

Arctic Sciences Division GPRA Highlights, FY 2009

Virtual Zooarchaeology of the Arctic Project (VZAP)

Highlight ID: 18172, Version: AC/GPA

Archaeological sites from Polar Regions are often rich in well-preserved animal bone. These animal remains provide a wealth of information about ancient human behaviors, past environments, and climate change. To analyze these materials appropriately, zooarchaeologists (archaeologists that specialize in the study of animal remains) require a comprehensive comparative collection of the bones of all northern mammals, fish, and birds. Unfortunately, such collections are very rare (only four complete collections exist in North America). Therefore, northern researchers are hampered in their study of these important remains both by the lack of existing comparative natural history collections and appropriate reference materials (photos and drawings) which may aid in their analysis.

The result of these difficulties is an analytical bottleneck - while most archaeological excavations in the north result in large, high resolution faunal collections, there are few locations where they can be adequately analyzed, therefore impeding, or halting northern archaeological and ecological research altogether. In reality, the vast majority of northern-derived faunal samples have gone unanalyzed. This is ironic, because polar-derived faunal assemblages, due to their often excellent preservation, represent some of the best data available for conducting fundamental research on the relationship between humans and the ecosystems they inhabit.

The Virtual Zooarchaeology of the Arctic Project (VZAP) seeks to develop the world's first comprehensive online (and fully interactive) three dimensional virtual vertebrate reference collection. Composed of photographs and interactive three dimensional models this project is producing a virtual collection of all the skeletal elements from 132 polar taxa. By doing so, this project will provide the comparative resources necessary for northern scientists to conduct analyses from any location. VZAP will also provide an in-depth resource for teaching and learning skeletal biology by providing access to an interactive virtual collection which can be used both inside the classroom and for laboratory studies.

More broadly, it is hoped that this project will have far ranging impacts on the archaeological and ecological community worldwide, by highlighting the potential benefit of sharing digital reference materials and collections in a fundamentally inclusive and democratized way.

At the center of this project is Idaho State University's Virtualization Laboratory (IVL), part of the Center for Archaeology, Materials, and Applied Spectroscopy (CAMAS). It is here where objects are photographed, measured, and scanned in three dimensions using one of three commercial laser scanners. Professional-level computer software is used to produce realistic and accurate (<0.3 mm resolution) full-color three-dimensional models of every bone in the subject specimen's skeleton. Thousands of these photographs and scans will then be made available on a groundbreaking website using "deep zoom" technology and integrated 3D PDFs.

Conducted in partnership with Canada's national museum, the Canadian Museum of Civilization, this project represents an experiment in exhibiting a virtual online museum/archaeological collection. This project will develop new and highly interactive means for providing access to museum collections, which will be available for exploration by anyone with access to the internet. Such a project will develop a means by which individuals (students, researchers, and the general public) can gain intimate and detailed access to fragile, restricted, and rare public museum collections. Thus, this project directly supports the mission of the National Science Foundation in education, research infrastructure, basic research, and public outreach.

Primary Strategic Outcome Goal:

- Networking and Computational Resources Infrastructure and Services (formerly Shared Cyberinfrastructure Tools) (AC/GPA selected)
- Research Resources (minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.) (AC/GPA selected)

Secondary Strategic Outcome Goals:

- International Collaborative Research
- Cyberinfrastructure (excluding Shared Cyberinfrastructure Tools; see Research Infrastructure)
- Social, Behavioral, & Economic Sciences
- Polar Sciences: Arctic and Antarctic Research
- K-12 Education
- Undergraduate Education and Undergraduate Student Research
- Graduate Education and Graduate Student Research
- Broadening Participation to Improve Workforce Development

In terms of intellectual merit, why is this outcome notable and/or important?

This project will provide northern scientists with the comparative resources necessary to conduct analyses of skeletal materials when access to museum comparative collections is unavailable or restricted. This project has the potential to increase the amount and accuracy of data on ancient human behaviors, past environments, and climate change that can be elucidated through zooarchaeological collections.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

The VZAP project will provide an in-depth resource for teaching and learning skeletal biology by providing access to an interactive virtual collection that can be used in the classroom (k-12 and undergraduate). This is particularly important in school systems where access to expensive casts of zoological specimens is beyond their resources. Conducted in partnership with Canada's national museum, the Canadian Museum of Civilization, this project represents an experiment in exhibiting a virtual online museum/archaeological collection. This project will develop new and highly interactive means for providing access to museum collections, which will be available for exploration by anyone with access to the internet. Such a project will develop a means by which individuals (students, researchers, and the general public) can gain intimate and detailed access to fragile, restricted, and rare public museum collections.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
Yes

This project utilizes cutting-edge technology in an innovative and previously unforeseen way - to create an interactive scientific reference collection. This interactive 3D database is a tool to aid archaeologists in the analysis of northern collection of animal bones, and provides a resource for teachers and students of vertebrate anatomy. This unique project is a model for future archaeologists and museum scholars to produce online interactive databases of critical cultural and natural history collections.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

The VZAP project will provide an in-depth resource for teaching and learning skeletal biology by providing access to an interactive virtual collection that can be used in the classroom (k-12 and undergraduate). This is particularly important in rural and inner-city school systems where access to expensive casts of zoological specimens is beyond their resources.

What may be the benefits of the proposed activity to society?

Yes

The VZAP project will provide an in-depth resource for teaching and learning skeletal biology by providing access to an interactive virtual collection that can be used in the classroom (k-12 and undergraduate). This is particularly important in school systems where access to expensive casts of zoological specimens is beyond their resources. Conducted in partnership with Canada's national museum, the Canadian Museum of Civilization, this project represents an experiment in exhibiting a virtual online museum/archaeological collection. This project will develop new and highly interactive means for providing access to museum collections, which will be available for exploration by anyone with access to the internet. Such a project will develop a means by which individuals (students, researchers, and the general public) can gain intimate and detailed access to fragile, restricted, and rare public museum collections. More broadly, it is hoped that this project will have far ranging impacts on the archaeological and ecological community worldwide, by highlighting the potential benefit of sharing digital reference materials and collections in a fundamentally inclusive and democratized way.

OPP/ARC 2009

Program Officer: Anna Kerttula de Echave

NSF Award Numbers:

[0808933](#)

Award Title: Virtual Zooarchaeology of the Arctic Project (VZAP)

PI: Herbert D.G. Maschner, maschner@isu.edu

Institution Name: Idaho State University

State Code: ID

PE Codes: 9150, 5221

[0508101](#)

Award Title: BE/CNH: Complex Ecosystem Interactions Over Multiple Spatial and Temporal Scales: The Biocomplexity of Sanak Island

PI: Herbert D.G. Maschner, maschner@isu.edu

Institution Name: Idaho State University

State Code: ID

PE Codes: 9150, 7304, 5221, 5205, 1691

[0722771](#)

Award Title: MRI: Acquisition of Mass Spectrometers and Related Equipment to Create the ISU Interdisciplinary Lab for Elemental and Isotopic Analysis (ILEIA)

PI: Herbert D.G. Maschner, maschner@isu.edu

Institution Name: Idaho State University

State Code: ID

PE Codes: 1189

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Cyberinfrastructure

Arctic Endangered Language in Cyberspace: Dena'ina Archiving, Training, and Access (DATA)

Highlight ID: 18201, Version: AC/GPA

Like most of the indigenous languages of Alaska, Dena'ina is no longer spoken by children and no longer functions as a language of daily communication. However, there is a keen interest in language revitalization and language learning within the community. While there are relatively few publications in or about the Dena'ina language, a wealth of documentation has been gathered by speakers and linguists over the past few decades. This documentation includes field notes, word lists, grammatical information, transcribed texts, and audio recordings. While some of this material has been circulated in limited form as mimeographs, little of it is extant and accessible within the Dena'ina community. Fortunately, much of this material can be found in the Alaska Native Language Archive. However, the archive is located in Fairbanks and is not readily accessible from the Dena'ina community.

The need to facilitate straightforward access to these materials was identified early in the project. During the first project planning meeting, Dena'ina speaker and author Andrew Balluta concluded: "You know, all these recordings ... if we don't get it out and learn about it, where are we going to learn from? These are old recordings. We want to get it out and teach our younger children what the elder people are talking about. I think that's a very good idea for getting it free so we can listen to them." [Andrew Balluta, recorded at Dena'ina Language Planning Workshop, Feb 2004, Anchorage, Alaska]

Begun in 2003, the Dena'ina Archiving, Training, and Access (DATA) project was designed primarily to address these access issues through the creation of a digital repository of Dena'ina language materials. Through a memorandum of agreement with the Alaska Native Heritage Center and the Kenaitze Indian Tribe, the project worked collaboratively to catalog all extent Dena'ina manuscripts and recordings held at ANLC and other locations and to convert those materials into digital form. These were made available via an online digital archive, itself embedded within a web portal providing comprehensive online resource for the Dena'ina language. The portal is hosted at the project site Qenaga.org, the name of which derives from the Dena'ina word *qenaga*, meaning 'language'.

While issues of access were central to the DATA project, the project was conceived around two additional supporting pillars: archiving and training. The development of archival protocols for digital data distributed across multiple sites presented a major challenge. Dena'ina language documentation is housed in multiple locations, with some items being duplicates of items housed elsewhere. Managing these data effectively required the development of an online database which facilitated remote access while also ensure secure and enduring storage of digital data. Not only is Dena'ina language endangered; Dena'ina language data are also endangered. Working closely with the Open Language Archives Community and the Electronic Metastructures for Endangered Language Documentation (E-MELD) project, the DATA project helped to shape best practices for the preservation of digital endangered languages data-many of which are now accepted as de-facto standards within the linguistic documentation community. Preservation copies of digital files are housed and maintained by the Arctic Region Super Computing Center, while presentation copies are made available through the Qenaga.org web portal. In this way DATA has served as a pilot project for the development and implementation of emerging standards in digital language documentation and archiving.

Technology training is integrated into every phase of the DATA project, with the goal of training a core of Dena'ina language learners to assist with the evolution of Dena'ina Language Archive into the future. In this respect training is the most important component of the DATA project. The need for a well-developed training component was particularly crucial for a project operating on the cutting edge of language technologies. It is crucial that human resource capacity be developed in order to be able to respond to continuing evolution of these technologies. In the DATA project training was undertaken on three fronts. First, the project provided mentoring to three Eastern Michigan University graduate students. These students gained experience in language technology,

and equally importantly, they gained a first-hand experience of the Dena'ina language situation. Under the direction of co-PI Holton the students worked closely with Dena'ina communities to understand technology needs and to develop a collaborative vision of the web portal. The graduate students in turn provided community-based training for members of the Dena'ina community as part of the Dena'ina Language Institute. Finally, the project also provided direct one-on-one technology training for key Dena'ina persons, including a curriculum developer at the Alaska Native Heritage Center; the tribal archivist at Kenaitze Indian Tribe; and a web developer for Kenaitze. These persons have gone on to make significant contributions to Dena'ina language work.

By integrating the three pillars of archiving, training, and access the DATA has project has served as a model for the development of electronic archives of other Alaska Native language materials. ANLC is currently working with two other language communities to develop similar community access portals, drawing on technology developed as part of the DATA project. Such projects alone will not save indigenous languages from the many threats they face. However, with careful attention to emerging standards of best practice in digital preservation and access, and with the integration of community-based training, digital language archives can provide enduring resources for indigenous language revitalization and research.

Primary Strategic Outcome Goal:

- Networking and Computational Resources Infrastructure and Services (formerly Shared Cyberinfrastructure Tools)

Secondary Strategic Outcome Goals:

- K-12 Education
- Undergraduate Education and Undergraduate Student Research
- Broadening Participation to Improve Workforce Development

In terms of intellectual merit, why is this outcome notable and/or important?

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In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

Technology training is integrated into every phase of the DATA project, with the goal of training a core of Dena'ina language learners to assist with the evolution of Dena'ina Language Archive into the future. In this respect training is the most crucial component of the DATA project. The need for a well-developed training component was particularly crucial for a project operating on the cutting edge of language technologies. It is crucial that human resource capacity be developed in order to be able to respond to continuing evolution of these technologies. In the DATA project training was undertaken on three fronts. First, the project provided mentoring to two Eastern Michigan University graduate students. These students gained experience in language technology, and equally importantly, they gained a first-hand experience of the Dena'ina language situation. Under the

direction of co-PI Holton the students worked closely with Dena'ina communities to understand technology needs and to develop a collaborative vision of the web portal. The graduate students in turn provided community-based training for members of the Dena'ina community as part of the Dena'ina Language Institute. Finally, the project also provided direct one-on-one technology training for key Dena'ina persons, including a curriculum developer at the Alaska Native Heritage Center; the tribal archivist at Kenaitze Indian Tribe; and a web developer for Kenaitze. These persons have gone on to make significant contributions to Dena'ina language work.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

Yes

The close collaboration between linguists and the Kenaitze Indian Tribe community members and students in the digitizing and making web accessible Dena'ina language materials was a transformational idea in 2003 when the award was made. These types of community based projects have increasingly become the standard for endangered language research and revitalization. Projects such as the DATA project have become models for current work in this field.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

By integrating the three pillars of archiving, training, and access the DATA has project has served as a model for the development of electronic archives of other Alaska Native language materials. ANLC is currently working with two other language communities to develop similar community access portals, drawing on technology developed as part of the DATA project. Such projects alone will not save indigenous languages from the many threats they face. However, with careful attention to emerging standards of best practice in digital preservation and access, and with the integration of community-based training, digital language archives can provide enduring resources for indigenous language revitalization and research.

What may be the benefits of the proposed activity to society?

Yes

This project has many elements that contribute to societal benefits. The attention to emerging standards of best practice in digital preservation and access, and with the integration of community-based training, digital language archives can provide enduring resources for indigenous language revitalization and research, as well as the long term goal of providing an exemplary project for communities trying to preserve their languages. This project could be replicated across the U.S. among the X tribes in danger of losing their languages. Community members are trained in data input and such a project could provide very rewarding jobs to some of our poorest communities.
OPP/ARC 2009

Program Officer: Anna Kerttula de Echave

NSF Award Numbers:

[0326805](#)

Award Title: DATA: Dena'ina Archiving, Training, and Access

PI: Helen Aristar-Dry, hdry@linguistlist.org

Institution Name: Eastern Michigan University

State Code: MI

PE Codes: 7773, 5221, 5201

[0709680](#)

Award Title: Collaborative Research: Workshop: Towards the Interoperability of Language Resources
PI: Helen Aristar-Dry, hdry@linguistlist.org
Institution Name: Eastern Michigan University
State Code: MI
PE Codes: 1311

[0720122](#)

Award Title: Collaborative Research: Implementing the GOLD Community of Practice: Laying the Foundations for a Linguistics Cyberinfrastructure
PI: Helen Aristar-Dry, hdry@linguistlist.org
Institution Name: Eastern Michigan University
State Code: MI
PE Codes: 1311

NSF Contract Numbers:

NSF Investments: American Competitiveness Initiative (ACI), Cyberinfrastructure

Melting on the Arctic Express

Highlight ID: 18536, Version: AC/GPA

The summer extent of the Arctic sea ice cover, widely recognized as an indicator of climate change, has been declining for the past few decades reaching a record minimum in September 2007 and nearly the same level in 2008. The retreat was particularly pronounced in the East Siberian, Chukchi, and Beaufort Seas. There are several possible causes of the dramatic loss, each of which has implications for the future trajectory of the arctic sea ice cover. Earlier work has established the general impact on ice extent of warming trends, changes in atmospheric circulation increased export of older ice out the Fram Strait, low clouds, advection of ocean heat from the Pacific and North Atlantic, and enhanced solar heating of the ocean. Scientists are currently trying to explore the relative roles of these various drivers, and determining the causes of the dramatic loss are important for efforts to predict the future trajectory of the arctic sea ice cover.

One well known hypothesis has been the often cited 'ice-albedo feedback mechanism,' in which melting ice creates open water, the open water absorbs solar energy and further melts the ice, producing a positive feedback eroding the ice pack. Using funding from two NSF programs and some other agencies, researchers were able to measure the ice melting through a season and model it accurately.

Of particular interest, the researchers were able to determine the amount of melting at the top and bottom surfaces of the sea ice cover. Top melting is determined by the net surface heat budget of the ice and thus includes changes due to radiative forcing and air temperature. Bottom melting is determined by the amount of heat in the upper ocean and the transfer of that heat to the underside of the ice. The observations indicate that there was an extraordinarily large amount of bottom melting of the ice in the in the summers of 2007 and 2008 and that solar heating of the upper ocean was the primary heat source. Calculations confirm that solar heating in the open water was sufficient in magnitude and in timing to produce the observed bottom melting. Indeed, the anomalously large areas of open water absorbed twice as much heat as was needed for the observed bottom melting.

While this is not the sole cause of the depleting ice, it quantifies a critical process that exacerbates its disappearance.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research (AC/GPA selected)

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

This is an elegant effort combining measurement supported by one program (Arctic Observing Network) and modeling and calculations supported by another program (Arctic System Science Program) to confirm and quantify a long held theory for a process contributing to the disappearance of sea ice.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

This project included significant outreach efforts to inform the general public about sea ice processes. This project is likely to contribute in significant ways to the overall understanding of the Arctic System, specifically, the results of this work should lead to improvements in climate models as well as derivation of sea-ice variables from remote-sensing data.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

Several female PIs are involved.

What may be the benefits of the proposed activity to society?

Yes

Indirect, through better understanding of global change that influences society, but not direct economic benefit.

OPP/ARC 2009

Program Officer: Neil Swanberg

NSF Award Numbers:

[0632130](#)

Award Title: Collaborative research on the state of the Arctic sea ice cover: An integrated seasonal ice zone observing network (SIZONET)

PI: Donald Perovich, perovich@crrel.usace.army.mil

Institution Name: Department of Army Cold Regions Research & Engineering Lab

State Code: NH

PE Codes: 5293

[0531026](#)

Award Title: Collaborative Research on Sunlight and the Arctic Atmosphere-Ice-Ocean System

PI: Bonnie Light, bonnie@apl.washington.edu

Institution Name: University of Washington

State Code: WA

PE Codes: 5219

[0531173](#)

Award Title: Collaborative Research on Sunlight and the Arctic Atmosphere-Ice-Ocean System
PI: Hajo Eicken, hajo.eicken@gi.alaska.edu
Institution Name: University of Alaska Fairbanks Campus
State Code: AK
PE Codes: 5219

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Environment (including the importance of fresh water and dynamics of water processes)

Changing Ice Paths: Healthy Bears and Old Explorers

Highlight ID: 18537, Version: AC/GPA

In this effort, a Barnard College undergraduate worked with researchers to study the potential trajectories of pollutants entrained in sea ice. With increased ice melt and areas of open water, both commercial traffic and human activities will likely expand along the Northwest Passage and Northern Sea Route. To understand the impacts of this, reconstructed past trajectories of sea ice originating from points along the major coastal traffic routes were overlaid with the approximate current ranges of three Arctic marine mammals, the polar bear, walrus and bowhead whale. Through this analysis the researchers identified regions vulnerable to release of pollutants from sea ice after long range transport across the Arctic Basin.

Of 15 start points from three different years, six of the trajectories (40%) in each of 1979, 1988, and 1996 melted out in regions where all three mammal ranges currently overlap. Two regions with maximum vulnerability to pollutants entrained in drifting ice - under recent conditions -- are the northern coast of Svalbard and Fram Strait. Both regions are the major termination locations of ice trajectories in all years and from start points spanning the Arctic. Current research is focusing on potential changes in the ice transport regime as the summer sea ice cover diminishes. While some observations indicate that fall/winter ice formed on the Siberian shelves will melt over the deep Arctic basin the following summer, some models and observations indicate that ice velocities will increase with reduced ice cover, potentially resulting in rapid, long-range transport of pollutants.

Northern Svalbard and eastern Greenland were identified as particularly vulnerable to pollutants due to the number of meltout events that occur in these regions. This initial analysis also indicates that meltout is occurring earlier in the year, shifting the timing of pollutant release relative to the spring bloom. Maximum meltout now occurs in May and June rather than July and August (as it did in 1979) and more concurrently - resulting in the potential for a short, sharp, early injection of pollutants. This may tend to maximize contaminant impact: when pollutants entrained in the sea ice melt out earlier, they coincide with a period of intense biological activity: polar bears emerge from snow dens with their cubs as late as April, walrus give birth in May and June, and bowhead whales calf during spring migration near the ice edge, coordinating with the earlier melt.

This project produced an interesting side story when the researchers initiated a new analysis to assess the experience of Fridtjof Nansen and Sir Ernest Shackleton in view of what we now know about polar variability. Using trajectories of sea ice drift they calculated possible alternate fates of both expeditions to assess the role of luck and skill in determining their outcomes. They found that Nansen and Shackleton were both lucky and unlucky in the natural conditions that they encountered during their expeditions. Had they traveled in most years since 1979, Nansen would have gotten much closer to the North Pole (his goal) than his ship did in 1895, so he was unlucky in that respect. On the other hand, he was lucky with the relatively short drift duration of his ship in the arctic pack ice. In the Antarctic, Shackleton, was also lucky in the rapid pace of drift within the pack. The fact that his trajectory was so far to the west might have been a factor in the crushing and sinking of his ship, but it also allowed him to land most of his men on Elephant Island while he

went for help. Shackleton's heroic, and harrowing, boat journey to South Georgia turned out to be helped by prevailing conditions as it was within the likely ocean drift trajectory from Elephant Island.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

This work informs us of the path of ice-bourn material, including pollutants, and the impact that changing climate is having on where their impact is felt. The PIs focused particularly on key marine mammals of important to local populations.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

The PIs focused particularly on key marine mammals of important to local populations. Changes in ice patterns focus contaminants on areas where the key mammal species occur. Additionally, the use of the data to illustrate impacts on old polar explorers has a significant public outreach impact.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

Female PI.

What may be the benefits of the proposed activity to society?

Yes

Could help decision makers regarding harvesting of marine mammals and contaminants.
OPP/ARC 2009

Program Officer: Neil Swanberg

NSF Award Numbers:

[0612455](#)

Award Title: Vulnerability of the Arctic Marginal Ice Zone to Changes in Drifting Ice

PI: Stephanie Pfirman, spfirman@barnard.columbia.edu

Institution Name: Columbia University

State Code: NY

PE Codes: 5219

NSF Contract Numbers:

NSF Investments: Climate Change, Environment (including the importance of fresh water and dynamics of water processes)

The Arctic is Burning!

Highlight ID: 18661, Version: AC/GPA

In Fall of 2007 there was a huge wildfire at the Anaktuvuk River (AR) in the tundra on the north slope of Alaska. This fire, in an area that does not burn often, but is increasingly exposed to fire as the climate changes, created a unique opportunity to observe the response of a pristine landscape

to a major disturbance. The area burned is large enough (>1000 km²) that its impacts can be measured directly at multiple scales, from small plots, to large water catchments and hill slopes, to the atmospheric boundary layer above the entire burn. Using one of NSF's rapid SGER awards, a team investigated this during the onset of spring 2008 following the burn. As the burned area recovers, observations of changes in key ecosystem processes and in terrestrial and aquatic communities can afford insights into controls and interactions among landscape components that would not be possible from fine-scale observation of an undisturbed tundra landscape. Because the area burned is so large, it provides an opportunity for measuring change at a scale that is directly relevant to large-area, pan-Arctic modeling and prediction.

Obviously after a burn the surface turns dark. Consequently, early in this first season after the fire there were dramatic differences in surface energy balance, with the severely burned site having an albedo (a measurement of reflectivity) much lower (less reflective) than in unburned areas. This very large difference in albedo had important consequences throughout the season in the form of higher surface temperatures, greater net energy radiation, greater heat flux, and much deeper soil thaw in burned than in unburned sites. Net Ecosystem Exchange of CO₂ was also dramatically affected by the burn with the severely burned site losing C throughout the day while the unburned site showed a typically strong pattern of net C accumulation in the middle of the day and brief net C loss late at night. As the 2008 season progressed, the development of greater leaf area by regrowth in burned sites was reflected in occasional net C accumulation on warm, sunny days.

Impacts of the burn can also be measured in the atmosphere high above the burned area. At elevations up to 1300 m, CO₂ concentrations above the center of the AR burn were somewhat higher than above unburned tundra 20-40 km away. The atmosphere was also more humid above the burn, with elevated water vapor pressure. These differences are consistent with the greater net C loss observed at the severely and moderately burned sites, and with the higher air and surface temperatures, humidity, and latent heat flux also observed on the ground. Because these measurements of the lower atmosphere can be related directly to changes observed on the ground, modeling and predicting changes in land-atmosphere interactions at the regional scale are greatly facilitated.

How important is fire? Aside from destroying the active ecosystems, the AR fire consumed an average of about 10 cm of organic matter from the surface peat layer, over at least 80% of the burn area. Assuming local peat composition, this leads to an estimate of C loss due to the burn itself of more than 2 M ton, about equal to the annual C "footprint" of a US city the size of Boston. If the average C:N ratio in this burned organic matter were typical, then over 65,000 tons of N were also lost, although about 15% of this would have been redeposited as ash on the surface. These amounts are roughly 20% and 15% of the total C and N pools within the seasonally-thawed soil active layer and vegetation, lost over an area roughly the size of Cape Cod, MA. All this suggests that increasing fire in tundra areas may prove to be a major cause of disruption, both of ecosystems and atmospheric balance.

Primary Strategic Outcome Goal:

- Biological Sciences
- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

The tundra is changing with climate change, at the same time that more storms are occurring in the high north, accompanied by lightning. This is leading to unprecedented fires in the arctic tundra. This unique event offers a chance to understand the consequences of increased fire on the tundra.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

Fire is of major importance to the people of the north, and managers need to know the impact of fire in order to make good decisions about actions. We also need to know the overall impact in order to understand the long term environmental consequences.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
Yes
Information may aid in decision making.
OPP/ARC 2009

Program Officer: Neil Swanberg
NSF Award Numbers:
[0808789](#)

Award Title: Effects of and Recovery from a Major Regional Disturbance in an Arctic Landscape, the Anaktuvuk River Fire of 2007
PI: Gaius Shaver, gshaver@mbl.edu
Institution Name: Marine Biological Laboratory
State Code: MA
PE Codes: 5219

[0829285](#)

Award Title: SGER: The Anaktuvuk River Fire of 2007: A Test Bed for NEON Technology and Protocols in Northern Alaska
PI: Gaius Shaver, gshaver@mbl.edu
Institution Name: Marine Biological Laboratory
State Code: MA
PE Codes: 7350

NSF Contract Numbers:
NSF Investments: Climate Change

Seas, Ice and Whales

Highlight ID: 18675, Version: AC/GPA

In a project that explored the oceanographic mechanisms that cause bowhead whales to aggregate and feed near Barrow Alaska, researchers investigated whether native whale hunting will continue to be successful at Barrow in spite of climate change.

In the field seasons of this project, significant interannual and short-term variability was observed in oceanography and weather, especially wind. A retrospective analysis also found significant interannual variability in fall whale harvest success, and the dates and length of the bowhead harvest season. During the two years of the intensive oceanographic fieldwork, interannual variability related to larger scale climate impacted water mass characteristics and associated biological and chemical properties. Shorter-term variability was driven by wind speed and direction, with dramatic impacts on the distributions and abundance of plankton, particularly bowhead whale prey (krill). Despite these differences in ocean conditions, bowhead whales reached Barrow during their fall migration in early September of both field years. Retrospective analyses showed that between 1985 and 2004 whales reliably reached Barrow by the third week of September, in some years arriving as

early as August 25. Transport of krill to Barrow from the Pacific Ocean in the large scale circulation coupled with local wind forcing provides at least two mechanisms by which krill are concentrated on the shelf near Barrow, resulting in a predictable and abundant food supply for the bowhead whales during their migration.

For the past two decades and at present, the window of opportunity for fall whaling at Barrow has been sufficiently long that enough days with good weather and suitably located whales have coincided, thereby allowing the community to achieve their annual quota. With climate change, weather conditions and wind patterns might change, or whale migration pathways might be altered due to changes in whale prey availability (from oceanographic, sea-ice, and/or marine ecosystem changes). Furthermore, the whales might avoid the Barrow region because of anthropogenic activity such as offshore oil exploration or drilling. In any of these scenarios, whaling could become more dangerous, more difficult and less successful. During interviews, whale hunters stressed their preferences for not traveling too far offshore to harvest whales, since the meat can spoil during the tow back to shore. The project found that the whale feeding region and the timing of the whales' arrival at Barrow have both continued reliably over the past two decades in spite of significant climate variability during this period, which suggests that fall whale harvest by the community at Barrow is likely to be relatively resilient to climate change. It is possible even that climate change could end up enhancing the feeding opportunities for bowhead whale if ocean circulation changes were to result in greater transport of Pacific Water, and with it, krill, a chief food source for the whales, to the Barrow region.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

Understanding how the physical changes in the Arctic are going to affect the ecosystem is necessary if we are to predict ecosystem trajectories for the future.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

Some native cultures of northern Alaska have a thousand year tradition tying them to the whale hunt - it is more than just food, it is the bond that holds the communities together. It is extremely important to them that we understand how changes will affect the whaling and what can be done in response.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

No

What may be the benefits of the proposed activity to society?

Yes

The results of this study are of direct importance to the people of Barrow, Alaska and other coastal villages.

OPP/ARC 2009

Program Officer: Neil Swanberg

NSF Award Numbers:

[0436009](#)

Award Title: Collaborative Research: Environmental Variability, Bowhead Whale Distribution and Inupiat Whale Hunting - Linkages and Resilience of an Alaskan Coastal System
PI: Craig Nicolson, craign@nrc.umass.edu
Institution Name: University of Massachusetts Amherst
State Code: MA
PE Codes: 5219

[0436131](#)

Award Title: Collaborative Research: Environmental Variability, Bowhead Whale Distributions, and Inupiat Subsistence Whaling - Linkages and Resilience of an Alaskan Coastal System
PI: Carin Ashjian, cashjian@whoi.edu
Institution Name: Woods Hole Oceanographic Institution
State Code: MA
PE Codes: 5219

NSF Contract Numbers:

NSF Investments: Climate Change, Human and Social Dynamics

Ice-tethered Instruments Reveal Arctic Ocean Secrets

Highlight ID: 18965, Version: AC/GPA

NSF-funded scientists from the Woods Hole Oceanographic Institution (WHOI) have risen to the challenge of improving Arctic Ocean data acquisition by deploying novel instrumentation that takes advantage of the very ice cover that has proven to be an obstacle in the past. WHOI scientists have developed an Ice-tethered Profiler (ITP) that is suspended below thick sea ice floes, which, because they move under the influence of winds and currents, provide a means for year-round Lagrangian sampling of the upper layers of broad areas of the Arctic Ocean.

The ITP system consists of a small surface buoy that sits atop an ice floe supporting a plastic-jacketed wire rope tether that extends through the ice and down into the ocean. A cylindrical, self-propelled vehicle carrying oceanographic sensors moves up and down the tether sampling the uppermost 500-800 m of the water column on a regular basis. The water property (salinity, temperature) data are telemetered in near-real time from the ITP via satellite to scientists hundreds, even thousands of kilometers away.

Since the first ITP was deployed in 2005, eight have completed their missions and another 24 are still in operation. Twenty of the ITPs that are still operating were deployed during the International Polar Year 2007-2009 as part of the Arctic Observing Network (AON).

ITP measurements have shown that long-lived anticyclonic eddies are present in large numbers in the Arctic halocline north of 75°N in the Canada Basin. Approximately 10% of the Canada Basin between about 76.8° and 77.7°N is covered by shallow eddies with lifetimes of 16-18 months. It is believed that the eddies have a significant effect on mixing and heat transfer in the halocline, the cold, salty water layer at the surface of the ocean.

ITP measurements have confirmed that Atlantic Water heat is transported vertically in the Canada Basin along a double-diffusive staircases in which individual vertical layers are only 1 m thick but extend horizontally for as much as 800 km. Modeling indicates that the vertical transport of heat

from the Atlantic Water via the staircase is only about 10% of the estimated mean surface mixed layer heat flux to the sea ice.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

- Major Research Instrumentation (MRI) Program
- Polar Facilities & Logistics

In terms of intellectual merit, why is this outcome notable and/or important?

Previous NSF awards to Arctic scientists have revealed significant changes in the physical oceanography and sea ice of the Arctic Ocean. Continued study to understand the causes and consequences of these changes has been hampered by the difficulties associated with obtaining year-round data in a timely fashion from an ocean with a perennial ice cover. ITPs are overcoming some of the obstacles and transforming the knowledge and understanding of Arctic Ocean properties and processes.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

This project has included significant outreach to the general public via a Web site and the scientists' involvement in NSF-funded International Polar Year education and outreach programs. This project is likely to contribute in significant ways to the overall understanding of the Arctic System; specifically, the results of this work should lead to improvements in climate models and the simulation of air-ice-ocean interactions.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

Yes

The Ice-tethered Profilers are innovative technology that is making it possible for the first time to reliably obtain data year-round in near-real time from broad areas of the Arctic Ocean. They are also reducing the cost of acquiring Arctic Ocean data and the need for prolonged human presence on the ice or aboard ships.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

No

What may be the benefits of the proposed activity to society?

Yes

There is direct societal impact through the fabrication of ITPs by a local small business. There is indirect societal impact through better understanding of the Arctic Ocean and its role in the global ocean and climate systems and their effect on society.

OPP/ARC 2009

Program Officer: Martin Jeffries

NSF Award Numbers:

[0519899](#)

Award Title: Design and Initialization of an Ice-Tethered Profiler Array Contributing to the Arctic Observing System
PI: John Toole, jtoole@whoi.edu
Institution Name: Woods Hole Oceanographic Institution
State Code: MA
PE Codes: 5205

[0631951](#)

Award Title: IPY: Towards an Arctic Observing Network: An array of Ice-Tethered Profilers to sample the upper ocean water properties during the International Polar Year
PI: John Toole, jtoole@whoi.edu
Institution Name: Woods Hole Oceanographic Institution
State Code: MA
PE Codes: 5293

[0722694](#)

Award Title: MRI: Development and Acquisition of Oceanographic Instrumentation to Enhance the Arctic Ocean Observing Network for the 2007-2009 International Polar Year Period and Beyond
PI: Andrey Proshutinsky, aproshutinsky@whoi.edu
Institution Name: Woods Hole Oceanographic Institution
State Code: MA
PE Codes: 1189

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Environment (including the importance of fresh water and dynamics of water processes)

Indigenous people observing the marine ecosystem of the Bering Sea region

Highlight ID: 18987, Version: AC/GPA

NSF-funded researchers at the Aleut International Association and the University of Alaska Anchorage have completed the first phase of an innovative project to develop a community-based observing network in the Bering Sea region. The Bering Sea Sub-Network (BSSN) involves indigenous people in six villages (three in Alaska, three in Russia) in every level of planning, design and implementation of a network that is engaged in making environmental observations on the primary subsistence species of the Bering Sea, e.g., salmon, Arctic char, halibut, walrus and seals.

BSSN is part of the Arctic Observing Network and began its work during the International Polar Year 2007-2009. BSSN has designed a survey instrument that is administered by trained village coordinators who gather information from community members before they go hunting and fishing and when they return. Entitled "The Bering Sea Coastal Community Observations of Hunting and Fishing" the survey instrument consists of standardized pre- and post-event questionnaires (in English and Russian) and a 'Manual for Village Coordinators'. BSSN is also developing a data and information management system that protects the intellectual property rights of the native

participants, yet allows information to be available in appropriate formats to the broader community of users, e.g., researchers, educators, decision-makers, policy-makers and the general public.

The survey instrument was first administered in summer 2008 and preliminary data analysis has already revealed two unanticipated results. First, Russian harvesters are encountering a larger number of species showing evidence of disease, e.g., lesions, sores, parasites, than are Alaskan harvesters. Second, Russian harvesters travel significantly shorter distances than their Alaskan counterparts due to poor transportation infrastructure, e.g., lack of boats, roads and fuel. Although these findings are preliminary and more data are needed, they have implications for the health of the marine species that individuals and communities rely on for subsistence, and on the ability of people to adapt and respond to environmental change in the Bering Sea region.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

- Public Understanding of Science and Lifelong Learning
- Broadening Participation to Improve Workforce Development

In terms of intellectual merit, why is this outcome notable and/or important?

BSSN is notable for its success in bringing together indigenous people and scientists in the development of a research-driven community-based observing network that meets both sides' needs. BSSN promotes intellectual and cultural connections among groups of people who have diverse backgrounds yet share similar concerns about their changing environment.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

BSSN is a model for community-based observing that can be adopted elsewhere in the Arctic and beyond. It builds capacity and empowers native communities to manage their natural resources and plan for and adapt to environmental change.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

Yes

BSSN is potentially transformative in that it represents a paradigm shift in the approach to Arctic science by engaging indigenous people directly in research planning, design and implementation, and returning the results of data analysis directly to the indigenous communities as well as to the researchers.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

Alaska natives - Aleut, Yupik and Inupiaq - are engaged directly in the scientific observation of Bering Sea subsistence species.

What may be the benefits of the proposed activity to society?

Yes

BSSN is building capacity and providing learning opportunities in Alaska native villages, and increasing opportunities for communities to meet their research needs.

OPP/ARC 2009

Program Officer: Martin Jeffries

NSF Award Numbers:

[0634079](#)

Award Title: International Polar Year Collaborative Project: Bering Sea Sub-Network:
International Community-Based Observation Alliance for Arctic Observing
Network (BSSN)
PI: Victoria Gofman, victoriag@alaska.net
Institution Name: Aleut International Association
State Code: AK
PE Codes: 7299, 5293

NSF Contract Numbers:

NSF Investments: Climate Change, Human and Social Dynamics, International Polar Year (IPY),
Environment (including the importance of fresh water and dynamics of water processes)

A tool for analyzing climate model output

Highlight ID: 19105, Version: AC/GPA

The large-scale flow at different levels of the polar atmosphere can be represented by an index that characterizes the strength of circulation patterns, known as the "annular mode index". For each hemisphere, the index varies with height, and is calculated from daily three-dimensional pressure fields. These annular mode indices provide information not just about long-term changes, but also provide a tool for understanding how the stratosphere and troposphere interact. In the Northern Hemisphere, stratospheric disturbances (weak vortex events) are seen to propagate downward to the surface during a 1-2 week time span (Figure 1).

Annular mode analysis of climate models (e.g., those assessed by the IPCC, or the chemistry-climate models used to understand ozone recovery) has been delayed simply because it presently is impractical to store the daily model output needed to calculate the annular modes. However, Mark Baldwin, at Northwest Research Associates, has developed a remarkably simple method to give essentially the same index using only daily longitudinally-averaged fields (roughly two orders of magnitude less data). This new tool is being used to examine how stratospheric changes (e.g., from ozone depletion and recovery or from increasing greenhouse gases) affect the climate and weather at Earth's surface.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

By reducing the amount of data storage and input/output time required, this development allows significant amounts of climate information to be readily extracted from climate models for future analysis and interpretation, data that could not be saved cost-effectively for future analysis otherwise.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

This project contributed to international scientific collaboration through extensive interactions with a Canadian research effort.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

No

What may be the benefits of the proposed activity to society?

No

OPP/ARC 2009

Program Officer: William Wiseman

NSF Award Numbers:

[0612289](#)

Award Title: The polar stratosphere and vertical coupling during International Polar Year

PI: Mark Baldwin, mark@nwra.com

Institution Name: NorthWest Research Associates, Incorporated

State Code: WA

PE Codes: 5280

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY)

A new proxy for paleo-temperatures from lake sediments

Highlight ID: 19107, Version: AC/GPA

The thermometer was invented in the early seventeenth century. Accurate thermometers appeared about a century later. Our ability to assess long-term change in climate variables, particularly temperature, from periods many centuries or millennia before present depends on proxies, variables that are believed to correlate accurately with temperature. One such proxy, in the oceans, is based on changes in the chemical structures of alkenones, long-chain hydrocarbons. In the oceans, these are produced by particular types of planktonic algae (*Emiliania huxleyi* and *Gephyrocapsa oceanica*) and well preserved in the sediments for millions of years due to their unique chemical stability. Thus, by analyzing sediment cores for alkenones, paleo-oceanographers can estimate the surface water temperatures at the time the sediments were deposited. Dr. Yongsong Huang, at Brown University, has identified a similar but genetically different alga that produces alkenones in Greenland lakes. He has developed a field calibration for the relationship between alkenone composition and temperature and is attempting to culture the alga in his laboratory to permit development of an improved calibration. He is applying this paleothermometer to the analysis of sediment cores from the lakes of southern Greenland. This will permit comparison of the temperature history of these low elevations with that derived from ice cores atop the Greenland Ice Sheet and, thus, identify how characteristic the latter is of regional temperature and its variability during the past 6000 years.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

Since proxies for paleo-temperatures are not a direct measure, the more such proxies we have that produce consistent results the stronger our confidence in the reconstructed temperature record from prehistoric times. Oceanographers have benefited from the analysis of alkenone data as such a proxy. The discovery of a similar alkenone record in fresh water lakes allows this technique to be transitioned to the terrestrial environment.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

This project has supported undergraduates entrained into the research enterprise and has supported the training of a PhD student who recently completed his degree program.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

No

What may be the benefits of the proposed activity to society?

No

OPP/ARC 2009

Program Officer: William Wiseman

NSF Award Numbers:

[0520718](#)

Award Title: Laminated west Greenland lake sediments as unique climatic and biogeochemical archives

PI: Yongsong Huang, Yongsong_Huang@Brown.edu

Institution Name: Brown University

State Code: RI

PE Codes: 5280, 5205

NSF Contract Numbers:

NSF Investments: Climate Change

Bering Sea Ecosystem Study

Highlight ID: 19109, Version: AC/GPA

The NSF and the North Pacific Research Board (NPRB), a non-profit organization in Alaska, have entered into a unique coordinated program to characterize the state of the ecosystem of the eastern Bering Sea shelf and to understand its response to climate change. NSF supports the climate, physical oceanography, and chemical oceanography research (Bering Sea Ecosystem Study - BEST), as well as the studies of lower trophic level plants and animals on which fish, birds, and mammals, studied with NPRB funding (Bering Sea Integrated Ecosystem Research Program-BSIERP), feed. Both organizations support modeling and social science studies. For multiple consecutive years, more than ninety scientists will be involved in regular cruises sampling the ecosystem from the ice-covered winter through late fall and modeling the results. Extensive outreach is also involved through teachers and members of the media who participate in the cruises, as well as visits to local communities. More than ninety North American scientists from academia, industry, and government are involved in the coordinated program. Visitors from foreign countries also participate on some cruises.

The first year of cruises of this interdisciplinary study has been successfully completed and the second year of cruises is underway. Modeling studies are proceeding smoothly.

Primary Strategic Outcome Goal:

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

The Arctic, including the Bering Sea, is experiencing unprecedented changes in climate forcing. How the ecosystem responds to these changes and how these changes ultimately impact the populations that depend upon the Bering Sea for their livelihood constitute a study of a complex, multi-scale system of challenging dimensions. The progress being made by the present collaboration is making a quantum leap forward in our understanding of the system

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

The large number of principal investigators and students involved in this project, all of whom are involved in outreach activities, will generate a significant level of interest in the science of climate change effects on ecosystems. More importantly, the outreach to Alaskan native communities - Aleut and Yupik - is a significant effort to share knowledge and understanding of the system between the Alaskan natives and the scientists.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

Yes

While there have been a few large marine ecosystem studies in the past, two aspects of this one are unique. The first is the attempt to study the entire system from climate through humans. The second is the attempt to model a system of this complexity in a fully-coupled model. If successful, this may alter the manner in which such systems are studied.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

Simply because of the number of participants and the interdisciplinary nature of the coordinated program, large numbers of students, many of them female, will be entrained into interdisciplinary science.

What may be the benefits of the proposed activity to society?

Yes

Roughly half of the commercial fisheries landing in the US are derived from the Bering Sea. Improved understanding of the ecosystem changes to be expected from climate variability will benefit the planning necessary to succeed in the fishing industry.

OPP/ARC 2009

Program Officer: William Wiseman

NSF Award Numbers:

[0518226](#)

Award Title: Planning Activities for Bering Ecosystem Studies (BEST)

PI: George Hunt, geohunt2@u.washington.edu

Institution Name: University of Washington

State Code: WA

PE Codes: 5280

[0732534](#)

Award Title: Collaborative Research: Downscaling global climate projections to the ecosystems of the Bering Sea with nested biophysical models

PI: Nicholas Bond, nick@atmos.washington.edu

Institution Name: University of Washington

State Code: WA

PE Codes: 5280

[0732301](#)

Award Title: Collaborative Research: BEST: Mesozooplankton-microbial food web interactions in a climatically changing sea ice environment
PI: Evelyn Sherr, sherre@coas.oregonstate.edu
Institution Name: Oregon State University
State Code: OR
PE Codes: 5280

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY)

Polar Weekend at the American Museum of Natural History

Highlight ID: 19266, Version: AC/GPA

The New York City Polar Weekend Symposia took place February 2-3, 2008 and February 7-8, 2009. The events shared the excitement of polar research and the International Polar Year 2007 with a broad public audience. Each weekend event consisted of a polar fair of booths on polar research, a lecture series for in-depth learning and polar arts presentations. This program design deliberately allows and encourages people to learn in several different ways: listening and viewing as well as interaction with scientists through one-on-one question and answer, demonstrations, and personal participation. The symposia convey the critical role of the poles in global climate and the dramatic changes that are already underway and they promote an understanding of what can be done to mitigate and adapt to global warming and an appreciation for careers in science and education. Polar themed plays, Native dancing, singing, storytelling and films provided another avenue to engage audiences in the polar regions. The main goal of this project is to enhance public understanding of science through a focus on the polar regions. As many as 5,000 people, families, individuals and school groups, participate during each two-day experience. At least 30% of museum visitors are members of under-served communities. Written and oral surveys from the first weekend provide feedback to incorporate in the second weekend and add to our understanding of how the public gets its information about science and on their impressions of polar research topics. Performers and presenters in 2008 and 2009 represented a wide variety of institutions including the American Museum of Natural History, Barnard College, Columbia University, Lamont-Doherty Earth Observatory, the Explorers Club, Wings World Quest, New York Times, New York University, NASA, the Central Park Zoo, Anne Aghion Films, the Cold Regions Research and Engineering Laboratory in New Hampshire, the Inuit throat singers from Canada and other international partners. Over 85 presenters participated in each Polar Weekend.

Primary Strategic Outcome Goal:

- Public Understanding of Science and Lifelong Learning

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

Polar Weekend was a successful collaboration between academic institutions and the American Museum of Natural History. In 2008 the project administered surveys to: understand visitors' experience at the NYC International Polar Weekend; determine the successes and shortcomings of the program, eliciting suggestions for improvement for next year' understand the event's impact on visitors, focusing on the content messages. The 400 written responses and 100 interviews, the 2009 weekend was able to make improvements based on user feedback. The surveys also indicate that people tend to prefer to get their science information from television, school and newspapers (museums was not a possible response). About half of the audience was interested and somewhat

knowledgeable about polar issues and about one-third attended the museum to participate in polar weekend.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

Each weekend the museum visitorship is approximately 12,000 people. The location of the Polar Weekend ensured that a large portion of visitors would walk through the rotunda where the polar fair was set up and each weekend estimates about 5000 participants. These symposia reach a diverse population, of visitors and presenters and through partnering with New York's Urban Advantage program for middle schools and New Visions for high schools, to serve economically, linguistically, and culturally diverse families. This project was integrated with other AMNH programming and, through evaluation, examined how the event influences visitors and presenters. While the main goal is engaging the public in understanding and appreciating polar environments and culture, by involving over 85 presenters who are scientists and scholars in developing presentations, activities and resources for a general audience, the project also contributed to the capacity of these academics to become active and articulate spokespeople for science during IPY 2007 and beyond.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

Yes

Selection of presenters focused on representing underrepresented groups in science including women and minorities. Alaska Native groups participated in outreach activities to broaden perspectives about Alaska Native cultures. The AMNH program for providing low income families with vouchers to attend the museum highlighted Polar Weekend as an event to attend.

What may be the benefits of the proposed activity to society?

No

OPP/ARC 2009

Program Officer: Renee Crain

NSF Award Numbers:

[0806509](#)

Award Title: Collaborative Research: NYC International Polar Weekend 2008-2009

PI: Stephanie Pfirman, spfirman@barnard.columbia.edu

Institution Name: Columbia University

State Code: NY

PE Codes: 5208

NSF Contract Numbers:

NSF Investments: American Competitiveness Initiative (ACI), Climate Change, International Polar Year (IPY), Environment (including the importance of fresh water and dynamics of water processes)

Greenland Inland Traverse - GRIT

Highlight ID: 19268, Version: AC/GPA

In spring 2008, NSF's arctic research support and logistics contractor successfully delivered 6,400 gallons of fuel to an international ice core drill camp and NSF's research facility in Greenland, Summit Station. The Greenland Inland Traverse (GRIT) was a proof of concept traverse to determine if fuel and cargo could effectively be delivered to research stations on the Greenland Ice

Sheet via overland traverse. Summit Station has evolved over a 20 year history that began in 1988 during the second Greenland Ice Sheet Project (GISP2) to collect a deep ice core near the highest point of the ice sheet. Since then, researchers retrieved a second nearby core from the Greenland Ice core Project (GRIP) and initiated a host of atmospheric and snow research measurements that are now carried out year-round and in seasonal research campaigns. In the winter, four people operate the station, collect data and maintain instruments and prevent snow from covering the buildings. In spring, they resurface the snow runway for LC-130 Hercules aircraft that transport people, fuel and cargo to the station in summer.

Under NSF's direction, the research community and the logistics provider, CH2M Hill Polar Services (CPS) are updating a redevelopment plan for Summit Station that will move the station toward a low-energy, efficient station that meets the year-round needs and can accommodate a seasonal influx of researchers. The traverse is an important aspect to that redevelopment plan. LC-130s introduce exhaust contamination to the relatively pristine research area and the planes are relatively expensive and inefficient, consuming about a gallon of fuel for every gallon delivered to the station. LC-130 aircraft also have a limited cargo space, dictating the size and shape of items flown, thus requiring on-station construction, which adds to the cost of the redevelopment plan. With a traverse, vehicles meet fuel economy standards and agricultural emissions standards or better and can haul heavy or oversized cargo. A logistics traverse may open doors for research traverse activities in places that are difficult to access.

To develop the traverse, the contractor, CH2M Hill Polar Services (CPS) collaborated with experts at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) who had been working on NSF's traverse in Antarctica to deliver fuel and cargo to South Pole Station. Both the Arctic Research Support and Logistics program and the Antarctic Infrastructure and Logistics Division face similar challenges to deliver heavy or oversized cargo to their inland research bases in a cost effective manner and the two programs are working together to solve technical issues for the overland traverse options. The 2008 proof of concept GRIT found a safe route, based on earlier satellite imagery analysis, from Thule Air Base in northwestern Greenland across 750 miles of ice sheet, sometimes traveling at 3% grade, navigating some crevasse areas, to deliver fuel to the North Eemian (NEEM) drill camp led by the Danish Polar Center. From NEEM the traverse hauled fuel to Summit Station. After a brief rest, the traverse team returned vehicles to the vicinity of Thule Air Base (near the old Camp Century) for pick-up in the fall, when the snow would be hard enough to come down off the ice sheet. This proof of concept traverse tested the vehicles planned for use, a Case STX 530 and a Tucker Sno-Cat equipped with attached ground penetrating radar for crevasse detection. The Tucker towed the housing module for the traverse team and the Case towed 11,000 gallons of fuel, delivering 4,100 to NEEM and 2,600 to Summit Station. The Case tended to sink into the snow and will be modified with wider tracks in future traverses. It took 53 days of travel to round trip. The results of the GRIT proof of concept are being integrated into a test traverse in 2009 that is just to confirm vehicle choices and test sled designs. The plan is for a fully developed fuel and cargo traverse to deliver supplies to Summit Station in 2010.

Primary Strategic Outcome Goal:

- Polar Facilities & Logistics

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

The best available technology is being used to develop a cost effective way of supporting the research mission at Summit Station. Satellite imagery is analyzed by experts at CRREL to determine a safe route from Thule Air Base to Summit Station. Equipment used on the traverse is the state of the art in tractors that are fuel efficient and have extremely low emissions. New sled technology is being developed by CRREL to carry liquid fuel and bulky cargo across the ice sheet. The effort is part of an overall emphasis on energy efficiency, reducing operating costs and supporting research and observations of the arctic climate system.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

The Greenland Inland Traverse GRIT is focused on a mission of supporting basic research at Summit Station. The project involves a collaboration between the Arctic and Antarctic logistics programs at

NSF and with experts in industry and CRREL to develop the most effective traverse capabilities. These capabilities are anticipated to support science directly on research traverses that may be proposed in the future. The traverse is also supporting the NEEM international ice coring camp.

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
No
OPP/ARC 2009

Program Officer: Patrick Haggerty
NSF Award Numbers:
NSF Contract Numbers:
0520837

Award or contract number required for submission.

NSF Investments: International Polar Year (IPY), Environment (including the importance of fresh water and dynamics of water processes)

Loss of arctic sea ice; the cost to polar bears

Highlight ID: 19270, Version: AC/GPA

As the areal extent of summer sea ice declines, polar bears are faced with increasingly large stretches of open water between shorelines and sea ice. Some spend the summer and early fall on the pack ice where they have continual access to seals, their primary food. Others spend summer and early fall on land in a "walking hibernation" with little or no access to food. The physiological costs of fasting on shore are important for predicting the impact of sea ice loss on the survival of this top predator of the Arctic marine ecosystem. While management biologists for many years have been able to monitor population responses to environmental change through satellite tracking and population modeling, proximal mechanisms by which polar bears may be impacted by decreased sea ice have been difficult to assess as physiological studies have been impractical for large, free-ranging, ice-associated mammals. This project uniquely takes modern physiological analyses - previously limited to the laboratory - to the field.

In August 2008, a collaborative effort between NSF-sponsored scientists from the University of Wyoming, The US Fish and Wildlife Service, the US Geological Survey, and the World Wildlife Federation, 29 polar bears (*Ursus maritimus*) were successfully captured along the Beaufort Sea coast of Alaska. After being anesthetized, the bears were weighed, and blood, breath, fat, and muscle samples were collected. Body fat content was measured using bioelectric impedance analysis. Twelve bears were fitted with GPS satellite collars, and a small temperature logger was implanted subcutaneously using sterile surgical procedures. The bears' movements and energy expenditures are being successfully tracked by satellite. They will be recaptured in summer 2009, at which time their body condition will again be sampled. The results of these field studies will be used in spatially-explicit individual-based population models to forecast changes in polar bear population in relation to scenarios of diminishing.

Primary Strategic Outcome Goal:

- Biological Sciences

- Polar Sciences: Arctic and Antarctic Research

Secondary Strategic Outcome Goals:

In terms of intellectual merit, why is this outcome notable and/or important?

The research will determine whether polar bears that remain on the pack ice during summer experience food deprivation, prolonged adaptive fasting, and skeletal muscle protein and strength retention in comparison with land-bound bears and the potential impact of varying sea ice conditions on the polar bear population.

In terms of broader impacts, why is this outcome notable and/or important?

[Merit Review Broader Impacts Criterion: Representative Activities, July 2007](#)

Arctic sea ice supports an ecosystem that will be substantially altered by climate warming. Polar bears play a key role as top-level predators in that ecosystem, and they are important economically and culturally to indigenous people in Alaska and other parts of the Arctic. The results will improve forecasts of polar bear population responses to climate change and pioneer methods that likely will find application to other ice-associated mammals.

The USGS staff has the mandate and expertise to monitor responses of polar bear populations to climate change. The University of Wyoming researchers have expertise in measuring and analyzing mammalian physiology. The combination of these groups and techniques will improve forecasting responses of polar bear populations to climate change beyond what either group could accomplish alone. Those forecasts will inform management decisions by the U. S. Fish and Wildlife Service and the international Polar Bear Specialists Group

Does this highlight represent transformative or potentially transformative research? If so, please explain why. For more information, see [Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008](#) and [Important Notice 130: Transformative Research](#)

No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)

No

What may be the benefits of the proposed activity to society?

Yes

Polar bears are important in the economy and culture of Alaskan Eskimos. The bears are harvested for food and skins used to make clothing and handicrafts. Polar bears also play an important role in structuring the biological community on which coastal Eskimos depend. Thus, this research will be important to forecasting impacts of climate change on the way of life of these northern people.

OPP/ARC 2009

Program Officer: Brendan Kelly

NSF Award Numbers:

[0732713](#)

Award Title: Adaptive long-term fasting in land- and ice-bound polar bears: coping with ice loss in the Arctic?

PI: Henry Harlow, harlow@uwyo.edu

Institution Name: University of Wyoming

State Code: WY

PE Codes: 5280

NSF Contract Numbers:

Award or contract number required for submission.

NSF Investments: International Polar Year (IPY)