Arctic Sciences Division
GPRA Highlights, FY 2007

Receding sea ice further endangers spectacled eiders

Highlight ID: 13407, Version: AC/GPA

Dr. James Lovvorn of the University of Wyoming has developed a numerical model that integrates spatially-explicit benthic data, data and models of ice conditions under different weather regimes, and results from his long-term research on the energetics of foraging by spectacled eiders, an endangered species. While the model results suggest that ice conditions have little impact on the eiders' energy balance, in terms of flight costs while searching for open-water feeding sites, they do indicate that night-time energy costs are greatly reduced if the birds can get out of the water and rest on ice rather than floating on the water. In fact, if there were no ice for nighttime roosting, the model suggests that the area of habitat with prey densities high enough to meet the energy needs of the birds would be reduced by almost 50%. The model suggests that this threatened species of eider may be as sensitive to loss of ice as the more celebrated polar bears and walruses. The importance of ice for nighttime roosting was an entirely unexpected result, and emphasizes the value of comprehensive models for identifying key ecological mechanisms that would otherwise go unnoticed.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

- Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
These results indicate a new and unexpected relationship between the health of an endangered species population and the climate variability. The model developed for this project will be of further use for exploring the ecology of this top predator. This tool can be adapted for application to other bird species.

Does this highlight represent transformative research?
Yes

This highlight is transformative in that the results are contrary to the existing paradigm.
OPP/ARC 2007

Program Officer: Wiseman William
NSF Award Numbers:
0454454

Award Title:	Climate-driven changes in impacts of benthic predators in the northern Bering Sea
PI:	James Lovvorn, lovvorn@uwyo.edu
Institution Name:	University of Wyoming
State Code:	WY
PE Codes:	5280, 5205

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility:

Center for Remote Sensing of Ice Sheets

Highlight ID: 13663, Version: AC/GPA

The Center for Remote Sensing of Ice Sheets is developing tools and techniques to determine the effect of climate change on polar ice sheets and the resulting impact on sea level change. It is also training next-generation scientists and engineers taking into account the diversity of our nation. Synthetic-Aperture Radars (SAR) are revolutionizing the study of polar ice sheets. Satellite-based radars have shown that parts of ice sheets in Greenland and West Antarctic are undergoing rapid changes. However, what is causing these rapid changes is poorly understood. Constraining conditions at the bed is key to understanding the processes causing these changes and incorporating this knowledge into models. CReSIS has developed a VHF radar to simultaneously image the ice bed, measure ice thickness and map internal layers; its potential was demonstrated with field experiments in Greenland.

The figure on the top is a synthetic-aperture radar (SAR) image-mosaic of the ice bed at summit, central Greenland. The image-mosaic is generated with the radar operating in the 120-200 MHz frequency range with 30-m spatial resolution. The two-dimensional SAR reflectivity map in this figure can be used to determine bed conditions. This is the first successful demonstration of imaging the bed through more than 3-km thick ice. The middle figure is a contour map of the same area produced by processing the data in depth-sounding mode to measure ice thickness and estimate bed topography. Until now, fine-resolution mapping of the bed topography was restricted to airborne radio-echo sounding along sparsely-spaced flight lines. With a SAR the bed topography and reflectivity can be determined with unprecedented detail with fine-spatial resolution over a large swath.

The bottom figure shows thickness of ice in Jakobshavn Isbrae, west Greenland, obtained from radar data, which is the only tool to get thickness information over large areas. This is the first successful measurement of ice thickness on this glacier and clearly shows the deep and narrow channel through which the ice flows. The inset shows the deepest part of the channel in more detail, and indicates an ice thickness of about 2.5 km. The Jakobshavn Isbrae retreated and accelerated significantly over the last few years. Information about the bed topography and thickness is crucial to identifying causes for these changes and to model its response to a warming climate.
CReSIS is a Center supported jointly by the Arctic and Antarctic Divisions of OPP and its research involves work in both Polar Regions.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

- Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This research will foster research that will advance the frontiers of knowledge and establish the nation as a global leader in fundamental science and engineering and will build the nation's research capability through critical investments in advanced instrumentation, facilities and experimental tools.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Program Officer: Jane Dionne
NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:
NSF Investments: Climate Change, International Polar Year (IPY)
Related Center or Large Facility: Center for Remote Sensing of Ice Sheets

Learning about change

Highlight ID: 13778, Version: AC/GPA

This project, one of a suite of projects exploring past changes in arctic environments by looking at lake sediments, has been pro-active in recruiting students to research. One masters student was engaged to lead much of the laboratory analyses. He submitted graduate student proposals for supplemental funding, wrote his thesis research proposal, presented a poster at the 36th annual Arctic Workshop in Boulder, CO (in March, 2006), and will present his latest findings at both the northeastern GSA meeting and the 37th Annual Arctic Workshop in Iceland (May 2007). A varved (annually layered) sediment record that was discovered forms the basis of his thesis research.
A second masters student at first assisted in sediment sample preparation, and now can fully identify the range of subfossil aquatic taxa being studied in Baffin Island lakes. She presented the results of the groups findings at an Arctic Workshop last year, and is planning to present the group's first inferred summer temperature graph from their study lake at this year's Arctic Workshop. She also submitted proposals for graduate fellowships and grants.

In addition, three undergraduates assisted in the lab this year. One is a Puerto Rican intern in the Buffalo Geosciences Program (an outreach geoscience education program focused on increasing

geoscience knowledge among underrepresented groups in the Buffalo region), a second (African American) is a new sophomore geology major, and a third is also an African American, who has not yet decided her major. All helped in the laboratory with sediment sample preparation.

Primary Strategic Outcome Goal:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This effort as strived hard to give opportunities for education and exposure to field and laboratory work to young students, including those from groups typically under-represented in scientific research.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Tags: FY09 OMB Budget Request
Program Officer: Neil Swanberg
NSF Award Numbers:
0455024

Award Title:	Collaborative Research: A Synthesis of the Last 2000 Years of Climate Variability from Arctic Lakes
PI:	Jason Briner, jbriner@buffalo.edu
Institution Name:	SUNY at Buffalo
State Code:	NY
PE Codes:	5219, 5205

NSF Contract Numbers:
NSF Investments: American Competitiveness Initiative (ACI), Climate Change, Educating Innovators for the 21st Century, International Polar Year (IPY)
Related Center or Large Facility:

Studying past changes in arctic fossils.

Highlight ID: 13785, Version: AC/GPA

This work contributes to understanding the Arctic system by placing 20th century climate change into a longer-term context of inter-decadal climatic variability spanning the last 2000 yr. To understand the modern Arctic system, its current unprecedented change, and its future requires the long-term perspective of the natural variability intrinsic to the system. Because observational records of the Arctic are relatively brief, we must depend on proxy records for this perspective. This work is part of a larger NSF-sponsored project to obtain and synthesize climatic data from the Arctic over the last 2000 yr. They are currently using assemblages of aquatic insect fossils from lake sediments to reconstruct past temperature on Baffin Island, eastern Canadian Arctic that will eventually be combined with many other like records from across the Arctic to generate a broad understanding of past temperatures in the Arctic

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This is research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit to the research community and society.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Program Officer: Neil Swanberg
NSF Award Numbers:
0455024

Award Title:	Collaborative Research: A Synthesis of the Last 2000 Years of Climate Variability from Arctic Lakes
PI:	Jason Briner, jbriner@buffalo.edu
Institution Name:	SUNY at Buffalo
State Code:	NY
PE Codes:	5219, 5205

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility:

Trajectory Shifts in the Arctic Freshwater Cycle

Highlight ID: 13787, Version: AC/GPA

A new analysis of 50 years of changes in freshwater inputs to the Arctic Ocean and North Atlantic may help shed light on what's behind the recently observed freshening of the North Atlantic Ocean. In a report, published in the August 25, 2006 issue of the journal, *Science*, MBL (Marine Biological Laboratory) senior scientist Bruce J. Peterson and his colleagues describe a first-of-its-kind effort to create a big-picture view of hydrologic trends in the Arctic. Their analysis reveals that freshwater increases from Arctic Ocean sources appear to be highly linked to a fresher North Atlantic.

The multi-disciplinary team of scientists led by Peterson calculated annual and cumulative freshwater input anomalies (deviations from expected levels) from net precipitation on the ocean surface, river discharge, net attrition of glaciers, and Arctic Ocean sea ice melt and export for the latter half of the 20th century. The scientists compared the fluxes to measured rates of freshwater accumulation in the North Atlantic during the same time period.
Their analysis showed that increasing river discharge and excess net precipitation on the ocean contributed the most freshwater (~20,000 cubic kilometers) to the Arctic and high-latitude North Atlantic. Sea ice reduction provided another ~15,000 cubic kilometers of freshwater, followed by ~2,000 cubic kilometers from melting glaciers. Together, the sum of anomalous inputs from all of the freshwater sources analyzed matched the amount and rate at which fresh water accumulated in the North Atlantic during much of the period from 1965 through 1995.

The team's comparison of freshwater sources and ocean sink records revealed that over the last half century changes in freshwater inputs and ocean storage occurred not only in conjunction with one another, but in synchrony with rising air temperatures and an amplifying North Atlantic Oscillation (NAO), a climatic phenomenon that has strong impacts on weather and climate in the North Atlantic region and surrounding continents, and the associated Northern Annular Mode (NAM) index.

Peterson and his colleagues contend that the interplay between the NAO and NAM, and continued rising temperatures from global greenhouse warming, will likely determine whether the Arctic and North Atlantic Oceans will continue to freshen. But the scientists caution that the difficultly in predicting fluctuations makes it impossible to know where we might be headed.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This is research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Does this highlight represent transformative research?
Yes

This work, the result of an NSF funded synthesis, has brought scientists from several disciplines together to look at a major problem from the perspectives of a number of fields. As a true synthesis product, it is transformative because it enables the field to see the truth that lies beyond disciplinary preconceptions, and it can thus change the way we think about the arctic system.
OPP/ARC 2007

Tags: FY 09 Congressional Budget Request, FY09 OMB Budget Request
Program Officer: Neil Swanberg
NSF Award Numbers:
0229302

Award Title:	Biogeochemical Tracers in Arctic Rivers: Linking the Pan-Arctic Watershed to the Arctic Ocean
PI:	Bruce Peterson, peterson@mbl.edu
Institution Name:	Marine Biological Laboratory
State Code:	MA
PE Codes:	5219, 1629

0436118

Award Title:	Synthesis and Scaling of Hydrologic and Biogeochemical Data on the North Slope and Coastal Zones of Alaska: A Basis for Studying Climate Change
PI:	Marc Stieglitz, marc.stieglitz@ce.gatech.edu
Institution Name:	GA Tech Research Corporation - GA Institute of Technology
State Code:	GA
PE Codes:	5219

0352754

Award Title:	Collaborative Research: North Pole Station: A Distributed Long-Term Environmental Observatory
PI:	James Morison, morison@apl.washington.edu
Institution Name:	University of Washington
State Code:	WA
PE Codes:	5293, 5225, 5205

NSF Contract Numbers:
NSF Investments: Climate Change, Dynamics of Earth's Water System
Related Center or Large Facility:

Embedded sea ice model with tidal forcing may improve climate projections

Highlight ID: 13979, Version: AC/GPA

A numerical model of the dynamics of an ice-covered ocean that includes tides has been developed, as part of Dr. Jennifer Hutchings' sea ice project, by Dr. William Hibler (University of Alaska) and colleagues. They utilize an approach that embeds the sea ice directly in the ocean model in a highly parameterized fashion. The results of the model compare favorably with observation when contrasted to similar comparisons with more common approaches to the modeling challenge. These results indicate one approach that may be taken to improve the accuracy of sea ice lead opening and closing.

These results are important because the opening and closing of sea ice leads on short time and space scales in models may improve our ability to model Arctic processes such as heat and moisture flux from the sea to the atmosphere, the growth of new sea ice, and the generation of brine from growing sea ice.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This work indicates a direction that improved climate models may take when addressing problems dealing with sea ice. Such models are an essential tool for the advancement of climate science.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Tags: FY09 OMB Budget Request, Societal Benefits
Program Officer: William Wiseman
NSF Award Numbers:

0520574

Award Title: Sea Ice Tide-Inertial Interaction: Observations and Modeling
PI: Jennifer Hutchings, jenny@iarc.uaf.edu
Institution Name: University of Alaska Fairbanks Campus
State Code: AK
PE Codes: 9150, 5280, 5205

NSF Contract Numbers:
NSF Investments: Climate Change, International Polar Year (IPY)
Related Center or Large Facility:

Inuit and Scientific Studies of the Narwhal: Connecting Parallel Perceptions

Highlight ID: 14090, Version: AC/GPA

The narwhal with its long protruding tusk has captivated artists, intrigued explorers and baffled scientists. Now a team of researchers led by Dr. Martin Nweeia from the Harvard School of Dental Medicine has discovered some capabilities of this extraordinary tooth that are proving stranger than its myths and lore.

“The tooth has capabilities of sensing temperature, pressure, particle gradients and motion together as a hydrodynamic sensor,” commented Nweeia. The tusk was previously thought to be an instrument for aggressive interaction amongst males to establish social hierarchy. The new findings of the tusk as a sensor for its arctic environment open myriad possibilities. Most adult males wield this eight to nine foot spiraled tusk which protrudes through their lip while only some females have them.

Begun in 2000, Narwhal Tusk Research, fueled by Nweeia’s curiosity and funded in part by the National Science Foundation began as a broad based, interdisciplinary and cross cultural investigation to solve one of nature’s most perplexing mysteries. Today, over 60 scientists have joined the effort and share the interest to unlock the secrets within this unique tooth. “Nothing about this tooth makes any sense,” stated Nweeia “It defies almost every known principle in the expression of mammalian teeth. By understanding the narwhal tusk, scientists can refocus attention on the evolutionary adaptation and importance of this sensory organ,” he continued. The scientific study has been endorsed by the International Polar Year Joint Committee in their recent letter to Dr. Nweeia which stated, "The Joint Committee considers that your proposal as submitted includes very strong scientific components and demonstrates a high level of organization and of adherence to the IPY themes and goals."

Among the features that distinguish Nweeia’s study from prior research efforts is the integration of science with traditional knowledge. Dr. Nweeia has collected over 50 interviews on archival digital video and audio files documenting the stories and observations of Inuit elders and hunters from High Arctic communities in northeastern Canada and northwestern Greenland. “These are the people who know the whale and the environment the best,” Nweeia stated. “All the science about this whale can’t match hundreds of years of collected observations on behavior, migration and anatomy.” Knowledge from these interviews collected in the past three years has given this work a new dimension of insight and understanding. The recordings have just begun to reveal the significance of collecting such traditional knowledge and using it to direct, support and change the course of scientific studies. One example is the discovery of tusk flexibility which was remarkable from the scientific evaluation of physical and chemical properties. The team, including Dr. Frederick Eichmiller, Dr. Naomi Eidelman and Anthony Giuseppetti from the Paffenbarger Research Center at the National Institute of Standards and Technology, described a tooth that was built inside out and had the ability to flex one foot in all directions over an eight foot span. “Elders described this flexibility before the scientific findings were revealed and I thought to myself ‘they must be exaggerating’,” Nweeia recounted with a smile. Other interview comments have influenced and

even contradicted scientific results. Dr. Nweeia has provided and encouraged a forum for their observations to be heard. On July 11th, 2006, NSF funding allowed Pavia Nielsen, an elder from Uummannaq in Greenland, to express his observations about narwhal population and migration at the Inuit Circumpolar Conference. His accounts of narwhal population contradicted scientific published accounts. Elder Paniloo Sanguya and hunter David Angnatsiak, both from Pond Inlet in Nunavut, Canada co-presented findings at the Inuit Studies Conference in Paris in October, 2006 with Dr. Nweeia. “Buried in these recordings are over a hundred new observations that we will uncover about the narwhal,” Nweeia noted. His research has touched two sides of a coin that are seldom seen at once. Here, premier scientists can meet Inuit elders and appreciate their insights and observations. “They might not share offices in the same building,” Nweeia says, “but I have them knocking on each other’s door.”

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering. (AC/GPA selected)

Secondary Strategic Outcome Goals:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
The research advances the frontiers of knowledge through its investigation of the narwhal tusk structure. Dr. Nweeia's research points to the tusk as a sensory organ contrary to previous hypotheses that it was a dominance organ. In addition, by working with Inuit hunters and Elders, Dr. Nweeia has not only advanced scientific knowledge of the narwhal tusk, his research has created collaborations with Inuit communities, captured the scientific imagination of Inuit youth, and expanded scientific literacy among this highly underrepresented group.

Does this highlight represent transformative research?
Yes

The research brings two knowledge systems, science and Inuit knowledge, together in a collaboration to increase our understanding of the narwhal. This research is a model for future scientists to utilize as they seek to better understand our world.
OPP/ARC 2007

Tags: FY 09 Congressional Budget Request, FY09 OMB Budget Request
Program Officer: Anna Kerttula de Echave
NSF Award Numbers:
0630561

Award Title:	Inuit and Scientific Studies of the Narwhal: Connecting Parallel Perceptions
PI:	Martin Nweeia, martin_nweeia@hsdm.harvard.edu
Institution Name:	Harvard University
State Code:	MA
PE Codes:	5221

0701534

Award Title: Inuit and Scientific Descriptions of the Narwhal, Connecting Parallel Perceptions: Interdisciplinary Studies of the Narwhal with a Focus on Tusk Function
PI: Martin Nweeia, martin_nweeia@hsdm.harvard.edu
Institution Name: Harvard University
State Code: MA
PE Codes: 5221

NSF Contract Numbers:
NSF Investments: International Polar Year (IPY)
Related Center or Large Facility:

The Central Aleutians Archaeological and Paleobiological Project

Highlight ID: 14165, Version: AC/GPA

An international, interdisciplinary research team is addressing coupled natural and human systems on Adak Island, Aleutian Islands, Alaska. Funded by a grant from the National Science Foundation, Office of Polar Programs, Arctic Social Sciences Program, archaeologists, ecologists, and geologists with the Central Aleutians Archaeological and Paleobiological Project are testing and documenting:

1) long term change in subarctic Holocene environments,
2) consequent change in terrestrial and marine animal populations and diversity and
3) how human inhabitants of the archipelago responded to shifts in the distribution, diversity, and abundance of resources, and, in turn, impacted their resource base.

Archaeological evidence suggests Aleut hunter-gatherers first inhabited Adak Island 6,000 years ago. Recovered shell and bones indicate that the earliest hunter-gatherers in the Central Aleutians heavily relied on sea mammal and bird hunting, fishing, and shellfish collection. Much younger, archaeological sites, dating 3,500 years old or younger, represent semi-sedentary villages and seasonal encampments for salmon fishing. Worldwide, obsidian (volcanic glass) is a coveted raw material for stone tools because, when broken and formed, it possesses a very sharp cutting edge. The only known geological source of obsidian in the Aleutians is Okmok Caldera on Umnak Island or Akutan Island, some 800 km east of Adak. The chemical signature of recently discovered Adak obsidian artifacts matches the source obsidian from Akutan suggesting long distance transport of goods in the Aleutian archipelago by 3500 years ago.

The Bering Sea ecosystem is under severe stress possibly due to: 1) global warming, 2) over fishing by large commercial fisheries, 3) biotic disruptions or, 4) two or more of the above. Archaeologists with the Central Aleutians Project are performing DNA and stable isotope analyses on animal bones representing different time periods in Aleutian prehistory.

Combined, these analyses can potentially provide information on past population sizes and diets of prehistoric seals, sea lions, and sea otters--animals, whose numbers have rapidly diminished in the past several decades. Comprehensive research on long term human-environmental interactions in the Bering Sea region throughout the Holocene is imperative if we are to: understand the dynamics of Aleutian natural and human systems; effectively address the social, political, and economic issues that arise from changes in those system dynamics; and help formulate policy decisions for the region today.

In partnership with the Adak community and school, the Central Aleutians project has established the Adak Discovery Community for teachers, students, and their families. Through a Discovery Community program, this project brings the science, Native Americans, students and policy makers together in education and collaboration.

The Central Aleutians project views this as a reciprocal learning experience. Teachers, students and community members are advising scientists on current Aleutian environmental and social concerns. In return scientists are informing the local community about methodologies and scientific ideas employed in the CAAPP project. The Adak Discovery Community website http://www.farmerbean.com/index.php?option=com_frontpage&Itemid1 brings scientists and the community together to share information and findings following the field season.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
The Central Aleutians Archaeology and Paleobiological Project is a strong interdisciplinary project of archaeologists, ecologists, and geologists collaborating to better understand a northern, island ecosystem and the impacts of human occupation on that ecosystem over the last 6,000 years. The time depth, the nature of the collaboration and the research itself promises unique developments of a theory of social and ecological change. In addition, the project is partnering with the Adak community and school system by developing the Adak Discovery Community for teachers, students and their families to participate in science. The Adak Discovery Community consists primarily of Aleuts, an Alaska Native tribe, which means the project is significantly expanding the scientific knowledge and literacy of a highly underrepresented group.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Program Officer: Anna Kerttula de Echave
NSF Award Numbers:
0353065

Award Title:	Collaborative Research: The Central Aleutians Archaeological and Paleobiological Project
PI:	Dixie West, dlwest@ksu.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	5221, 5205

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility:

Sprucing up the House: Tree Ring Dating Inuit Sites in Labrador

Highlight ID: 14175, Version: AC/GPA

In 1999, while excavating at *Uivak Point 1*, an Inuit 18th century whaling settlement in the Okak region of Labrador, Canada, archaeologists Susan A. Kaplan (Bowdoin College) and Jim Woollett (doctoral candidate, CUNY) and their students uncovered wood that was so well preserved that it smelled like freshly cut spruce. They realized that if they could date the wood they would be able to date the house from which it was removed more exactly than had been possible using artifacts. Also, the archaeologists were interested in how Labrador Inuit responded to climate change, and were excited by the possibility of accessing a local climate record derived through the study of tree ring growth.

The archaeologists contacted dendrochronologists Rosanne D'Arrigo and Brendan Buckley (Columbia University Lamont-Doherty Earth Observatory), who work in Labrador, about dating the wood and extending the Labrador tree-ring sequence (which stopped at A.D. 1605) further back in time using old growth wood and wood recovered from archaeology sites. Together they developed a project that was funded by the National Science Foundation.

In 2000 Buckley and Kaplan and their crews went into the field together. They quickly realized that their fieldwork techniques were quite dissimilar. Buckley had to cover a lot of territory on foot looking for old growth to sample in an effort to extend the range of the tree ring record. Kaplan had to spend weeks at one site to locate and excavate wood.

However, by working together, they learned to appreciate one another's disciplinary needs and see the landscape in new ways. The dendrochronologists had had the impression that when walking in northern Labrador they were traversing untouched wilderness, until the archaeologists started to point out all the archaeology sites the dendrochronologists were walking through.

For their part, the archaeologists had always ignored the question of why spruce trees were present in some places and not others. They began to realize that in the past Inuit had harvested trees so intensively in some areas that what were now windswept, tundra-covered passes had once been tree-covered. Both groups realized that building landscape history needed to become a significant part of their work.

At the conclusion of three-years of fieldwork and additional years of analysis, the teams were able to extend the tree ring sequence back an additional 150 years to A.D. 1453. Two occupations of the Inuit house were dated using dendrochronology, one from 1772 to 1780 and the other from 1792 to 1806. The climate record revealed that the Inuit had inhabited the house during a period of environmental stability. These findings and analyses of animal bones at the site indicate that the inhabitants of Uivak enjoyed a bountiful life. Studies of Inuit use of terrestrial resources and efforts to extend the tree ring sequence further back in time are ongoing.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This research is the first tree ring dating of Inuit house sites in Arctic Labrador. Although archaeologists have utilized the methodology and findings of dendrochronologists for decades they rarely participate in interdisciplinary field research, such as is demonstrated by this project. By working together, the disciplines informed each other's hypotheses and analyses in ways that would not have occurred in the lab. The archaeologists learned that the Inuit had intensively harvested

trees in the region in ways not previously described and thus contributed to a change from forested ecosystems to tundra. The dendrochronolgists learned that what they thought was previously uninhabited landscape had been utilized by the Inuit for over 1,500 years. These interdisciplinary lessons helped the researchers to develop a new way of thinking about the Labrador ecosystem and Inuit social system not previously done.

Does this highlight represent transformative research?
Yes

The interdisciplinary nature of the project helped the researchers of different disciplines to think about their data in new ways. The interdisciplinary lessons learned on the project helped the researchers to develop a new way of thinking about the Labrador ecosystem and Inuit social system not previously done and in doing so, advanced the scientific understanding of the relationships between the natural and social worlds in new ways.
OPP/ARC 2007

Tags: FY09 OMB Budget Request
Program Officer: Anna Kerttula de Echave
NSF Award Numbers:
9910982

Award Title:	Tree-Ring Dating of Inuit Sites in Labrador
PI:	Susan Kaplan, skaplan@bowdoin.edu
Institution Name:	Bowdoin College
State Code:	ME
PE Codes:	5221, 5205, 1530

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility:

Nunamiut Students Interpret Middle Holocene Assemblage Variability in the Arctic

Highlight ID: 14178, Version: AC/GPA

During the summer of 2004 researchers from Brown University and the National Park Service initiated a joint archaeological project at the Tuktu-Naiyuk Site near Anaktuvuk Pass, northern Alaska. The site was originally identified in 1959 by archaeologist Jack Campbell with the help of Anaktuvuk Pass residents Thomas Rulland and Robert Paneak. A sequence of archaeological cultures proposed by Campbell based on this work has served as a cornerstone for interior Alaskan prehistory, particularly the Northern Archaic period, for more than 40 years. The goals of the 2004 research were to unravel the site's complex occupational history, obtain new radiocarbon dates, and identify activity areas and artifact assemblages that could elucidate the nature of mid-Holocene Arctic hunter-gatherer adaptations. An important element of this research was the participation and training of local students, who engaged in both formal classroom studies and hands-on field work.

Survey and mapping efforts identified over 61 small (ca. 3m diameter), discrete clusters of artifacts, which are interpreted to result from brief episodes of activity. Most of the archaeological evidence at Tuktu-Naiyuk comes in the form of flaking debris created in the production and shaping of stone tools. Only a limited number of stone tools were found here: projectile points (side notched and straight based lanceolate), biface blanks, unifaces (end scrapers and retouched flakes, and cobble tools (choppers and notched pebbles). Most of the diagnostic stone tools are consistent with the Northern Archaic tradition found in the western Brooks Range and further south in Alaska. Radiocarbon dates from hearth charcoal demonstrated that at least two artifact clusters did indeed fall within that time period (Napaaq quartz point area: 5070±40, 5109±41, 5109±42, 5126±42,

5255±59, Napaaq obsidian point area: 4001±57, 4095±59, 4980 ± 42, 8240 ± 50; all radiocarbon years before present).

A focus of the research was in understanding variation among the site's artifact clusters as a result of particular human behaviors and with reference to seasonal rounds, raw material procurement strategies, and tool use and replacement. Differences and similarities among sets of artifacts at one site provide important clues to these behaviors. Raw materials included common black and grey cherts with source areas in the western Brooks Range, obsidian with a source on the Koyukuk River to the southwest, local but rare quartz crystal, and local argillites. Flaking debris shows that the site occupants brought formed tools (projectile points and scrapers) made of non-local stone with them to the site, likely in hafts, where they were resharpened or discarded when completely worn. People at Tuktu-Naiyuk also produced rough bifacial blanks using raw materials found nearby in the Anaktuvuk River valley. In sum, this broad kame terrace was used over several millennia as a place for short term camping, a hunting overlook, occasional animal and hide processing, and the manufacture and repair of hunting tools.

Students from high schools in Anaktuvuk Pass and Noatak Village and from University of Alaska at Anchorage and Fairbanks were employed as field crew and had first hand training and experience in artifact identification, site survey, archaeological excavation, mapping, data collection and recording, and artifact analysis. Project directors also taught archaeological methods and displayed results of the Tuktu-Naiyuk project in science classes for students at the Nunamiut School in Anaktuvuk Pass. Students were involved in all aspects of this project, from initial investigations to information dissemination in the form of a poster displayed at an Alaska Anthropological Association meeting, Nunamiut School, and Simon Paneak Museum. This project allowed students to develop useful skills for later employment (at least three of the high school students had jobs as archaeological assistants in following field seasons) and positively promoted archaeology in the Anaktuvuk Pass community.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
The research highlighted is based on a dissertation improvement grant. The main goal of the research was to unravel the sites complex occupational history in an attempt to better understand Northern Archaic artifact assemblages. The research advances our knowledge of mid-Holocene Arctic hunter-gatherer adaptations and provides insight into the impacts of a changing climate on contemporary subsistence economies. Secondarily, the project included students from the local Alaska Native (Nunamiut) Community of Anaktuvuk Pass and Noatak Village. The research promotes the inclusion of underrepresented groups in science and expands the scientific literacy of the Nunamiut people.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Program Officer: Anna Kerttula de Echave
NSF Award Numbers:

0352798

Award Title:	Doctoral Dissertation Research: Interpreting Middle Holocene Assemblage Variability: A Functional Approach
PI:	Douglas Anderson, Douglas_Anderson@Brown.edu
Institution Name:	Brown University
State Code:	RI
PE Codes:	5221

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility: none

Barrow, Alaska to Oaxaca, Mexico: Indigenous Students Learn about their Environments through Climate Change Research

Highlight ID: 14291, Version: AC/GPA

This project was the brain child of anthropologist Barbara Bodenhorn and the Iñupiat community in Barrow, Alaska. Having worked in Barrow on and off for twenty-five years and currently working in two forest communities in Mexico, Dr. Bodenhorn felt that it would be important to create the opportunity for students to learn together about the diversity of ecosystems and cultures, thus enriching an appreciation of their local environments while at the same time developing a more profound understanding of global environmental processes. Climate change is manifesting itself dramatically in the Arctic, fostering a wide range of research supported by the Barrow Arctic Science Consortium and the NSF – the reason we began our interchange in Barrow. At the same time, the Mexican communities of Ixtlan de Juarez and San Juan Nuevo Parangaricutiro enjoy extraordinary levels of bio-diversity and therefore offer different sorts of challenges to our understanding of environmental processes. Thus we thought it was crucial to develop the opportunity to work alongside scientists, as well as to benefit from the considerable historical and environmental knowledge of local experts. As a result, twelve students from three indigenous communities were invited to participate in on-going research, for a month in Alaska followed by another month in Mexico. The Mexican students joined their Barrow hosts early in August, just as the midnight sun was coming to an end, and were integrated into four research projects: two bio-complexity teams, one group of archaeologists and the biologists from the Department of Wildlife Management. They also attended classroom presentations by resident scientists, compared notes regularly to learn about similarities and differences between different scientific methods, and visited with Barrow elders and other history and language experts to learn more about local environmental knowledge. In September, the same group travelled back to Mexico for parallel experiences in the Zapotec community of Ixtlan de Juarez and the Purepecha community of San Juan Nuevo where they worked with local ecologists, forest technicians, biologists and historians. The students thus worked together for two months, crossing linguistic, cultural, scientific and environmental boundaries in ways that generated new modes of understanding as well as new – and lasting – relationships. Although for many of the students this was the first time they had left their families for an extended period of time, there was 100% completion rate. The pilot project was supported by local authorities and in particular by Ilisagvik College, which recognized the satisfactory completion of students' work with 3 credits in an introductory survey course on 'The Nature of Science', 3 humanities credits in 'The individual in Society and Culture' and 1 credit in IT. Several students remarked that the interchange had been life-changing and are eager to expand the experience if the opportunity presents itself. This innovative project exemplifies NSF's commitment to interdisciplinary research, education, international exchange, and increasing the participation of underrepresented groups in the sciences.

Primary Strategic Outcome Goal:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?

a) to promote further study in scientific disciplines on the part of young people who are likely to assume positions of decision-making responsibility in their own communities.
b) to deepen our understanding of the ways in which knowledge practices generated by scientists and others may come together fruitfully both inside and beyond the formal learning context.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Tags: FY09 OMB Budget Request
Program Officer: Anna Kerttula de Echave
NSF Award Numbers:
0632333

Award Title:	Learning About Environmental Research in a Context of Climate Change: An International Scholastic Interchange
PI:	Barbara Bodenhorn, bb106@cam.ac.uk
Institution Name:	Barrow Arctic Science Consortium (BASC)
State Code:	AK
PE Codes:	7316, 5221, 5205

NSF Contract Numbers:
NSF Investments: Climate Change
Related Center or Large Facility: None

New Climate Observatory Being Developed in Tiksi, Russia

Highlight ID: 14459, Version: AC/GPA

A new state-of-the-art Arctic Climate Observatory site is being developed in Tiksi, Russia (71.6 N, 128.9) through a partnership between the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), and the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet). This intensive observing site will be coordinated with and will complement other existing and similar sites around the Arctic including ones presently in Barrow/Alaska, Alert and Eureka/Canada, Summit/Greenland, and Ny-Alesund/Norway to contribute to a more circum-polar view of the Arctic atmospheric processes and climate.

The Tiksi Observatory project has been developed initially by NSF and NOAA in two phases; in Phase 1, the existing weather station in Tiksi was replaced in the summer/fall of 2006 with a new building (Fig. 1). This new structure was designed to house additional laboratory and roof space intended to support instruments for research, climate studies and monitoring studies. Phase 2 plans include the fabrication and construction of a second facility in the summer of 2007 and will be sited 1.5 km north west of the new weather station. The site for the second facility has been selected so that the surrounding terrain is horizontally homogeneous, undisturbed, and with a significant clean air sector (Fig. 2). This second facility will include towers, roof space, air sampling stacks and

boardwalks to maintain the pristine environment. In addition to routine measurements of meteorological variables, high quality measurements will be made of air chemistry and air quality, surface radiation parameters, and precipitation and moisture variables using a variety of instruments provided by NOAA.

It is intended that the Tiksi Observatory facility will support the research needs of NSF funded researchers and the international community, across multiple disciplines. A work requirements document will be finalized in March 2007 and fabrication for the new facility will begin shortly thereafter. Measurement activities and programs will be coordinated by a Tiksi Science Steering Committee to fully utilize resources between programs, disciplines, agencies and countries.

Primary Strategic Outcome Goal:

- Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
Research Infrastructure: This new polar climate research station builds upon and extends our research capabilities by creating an observing node that will enable researchers to obtain multi-disciplinary measurements across the pan-Arctic region.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Tags: FY09 OMB Budget Request
Program Officer: Janet Intrieri
NSF Award Numbers:
NSF Contract Numbers:
0520837

Award or contract number required for submission.
NSF Investments: Climate Change, International Polar Year (IPY)
Related Center or Large Facility:

Winter Research Capability at Toolik Field Station, Alaska

Highlight ID: 14637, Version: AC/GPA

Winter lasts nearly 3/4 of the year in the Arctic, yet relatively few scientific studies have been carried out in the arctic winter because of the significant challenges of conducting scientific research in the extreme cold and dark. Even access to automated measures of environmental parameters has been limited due to a lack of continuous power and communications at major field sites. Recently, scientists have increasingly recognized the compelling need for winter studies, despite the logistical challenges. For example, important issues that can only be addressed by winter studies include 1) understanding the radiation balance in the winter and how it is changing (which is essential to understanding climate change in the Arctic), 2) understanding the role of snow and ground temperature in overwinter carbon and nitrogen cycling, which affects summer growth of vegetation and feed back of greenhouse gases to the atmosphere (one of the principal ways that the Arctic affects global climate), and 3) understanding how animals and plants survive extreme winter conditions, and how these adaptations may constrain their response to changing environmental conditions. Although many biological processes are slower in the winter because of low temperatures, microbes, plants, and animals continue to be active through the long winter night, and their activities establish a legacy that affects summer processes. For example, overwinter

decomposition by soil microbes sets the conditions for summer uptake of nutrients and growth by plants.

The University of Alaska's Toolik Field Station was open for continuous winter operations for the first time in 2006-2007. Science conducted there this first winter included studies of overwintering insects (Duman, University of Notre Dame, and Barnes, University of Alaska, Fairbanks), studies of the patterns of snow accumulation and density behind snow fences and their effects on shrub mortality (Bret-Harte, University of Alaska, Fairbanks) and overwinter CO2 flux (Welker, University of Alaska, Anchorage), winter meteorological measurements at a variety of newly established locations across the north slope (Kane, University of Alaska, Fairbanks), establishment of a snow-cover observation camera for long-term records of snow arrival and snowmelt (Barnes, Bret-Harte, University of Alaska, Fairbanks), studies of stream community ecology overwinter in unfrozen springs (Huryn, University of Alabama) and a NASA-funded study of auroral winds, for which TFS was one of several sky-observing station in northern Alaska (Craven, Lummerszheim, University of Alaska, Fairbanks). Continuous relay and monitoring of existing meteorological stations operated by the Arctic Long Term Ecological Research Program (Hobbie, Marine Biological Laboratory) were carried out. Baseline environmental observations were collected by TFS staff throughout the winter. All of these studies will advance our understanding of winter processes and their legacies for the summer.

Continuous winter operations were successful, despite posing some significant challenges. TFS was staffed continuously, and heat, power, internet connectivity, and both logistic and science support for groups of up to 20 scientists were maintained through winter storms and temperatures down to –60 degrees C. With assistance from the Arctic Logistics provider Veco Polar Resources, a number of modifications to buildings originally designed for summer use allowed expanded winter operations. Two residence buildings, a kitchen, a communications room, and one laboratory were kept open continuously, and the central generation facility was maintained and kept running. Other operations challenges included plowing the access road to keep it open despite drifting snow.

TFS supported 10 different projects for a total of 191 user days projected from October through April. Requests for letters of support for pending proposals were received from 5 new projects planning to do winter research at TFS in the future, and 2 projects that are already funded have announced plans for winter work at TFS. The overwinter capability of TFS will enable numerous studies in the coming years and is timed well to accommodate research conducted as part of the International Polar Year.

Primary Strategic Outcome Goal:

- Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

Secondary Strategic Outcome Goals:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?
This is an important advance in research infrastructure that will enable research that was arduous to conduct in the Arctic and that is important to our understanding of the Arctic.

Does this highlight represent transformative research?
No
OPP/ARC 2007

Tags: FY09 OMB Budget Request
Program Officer: Renee Crain
NSF Award Numbers:

0455541

Award Title:	Toolik Field Station Base Funding
PI:	Brian Barnes, ffbmb@uaf.edu
Institution Name:	University of Alaska Fairbanks Campus
State Code:	AK
PE Codes:	5205

NSF Contract Numbers:
0520837

Award or contract number required for submission.
NSF Investments: Climate Change, International Polar Year (IPY)
Related Center or Large Facility: