Glaciers. The distribution of ice sheets in the Arctic, sub-Arctic, and Antarctic are critically linked to water availability for both human and ecological needs, as well as changes in sea level worldwide, and, therefore, have global-scale ecologic and socioeconomic impacts.

These images, as part of this atlas, are part of a worldwide series that will help in assessing the current distribution of glacial ice and rates of glacial ice retreat, as well.

Another effort that's ongoing at USGS is the development of the state of the Earth's cryosphere at the beginning of the 21st century. This long-term monitoring program of the Earth has been a cornerstone of USGS throughout its history. The USGS has been monitoring many physical and biological parameters in the Arctic, and these include three benchmark glaciers for climate change, the monitoring of stream runoff, and several critical marine mammals and their health. The results of these monitoring efforts will be examined, analyzed, and reported on during the course of the IPY.

Another effort that we're conducting now, and is starting to gain a lot of momentum, is the development of the Yukon River Basin Project, which will address rates and effects of permafrost thawing in the Arctic.

USGS scientists and managers are working with a consortium of U.S. and Canadian Federal, State, and provincial agencies, university scientists, including those from the University of Alaska Fairbanks, and tribal organizations along the Yukon River Basin to initiate a major project to understand and predict climate-induced changes to the air, water, land, and biota within the Yukon Basin. This effort will provide a benchmark for tracking and understanding changes to biological communities, stored carbon, the water cycle, and human infrastructure as a consequence of climate-induced permafrost thawing and landscape change. And I'd like to point out, in a question Senator Stevens had to the first panel, we are also pursuing the possibility of providing a science and education outreach person in one of the native communities that will work with all the communities on the Yukon Basin to help establish an educational program and a stream—or a river-monitoring program for water quality with the native population.

Another effort that's ongoing at the USGS is the petroleum resource assessment of the Arctic. The USGS World Petroleum Assessment of 2000 estimated that a significant portion of the remaining oil and gas resources of the world reside in the Arctic. This follow-on study will examine Arctic basins in more detail and report on oil and gas resource potential of unexplored basins. The initial results should be completed during the course of the IPY.

And, finally, one other effort I'd like to talk about briefly with you is the Landsat 7 Image Map of Antarctica, also known as LIMA. The LIMA will create three high-quality, remotely sensed mosaics of Antarctica from more than 1200 Landsat scenes, in cooperation with the British Antarctic Survey, the National Science Foundation, and NASA.

Other agencies within the Department of the Interior are planning to carry out activities incorporating International Polar Year components. Most notably, these include the U.S. Fish and Wildlife Service as the lead agency for the Conservation of Arctic Flora and Fauna Working Group, also known as CAFF. This is part of the Arctic Council and the international development of the Circumpolar Biodiversity Monitoring Program, which will also serve to guide and coordinate monitoring activities in the Arctic region, fa-

cilitate methodologies, and address gaps in existing data on status and trends.

The Circumpolar Seabird Information Network, another new initiative led by the Service, will greatly expand the international knowledge base of the Arctic Region and its ability to address issues regarding bird species of conservation concern.

And, finally, the Minerals Management Service will continue to—its environmental and sociocultural research in and around the Beaufort/Chukchi Seas of the Arctic to support management of offshore gas and oil resources. Research planning activities include collaboration with the National Oceanographic Partnership Program, individual agencies, and research scientists to incorporate IPY components, when feasible.

This concludes my testimony. My intention was to leave you with a brief portrayal of just some of the Department of the Interior's many science, monitoring, and assessment studies, and related support infrastructure that are firmly within the scope and spirit of the International Polar Year. I thank you for the opportunity to speak with you today, and I look forward to answering any questions that you may have.

[The prepared statement of Dr. Armstrong follows:]

PREPARED STATEMENT OF DR. THOMAS ARMSTRONG, PROGRAM COORDINATOR, EARTH SURFACE DYNAMICS, U.S. GEOLOGICAL SURVEY (USGS), DEPARTMENT OF THE INTERIOR

Thank you for the opportunity to address you, and the Committees, on the issue of U.S. Geological Survey (USGS) activities related to the International Polar Year (IPY). My name is Thomas Armstrong, and I am the Program Coordinator for the Earth Surface Dynamics Program at USGS. I also represent USGS and the Department of the Interior (DOI) on the Arctic Council's Arctic Monitoring and Assessment Program's Climate Working Group, and activities related to the Arctic Climate Impact Assessment.

Background

The USGS serves the United States by providing reliable scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, manage water, biological, energy, and mineral resources; and, enhance and protect our quality of life. It is within the spirit of this mission that the USGS has developed plans for participation in the International Polar Year, working with partners in DOI, with other Federal and State agencies, and with scientific colleagues around the world.

The IPY will extend from March 2007 through March 2009. This period will commemorate the fiftieth anniversary of the 1957–1958 International Geophysical Year. The IGY, as it was called, was modelled on the International Polar Years of 1882–1883 and 1932–1933, and was intended to allow scientists from around the world to take part in a series of coordinated observations of various geophysical phenomena. The work of scientists from over 60 countries literally spanned the globe from the North to the South Poles. Although much work was carried out in the Arctic and equatorial regions, special attention was given to the Antarctic, where research on ice depths yielded radically new estimates of the earth's total ice content. In a similar spirit of discovery and understanding, IPY 2007–2009 is envisioned as an intense scientific campaign to explore new frontiers in polar science, and to improve our understanding of the critical role of the polar regions in global processes. Most significantly, IPY is envisioned as an opportunity to engage the public in polar discovery and help attract the next generation of earth scientists.

Within current funding amounts, the USGS will participate in the IPY through extension and enhancement of programmatic activities in research, assessment, and monitoring in the Polar Regions that support the scientific mission of our organization, and address the themes and goals of the IPY. These activities span the biologic, geologic, hydrologic, geographic, and information sciences and will include but not be limited to:

- Research and monitoring of the status and distribution of fish, wildlife and vegetation; determination of species at risk; permafrost evaluation to include assessment of changes in the thermal regime and feedbacks with the changing climate, organic carbon characteristics and distribution; evaluation of hydrologic inputs to the carbon budget—including the influence of large river deltas on carbon flux to the marine system, snow and water-borne contaminants and freshwater inputs; and the evaluation of surficial and geochemical processes in understanding the changing polar environment.
- Integrated monitoring for assessing the relationship between major stressors, like climate change, and regional changes in the carbon cycle of Arctic watersheds; ground and satellite-based monitoring of glaciers and icecaps for volumetric changes, and monitoring of thermal changes in permafrost; reconstruction of past climate cycles and evaluation of current changes from sediment and ice core records; monitoring and assessment of changes in rates of coastal erosion and surficial processes; evaluation of changes in status and distribution of circumpolar vegetation, fish and wildlife, and freshwater discharges in the Arctic.
- Evaluation of the nature of arctic/boreal hydrologic interactions and the relationships between climate and plant growth, productivity, permafrost depth, and resulting effects on nutrient availability and atmospheric heat sources and sinks.
- Establishment or extension of permanent monitoring infrastructure for permafrost, global seismicity, and geomagnetic activity. Assessment of energy resources in the circum-arctic area including oil, gas, coalbed methane and methane hydrates.
- While the USGS will not conduct specific social science research as a part of IPY, several of our studies will have implications for populations living in the Polar Regions. These include our energy and mineral assessments, especially studies of coalbed methane potential for providing energy to isolated communities; natural hazards monitoring; studies of scour modelling due to changes in hydrology and their impacts on manmade structures; and 3-dimensional assessments of changes in permafrost that may have serious impacts on Arctic road networks and other forms of infrastructure.
- An additional element will include the production of geospatial information related to high-resolution elevation data and digital ortho-imagery for Polar Regions of Alaska, and the development of an IPY portal on the USGS public website. The portal will provide one-stop access to USGS science datasets; information products (e.g., maps and reports); educational resources for teachers; and tools and applications (e.g., geospatially referenced index of pertinent data, bibliography of key references, scientific collaboration tools). The USGS IPY portal will be linked to Geospatial One-Stop (*www.geodata.gov*), in order to leverage geospatial data and tools available from other agencies and organizations.

Beginning with the very first geophysical and geological surveys carried out in Antarctica over a half-century ago, the USGS has maintained a long tradition of scientific monitoring, assessment, and research in the Polar Regions. The USGS has an extensive history of activities including topographic mapping and geodetic control in Antarctica, satellite and ground-based monitoring of glaciers and ice caps, research on movements, distribution patterns and adaptation of polar wildlife, operation of a seismic array at the South Pole, estimations of energy resources of the circum-Arctic, mapping of the distribution of circum-arctic vegetation, and the development of paleoclimate records from Alaskan sediments and polar ice cores.

USGS participation in the International Polar Year allows the Agency to celebrate this enduring tradition with the global polar research community and to renew our commitment to polar science at a time when the eyes of the world are focused on these fragile regions.

Numerous USGS programs are involved in research, assessment, and monitoring in the Polar Regions that support the scientific mission of the USGS and the Department of the Interior, and address the themes and goals of the IPY. Some of these specific activities and related products are listed below.

1. Research and Long-Term Monitoring of the Polar Regions

Products and activities include:

- Satellite Image Atlas of Glaciers of Asia, Alaska, and Iceland *http://www.glaciers.er.usgs.gov/html/chapters.html*

Glacial ice distribution, including major ice sheets in the arctic, subarctic, and Antarctic, are critically linked to water availability for both human and ecological needs, as well as changes in sea level worldwide. Changes in these ice masses therefore have global-scale ecological and socio-economic impacts. Over the last several decades, the majority of the world's glaciers have decreased in size and volume. These images, part of a worldwide series, will help in assessing the current distribution of glacial ice and rates of glacial ice retreat worldwide.

- State of the Earth's Cryosphere at the Beginning of the 21st Century: Glaciers, Snow Cover, Floating Ice, Permafrost and Their Impacts on Indigenous Marine Mammals

  The USGS has been monitoring permafrost temperature in the Arctic; three Benchmark Glaciers for climate change, glacier geometry, glacier mass balance, glacier motion, and stream runoff; and marine mammals for many decades. The results of those monitoring efforts will be examined, analyzed and reported on during the IPY.

- Yukon River Basin—Rates and Effects of Permafrost Thawing in the Arctic

  USGS scientists and managers are working with a consortium of U.S. and Canadian Federal, state, and provincial agencies, university scientists, and tribal organizations to initiate a major project to understand and predict climate-induced changes to the air, water, land, and biota within the Yukon River Basin. This collaborative scientific effort will provide a benchmark for tracking and understanding changes occurring throughout the Arctic and Sub-arctic region to biological communities, stored carbon, the water cycle, and human infrastructure as a consequence of climate-induced permafrost thawing and landscape change.

- Petroleum Resource Assessment of the Arctic

  The USGS World Petroleum Assessment of 2000, estimated that a significant portion of the remaining oil and gas resources of the world reside in the Arctic. This follow-on study will examine Arctic basins in more detail and report on oil and gas resource potential of unexplored basins. The initial results should be completed during the IPY.

- Landsat 7 Image Map of Antarctica (LIMA)

  The LIMA will create three high-quality remotely-sensed mosaics of Antarctica from more than 1,200 Landsat scenes in cooperation with the British Antarctic Survey. This work is also funded by the National Science Foundation.

2. USGS Facilities and Resources for Arctic and Antarctic Research

The USGS includes numerous facilities throughout the United States and Antarctica that are focused on activities that directly link to the International Polar Year. These facilities include:

- U.S. National Ice Core Laboratory, USGS, Denver, CO

  The U.S. National Ice Core Laboratory (NICL) stores, curates, and facilitates study of ice cores recovered from the polar regions of the world. It provides scientists with the capability to conduct examinations and measurements on ice cores, and it preserves the integrity of these ice cores in a long-term repository for current and future investigations. Ice cores contain an abundance of climate information, more so than any other natural source of climate information such as tree rings or sediment layers. *http://nicl.usgs.gov/*.

- U.S. Antarctic Resource Center, USGS, Reston, VA

  The U.S. Antarctic Resource Center (USARC) is the Nation's depository for Antarctic maps, charts, geodetic ground control, satellite images, aerial photographs, publications, slides, and video tapes. These resources are items produced by Antarctic Treaty parties in support of their activities in Antarctica and provided to the USARC in connection with a resolution of the treaty providing for exchange of information. *http://usarc.usgs.gov.*

- USGS Alaska Science Center, Anchorage, AK

  The USGS Alaska Science Center is a Center of Excellence for the Department of the Interior to address important natural resources issues and natural hazards assessments in Alaska and circumpolar regions through long-term data collection and monitoring, research and development, and assessments and applications. Their mission is to provide scientific leadership and accurate, objective, and timely data, information, and research findings about the earth and its flora and fauna to Federal and State resource managers and policymakers,

local government, and the public to support sound decisionmaking regarding natural resources, natural hazards, and ecosystems in Alaska and circumpolar regions. *http://alaska.usgs.gov/index.php.*

- McMurdo Long-Term Research (LTER) Program

  The USGS provides cooperative support to the McMurdo Long-Term Research program for water resources data collection and related activities. The support provided is in the form of field assistance, guidance, and review of surface-water data collection by INSTAAR and University of Colorado researchers in the McMurdo Dry Valleys (Taylor Valley and Wright Valley) of Antarctica. Cooperation is also provided in the form of guidance and support for, and access to, USGS databases and streamflow-records processing applications.

- Antarctic Seismic Data Library System (SDLS)

  The SDLS is an Antarctic Treaty effort under the auspices of the Scientific Committee on Antarctic Research (SCAR) to collate and make openly available for research purposes all marine multichannel seismic reflection data (MCS) acquired in Antarctic regions (*i.e.,* south of 60 degrees South). The SDLS was implemented in 1991 under USGS sponsorship, but since about 1996, the SDLS has been run jointly by USGS (with National Science Foundation—Office of Polar Programs and USGS funding) and Osservatorio Geofisico Sperimentale (OGS, Trieste, Italy). The seismic library has branches in 10 countries, with two branches in the United States. The MCS data are sent to the SDLS by data collectors, put onto CD–ROM and distributed to SDLS branches where they can be viewed and used under the SDLS guidelines specified in SCAR Report #9 (and addendums). To date, 60 CD–ROMs holding more than 120,000 km of stacked MCS data have been produced for SDLS branches.

- Web-Enabling the U.S. Antarctic Photography Collection From the USGS Earth Resources Observation Science (EROS) Center

  For more the 30 years, it has been USGS's privilege to archive and serve the U.S. Antarctic Program, the international Antarctic research community, and the public with access to the U.S. Antarctic aerial photography collection held at the USGS Center for Earth Resources Observation and Science (EROS). This collection consists of an estimated 400,000 frames of historical aerial photography dating back to the 1940s. This collection is the best collection of Antarctic aerial photography held by any country, and its value to the Antarctic research community will only increase with time as work and research continues in Antarctica.

  However, neither online metadata, browser images, photographs, nor film products are available via the Internet for the U.S. Antarctic Program Antarctic aerial photography collection. New technology and improved digitizing methods have made it possible to digitize the original aerial film rolls creating browse and medium resolution images of each frame. We propose to link the digitized USAP aerial photography browse and medium resolution image files to the USARC paper map-line plots, and web-enable the digitized collection in such a way that users could download images over the Internet at no cost to the user. Implementation of the proposal will result in an integrated on-line query, browsing and delivery capability for all historical USARC photography in the USGS EROS Center.

- Antarctic Geographic Place Names

  The USGS operates the U.S. Board on Geographic Names (USBGN) conjointly with other Federal agencies. In accordance with recommendations of the Advisory Committee on Antarctic Names (ACAN), the USBGN approves all new names to be used in Antarctica by the U.S. Government.

In addition to work being done by the USGS, other agencies within the Department of the Interior are planning to carry out activities incorporating International Polar Year components. Most notably:

- Fish and Wildlife Service Initiatives With the Arctic Council

  The U.S. Fish and Wildlife Service (Service) is the lead agency for the Conservation of Arctic Flora and Fauna Working Group (CAFF) of the Arctic Council. As a contribution to the International Polar Year, the Service has taken a lead role in the international development and implementation of the Circumpolar Biodiversity Monitoring Program, which will serve to guide and coordinate monitoring activities in the Arctic region, facilitate common methodologies, and address gaps in existing data on status and trends. In addition, the Service, in cooperation with representatives from other Arctic countries, will convene an

international group of experts to develop an action plan for mapping the boreal forest, a northern ecosystem critical to migratory birds and other trust species. The Circumpolar Seabird Information Network, another new initiative led by Service (and approved as well as jointly funded by the Arctic Council countries), will greatly expand the international knowledge base of the Arctic region, and it ability to address issues regarding bird species of conservation concern.

- Minerals Management Service Research

  The Minerals Management Service will continue its innovative mission-focused environmental and sociocultural research in and around the Beaufort-Chukchi Seas area of the Arctic to support management and development of offshore gas and oil resources. Research planning activities for Fiscal Year 2007–2009 include collaboration with the National Oceanographic Partnership Program, individual agencies and research scientists to incorporate IPY components when feasible. Plans include studies of marine mammals and birds and their ecosystems, mesoscale meteorology, river plume transport processes, ocean circulation, sea-ice modeling and potential collaboration with the developing Arctic component of the Integrated Ocean Observing System (IOOS).

This concludes my testimony. My intention was to leave you with an accurate portrayal of just some of the Department of the Interior's many science, monitoring, and assessment studies and related support infrastructure that are firmly within the scope and spirit of the International Polar Year. I thank you for the opportunity to speak with you today, and I look forward to answering any questions that you may have.

Chairman STEVENS. Well, thank you very much, Doctor. I remember so well when there were forces that tried to move USGS out of Alaska. I'm delighted to know that you're coming back and have a more robust program in our State. I think it's a very important function for us to maintain.

I'm going to let Senator Murkowski start the questioning off on this panel, please.

Senator MURKOWSKI. Thank you.

Dr. Armstrong, I'll just begin with you, since we just finished up, there. You have detailed just a few of the ongoing programs within not only USGS, but within Interior, as a whole. So, we know that there are a lot of good things going on now. We will assume that after IPY comes and goes, there will continue to be good things.

Do you—is it the expectation that the level of collaboration and sharing of the data that will be collected during these years of IPY will continue so that you, within USGS, can be working with—whether it's other agencies or other countries, in the data that they have collected and, through various programs, will continue to collect? Is that, kind of, where you see this going?

Dr. ARMSTRONG. Yes, Senator. I think one of the real beauties of our participation in IPY is the fact that this is all part of our current core program. And what IPY has been able to provide us is a focus mechanism to really focus on addressing some of the critical Arctic and polar issues, both in Antarctica and the Arctic itself. The work that we're talking about is long-term basic science, applied science, long-term monitoring and assessment, including adaptive assessment. I see this work going on well beyond the end of IPY. I think, frankly, this is not even the beginning. We've been doing a lot of this work for many years, and we'll continue to promote this work for a long time to come.

Senator MURKOWSKI. That was exactly the answer I wanted to hear.

Dr. Bell, I want to understand—recognizing your position on the International Planning Committee—if you've got some 63 different

countries, each country perhaps having a—perhaps a little bit different perspective, or looking for something a little bit different, you have all of the programs that we are hopeful will advance—in terms of how you coordinate all of this to make sure that you don't have a multitude of different projects all going after the same thing, everybody spending their dollars, how do you make sure that we are collaborating to the fullest extent possible so that we get the maximum for the dollars that will be spent?

Dr. BELL. I think that's an excellent question. And one of the tremendous differences between this International Polar Year and IGY in 1958, and the earlier two, is that—the way in which we do science. The earlier three were all—came directly out of the military and were all very top-down. And it would have been a lot easier—any one of us could have sat down and written a science plan and come up with priorities, and then shared it with people—similar people in other nations, and just decided. But the process was very different. It was much more of a grassroots process based on very much the way we run science here in the U.S. And one of the nice things is, is that the U.S. was actually ahead in the planning, and much of the framework you see was set up by the U.S. science community. It's important to remember, each of these little honeycombs is a group of scientists somewhere between, say, 20 and a couple of hundred—who have gotten together and recognized that this is an unique opportunity for them to work together. And they are working very hard to do exactly what you're asking, is to leverage the resources, and to be able to go places and ask questions and install monitoring systems that, without the IPY, we wouldn't have the motivation to do.

Senator MURKOWSKI. But who is coordinating so that the 20-some-odd scientists that are at the top of the honeycomb over here—who's telling them, "Look, the same guys are—a different group of guys are doing the same project down here. Get together with them"? Is there that level of coordination and collaboration?

Dr. BELL. There's no one sitting there—as much fun as it would be to be the one sitting there telling everybody they must work together, there's no one actually saying that groups must work together. These were grouped—all the ideas were put forward internationally. It was very much a sort of web-based approach to this, almost like an international dating service for scientists, in that all the ideas were put forward first, scientists were able to search the database, look for people who had similar ideas, and then out of that grew this honeycomb. So, all along there has been an encouragement of the community to work together, but—scientists don't always work together, but all of these are having to go through their national programs, and it's through the national programs, it's through the NSFs, the NOAAs, the NASAs, who are—the agencies are talking between nations. That's where much of the coordination is actually happening. The ideas are coming out of the scientists, and the coordination is happening at the agency level.

Senator MURKOWSKI. In your, kind of, summary, you've indicated if there's something that needs to be done, we need to have the participation, basically a buy-in by the agencies. But your second point was, we've got to increase the coordination between the projects and the countries. So, is the coordination and the commu-

nication adequate, at this point? If not, what more do we need to do?

Dr. BELL. I think it's barely adequate. It think it could be better if there was, in essence, a little bit more infrastructure working to encourage what you're asking.

Senator MURKOWSKI. On the U.S., international——

Dr. BELL. I think both U.S. and international. I think both of them are really being done on a shoestring, at this point.

Senator MURKOWSKI. And does that go through NSF?

Dr. BELL. The international coordination is currently housed at the British Antarctic Survey, some funding from the British Government, a little bit from the Chinese, and the National Academies just put forward some funds to encourage that coordination office to move forward. Within the U.S., it's really being spearheaded by NSF and through their interagency coordination.

Senator MURKOWSKI. And do you think that that's adequate?

Dr. BELL. Oh, I think there could be some more coordination happening. And I think it really requires more funding. I mean, they need a more dedicated effort.

Senator MURKOWSKI. Dr. Parkinson, did you want to chime in here?

Dr. PARKINSON. Yes. Just, perhaps, as an example to help clarify the coordination issue. If you look at the honeycomb there, and project number 167 is the Arctic Human Health Initiative, and that is the—that is a cluster project which is the result of some 13 Letters of Intent and 8 full proposals from researchers who want to do health in the Arctic. They have submitted their proposals to the International Polar Year Joint Committee, and they are now clustered under the Arctic Human Health Initiative. And that is a coordinating—we are a coordinating body for those projects, and we can help coordinate the research and the results, and make sure the results are distributed, as well.

Senator MURKOWSKI. So, you didn't all come together with the same idea. It was a group that was focused on similar issues, and you were brought together, this dating service, as Dr. Bell——

Dr. PARKINSON. Yes, correct. We had some international meetings. We had meetings in Alaska, we've been involved with the native communities across the circumpolar north, to find out what their vision was, what their ideas were for health and health research in the IPY. And so, we came back with this laundry list of concerns. You know, climate change is certainly one; environmental contaminants, so on and so forth. And then, individual researchers in various countries came forward with proposals. And one of the requirements for the International Polar Year, of course, is that it's international. And so, we would link them up with other investigators in other countries, so they're all working on the same project. And so, we'll have a international collaborative project on pneumococcal disease or environmental contaminants.

Senator MURKOWSKI. So, for instance, in your comments you've mentioned a few health concerns for Arctic people. You mentioned the infectious diseases, breast cancer, work-related injuries. Are these all areas that we are seeing proposals that have been submitted for—to be approved for IPY projects, then, through your cluster of scientists?

Dr. PARKINSON. Not all of those are addressed. Those were—that was just the list of concerns, and investigators with interests in those areas can submit proposals——

Senator MURKOWSKI. OK.

Dr. PARKINSON.—apply for funding through their specific funding sources in their particular country, and then undertake collaborative research to answer questions in that health arena.

Senator MURKOWSKI. Well, that helps me understand, a little bit better, how they come together.

Dr. Sharpton, I don't really have a question for you, but I do just want to thank you for your statement about how you envision that Alaskans and Alaska Natives will be involved, not as subjects, you said, but as research partners. And I think we view this as a real opportunity. We don't want to just welcome the scientists to come up and use the hotels and charter the air services, we want to help. And I hope that we will be viewed as just exactly that: research partners. And I would certainly encourage, in as many efforts as possible, if we can get the kids involved in the research projects, if it's as simple as going out and collecting bird feathers or whatever it might be, or making observations in their scientific notebooks in sixth grade, what we not only gain is the data that they help us with, but you instill a lifetime of scientific exploration in these kids, and you can help them make this real, as I mentioned in the earlier panel. So, thank you for including them as research partners, and we look forward to working with you on that.

I commend the University of Alaska for their, just, great efforts in moving this forward. There were a couple of different issues that you had mentioned: the network connectivity, needing to upgrade that. I think we recognize that is something that we've got to do. The mapping is just so obvious, I—I think it still stuns us to recognize how woefully behind we are in our mapping. But we look forward to working with you on those projects, as well.

Dr. SHARPTON. Thank you.

Senator MURKOWSKI. Thank you.

Chairman STEVENS. Thank you very much, Senator.

Running through the comments today, there has been this reference to maps. Now, I've been around for a little while, and I've known some of the things the Navy did there in—during the days of our standoff with the Soviet Union, and particularly the submarines. Has anyone checked to see whether the Navy has any specific maps that have been made of the areas that we're concerned with, particularly around our State?

Dr. SHARPTON. Are you addressing me, Senator?

Chairman STEVENS. Whoever.

Dr. SHARPTON. Well, actually, I think probably one of the previous panelists would probably be more appropriate to answer that.

My interest in maps really extends only to the land areas that we have. I think that's—you know, you use an entirely different type of technology for that.

Chairman STEVENS. Well, I will ask the Coast Guard again, but——

Dr. SHARPTON. Yes.

Chairman STEVENS.—it does seem to me that very clearly there has been less of a demand for maps in the polar area of the world,

in terms of population demands. And there's a great many people visiting—more people visiting Florida than there are the beaches around Barrow, so we understand the lack of maps. But I'm going to try to get a handle on, how important are these maps to the proceedings under the IPY? Dr. Bell, do you have any feeling about—how important are maps to us before we complete this IPY?

Dr. BELL. Well, you're talking to somebody who, you know, lives for understanding what's underneath ice sheets. So—and maps are how I do it, so I'm terribly prejudiced on this front. But one of—there a couple of issues, in terms of the North. There is the mapping offshore, which is certainly something you alluded to before. And there have been efforts to release some of the Navy data. And there are a number of people who could update you on exactly how much the Navy submarine data, at this point, has been released.

Certainly, moving to where we better understand both poles, in terms of what's underneath the ice, whether it's the floating ice or the ice that's fixed, is one of those goals, I think, that the science community has put forward as something that would be wonderful to come out of the IPY. It's—in the southern regions, there are actually features the size of the Alps that we don't know about, because we only have one profile. It's actually worse than Alaska, in Antarctica, in terms of understanding what the basic topography of our planet looks like. We understand Mars much better. So, it is one of those tremendous outstanding needs of our planet, to know what the fundamental shape of it is beneath both poles, because it's what underneath that's going to control how ice is going to move in the long run.

Chairman STEVENS. And are you privy to the type of technology base we have now for that mapping? Is it adequate to do the mapping you want?

Dr. BELL. Oh, do we have the—the technology exists to do it, it's really whether or not there are the focus programs that are going to go out—well, I'm not—I've been primarily—I have not talked about on-land mapping in Alaska.

Chairman STEVENS. No, I'm not talking on——

Dr. BELL. OK.

Chairman STEVENS. I——

Dr. BELL. You're talking——

Chairman STEVENS. We are——

Dr. BELL.—underneath——

Chairman STEVENS.—proceeding with the on-land mapping through Interior on an annual——

Dr. BELL. Right.

Chairman STEVENS.—basis. It's——

Dr. BELL. Right.

Chairman STEVENS.—coming along pretty well.

Dr. BELL. Right.

Chairman STEVENS. But the offshore, I don't think we have ever had a request for any.

Dr. BELL. For mapping all of the offshore.

Chairman STEVENS. Yes.

Dr. BELL. I don't think we have. I think you're right.

Chairman STEVENS. You're——

Dr. BELL. It's been very much——

Chairman STEVENS.—really interested in the characteristics of the ocean floor——

Dr. BELL. Right.

Chairman STEVENS.—right?

Dr. BELL. Right. Ocean floor and sub-ice. I'm continuing to wear my hat of looking at both poles, and sub-ice in both poles is a key unknown on our planet.

Chairman STEVENS. Well, I shall ask the staff to prepare a request from me from the—to the Department of the Navy to find out precisely what they have and how classified it is.

Dr. BELL. Yes.

Chairman STEVENS. I think that ought to be a starting point.

Now, with regard to this IPY—again, running through the testimony we've had is the question about a little bit more urgency, in terms of funding. Each of your agencies that are—each entity you have—not just entities, but—has some funding. Is this something I should have asked Mead Treadwell's—who is going to put together the proposal for the money that we—that you all would like to have, as opposed to what you've got?

Dr. Armstrong?

Dr. ARMSTRONG. Yes, you—again, going back to the USGS IPY activities, these are part of our core program. This is work that is either being conducted or will be conducted from our appropriated funds. We typically—like with the Yukon Basin study, we will be pursuing additional funding for that activity as part of my Earth Surface Dynamics Program, but it's on a program-by-program basis. But the activities that I outlined today are activities that are currently funded within our core program.

Chairman STEVENS. Well, if I were to seek to add some money to one of these appropriations bills, there would be another scream about pork. Frozen pork, I guess would be this one.

[Laughter.]

Chairman STEVENS. But are we to—are we going to see some sort of collaboration with regard to how much money is needed to make IPY a—really, the kind of function we want it to be, and how those moneys would be allocated? Is that, again, a question I should have asked the previous panel?

Dr. BELL. I think it would have been good to ask the previous panel. And I can offer you the little bit of work we did on this through the National Academies. We did two parts of planning. We put together the *Vision Report* that very much reflects the frontiers and the environmental change, themes I put on the table today, plus involving the humans in the polar regions. That came out of the *Vision Report*. But, following that, we held an interagency workshop where we brought together the agencies and had them discuss about what they do, and made a wish list, you know, because, at that point, people were being very conservative. And so, at that point there was a wish list made, and an order-of-magnitude number put on the table, but nobody's gone back and systematically looked through what's possible to do now and what sort of numbers would be necessary.

Chairman STEVENS. Do you need ships, surface ships, for your type of—developing the kind of information you need?

Dr. BELL. Me, personally? I use——

Chairman STEVENS. No——

Dr. BELL.—airplanes.

Chairman STEVENS.—your part of this basic research.

Dr. BELL. Oh, on—the basic research will involve ships, airplanes, and satellites. It will involve every tool—as well as, you know, autonomous vehicles, whether they fly or swim. I mean, the goal is to use all the technology that we have in our toolbox today.

Chairman STEVENS. Dr. Bement, you're still here, aren't you, somewhere? He left? All right. Well, I'll send him a letter and ask him about it. We just have a provision in a bill that just is ready to pass, that the NSF must pay the Coast Guard for the use of the vessels that they want to use in their basic research projects. There's a problem there of one agency assuming that the other agency is going to put up the money for their functions. But I'm trying to get a grasp on the concepts of what we need to make sure we—you go forward. How much does—let me back up and say—I tried to build a new Arctic Research Institute building in Barrow. I'm sure you all know that. But we have not succeeded yet. Is that going to be needed for this function? Is it necessary to have any more facilities in Alaska to carry out the work that you would all like to see being done?

Dr. Sharpton, what do you think?

Dr. SHARPTON. Well, I think, with the new facility that's being constructed, now, Senator Stevens, we probably have ample, but not excessive, infrastructure for Barrow. The real issue for Barrow, in my estimation, is providing the connectivity with the rest of the world. I mean, you know, it is going to be a site of tremendous scientific activity, and we've got to be able to get that information from Barrow to the rest of the world in an effective way. And so, having some means of telecommunications that is reliable and broadband is going to be absolutely essential.

Chairman STEVENS. That would be simple to do if we could get the communications bill that's currently stalled on the floor of the Senate. But I will look into that, yes.

Are there—is there anything else that you all think that is necessary to pursue this IPY that we do not have currently scheduled for—in terms of funding?

[No response.]

Chairman STEVENS. Any activities? Let me just go to Dr. Bell.

Dr. BELL. Well, I think, in essence, what the science community has been concerned about is whether or not—and this is why I don't think you can—it would be called "polar pork"—is because what the science community is looking for is funds to compete for—you know, funds that will go through the peer-review process. And the science community is concerned whether or not there will be any incremental new funds, and how much new funds. The order-of-magnitude number that was talked about at that workshop was on the order or $500 million new funds across the agency.

Chairman STEVENS. In what period of time?

Dr. BELL. Over the course of 4 years.

Chairman STEVENS. All right. That's——

Dr. BELL. And——

Chairman STEVENS.—a good figure. Dr.——

Dr. BELL. Right.

Chairman STEVENS.—Sharpton, what do you think?

Dr. SHARPTON. Well, as far as additional funding, we certainly need to have the Arctic Region Research Vessel funded. I think that's going to be an important element. It's probably not going to come online—obviously, it won't come online for IPY, but it can be considered one of those—one of those legacies that fall out of global attention to polar activity, polar issues during IPY.

Chairman STEVENS. How would you—well, let me finish this question first. What do you think, Dr. Parkinson?

Dr. PARKINSON. In terms of funding, Senator?

Chairman STEVENS. Yes.

Dr. PARKINSON. I'm——

Chairman STEVENS. What funding do you think we need that we don't have?

Dr. PARKINSON. I'm not aware of any specific funding for health, so to speak. A number of agencies are involved in the Arctic Human Health Initiative. What—the way we have been looking at it up until now is that it's some—like a potluck, where each agency brings something to the table, and we are hoping that there's enough to go around.

Chairman STEVENS. And you, Dr. Armstrong?

Dr. ARMSTRONG. As I said, we have a substantial amount of core funding in Arctic and Antarctic research, about $25 million, at USGS. We are trying to promote the establishment of larger programs in the Arctic, in Alaska, in the sub-Arctic. I—from a programmatic perspective, more money for monitoring—we can, in Alaska, a State that's so important to understanding climate change in sensitive areas, the need for more stream gauges for carbon flex monitoring, those are examples of things that we certainly need more of. And—but it's not just for USGS or the Department of the Interior, it's in cooperation with our partners at the universities—NASA, NOAA, NSF. And these are discussions that are—we have at the Climate Change Science Program, where we all get together and talk about priorities in the Arctic and the Antarctic. So, it's—there's always a need for more work to enhance what we're doing, and more funding for that. But those are just a couple of examples of things that are really needed in a place like Alaska, where, you know, for the issues that we're talking about, there is a need for substantial infrastructure.

Chairman STEVENS. How do you think our contribution as a nation to this IPY compares to other countries that are involved? Have—anybody got any judgment on that? Do you, Dr. Bell?

Dr. BELL. I think, intellectually, so far, we've been playing a leading role. Many of the programs you're familiar with—the SEARCH program, for example, the study of environmental change in the Arctic—are an integral part of the fabric and—of that overwhelming honeycomb diagram. That really captures much of the planning that came out of the U.S. science community.

I think—relative to putting the resources on the table, I think we have not—the Canadians have put $125 million, the Chinese have put $65 million, and a number of places are building new ships or new stations. So, I don't think we've quite stepped up to the plate as much as we can, as a nation, or as much as we need to, financially, to assure the leadership that we're, sort of, posed to grab.

Chairman STEVENS. Mead, how long before that wish list of yours will be ready?

Mr. TREADWELL. We can give you an analysis of what's in the Arctic plan and what's not in the budget soon. I've got an analysis of what was appropriated in NOAA last year and not requested this year, and we can get you those things.

Chairman STEVENS. How long will that take to get together?

Mr. TREADWELL. We can get you some numbers today, Senator.

Chairman STEVENS. I don't need it today. I mean—in time.

Mr. TREADWELL. The Commission will be meeting the 9th and 10th of October, and we could resolve something by that time.

Chairman STEVENS. All right. My feeling is, we ought to have, maybe, a teleconference session to really examine—when Mead gets that together—to see whether you all agree, and then we ought to try to see if we can get an appointment with OMB and Josh Bolten to see how we can get some energy behind this movement. I think we ought to be in the forefront of it. If we're not, we're going to be left behind. I'm thinking about the study that shows how we're far behind in educating our people now. I don't think we can afford to get behind in this, now. This is something we should stay ahead of. And it might be a stimulus to help us play catch-up, in terms of some of the education we need for science, math, and technology.

So, I'm going to—you deal with the substance, milady, I'll try to deal with the money.

Senator MURKOWSKI. That works for me, Senator.

[Laughter.]

Chairman STEVENS. We thank you very much and appreciate your courtesy of being with us. We look forward to working with you. I think that this is a stimulating thing, as far as Alaska is concerned, and we want to try and stay on top of it. But it cannot turn into being just an Alaska item or it'll just be knocked aside as another one of those, you know, things that have four legs and a swirly tail. So——

Dr. BELL. That's why it's so important to consider both poles as we move forward.

Chairman STEVENS. I've been down to Antarctica.

Dr. BELL. Yes?

Chairman STEVENS. We've got another scheduled trip down there.

Dr. BELL. Good.

Chairman STEVENS. We should go down again, and——

Dr. BELL. Good.

Chairman STEVENS.—maybe some of you could go along with us. Thank you very much.

[Whereupon, at 5:20 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. DANIEL K. INOUYE, U.S. SENATOR FROM HAWAII

Chairman Stevens, Senator Murkowski, thank you for calling attention to the upcoming International Polar Year (IPY). I look forward to celebrating 125 years of scientific achievement and international collaboration and expanding on this legacy of polar research in 2007 and 2008.

I am excited by the prospect that this upcoming 'burst' in scientific research will lead to a greater understanding of the unprecedented environmental change currently underway at the polar regions.

Today we face many environmental issues, but one of the greatest is global climate change. The indigenous people of the Arctic already see the effect of climate change on their lives, but it is only a matter of time before the impact of these changes will be felt around the globe.

For example, as the Earth's temperature has increased, the melting of icecaps and glaciers has become evident.

By 2100, sea levels could be several feet higher than they are now, which would have devastating effects on coastal areas, including my home State of Hawaii and the other Pacific Island nations.

We have already seen the powerful destruction a tsunami or severe weather can have on our low-lying islands, and this damage will be magnified under the National Oceanic and Atmospheric Administration's (NOAA) projections of a one to three foot rise in sea level.

The polar regions are important places for the United States to research and I am pleased that the Committees will hear about the United States' current plans to participate in the upcoming IPY, as well as actions we still must take to ensure the United States continues to support this significant research.

This effort also should attract a new generation of scientists to the study of our Earth systems—and the oceanic and atmospheric forces that drive the system.

However, I am concerned that the Administration has not provided sufficient support to NOAA and the Coast Guard to make this IPY a true success, and I hope our witnesses speak to that issue.

Adequate U.S. support for IPY is vital, not only because the scientific findings from this IPY will encourage us to be better stewards of the health of this planet, but because its true and lasting legacy will be a new generation of Earth scientists—a generation that will be tapped to reverse the awful trajectory of global warming.

PREPARED STATEMENT OF HON. FRANK R. LAUTENBERG,
U.S. SENATOR FROM NEW JERSEY

Let me thank both Chairs for today's hearing. I strongly support America's participation in the upcoming International Polar Year. In 1882, twelve countries set out on fifteen expeditions in the First International Polar Year. That expedition taught us lessons about Earth's science and geography we still rely on. It also taught us the value of international science cooperation—a legacy I hope we will continue.

I have been to Antarctica and to the Arctic. I know that changes are underway that can alter the marine life at both poles, raise each region's temperatures, and increase the sea level across our planet. Many of these changes are the result of global warming, and I hope the coming International Polar Year will deepen our knowledge into the harm global warming causes to our polar regions and globe.

Several Federal agencies will help contribute to the success of the International Polar Year, including the NSF, the Coast Guard, and NOAA. I hope the impacts of global warming, including its role in changing the ocean food chain, will be a major part of our Nation's research agenda for the International Polar Year.

I also want to talk about the condition of the Coast Guard's icebreakers. We have three vessels which break polar ice and serve as research platforms for our scientists. Two of these icebreakers are thirty years old and rife with maintenance trouble. Congress has provided insufficient funding for the Coast Guard in the past and I hope we will not repeat that mistake. Let us give the Coast Guard the money it needs, both for the Arctic and Antarctica, and for protection of America's seas.

PREPARED STATEMENT OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), DEPARTMENT OF COMMERCE

This statement for the record will provide a brief background on International Polar Year (IPY), and discuss how the National Oceanic and Atmospheric Administration (NOAA) supports this important research opportunity. IPY is an excellent opportunity to advance science and Earth observations in the polar regions. Our statement summarizes our initial plans and provides an update to expected IPY activities during Fiscal Year 2007 to Fiscal Year 2009.

IPY has been declared by the International Council of Science (ICSU) and the U.S. National Academies to extend from March 2007 through March 2009. The objectives of IPY are to explore new frontiers in polar sciences; improve our understanding of the critical role of the Earth's polar regions in global processes; create a legacy of infrastructure and data for future generations of scientists; expand international cooperation; engage the public in polar discovery; and help attract and educate the next generation of scientists and engineers.

NOAA began planning for IPY activities in the Fall of 2004. NOAA's Office of Oceanic and Atmospheric Research and programs across NOAA are using existing resources to conduct IPY-related activities. Our statement highlights work on 11 NOAA IPY-related projects. Each of these projects is associated with a formal International Council for Science-World Meteorological Organization (ICSU–WMO) IPY-endorsed project. These projects will contribute new data to Earth observing efforts, such as the Global Earth Observation System of Systems (GEOSS), and will advance understanding and predictability of the polar environment in NOAA's mission areas.

IPY Activities

Ocean Exploration in Polar Regions

NOAA's Office of Ocean Exploration (OE) solicited specific projects for IPY via *Federal Register* announcements in calendar years 2005 and 2006. OE also expects to solicit IPY-related projects during the calendar year 2007 *Federal Register* notice. OE, together with the NOAA Arctic Research Program and the Russian Academy of Sciences, plans to facilitate an expedition to the Arctic Ocean in 2008, as part of the ongoing RUSALCA (Russian American Long-term Census of the Arctic) program. The expedition will carry out a census of life in the unknown waters of the Arctic north of the United States and Russia, from the sea ice to the seafloor below. This information provides background observations necessary for the monitoring of changing ecosystems in the Pacific Region of the Arctic.

Causes and Impacts of Recent Changes in the Arctic Ocean

Unprecedented minima of sea ice area have occurred in the Arctic Ocean during the four most recent summers. Summer 2003 and 2004 brought record forest fires and drought to eastern Siberia and Alaska after a decade of warm springtime temperature anomalies. In surrounding seas there has been a northward shift of ice-dependent marine animals. Changes in the Arctic Ocean are continuing, despite the observation that climate indices such as the Arctic Oscillation were negative or neutral for six of the last 9 years. The Arctic Ocean may have a larger role in shaping the persistence of Arctic change than has been previously recognized. We will work with our partners to carry out observations in this area to measure movement of water through the Bering Strait, gather observations about physical change in the state of the ocean in the Bering and Chukchi Seas, and study impacts of physical change on marine ecosystems in this region. Bering Strait mooring programs will be conducted, as well as mooring and ship-board studies in the eastern Bering Sea. Limited ship-board studies will be made in ice-free areas in the vicinity of Bering Strait and Chukchi Sea in association with mooring cruises. (For more information, see *www.arctic.noaa.gov.*)

Polar Atmospheric Observatories and Field Campaigns

As part of the IPY project "International Arctic System for Observing the Atmosphere," a system of strategically located, long-term atmospheric observatories will

be developed around the Arctic to carry out both routine measurements made at meteorological stations and intensive measurements at the surface and through the depth of the atmosphere. Measured quantities can include solar radiation, aerosols, air chemistry, trace gases, cloud properties, water vapor, ozone, temperatures, winds, precipitation, surface albedo, and stratospheric properties. These measurements are essential to calibrate and validate satellite sensors and to improve the reliability of climate models. The atmospheric observatory partnership includes the United States, Canada, Russia, Norway, Finland, and China. NOAA's existing baseline observatories at Barrow Alaska and South Pole will continue to focus on measurements of trace gases and aerosols.

Polar Stratospheric Ozone Depletion Observations

As a part of the International Geophysical Year in 1957, column ozone measurements were initiated at South Pole, Antarctica, using Dobson spectrometers. NOAA scientist, Susan Solomon, was the leading scientist in identifying the cause of the annual stratospheric ozone depletion over Antarctic known as the ozone hole, first observed in the early 1980s. Solomon and her colleagues suggested that chemical reactions involving man-made chlorine from chlorofluorocarbons (CFCs) interacting with icy clouds in the cold polar stratosphere could be responsible for the unprecedented losses of ozone during the Antarctic springtime. She then led two U.S. scientific expeditions to Antarctica in 1986 and 1987 that succeeded in providing key observations confirming the theory. The Arctic stratospheric ozone changes, though lesser in magnitude than the Antarctic ozone hole, are by no means of lesser importance. Key studies will be undertaken in the Arctic to monitor these changes. Routine observations of ozone will continue at Barrow and South Pole during IPY. These projects are continuations of NOAA's ongoing stratospheric ozone depletion measurement programs.

Antarctic Living Marine Resource Survey

The principal objective of the NOAA Antarctic Living Marine Resource research program is to collect the scientific information needed to detect, monitor, and predict the effects of harvesting and associated activities on target, dependent, and related species and populations of the Antarctic marine living resources and the ecosystem(s) of which they are a part. A 35-day ship-based research program is planned for Fiscal Year 2007.

Short-Term Arctic Predictability

A scientific study in short-term Arctic predictability will explore the variability, and associated predictability of weather, sea ice, ocean wave, and land surface processes in the Arctic Region in the 3–90 days time range, with special emphasis on improving forecast guidance for high impact events in the 3–14 day lead time range. NOAA will complete a study of northwest Alaskan coastal waves during the IPY. NOAA will also participate in sea ice studies at both poles aimed at improving measurement of ice thickness and forecasting. The NOAA THORPEX program will make observations and introduce forecast products to improve weather and intraseasonal forecasts for the Arctic.

Advances in Satellite Products and Their Use in Numerical Weather Prediction

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

Arctic Climate Modeling

The general goal of the Arctic climate modeling project is to improve predictions of the Arctic environment on timescales ranging from seasonal to decadal. Thus, our research will focus on analyzing and modeling the physical processes and connections between the Arctic and the rest of the globe. NOAA will continue to improve global climate models that include polar processes.

Arctic System Reanalysis

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

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

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

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

NOAA intends to build and maintain a pan-Arctic view of climate variability and change that will serve decisionmakers with information products. These range from baseline atlases against which future assessments can be carried out, to the Near Real-time Arctic Change Indicator website (*http://www.arctic.noaa.gov/detect/*), where information on the present state of Arctic ecosystems and climate is given in historical context. NOAA Data Centers will assist NOAA scientists to archive their IPY data. NOAA will continue to acquire historical data and present it on the Arctic Change Indicator website to describe the state of the Arctic climate over the past 150 years, allowing a better context for new data collected during IPY.

Decision Support for Increasing Adaptive Capacity to Climate Change and Variability in Alaska and the Arctic

The cornerstone of NOAA's Regional Climate Decision Support program for Alaska and the Arctic is to establish an integrated program spanning stakeholder-influenced research and development of decision-support tools for the sustained delivery of customer services. This includes establishing in Alaska a Regional Integrated Sciences & Assessments (RISA) to foster growth of climate services. NOAA plans to initiate the Alaska RISA, in 2006, through the University of Alaska. The Alaska RISA is a 5-year program designed to address regionally important climate issues to aid policy and decisionmaking. The Alaska RISA program could contribute significant results to our understanding of key climate related challenges facing the state, and would allow for innovative partnerships with neighboring countries.

NOAA is part of the U.S. presence in the Arctic Council. The Arctic Council plans to conduct several assessments during the IPY period, including the Arctic Marine Shipping Assessment, an assessment of the Arctic carbon cycle, and others. NOAA will provide expertise and financial support within available resources. NOAA expects to contribute to the Arctic Council climate-related assessment tasks during IPY.

Other Activities

Ice Services

The National Ice Center (NIC) is a U.S. Government agency that brings together elements from NOAA, the U.S. Navy, and the U.S. Coast Guard to support coastal and marine sea ice operations and research globally. The mission of the NIC is to provide the highest quality strategic and tactical ice services tailored to meet operational requirements of U.S. national interests. Over the Arctic, particularly, the NIC provides operational strategic basin-scale sea ice charting. The NIC products include a hemispheric and over 30 individual regional charts, sea ice tactical ice navigation support, Chukchi Sea and Beaufort Sea ice seasonal forecasts. In addition, the NIC supports the development of sea ice climatology for the Arctic, and manages the U.S. Interagency Arctic Buoy Program (USIABP). The NIC is participating directly or indirectly in an increased number of research and application cooperative projects with other national and international groups as part of IPY activities throughout 2007 and 2008.

Snow and Ice Data

NOAA's National Data Centers handle a wide variety of Arctic data. An affiliated data center, the National Snow and Ice Data Center (NSIDC), part of the Coopera-

tive Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder, has a NOAA NESDIS supported program (*http://nsidc.org/noaa/*) to produce and manage selected datasets. Significant datasets are the Online Glacier Photograph Collection of over 3,000 photographs dating to the late 1800s; upward looking sonar data from submarines, providing estimates of sea ice thickness; and the Sea Ice Index, a site that shows, with graphical products, trends and anomalies in sea ice cover. Overall, the NOAA team at the NSIDC emphasizes data rescue and *in situ* data. This emphasis helps collect and maintain the long-time series with broad spatial coverage that is necessary to track and attribute Arctic change. The program complements the activities of the Distributed Active Archive Center, a NASA funded center at NSIDC that supports the bulk of NSIDC's activities.

Education

NOAA's Climate Program Office is leading a NOAA-wide effort with respect to the IPY. The Climate Literacy Working Group, based at the Climate Program Office, is coordinating NOAA-wide IPY education and outreach activities with the NOAA Office of Education. The NOAA IPY effort is part of the NSF-led interagency IPY education effort, and will collaborate and coordinate their efforts with agencies participating in the IPY. Several formal and informal education initiatives are focusing primarily on teacher professional and science center or museum exhibitions. In addition, several formal lesson plans will be developed as part of our IPY efforts.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DANIEL K. INOUYE TO VICE ADMIRAL ROBERT PAPP

Question 1. How much would it cost and how long would it take to replace the POLAR STAR and POLAR SEA?

Answer. Initial estimates to replace the POLAR STAR and POLAR SEA are $600 to $700 million per vessel (2006 dollars). A more accurate assessment of resource needs will be required after the capability and initial design requirements are completed during the major acquisition process.

Once funds are appropriated for a polar icebreaker major acquisition, it will take approximately 8 to 10 years to complete construction of the polar icebreakers and have them ready to support polar operations.

Question 2. Can we expect funding in the Fiscal Year 2008 budget request to begin the process of replacing these two icebreakers? If not, why not?

Answer. No. Although the recently released National Research Council's (NRC) report "Polar Icebreakers in a Changing World: An Assessment of U.S. Needs" recommended the "United States immediately program, budget, design, and construct two new polar icebreakers to be operated by the Coast Guard," the Coast Guard is seeking an updated national policy on icebreaking before the service begins the acquisition. The Coast Guard is in the process of requesting a revised national policy from the National Security Council (NSC), and will be poised to start the acquisition if the Administration identifies the Coast Guard as the best Agency to continue providing national icebreaking services.

Question 3. Does the Administration and Coast Guard have a plan for how the United States is going to meet our immediate icebreaker needs until the POLAR STAR and POLAR SEA can be replaced?

Answer. Provided a national policy decision is made that identifies the Coast Guard as the lead agency for icebreaking operations, it will take approximately 8–10 years to complete a major acquisition to replace POLAR SEA and POLAR STAR.

In the interim, provided NSF will adequately fund, the Coast Guard will:

1. Continue sustainment maintenance work on POLAR SEA to gain additional years of service-life.

2. Recommend completing sustainment maintenance on POLAR STAR similar to what has been completed on POLAR SEA. Over a 2 to 3 year period, this would likely require $25 to $30 million additional funds but would extend the life of POLAR STAR by 4–8 years, and effectively restore the U.S. polar icebreaker fleet to three vessels. This would reduce operational risk to the U.S. Antarctic Program and would eliminate NSF's need to rely on foreign icebreakers.

3. Investigate increasing HEALY's annual operating days. HEALY currently operates at a Coast Guard standard 185 days away from homeport each year with one crew. The Coast Guard is investigating crewing options and resource requirements to increase the annual use of HEALY in the Arctic.

Question 4. What does the Coast Guard recommend as a strategy to fill our gaps in capacity during this transition period?

Answer. If a national policy decision were to be made that identifies the Coast Guard as the lead agency for icebreaking operations, it will take approximately 8–10 years to complete a major acquisition to replace POLAR SEA and POLAR STAR.

If the Coast Guard is identified as the lead agency, then along with continuing sustainment maintenance work on POLAR SEA, the Coast Guard would also recommend:

1. Completing sustainment maintenance on POLAR STAR similar to what has been completed on POLAR SEA. Over a 2 to 3 year period, this would likely require $25 to $30 million additional funds, but would extend the life of POLAR STAR by 4–8 years, and effectively restore the U.S. polar icebreaker fleet to three vessels. This would reduce operational risk to the U.S. Antarctic Program and would eliminate NSF's need to rely on foreign icebreakers.

2. Increasing HEALY's annual operating days. HEALY currently operates at a Coast Guard standard 185 days away from homeport each year with one crew. The Coast Guard is investigating crewing options and resource requirements to increase the annual use of HEALY in the Arctic.

3. Restoring budget authority for polar icebreakers to the Coast Guard and funding the program to sufficiently support three polar icebreakers.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO VICE ADMIRAL ROBERT PAPP

Question 1. Has funding been adequate to maintain all three of the Coast Guard's icebreakers?

Answer. No. In order to fully support the HEALY and POLAR SEA's operations and maintenance needs, the National Science Foundation (NSF) decided to place POLAR STAR "In Commission, Special" caretaker status.

Question 2. How is the Coast Guard going to carry out its polar icebreaking mission now and in the future, given the state of the two polar icebreakers?

Answer. Given that appropriations for polar icebreaking operations were transferred to the National Science Foundation (NSF) in FY06, and the NSF now pays the Coast Guard to operate and maintain the polar icebreaking fleet, all missions are executed only after close coordination between the NSF and Coast Guard.

To help preserve the Coast Guard's ability to be the sole U.S. provider of polar icebreaking services, POLAR SEA recently completed nearly 2 years of sustainment maintenance which should extend its service life by approximately 4–8 years, depending on ice conditions and annual use.

Historically, POLAR SEA and POLAR STAR would alternate Deep Freeze missions due to the arduous nature of the ice conditions encountered, and to allow a backup in case the primary vessel broke down. This practice aligns with the 1990 Presidential Determination on polar icebreakers, which the Coast Guard still considers to be sound policy.

With the POLAR STAR in caretaker status, the National Science Foundation (NSF) plans to use foreign icebreakers to provide contingency capability in the Antarctic, and therefore is willing to accept a higher level of risk to the mission. To reengage POLAR STAR for an extended period of time, it would require approximately 2 years of sustainment maintenance similar to what POLAR SEA recently completed.

HEALY was commissioned in 1999, and is operating well. The Coast Guard is studying options to increase HEALY's annual Days Away from Homeport (DAFHP) from the service-standard 185 to up to 300 days per year to accommodate national polar research demands.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO VICE ADMIRAL ROBERT PAPP

Question 1. In their recent report "Polar Icebreakers in a Changing World: An Assessment of U.S. Needs," The National Academy of Sciences concludes that with repair work deferred due to inadequate funding "U.S. icebreaking capability is now at risk of being unable to support national interests in the north and south." Does this assessment fit with the Coast Guard's view of current icebreaking operations? If so, what is the level of resources necessary in order to ensure adequate icebreaking capacity?

Answer. Yes. By putting the POLAR STAR in caretaker status, the National Science Foundation (NSF) has accepted a higher level of risk to the U.S. Antarctic Program resupply effort.

To maintain an acceptable level of risk, two heavy icebreakers are needed for the McMurdo icebreaker mission. Rather than keep POLAR STAR in service, NSF has opted to contract with foreign icebreakers to backup POLAR SEA. In 2005 and 2006, NSF contracted the Russian icebreaker KRASIN, and NSF has contracted the Swedish icebreaker ODEN for 2007. Not only are these icebreakers less capable than POLAR STAR, they are also subject to being reprioritized by their company or country to support non-U.S. missions.

In the long-term, *three* properly configured U.S. polar icebreakers would be sufficient to support the annual U.S. Antarctic Program resupply effort and maintain a continuous presence in the Arctic. To further meet the needs of the polar research community the Coast Guard is investigating options to increase HEALY operational days from 185 to 300 days per year. A fleet mix analysis is necessary, but additional ice-strengthened vessels may also be required to preserve future national interests in the Arctic.

Question 2. The POLAR SEA and the POLAR STAR are nearing the end of their thirty-year design lives. The National Academy of Sciences recommends that the Coast Guard "immediately program, budget, design, and construct two new polar icebreakers to be operated by the U.S. Coast Guard" to replace these aging assets. Do you agree with this recommendation?

Answer. A national policy decision by the Administration would have to identify the Coast Guard as the primary national service provider for icebreaking before the service would commence a major acquisition project to replace POLAR SEA and POLAR STAR.

Question 3. Has the Coast Guard begun to take steps to plan for the long-term replacement or recapitalization of these unique assets, and if so, could you please describe these steps for me?

Answer. Yes, to prepare for the Administration's revised national policy decision, the Coast Guard has completed some preliminary steps to support long-term replacement or recapitalization. In 2005, the Coast Guard completed a mission analysis study and funded the National Research Council's assessment of polar icebreaker needs in 2006. In addition, the Coast Guard has completed some preliminary analysis on Service Life Extension Project (SLEP) options for the POLAR SEA and POLAR STAR. However, a national policy decision by the Administration would have to identify the Coast Guard as the primary national service provider for icebreaking before the service would commence a major acquisition project to replace POLAR SEA and POLAR STAR.

Question 4. As you know, the Administration is again proposing that funding for the Coast Guard's polar icebreaker fleet be routed through the National Science Foundation (NSF), despite recommendations by the National Research Council (NRC) that the Coast Guard should be budgeted funds to maintain the fleet. Admiral, has this arrangement worked to the satisfaction of the Coast Guard?

What steps will the Coast Guard take this year to ensure transfer of funds from NSF in a timely fashion?

Answer. In the short-term, this arrangement has worked, since it has isolated the polar icebreaker budget from other Coast Guard programs.

In the long-term, NSF and several of their Congressional staffs have stated that if the polar icebreaker budget authority remains with NSF, then NSF should only be required to support NSF's mandates; not all USCG mandates that pertain to use of the polar icebreakers (i.e. Enforcement of Laws & Treaties, Search & Rescue, or Pollution response). Since the frequency and importance of other USCG missions are expected to expand in the Arctic and Antarctic, continued funding through NSF could become more problematic. In addition, NSF has stated that they prefer to contract polar icebreaker services. The Coast Guard has already seen NSF reprioritize polar icebreaker funds to contract for foreign icebreakers to support the U.S. Antarctic Program. Use of foreign icebreakers weakens the U.S. polar icebreaker program and diminishes our ability to project power and influence into the polar regions at a time of growing interest, especially in the Arctic. The NRC report, and the 1990 Presidential Determination on U.S. polar icebreaker requirements, state that national sovereignty and projection of power and influence are key aspects of the U.S. polar icebreaker program.

For Fiscal Year 2007, the Coast Guard has submitted a spend plan to NSF requesting $57 million. NSF is currently reviewing the spend plan. Even though the spend plan is still being negotiated, NSF has given the Coast Guard authority to

spend $20 million during the first quarter of FY07 while NSF operates under a continuing resolution.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DANIEL K. INOUYE TO DR. ARDEN L. BEMENT, JR.

Question 1. The IPY envisions establishment of polar observing equipment and monitoring systems that will eventually need to be taken over and maintained after the close of the IPY, beginning in 2009.

What kind of fiscal burden will taking over these systems place on NOAA?

Answer. NSF is aware that NOAA received the same question and they are the lead agency to address this issue.

Question 2. To the best of your knowledge, what other Federal agencies will be responsible for maintaining post-IPY observing and monitoring activities?

Answer. NOAA is already supporting important components of the system, particularly in establishing climate reference stations working with Canadian and Russian counterparts. NOAA is also supporting key observations in the Bering Strait. It is critically important that NOAA support these activities beyond IPY. NASA will provide access to critical remote sensing synoptic observations from satellites (also with NOAA) during and beyond IPY. Continued support of DOE measurement programs in Alaska is also important, as is a continuation of important DOI (USGS) river discharge measurements. The U.S. Coast Guard, which operates the Nation's fleet of polar icebreaking ships, has requested that NOAA identify the polar icebreaker support required for maintaining polar observing systems.

Question 3. What will happen to the scientific knowledge gained through polar monitoring and research if we do not have resources to continue monitoring during and after IPY?

Answer. Science results will be published and basic data will be archived in National Data Centers. However, the core issues and questions related to the changing Arctic cannot be resolved in such a short time window as the IPY. Fundamentally, the rationale for an Arctic Observing Network (AON) is for observations on decadal time scales.

Question 4. The U.S. Antarctic Marine Living Resources (AMLR) program, managed by the National Marine Fisheries Service (NMFS), supports international efforts to protect the Antarctic and its marine life through the Commission for Conservation of Antarctic Marine Living Resources (CCAMLR). CCAMLR has planned a Southern Ocean synoptic predator-prey study, formally recognized and designated as IPY's lead project for the topic "Natural Resources, Antarctic." At one point, AMLR was prepared to offer ship time to the project.

At this time, what resources does the AMLR Program plan on dedicating to IPY-related activities?

Question 5. Is that level sufficient to fulfill U.S. commitments in support of CCAMLR?

Question 6. Is the level of participation the U.S. is currently envisioning to dedicate through AMLR to this project likely to compromise CCAMLR's ability to participate meaningfully in the IPY?

Answer to Questions 4–6. NSF is aware that NOAA received the same three questions about its programs. They are the lead agency to address these issues.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARIA CANTWELL TO DR. ARDEN L. BEMENT, JR.

Question. What steps will NSF take to ensure that funds for the polar icebreaker fleet are transferred to the Coast Guard in a timely fashion so that maintenance will not be delayed or compromised?

Answer. As outlined in the MOA between NSF and USCG, NSF annually tasks the USCG polar icebreakers. USCG submits a corresponding budget. NSF and USCG negotiate the budget and, once agreement is reached, NSF approves the budget. NSF issues a Letter of Intent to USCG for the approved budget, and reimburses USCG as expenses are incurred for approved tasking. In cases where NSF is operating under a Continuing Resolution, and, therefore, funds are limited (as has been the case for the two years that NSF has had fiscal responsibility for the polar icebreaker program), USCG submits its cash-flow requirements to NSF. This document outlines the funds required on a monthly basis for personnel, operations, and maintenance contracts. Provided NSF has sufficient spending authority under

the Continuing Resolution, NSF reimburses USCG on a monthly basis. The working relationship between USCG and NSF officials responsible for managing the MOA appears to be effective.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO DR. ARDEN L. BEMENT, JR.

Question 1. Why has the NSF spent appropriated funds for chartering foreign vessels, rather than for operations and maintenance of the Coast Guard's fleet of icebreakers?

Answer. Resupply of the McMurdo and South Pole Stations, as well as temporary remote field stations in Antarctica, is necessary to meet both research and longstanding U.S. geopolitical policy goals. It depends on gaining access to the McMurdo pier through the sea ice in McMurdo Sound. In most previous years, the channel was opened by one U.S. Coast Guard Polar Class vessel (either the POLAR STAR or the POLAR SEA), but more recently two icebreaking vessels have been needed due to extreme ice conditions and concerns about the reliability of the aging polar icebreakers.

NSF has made significant investments in maintenance of the USCG polar icebreakers. Thus, the POLAR SEA is ready for duty and will be used for the upcoming Antarctic break-in. However, USCG has recommended that a backup vessel be available, and there is no U.S. icebreaker capable of providing this assistance. NSF has therefore concluded a charter for the Swedish icebreaker ODEN as back-up for the POLAR SEA this December and January.

In addition, Presidential Memorandum 6646, as well as guidance from Congressional appropriations committees, directs NSF to find the most cost-effective, reliable means of achieving the national goals of the U.S. Antarctic Program.

Question 2. The Bush Administration has already established a record of censoring scientists with whom it disagrees on global warming. How will you both ensure that the research for the International Polar Year is selected, and conducted, without interference from the White House?

Answer. The Administration values science as a basis for effective action in its service to the public, and regards the timely, complete, and accurate communication of scientific information an important part of that service. Administration guidance has required Federal agencies to develop, revise, or re-emphasize policies related to scientific openness, and to ensure that employees and management understand their rights and obligations under these policies.

Specific to NSF, the Foundation will determine which proposals to fund by asking expert independent scientists, identified by cognizant NSF staff, to assess the proposals' merits against the standard NSF merit review criteria (intellectual merit; broader impacts) and the guidelines established by the National Academies of Science National Research Council. The latter guidelines were published in the NAS/NRC document, "A Vision for the International Polar Year 2007–2008."

As with all other projects selected and supported by NSF, NSF does not interfere with grantees' conduct of their research, other than to monitor it to insure that it is being conducted as proposed. NSF does not have its own research laboratories; and, therefore, the proposed projects will come from independent scientists and engineers who are not government scientists: but are from academic institutions.

Question 3. What assurances can you give us that the results of the U.S. research will be communicated freely and clearly by U.S. scientists, even if they conflict with the views of the White House and the oil and automobile industries?

Answer. Since NSF does not have its own research laboratories, the scientists and engineers we support are typicay members of universities, colleges, and independent laboratories, not government employees. NSF expects all grantees to publish their research results in the open literature so that all research and education communities have access to the data. NSF does not involve itself in the preparation of the manuscripts. Scientists seeking support from NSF are evaluated by their peers on the quality of the publications from prior support. Therefore. to a large degree, the scientific community enforces open publication of NSF-funded research.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO ROBIN E. BELL, PH.D.

Question 1. I am concerned about the recent reports that global warming is rapidly affecting the ocean's chemistry—making it more acidic. Will our U.S. research effort include monitoring ocean chemistry and its potential impacts on the food

chain? Do we have any sense of how bad things are already, or when we are likely to see the impacts of acidification?

Answer. The topic of how global warming may affect the ocean's chemistry, making it more acidic, is an important one. Among the projects being proposed as part of International Polar Year are activities that would include collection of sea water and measurement of sea water carbon parameters. At this time, it is not yet known which actual projects will be funded, either here or by other nations.

It is known that CO_2 from the atmosphere dissolves and forms an acid in seawater. In the past 200 years, the oceans have absorbed about half of the CO_2 produced by humans. As seawater becomes more acidic, the capacity of the ocean to absorb CO_2 will decrease. One program, called the SEARCH program (Study of ARctic Environmental CHange), intends to make these kinds of measurements as part of the planned Arctic Observatory Network. Until relatively recently, although studied by a small number of oceanographers, ocean acidification has not been a critical national concern, but the topic is moving onto the national agenda (*e.g.,* it is the subject of an article in November, in *New Yorker* magazine, as well as recent Science and Nature papers and recent national and international conferences). Oceans have a high capacity to buffer the effects of additional carbon, but current research is suggesting that the levels of anthropogenic CO_2 input are so high that the ocean has already become measurably more acidic. A more acidic ocean inhibits the formation of calcium carbonate skeletons which form the shells of many marine organisms, including corals and several key planktonic species, including *coccolithophores,* a microcellular marine algae common in subpolar regions.

Question 2. How does climate change or ocean warming affect the ability of krill to resist over-harvesting? How much more vulnerable does it make them? How much would a sharp decline in krill populations affect other species and the food chain?

Answer. More than acidity, krill will be impacted by warming ocean temperatures. Studies along the Western Antarctic Peninsula have discovered that during low winter sea-ice years the plankton is dominated by salps instead of krill. This is because krill heavily depend on sea-algae as their food source. Krill, similar to other marine organisms, are adapted to live in a limited range of pH, so any extreme change in ocean acidity will affect these organisms. Krill and copepods are key members of the marine food chain, so changes in their populations can be expected to have potentially large impacts through the ecosystems. Along the Antarctic coast, krill is the primary food source for penguins, and many marine mammal species and a sharp decline in krill's abundance would severely impact their populations. Potential impacts on marine organisms directly relying on calcification, such as those that make up commercial crustacean fisheries (shrimp, crab) and mollusk fisheries (bivalves, gastropods) may be of economic concern in the future.

The concern about increasing ocean acidity is one of the research areas mentioned in the draft Ocean Research Priorities Plan prepared by the Joint Subcommittee on Ocean Science and Technology under the National Science and Technology Council. Generally, this is an emerging area of concern that has yet to be thoroughly studied. The National Academies is currently considering developing a study on this topic.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DANIEL K. INOUYE TO NOAA

Question 1. The IPY envisions establishment of polar observing equipment and monitoring systems which will eventually need to be taken over and maintained after the close of the IPY, beginning in 2009.

What kind of fiscal burden will taking over these systems place on NOAA?

Answer. NOAA is making use of existing resources to conduct IPY work, so continuing support for polar observations would be provided through the President's budget without any additional fiscal burden.

In addition to other NOAA exploration, prediction, modeling, data, outreach, and decision support IPY projects, the President's Fiscal Year 2007 Budget Request includes funding for the following four polar observation-specific projects:

Project	Pres Bud Fiscal Year 2007
Causes and Impacts of Recent Changes in Pacific Arctic	$3,650,000
Polar Atmospheric Observatories and Field Campaigns	$2,675,000
Polar Stratospheric Ozone Depletion Observations	included above
Antarctic Living Marine Resource Survey	$1,467,000
Total	$7,792,000

Question 1a. To the best of your knowledge, what other Federal agencies will be responsible for maintaining post-IPY observing and monitoring activities?

Answer. The Office of Science and Technology Policy assigned the National Science Foundation the leadership role for coordinating interagency IPY activities.

In Fiscal Year 2007, a new Arctic observatory in Eureka, Canada, will operate during the IPY, and the observatory in Tiksi, Russia, will be partially operational. Post-IPY, Canada will maintain and operate the Eureka Observatory and NOAA will conduct measurements. At the site in Tiksi, the National Science Foundation is contributing substantially to the development of the infrastructure, and NOAA will assist in providing instrumentation. Post-IPY, NOAA will maintain the Tiksi Observatory as one of our Arctic Observation Network systems.

NOAA's existing baseline observatories at Barrow, Alaska, and the South Pole will continue to focus on measurements of trace gases and aerosols during IPY.

Question 1b. What will happen to the scientific knowledge gained through polar monitoring and research if we do not have resources to continue monitoring during and after IPY?

Answer. NOAA will be archiving NOAA datasets during IPY to ensure that the scientific knowledge gained through polar monitoring and research during IPY is available to benefit future polar research and management. It is important that the Nation continue polar monitoring after IPY to observe and understand the changing Arctic in the years to come.

Question 2. The U.S. Antarctic Marine Living Resources (AMLR) Program, managed by the National Marine Fisheries Service (NMFS), supports international efforts to protect the Antarctic and its marine life through the Commission for the Conservation of Antarctic Living Marine Resources (CCAMLR). CCAMLR has planned a Southern Ocean synoptic predator-prey study, formally recognized and designated as IPY's lead project for the topic "Natural Resources, Antarctic." At one point AMLR was prepared to offer ship time to the project. At this time, what resources does the AMLR Program plan on dedicating to IPYrelated activities?

Answer. The International Polar Year (IPY) actually runs from March 2007 through March 2009 (two years; to ensure that researchers get the opportunity to work in both polar regions or work summer and winter if they wish). The Antarctic Marine Living Resources (AMLR) Program had indicated an interest in supplying ship time and scientific expertise to CCAMLR's survey starting in January 2008. However, the AMLR Program's participation in Fiscal Year 2008 IPY-related activities is contingent upon the availability of an ice-strengthened research vessel with appropriate endurance.

NOAA only needs a 35-day cruise in 2008 to fulfill U.S. requirements under CCAMLR. However, it is not clear that NOAA will be able to lease the same vessel as in the past for such a short cruise. NOAA is reviewing options should this ship become unavailable.

In Fiscal Year 2008, NOAA will evaluate all options for continuing ship-based research that would enable the AMLR to contribute to CCAMLR's IPY-related research activities in the Southern Ocean.

Question 2a. Is that level sufficient to fulfill US. commitments in support of CCAMLR?

Answer. A 35-day cruise would be sufficient to fulfill U.S. commitments in support of CCAMLR.

Question 2b. Is the level of participation the U.S. is currently envisioning to dedicate through AMLR to this project likely to compromise CCAMLR's ability to participate meaningfully in the IPY?

Answer. NOAA will evaluate all options for continuing ship-based research that would enable the AMLR to contribute to CCAMLR's IPY-related research activities.

If AMLR is unable to secure an appropriate vessel to conduct the survey, it will compromise CCAMLR's ability to participate in the IPY synoptic survey.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DANIEL K. INOUYE TO MEAD TREADWELL*

Question. The National Research Council (NRC) of the National Academy of Sciences recently released their final report assessing polar icebreaker roles and needs. The report recommends that the United States replace the two older vessels, the POLAR STAR and POLAR SEA, while maintaining and repairing the POLAR SEA and keeping the POLAR STAR in caretaker status during the transition period.

- Do you support the NRC's recommendations?
- If the recommendation pertaining to icebreaker capabilities were implemented would that level of icebreaker capacity be sufficient to meet the needs of the U.S. Arctic Research Program?

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO MEAD TREADWELL*

Question 1. How important are the Coast Guard's icebreakers as a platform for scientific research during the International Polar Year and beyond? Do you support the National Research Council's recommendation to ensure long-term U.S. polar icebreaking capability?

Question 2. The Bush Administration has already established a record of censoring scientists with whom it disagrees on global warming. How will you both ensure that the research for the International Polar Year is selected and conducted without political interference from the White House?

Question 3. What assurances can you give us that the results of the U.S. research will be communicated freely and clearly by U.S. scientists, even if they conflict with the views of the White House and the oil and automobile industries?

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO DR. THOMAS ARMSTRONG AND DR. VIRGIL L. "BUCK" SHARPTON*

Question 1. I am concerned about the recent reports that global warming is rapidly affecting the ocean's chemistry—making it more acidic. Will our U.S. research effort include monitoring ocean chemistry and its potential impacts on the food chain? Do we have any sense of how bad things are already, or when we are likely to see the impacts of acidification?

Question 2. How does climate change or ocean warming affect the ability of krill to resist over-harvesting? How much more vulnerable does it make them? How much would a sharp decline in krill populations affect other species and the food chain?

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*Reponse was not available at the time this hearing went to press.