Witness the ARCTIC

Chronicles of the NSF Arctic Science Section Fall 2014, Volume 18 Number 3

In this Issue

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Study of Environmental Arctic Change (SEARCH) Update

New SEARCH Structure and Activities

The major news for SEARCH since the *Witness* issue earlier this year (http://www.arcus.org/witness-the-arctic/2014/2/article/21127) is that the proposal to the NSF Division of Polar Programs' Arctic Sciences Section to develop a new SEARCH structure and activities has been funded. The new structure and activities have several departures from SEARCH's focus in the past. Key changes include:

- A central vision of "Knowledge to Action": scientific understanding of arctic environmental change to help society understand and respond to a rapidly changing Arctic;
- A move from the general organizing themes of observing, understanding, and responding to focused science themes (listed below);
- Change from an all-volunteer committee structure (formerly Panels) to Action Teams—with funded support—that correspond to the science themes;
- A suite of synthesis activities that will feed into "Arctic Futures 2050" scenarios;
- Support for a full time SEARCH Executive Director; and
- A formalized organizational structure and process through a Terms of Reference.

The science themes and corresponding Action Team leads are:

- Improve Understanding, Advance Prediction, and Explore Consequences of Changing Arctic Sea Ice (Action Team co-leads: Jennifer Francis, Rutgers University and Henry Huntington, Huntington Consulting)
- Document and Understand How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems (Action Team lead: Ted Schuur, Northern Arizona University)
- Improve Predictions of Future Land-ice Loss and Impacts on Sea Level (Action Team co-leads: Ted Scambos, University of Colorado Boulder and Fiamma Straneo, Woods Hole Oceanographic Institution)

As a first step in implementing activities under the new grant, SEARCH held a small kick-off meeting in September in Boulder, Colorado. The outcomes of this meeting included:

- Provided the first opportunity for the Science Steering Committee (SSC) (http://www.arcus.org/search-program/sciencecoordination/ssc-committee) members, Action Team leads, ACADIS project (https://www.aoncadis.org/home.htm) representatives, and other key participants to meet in person as a group and reaffirm the common vision for SEARCH.
- Obtained input from Interagency Program Management Committee (IPMC) (http://www.arcus.org/search-program/sciencecoordination/ipmc) and Interagency Arctic Research Policy (IARPC) (http://www.iarpccollaborations.org/index.html) representatives on key elements of SEARCH strategy and tactics.
- General agreement on approaches for the Action Teams.
- General agreement on a job description and recruitment strategy for a SEARCH Executive Director.

The agenda, participant list, presentation files, and background readings from the meeting are available at: http://www.arcus.org/search-program/meetings/2014/kick-off-tactics

Current SEARCH activities are focused on finalizing the Terms of Reference, populating the Action Teams, developing a scope and charge for an AON-focused committee under the new structure, and finalizing the details of Executive Director position in preparation for a position announcement in January 2015.

SEARCH at the American Geophysical Union (AGU) Fall Meeting

A SEARCH Town Hall meeting will be held Monday, 15 December 2014 at 12:30-1:30 p.m. in Moscone West, Room 2005, in conjunction with the AGU 2014 Fall Meeting in San Francisco. The Town Hall will:

- Provide updates on the new SEARCH funding and activities, including those related to SEARCH five-year science goals and the Arctic Observing Network.
- Discuss how researchers and others can participate in SEARCH.
- Address questions and concerns.

Members of the Arctic science, education, and policy communities, are invited to attend. SEARCH particularly encourages students and young investigators to participate. Refreshments will be served.

More information about SEARCH events at the AGU Fall Meeting is available at: http://www.arcus.org/search-program/meetings/2014/agu

Arctic Observing Network (AON) Position Paper

SEARCH circulated a draft position paper on the design and implementation of an integrated AON. Craig Lee, chair of the SEARCH Observing Change Panel (OCP) (http://www.arcus.org/search-program/sciencecoordination /observing) led the drafting of the paper, with input from the OCP, the SEARCH SSC, and the SEARCH Project Office at ARCUS. The four-page paper represents a synthesis of discussions within SEARCH over the last year and builds on past SEARCH-AON community events and workshops. Key issues addressed in the paper include governance, network integration, and sustained funding.

The draft paper is available at: http://www.arcus.org/search-program/aon and will be discussed at the SEARCH Town Hall Meeting at AGU.

Sea Ice Prediction Network (SIPN)

The SIPN project, a contribution to SEARCH, completed a successful season of the Sea Ice Outlook (SIO), which provides an open process to share predictions and ideas on the September minimum arctic sea ice extent. The SIO features reports in June, July, and August containing a variety of perspectives on arctic sea ice—from observations of current conditions, to advanced numerical models, to qualitative perspectives from citizen scientists. This year, there were 88 submissions for the SIO reports. With the move of the SIO from a volunteer effort to one funded as part of the SIPN project, the SIO reports this year were a highly collaborative writing process that incorporated input from a wider variety of researchers and provided a more thorough assessment of the individual SIO contributions.

Earlier this fall, SIPN held an open webinar on post-season analysis of the 2014 SIO, including processes that influenced sea ice melt this year and a review of the differing approaches to predicting the sea ice minimum extent. Seventy participants attended the webinar and the webinar archive is available at: http://www.arcus.org /sipn/meetings/webinars/archive

SIPN also convened a Sea Ice Outlook Action Team to work with SIPN leadership to develop a SIO post-season report to assess the physical processes that factored into the sea ice dynamics during the 2014 melt season, as well as a discussion of the various SIO methods. The Action Team members are listed at: http://www.arcus.org /sipn/action-team. A draft post-season SIO report was circulated via the SIPN Mailing List (http://www.arcus.org /sipn/mailing-list) for input. The draft report can be found at: http://www.arcus.org/sipn/sea-ice-outlook /2014/summary and a final report will be circulated in in December.

SIPN will hold a meeting at the AGU Fall Meeting on Wednesday, 17 December from 12:30-2:00 pm. This year's SIPN AGU meeting will focus on issues related to predicting sea ice with methods that are sensitive to initial conditions. Specifically, the goal of this meeting is to set up a common protocol for experiments to test sensitivity to initial conditions in sea ice forecasts of summer 2015. More information about the meeting can be found at: http://www.arcus.org/sipn/meetings/agu/2014/modeling

A SIPN poster, "Arctic Sea Ice Predictability and the Sea Ice Prediction Network" (Helen Wiggins and Julienne Stroeve) will be presented on Thursday, 18 December in Moscone West Poster Hall (Session C43-0393 at 1:40-6:00 pm). See the poster abstract here. (https://agu.confex.com/agu/fm14/meetingapp.cgi#Paper/19819)

In addition, SIPN developed a list of sea ice-related presentations is a tool to help attendees of AGU 2014 find sea ice talks and posters. The list is available here. (http://www.arcus.org/sipn/meetings/agu/2014)

For More Information

For more information about SEARCH, see the SEARCH website (http://www.arcus.org/search-program) or contact Hajo Eicken, U. of Alaska Fairbanks (SEARCH SSC Chair) at hajo.eicken@gi.alaska.edu or Helen Wiggins, ARCUS (SEARCH Project Office) at helen@arcus.org.

Updates on SEARCH are also provided through ARCUS' twitter account: @ArcticResearch.

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Arctic Ocean Sea Ice Loss: Modeling the effect on Wind-to-Ocean Momentum Transfer

By Torge Martin, Polar Science Center, Applied Physics Laboratory, University of Washington, now at GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany; Michael Steele, Polar Science Center, Applied Physics Laboratory, University of Washington; and *Jinlun Zhang, Polar Science Center, Applied Physics Laboratory, University of Washington*

Over the past decades arctic sea ice thickness and extent shrank dramatically, which has gained major scientific and public attention. Sea ice inhibits the exchange of heat, moisture, and gases between the atmosphere and the ocean. Our NSF funded project "InMotion: Influx of Momentum into the Arctic Ocean--Changes Associated with Sea Ice Reduction" (http://www.nsf.gov/awardsearch/showAward?AWD_ID=1203240&HistoricalAwards=false) was designed to investigate how a changing sea ice cover affects the amount of wind energy entering the Arctic Ocean.

Figure 1. An areal view of loose Arctic pack ice in summer (August 2004) with open water patches, floe edges and ridges. Image courtesy of Torge Martin.

In the Arctic, wind is the dominant driver of sea ice and ocean motion. The momentum flux from the atmosphere into the ocean (also known as ocean surface stress) depends on various factors such as wind speed, surface layer stability, surface roughness, and sea ice conditions. Roughness changes in response to changing ocean surface waves and variations in the geometry of ice floes and ridges. Three regimes characterize how sea ice moderates momentum transfer into the Arctic Ocean:

1. At very high ice concentrations, near 100%, the pack ice is so compact that it barely responds to the wind forcing and hence also shields the ocean from the wind.
2. Slightly lower ice concentrations, about 80-90%, allow the ice to drift freely with the wind as pressure within the ice pack is reduced to a minimum, while floe edges and ridges provide high drag (See Figure 1). We refer to this as an "optimal ice concentration", because ocean surface stress is maximal in this case -- as illustrated in the graph of ocean surface stress as a function of sea ice concentration derived from Pan-Arctic Ice Ocean Modeling and Assimilation System[1] (PIOMAS) (http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/) output (See Figure 2).
3. For still lower ice concentrations, stresses decline because open water—even with surface waves—is generally smoother than pack ice.

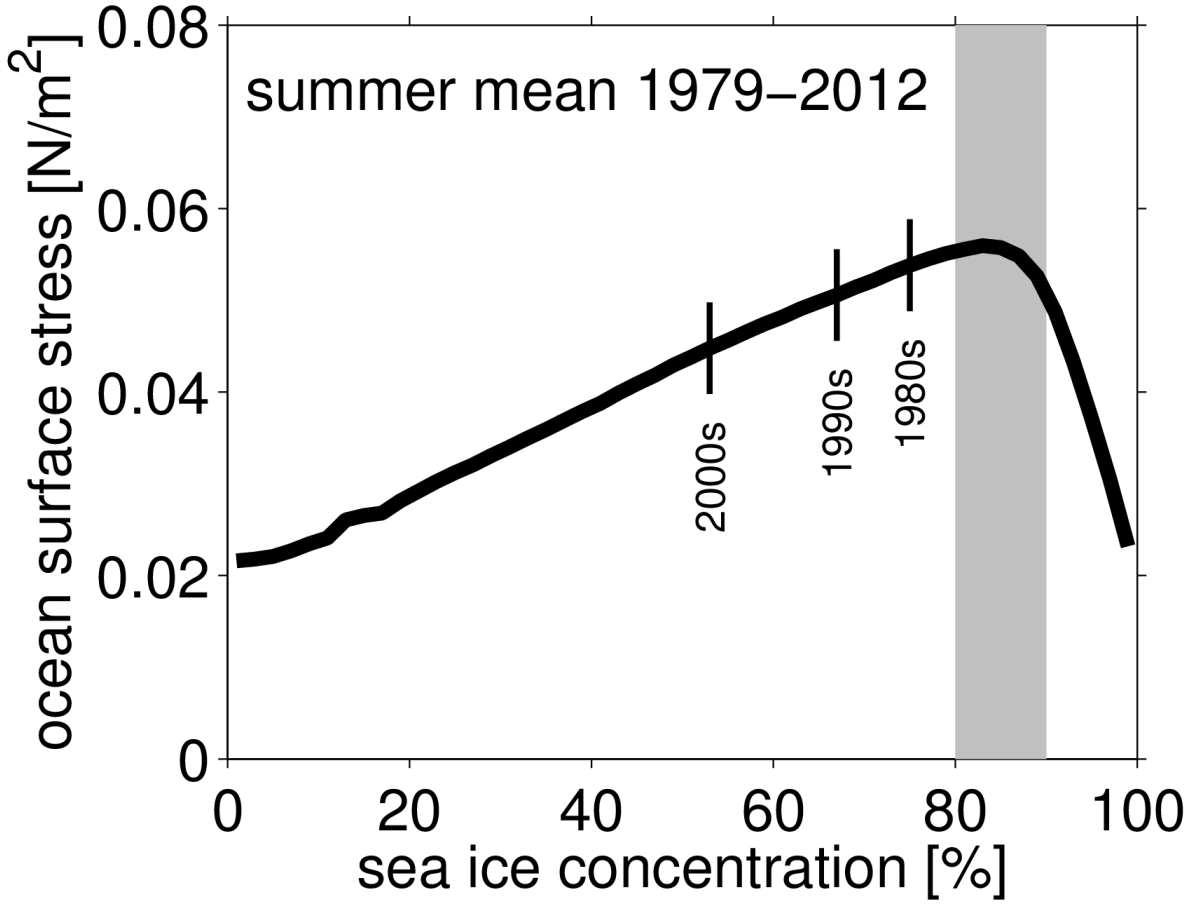

Figure 2. Ocean surface stress (N/m2) as a function of sea ice concentration derived from PIOMAS output. For details see Martin et al. (2014). Vertical lines mark the mean ice concentration for the periods as labeled. Gray shading indicates the optimal ice concentration of 80-90%. The results refer to the Arctic Basin (black outline in Fig. 3a) and summer months July to September of 1979 to 2012. Image courtesy of Torge Martin.

Our PIOMAS simulation enables us to create a map of annual mean Arctic-wide ocean surface stress (See Figure 3a). Stress is high where wind forcing is strong and the ice cover generally less compact, such as in the Nordic and Barents Seas. Stress is low where the pack ice is thick and dense (e.g., north of Greenland) or where there is rigid winter landfast ice (e.g. along the Siberian coast). A belt of moderate ocean stress lies between these two regions.

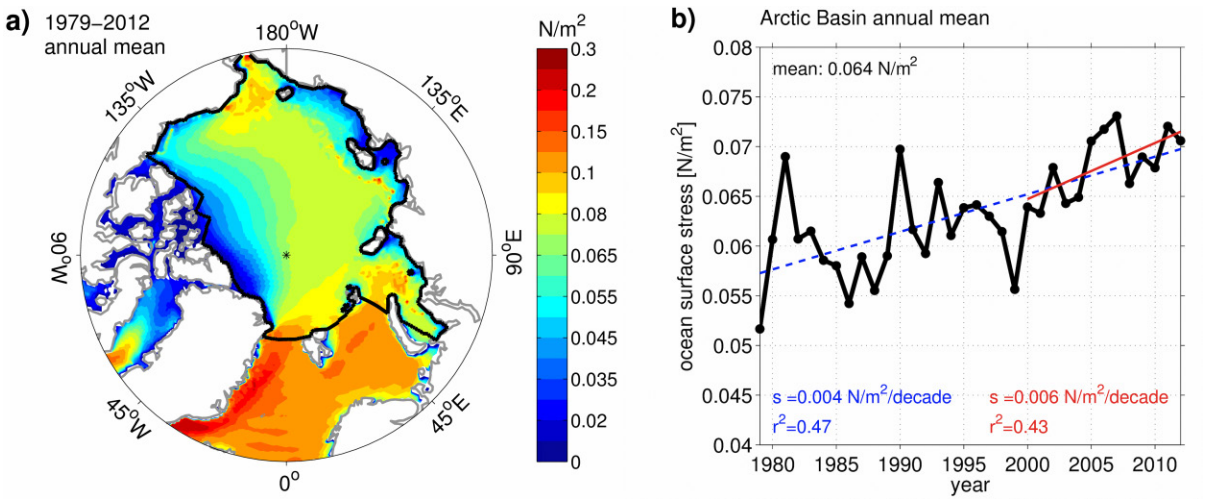

Figure 3 (a) Map of annual mean ocean surface stress (N/m2) averaged over the period 1979 to 2012 from a PIOMAS simulation. (b) Time series of annual mean ocean surface stress (N/m2) averaged over the Arctic Basin (see bold black outline in map on left); the dashed blue line depicts the linear trend for 1979 - 2012 and the red line the trend for 2000 - 2012, which both are significant at a level of 0.99; trend slope s and explained variance r2 are both printed in the plot for each trend in the respective color. Image reproduced from Martin et al. 2014.

Annual mean ocean surface stress over the Arctic Ocean is increasing with a recent steepening of the trend (See Figure 3b). Since there is no significant increase in the wind forcing—i.e. the source of momentum—over the same period (Kwok et al., 2013) we link this increase entirely to the decrease in sea ice thickness. A thinner and thus weaker ice cover has less resistive force against the wind forcing, and hence enables greater momentum transfer into the ocean.

On the other hand, we found that a shrinking summer sea ice extent means less momentum flux into the ocean in this season. How is that? In the 1980s and 1990s most of the Arctic Ocean featured high ice concentrations, even in summer, with an average close to the 80-90% optimum (See Figure 2). In recent years however, vast areas of open water have reduced the mean ice concentration below this optimum, which results in an overall ocean stress decrease at a small but significant rate in summer.

What does the future hold? The area of high momentum flux (See green in Figure 3a) is shrinking toward Greenland as sea ice continues to retreat. Further, an expanding summer season with increasingly less ice coverage might steepen the negative ocean stress trend and eventually even reverse the positive trends in spring and fall. But this assumes that wind forcing and ocean surface waves do not grow, an assumption that might prove incorrect in a changing climate. This illustrates the fascinating interplay between opposing forces that will determine the magnitude of Arctic Ocean currents in the future.

More details on our study, ocean surface stress seasonality and trends, and the optimal ice concentration can be found in Martin et al. (2014). Daily fields of ocean surface stress from 1979 to 2012 based in ourPIOMAS simulation can be found on the ACADIS InMotion page (https://www.aoncadis.org/project/InMotion.html). For more information, please contact Torge Martin (torge.martin@gmail.com).

[1] *We ran PIOMAS for the period 1979 to 2012 forced by atmospheric fields of the NCEP/NCAR reanalysis (Kalnay et al., 1996) and restrained by the satellite-observed sea ice edge provided by the NSIDC (Nolin et al., 1998).*

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Torge Martin (https://sites.google.com/site/torgemartin/) is a meteorologist and sea ice physicist who is particularly interested in atmosphere-ice-ocean interaction. He is running and advancing numerical models to improve the understanding of complex mechanisms in the climate system. After spending two and a half years at the Polar Science Center in Seattle he recently moved back to GEOMAR in Kiel, Germany where he continues to work with modelers and observationalists on the role of the polar oceans in global climate change.

Michael Steele (http://www.apl.washington.edu/people/profile.php?last=Steele&first=Mike) is a physical oceanographer at the Polar Science Center, Applied Physics Lab, University of Washington. His focus is on the sea ice and upper ocean of the arctic seas, using in situ and satellite data, as well as numerical model output. His UpTempO buoy project collects upper ocean temperature profiles in open water and under sea ice with hourly resolution, with the purpose of better understanding the seasonal ocean warming and cooling that happens in response to sea ice loss.

Jinlun Zhang (http://psc.apl.washington.edu/zhang/zhang_home/home.html) earned his PhD in sea ice and ocean dynamics in 1993 at the Thayer School of Engineering, Dartmouth College. Currently a senior principal oceanographer at the Polar Science Center, Applied Physics Laboratory, University of Washington, he investigates changes in polar climate using sea ice and ocean modeling and assimilation systems. He also studies the impact of changes in Arctic sea ice on marine planktonic ecosystems.

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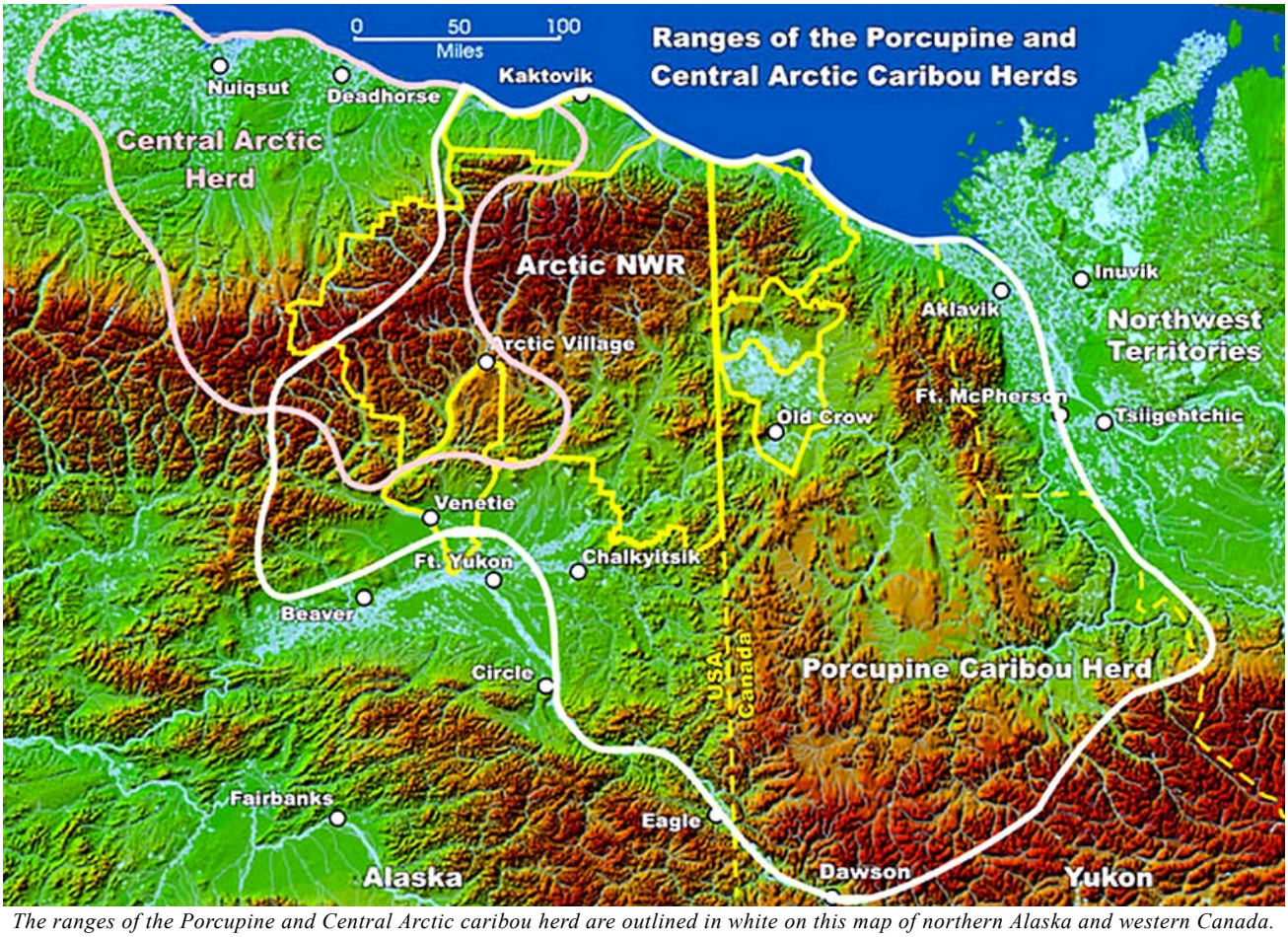
Linguistic Team Studies Caribou Anatomy

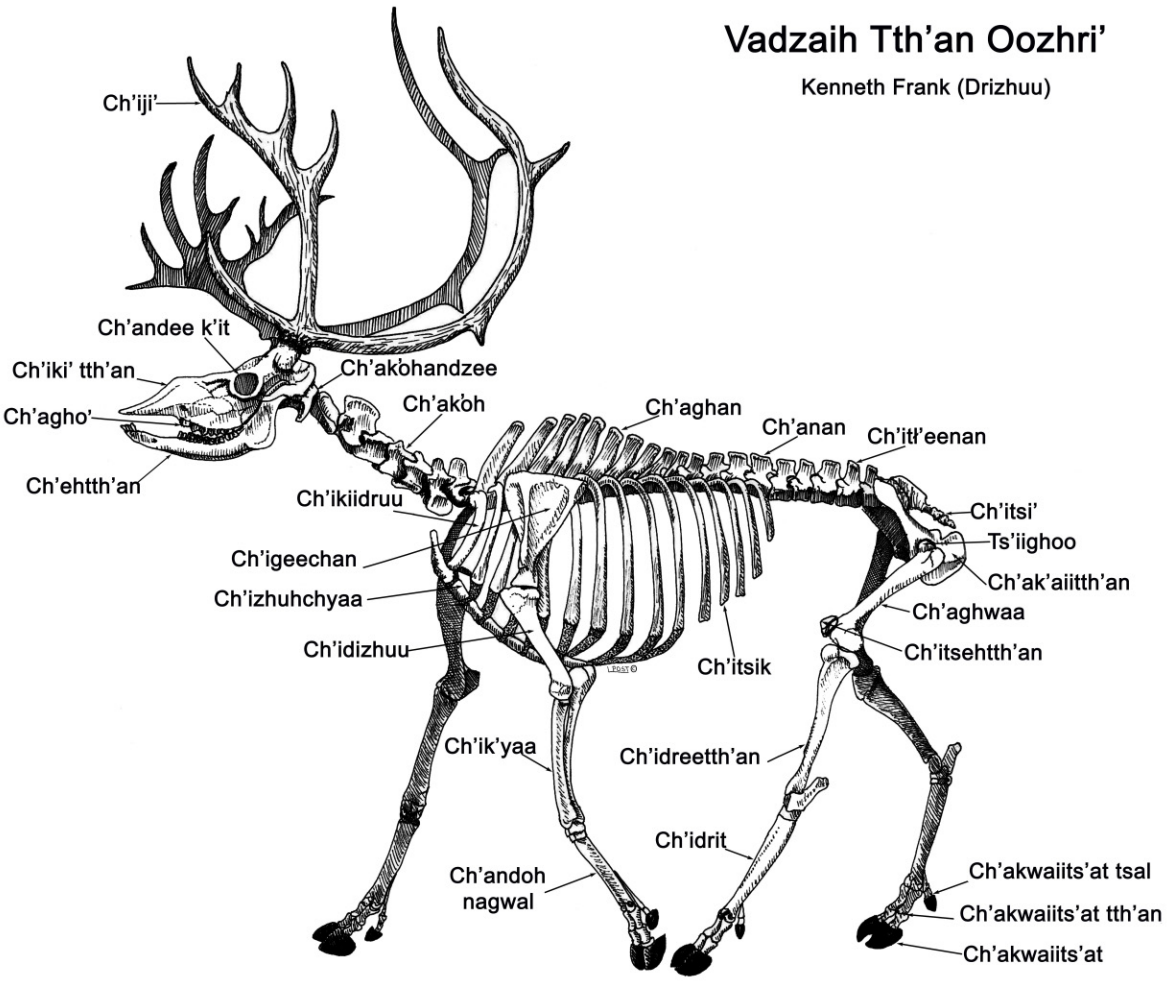
By: Craig Mishler, Research Professor, Alaska Native Language Center, University of Alaska Fairbanks

As the buffalo is to the Plains Indians and the bowhead whale is to the Inuit, so too is the caribou (vadzaih) to the Gwich'in people of northeast Alaska and northwest Canada. In 2011 a team of Gwich'in linguists affiliated with the Alaska Native Language Center (http://www.uaf.edu/anlc/) at the University of Alaska Fairbanks (http://www.uaf.edu/) began to document traditional knowledge of caribou anatomy under a grant (http://www.nsf.gov/awardsearch/showAward?AWD_ID=1162600&HistoricalAwards=false) from the National Science Foundation Arctic Social Sciences Program. The project coordinator is Craig Mishler, and the lead research associate and elder is Kenneth Frank, of Venetie and Arctic Village, now residing in Fairbanks. Between 2011 and 2014 Mishler and Frank conducted field interviews in Arctic Village, Venetie, Fort Yukon, and Fairbanks, Alaska, and Old Crow, Yukon.



The ranges of the Porcupine and Central Arctic caribou herd are outlined in white on this map of northern Alaska and western Canada. Gwich'in villages are also identified. Map courtesy of the U.S. Fish and Wildlife Service.

Associated with the caribou's anatomy are not just descriptive Gwich'in names for all of the bones, organs, and tissues (to date over 150 names for body parts have been collected), but an encyclopedia of stories, songs, games, toys, ceremonies, traditional tools, skin clothing, personal names and surnames, and a highly developed ethnic cuisine. One especially productive area has been the documentation of traditional hunting, butchering, and cooking methods. Another productive endeavor has been the recording and processing of oral narratives, including traditional tales, ethnohistorical accounts, and memorates (narratives from memory relating a personal experience). Elders have been especially vocal about respecting caribou by observing taboos.



Caribou bone names in Gwich'in, by Kenneth Frank. Sketch courtesy of Lee Post.

A major goal for our team has been to map Gwich'in local knowledge about caribou (Rangifer tarandus) as a keystone subsistence species, using still cameras, videography, digital audio, field notes, structured interviews with elders, and participant observation. A fundamental question for the research is to elicit not only what the Gwich'in know about caribou anatomy, but how they see caribou and what they say and believe about caribou that defines themselves, their dietary and nutritional needs, and their subsistence way of life.

We are convinced that all of this has profound implications for zooarchaeology, for applied linguistics, and for folklore and cultural anthropology. It is an empirical approach, which essentially weds natural science with the humanities and osteology (the scientific study of bones) with verbal art. Language is the key that unlocks the door, but Gwich'in is a severely endangered language.

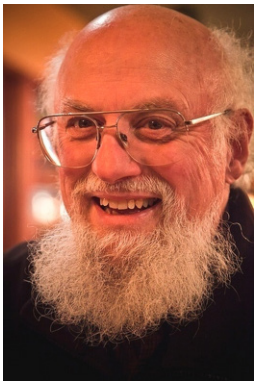
Another important goal, which has gradually emerged over the past three years, is enhancing the writing and translation skills of younger Gwich'in speakers. The two youngest speakers involved in transcribing and translating texts are Crystal Frank and Allan Hayton. Ultimately, this mentoring may be more important than documenting traditional knowledge about caribou, in that it makes strides to maintain and perpetuate the Gwich'in language for at least another generation. Unfortunately, the specialized lexicon for caribou body parts has largely escaped younger speakers.

Project team in Arctic Village, 2013. From left to right: Allan Hayton, Crystal Frank, Kenneth Frank, and Craig Mishler. Photo courtesy of Allan Hayton.

One key to the continued success of the project has been its methodology. A great deal of our work is done online with the help of Skype and Google Drive. Although we live in different locations, we are still able to work about two hours a day in real time to edit and translate oral texts. Our methods are described in more detail in a recently published paper, "Collaborating in Gwich'in on the Web: Khahlok Gwitr'it'agwarah'in." In: Working Papers in

Athabaskan (Dene) Languages, 2013. Vol. 12 (22-29). Alaska Native Language Center, University of Alaska Fairbanks, 2014.

We have made several oral presentations at professional meetings and are scheduled again at the 4th International Conference on Language Documentation and Conservation (http://icldc-hawaii.org/) in Hawaii on 26 February 2015. Ultimately a book is planned, but also underway is an auto-ethnographic film, "Making Caribou Dry Meat," by Kenneth Frank, and a newly launched project web page (http://www.arcus.org/www.vadzaih.com). For additional information, please feel free to write to us at the Alaska Native Language Center, University of Alaska; Fairbanks, Alaska 99775. Or contact Craig Mishler (vadzaih@gmail.com).



Craig Mishler, Susanti' is Project Coordinator, folklorist, cultural anthropologist, and Research Professor, Alaska Native Language Center, University of Alaska Fairbanks. Author, co-author, and editor of eight books, including: The Crooked Stovepipe: Athapaskan Indian Fiddling and Square Dancing in Northeast Alaska and Northwest Canada (1993), Neerihiinjík: We Traveled from Place to Place: the Gwich'in Stories of Johnny and Sarah Frank (2000), Tanana and Chandalar: The Alaskan Field Journals of Robert A. McKennan (2006), and most recently, The Blind Man and the Loon: the Story of a Tale (2013).

Kenneth Frank, Drizhuu is an Elder from Venetie and Arctic Village and a storyteller, singer, drum maker, translator, editor, and Research Associate at the Alaska Native Language Center, University of Alaska, Fairbanks. He is a 2014 recipient of the Oscar Kawagley Indigenous Scholar Award.

Crystal Frank, Diti' Zhyaan'ee is Administrative Assistant for the Department of Alaska Native Studies and Rural Development and a Gwich'in language learner and transcriber at University of Alaska Fairbanks.

Caroline Tritt-Frank, Maggie Gwat earned Bachelor of Arts and Masters of Arts degrees from the University of Alaska Fairbanks. She is a retired teacher, Gwich'in translator, transcriber, and language instructor.

Allan Hayton, Diton grew up in Arctic Village and is the grandson of Robert and Lena Albert. He holds a Bachelor of Arts degree in theatre and film from the University of Kansas, and a Masters of Arts degree in applied linguistics from the University of Alaska Fairbanks. Allan is an actor, playwright, and director. He is a former Program Manager at theGwich'in Steering Committee, transcriber and translator at the Alaska Native Language Center, University of Alaska Fairbanks.

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ACADIS Data Usage and Science Relevance

By: ACADIS Community Support Team members Karen Andersen, Toni Rosati, Lynn Yarmey, Lisa Booker, Don Stott, Janet Scannell, Eric Nienhouse, and Sean Arms

The Advanced Cooperative Arctic Data and Information Service (ACADIS) (http://www.aoncadis.org/) team requested input from NSF funded principal investigators (PIs) to help create a list of research that utilized data housed in ACADIS. Thus far, the ACADIS staff has complied over 300 publications in this effort. Further contributions from the community are welcome. To contribute a list of publications, please the ACADIS Publication Reference Submission website (http://tinyurl.com/acadisPubSubmit).

ACADIS data and systems were recently featured at the NSF Polar Cyberinfrastructure DataViz Polar Hackathon (http://www.arcus.org/witness-the-arctic/2014/3/article/22798) in New York at the Parsons School of Design on 3-4 November 2014. The workshop focused on bridging the cyberinfrastructure, data visualization, and polar science communities. More information is available on the workshop website (http://nsf-polarcyberinfrastructure.github.io/datavis-hackathon).

The ACADIS data collections continue to grow—data volume in the ACADIS Gateway recently doubled in size to almost 1 terabyte of data. ACADIS covers a diverse range of domains. The word cloud figure below provides an overview of ACADIS data topic areas.

This word cloud illustrates the diverse range of Arctic research data in ACADIS collections. Image courtesy of ACADIS.

ACADIS, funded by the NSF Division of Polar Programs, is a joint effort by the National Center for Atmospheric Research (NCAR) (http://ncar.ucar.edu/), University Corporation for Atmospheric Research (UCAR) (https://www2.ucar.edu/), and the National Snow and Ice Data Center (NSIDC) (http://nsidc.org/).

The ACADIS team will be present at the upcoming American Geophysical Union (AGU) (http://fallmeeting.agu.org/2014/) and the American Meteorological Society (AMS) (http://annual.ametsoc.org/2015/meetings). To set up a meeting with team members, call (720-443-1409) or email (contact support@aoncadis.org). See you in San Francisco!

For more information about ACADIS; to send feedback; or to submit, retrieve, and search data; please visit the ACADIS website (http://www.aoncadis.org/).

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"DataViz Hackathon": Creative Collaboration between Polar Researchers and the Cyberinfrastructure Community

By Chris A. Mattmann, PhD, Adjunct Associate Professor, Computer Science Department, University of Southern California.

The National Science Foundation (NSF) recently sponsored the "DataViz Hackathon for Polar CyberInsfrastructure," a workshop designed to build bridges between the polar research community and the cyberinfrastructure (CI) and data visualization communities. The workshop convened on 3-4 November 2014 at the Parsons New School for Design in New York City.

"DataViz"—also known as data visualization—is a set of tools that provide graphic communication of complex data. Effective data visualization of polar research data can support better information analysis, foster greater understanding of the spatial and temporal dynamics at play in polar regions, and promote new discoveries. Developing these tools requires communication and collaboration between researchers and the CI community.

Figure 1. The NSF DataViz Hackathon for Polar CyberInfrastructure website. Image courtesy of NSF.

The DataViz Hackathon brought polar scientists together with CI experts and data visualization experts, including data artists and early career researchers, to exploit the power of collaborative interaction. One workshop goal was to produce high impact novel code prototypes and data visualization tools and to recommend these CI technologies to the NSF Polar CI program. Releasing these prototypes will allow NSF to make longer-term investments in technologies and visualizations that can be adopted by the research community.

Other workshop goals were to:

- Create new polar datasets through a variety of approaches such as reformatting older American Standard Code for Information Interchange/Comma Separated Value (ASCII/CSV) files to modern JavaScript Object Notation (JSON);
- Geospatially locating datasets;
- Loading datasets into search tools and big data infrastructure;

- Design and evaluate new visualization approaches including D3.js (http://d3.org/), and TangeloHub (https://github.com/tangelo-hub); and
- Generate a final report summarizing workshop outcomes.

Session proposer Lewis John Mcibbney of NASA, JPL gives a lightning talk describing his session: Polar Data as a Service. Photo courtesy of Chris Mattmann.

A total of 40 participants from 28 institutions including academia, private industry, government and non-governmental organizations participated in the meeting. Datasets were obtained in a variety of ways. Participants used CI to "crawl" data sets at NSF's Advanced Cooperative Arctic Data and Information System (ACADIS) (https://www.aoncadis.org/home.htm), NASA's Antarctic Master Directory (AMD) (http://gcmd.gsfc.nasa.gov /KeywordSearch/Home.do?Portal=amd&MetadataType=0) and the National Snow and Ice Data Center's (NSIDC) (http://nsidc.org/) Arctic Data Explorer (ADE) (http://nsidc.org/acadis/search/); and they brought their own data including station data from the University of Wisconsin Madison, and Open Geospatial Consortium (OGC) (http://www.opengeospatial.org/taxonomy/term/554) web services from Arizona State University.

The meeting agenda was run in an "unconference" style. Workshop participants proposed all sessions and shaped the agenda prior to the meeting. During the workshop each of the 15 sessions began with the session proposers giving a "lightning talk" pitch that included a brief synopsis and statement of expected outcomes. Hackathon participants then identify their interests by writing their names next to session names. Workshop organizers used this information to allocate sessions running in parallel alongside of four "hacks" over the two days. Each hack was a one to two hour time-span of coding, preparing data, and creating visualizations. Data "artists" and visualization faculty from Parsons—the New School and the Parsons Institute for Information Mapping (PIIM) (http://piim.newschool.edu/) provided design guidance and feedback to the participants in selected sessions over the two-day period.

Some notable outcomes of the sessions included development of:

1. A data converting script and web service to covert Antarctic Meteorology Research Center (AMRC) Automatic Weather Station (AWS) data from simple text data to JSON data and then loading that data into Apache Solr (http://lucene.apache.org/solr/)) to create an AWS Polar data search. More outcomes are described here (https://github.com/NSF-Polar-Cyberinfrastructure/datavis-hackathon/issues/3);
2. Code for 3-d printing of an Arctic bathymetry. More information about this session and its outcomes is available here (https://github.com/NSF-Polar-Cyberinfrastructure/datavis-hackathon/issues/50); and
3. A visualization wire-frame for a 7th-8th grade oriented tool to allow comparison of sea live rise using two glaciers as an example. More information about this outcome is described here (https://github.com/NSF-Polar-Cyberinfrastructure/datavis-hackathon/issues/82).

Wireframe of a glacier comparison tool showing the results of a sea-level rise in the Arctic. Photo courtesy of Chris Mattmann.

All of the contributions from the workshop sessions are stored in a public Github repository freely accessible and licensed under the Apache License, version 2 ("ALv2"). More information about the repository can be found here (https://github.com/NSF-Polar-Cyberinfrastructure/datavis-hackathon/).

3-d printing model of Greenland with sea-ice extent from NSIDC contributed by Alex Boghosian, Lamont-Doherty Earth Observing Laboratory, Columbia University. Image courtesy of Chris Mattmann.

Workshop organization was led by Chris Mattmann, from the University of Southern California, and Parsons—the New School and the Parsons Institute for Information Mapping (PIIM) (http://piim.newschool.edu/). Amazon Web Services Inc. (AWS) provided cloud-computing resources. The meeting was hosted by PIIM Associate Director, Jihoon Kang and, Katie Wanner. Personnel from the Jet Propulsion Laboratory, California Institute of Technology (JPL) and the National Aeronautics and Space Administration (NASA) contributed to onsite logistics including creation of the website. Earth Science Information Partners Federation (ESIP) provided cross promotion and marketing. The full attribution and contributors list to the workshop can be found here (http://nsf-polar-cyberinfrastructure.github.io/datavis-hackathon/#committee) and here (http://nsf-polar-cyberinfrastructure.github.io/datavis-hackathon/#contact).

For more information about the hackathon and its outcomes, please contact Chris Mattmann (chris.a.mattmann@nasa.gov). For more information about the NSF Polar CyberInfrastructure program, please contact MarcoTedesco (mtedesco@nsf.gov).

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A Graduate Student's Introduction to Science Policy in Washington, D.C.

By Julia Bradley-Cook, PhD Candidate in Ecology and Evolutionary Biology at Dartmouth College

Science and policy are inextricably linked: science informs decisions we make at local to international levels, and policy determines the budgets and priorities that drive research. As an ecology PhD student interested in societal issues, I am compelled to complement my scientific graduate training with an understanding of science policy. The American Meteorological Society (AMS) (http://ametsoc.org/) Summer Policy Colloquium (http://www2.ametsoc.org/ams/index.cfm/policy/summer-policy-colloquium/) offers one such opportunity—an introduction to science policy in Washington D.C. The colloquium is an immersive ten-day experience that gives participants an understanding of the policy process and arms them with tools to engage with decision makers.

In the beginning of June, I was awarded National Science Foundation funding to attend the AMS colloquium, along with two other PhD fellows in Dartmouth's polar environmental change Integrative Graduate Education and Research Traineeship (IGERT) (http://www.dartmouth.edu/~igert/), an NSF-funded program. Alexandra Giese, Gifford Wong, and I joined a group of 36 participants, including graduate students from 13 universities, post-docs, professors, a science educator, research scientists, and professionals from the federal government and industry. With expertise that ranged from weather forecasting to social science to climate modeling, our diverse backgrounds made for insightful discussions with speakers, dynamic participation in activities, and engaging conversations over meals and coffee breaks.

The colloquium started with a crash course on the fundamentals of science policy. We learned about the key structures and roles in the legislative branch, along with the procedures and politics that guide the policy-making process. This foundation prepared us for the subsequent sessions, in which we met experts in government affairs, military and defense, international affairs, science communication, science policy careers, and leadership.

To learn about the legislative branch, we visited Congress and met staffers from both sides of the aisle in the Senate and House of Representatives. We had candid discussions about the congressional politics and gained a sense of "how the sausage is made." We also learned about the executive branch from presentations by experts from the Office of Science and Technology Policy and the Office of Management and Budget, who spoke about the use of science in the Administration and the complex budget process.

After three days of domestic science policy, we broadened our perspective to the international level. We gained a historical perspective of U.S. climate policy, including international negotiations, regional cap and trade initiatives, and executive orders enacted during the Obama Administration. We heard about climate, weather, and environmental programs that forge relationships with other countries. I was especially interested to learn about science diplomacy, which entails the use of international science as a tool to enable communication and partnerships around shared goals. A number of speakers highlighted the Arctic, including noting the significance of United State's upcoming role as Chair of the Arctic Council.

In addition to the meetings and lectures, we participated in two hands-on exercises to deepen our understanding of the policy process. First, we played the role of Senators in the Energy and Natural Resources Committee and met to consider climate change risk management legislation. We learned amendment strategies and acted out a simplified version of the committee process to mark-up and vote on the bill that would be sent to the Senate floor. Second, we took on a water resource management case study to conceptualize inter-agency coordination among the U.S. Army Corps of Engineers, the National Weather Service, and the U.S. Geological Survey to address water resource management challenges, such as drought in the western U.S. We discussed the needs, opportunities, and challenges of such collaboration, and received feedback from expert panelists.

Towards the end of the colloquium we spent a full day on science communication to explore tools and best practices for communicating with decision makers and public. Science communication specialists from the American Geophysical Union hosted the workshop, including interactive storytelling and message-crafting activities. The workshop aligned well with an overriding message from the colloquium: relationships are important. Scientists need to cultivate relationships with decision makers in order to understand, connect with, and effectively communicate with them. This effort requires listening and communication skills that go beyond manuscript writing and professional presentations.

Colloquium participants share ideas for communicating with policy makers. Photo courtesy of Julia Bradley-Cook.

At the end of the colloquium, Dr. William Hooke, the founder and generous mentor of the colloquium, posed a big question to the group: "In 100 years, do you think the Earth will be a better or worse place?" We discussed the very serious challenges that we face: climate change, unpredictable threats to life, and widespread human impact on the earth system. As Dr. Hooke pointed out, we are solving tomorrow's problems with yesterday's technologies. On the other hand, many people expressed optimism about the opportunity for science and innovation to address challenges. There are many smart, passionate, and motivated people who are working to tackle the grand challenges of our times.

Having met several of these people working at the federal level, I came away with a better sense of the critical role of science in the policy arena and the vast amount I have to learn about it all. I am more motivated than ever to use my skills as a scientist to bring science and a scientific perspective to policy in the next step of my career.

Photo courtesy of Julia Bradley-Cook.

Julia Bradley-Cook is a PhD Candidate in Ecology and Evolutionary Biology at Dartmouth College and a participant in the Dartmouth IGERT program.
She is pictured here in front of the U.S. Capitol with fellow Dartmouth IGERT program participants, Gifford Wong (left) and Alexandra Giese (right). Photo courtesy of Julia Bradley-Cook.

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New Brochure Addresses 'Why the Arctic Matters'

By Laura Raines, U.S. Arctic Research Commission staff member

To a greater extent than ever before, scientists and researchers, politicians and policy makers, captains of industry and conservationists are recognizing the significance of the Arctic. However, in the minds of many people living south of the Arctic Circle, the region is often perceived as remote and disconnected from their lives. To address this cognitive gap, the U.S. Arctic Research Commission (USARC) (http://www.arctic.gov/) and The Arctic Institute (http://www.thearcticinstitute.org/) have launched an initiative entitled "Why the Arctic Matters" with production of a brochure illustrating the impact of the Arctic on weather, security, research, health, and the environment. This brochure, the first in a series planned by the initiative, is designed to show non-Arctic residents how their lives are linked to events in this region.

Some of these links may be familiar, such as the connection between melting Arctic land ice (e.g., glaciers, ice caps, the Greenland Ice Sheet) and global sea level rise. The "Why the Arctic Matters" brochure goes one step further by emphasizing the connection between the concept of global sea level rise and its consequences for society. Who can forget Superstorm Sandy and the flooding, shoreline erosion, infrastructure and property damage, and displacement of people it caused? As sea levels rise globally, storm surges caused by events like Sandy are likely to be more frequent, particularly along the densely populated coastline between Cape Hatteras, North Carolina and Boston, Massachusetts. By looking at the effects of global sea level rise in this manner, "Why the Arctic Matters" brings home the significance of melting Arctic ice for U.S. citizens living in mid-latitude coastal and low-lying inshore regions.

Aerial views during an Army search and rescue mission show damage from Hurricane Sandy to the New Jersey coast, Oct. 30, 2012. Photo courtesy of U.S. Air Force Master Sgt. Mark C. Olsen.

On the other hand, some of the links to the Arctic described in the publication will likely be a revelation. Few outside the world of medical research are aware that the study of Arctic bears and ground squirrels is playing a significant role in cutting edge pharmaceutical research. Scientists are studying small, protein-like molecules called peptides, which can slow down the metabolism of these hibernating animals, in order to better understand metabolic change in humans and to create drugs that precisely control a patient's metabolism and temperature. This "targeted temperature control" could be used to minimize brain damage from strokes, spinal cord injuries, drowning, and traumatic brain injuries. A pharmacological treatment could be a safe, effective, and inexpensive alternative to current medical practices, in which ice bags, chilled intravenous saline, and other difficult and expensive methods are used to lower body temperature and metabolism. As such, it would be of tremendous significance to doctors, patients, and people at risk of brain and spinal injuries, regardless of their geographic location.

Arctic Ground Squirrel feeding on lupine seeds, Izembek National Wildlife Refuge, Alaska. Image courtesy of Kristine Sowl, USFWS.

These and other topics covered in "Why the Arctic Matters" show the significance of the Arctic region, not only as a geopolitical hotspot, but also as a place whose influence can be felt by people around the world.

The brochure, "Why the Arctic Matters," is available to be downloaded here (http://www.arctic.gov/publications/brochures/wtam_broch.html).

Further information is available on the USARC website (http://www.arctic.gov/).

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A Perspective on the Arctic Council's Arctic Biodiversity Assessment, Recommendations, and 2014 Congress

By Hans Meltofte, Chief Scientist and Executive Editor of the Arctic Biodiversity Assessment

The Arctic Council's working group on Conservation of Arctic Flora and Fauna (CAFF) (http://www.arctic-council.org/index.php/en/conservation-of-arctic-flora-and-fauna-caff) published it's hitherto largest analysis of "Status and trends in Arctic biodiversity" in the Arctic Biodiversity Assessment (ABA) (http://www.arcticbiodiversity.is/) in 2013. In this 674 page book, 253 Arctic scientists evaluate the current situation for species and ecosystems in the Arctic and give a multitude of recommendations on better management and conservation in the Arctic as well as abroad—the latter regarding anything from climate change and contaminants to the living conditions for migratory species when spending the wintertime spread over almost all parts of the globe.

A major oil spill in ice filled Arctic waters would be harmful to species such as these beluga whales. Photo courtesy of ARCUS.

Taken together, the most serious pressure on Arctic Biodiversity in the past was overharvest, whereas the most serious present and future pressure is climate change. Most overharvest problems are relatively easy to address and many have been alleviated, while others such as heavily depleted seabird populations in Greenland remain to be solved. An effective response to climate change, on the other hand, seems at the moment to be outside the capacity of human societies. This gives gloomy prospects for ecosystems and species in the Arctic and elsewhere.

To safeguard Arctic biodiversity and the services we receive from it, three spatial levels of stressors must be addressed: (1) global and circumpolar stressors like climate change and long-range transport of contaminants by air and sea water, (2) regional stressors like overexploitation, expanding boreal and invasive alien species, and (3) more 'localized' stressors like mineral extraction, oil development and ship accidents.

Concerted international efforts are needed to conserve staging and wintering wetland areas for Arctic waterbird migrants.. Photo courtesy of ARCUS.

The most important recommendations, as prioritized by the 35 lead authors of the ABA, are:

- Conserving the unique Arctic biome will require all possible efforts to curb human-induced global warming. As I see it, this should include reductions in both ends of the supply chain: more than half the already known oil, gas, and coal reserves must be left in the ground—preferably including the most risky areas—for the next several decades, combined with significant reductions in the combustion of fossil fuels.

- Global and regional actions to reduce both legacy and new environmental contaminants entering Arctic ecosystems should continue and, where necessary, intensify under existing international conventions.
- Effective conservation of Arctic biodiversity needs to be global in scope and requires significant international cooperation to succeed. Any action to solve one global challenge should take others into account so that measures to solve one stressor do not worsen others.
- To maximize the resilience of Arctic ecosystems, effective protection of large representative tracts of habitat, including hotspots for unique Arctic biodiversity (i.e. not areas with most species or high productivity, but areas with most Arctic endemic species) and northern 'refugia' areas, is of paramount importance. This includes Arctic islands together with mountainous areas and multi-year sea-ice refuges where unique marine Arctic biodiversity has the best chance of surviving climate change.
- A major oil spill in ice filled Arctic waters would be detrimental to biodiversity and very difficult to clean up, particularly under problematic weather, light, and ice conditions. However, if oil development is undertaken, a precautionary approach adhering to regulations and guidelines specific to the Arctic and based on the best available science would reduce risks. This approach should include avoiding development activities in the most sensitive areas.
- Focused harvest management of fish, birds and mammals is needed on those species and populations that have experienced major declines for which harvest is one of the causal factors.
- To protect staging and wintering wetland areas for Arctic waterbird migrants from both habitat loss and overharvest, concerted international efforts should be conducted to conserve a network of key areas and address overharvest. This is especially critical in the East Asian flyway.
- To effectively protect Arctic native species and ecosystems from devastating effects of invasive alien species, appropriate efforts are needed to prevent their establishment in the Arctic. Early detection and preventative actions should focus on areas of human activity and disturbance.
- To protect Arctic biodiversity from severe impacts from local development and industrial activity, biodiversity conservation needs to be a cornerstone of natural resource management and land and marine planning.
- Improved monitoring and research is needed to survey, map, monitor, and understand Arctic biodiversity including integrated and repeated data collection following recommended standardized protocols and priorities, and involving Arctic citizens in the survey and monitoring, if we are to move ahead with science-informed decisions in the Arctic.

The most obvious next step is a circumarctic spatial analysis of hotspots for Arctic endemic biodiversity, so that a total terrestrial and marine Arctic network of protected areas can be outlined based on the 'complementary species richness' method. Thus, the ABA has succeeded in identifying what needs to be done. Now comes the harder step of actually doing it.

As a major follow up on the ABA report, the Arctic Biodiversity Congress (http://www.arcticbiodiversity.is/congress) was convened 2-4 December 2014 in Trondheim, Norway. The event was organized to promote the conservation and sustainable use of Arctic wildlife and ecosystems by encouraging interdisciplinary dialogue and action between scientists, policy makers, indigenous peoples, industry, and civil society.

Goals of the 2014 Congress included:

- Present and discuss the main scientific findings in the ABA report;
- Facilitate inter-disciplinary discussion, action, and status updates on the ABA recommendations (see priority recommendations above) among scientists, government officials, policy makers, traditional knowledge holders, indigenous peoples, and industry representatives;
- Provide scientific, indigenous, policy, non-governmental organizations (NGOs), academia, and industry audiences the opportunity to collaborate around the themes of the ABA;
- Advise the Arctic Council's CAFF on national and international implementation of the ABA recommendations and on development of an ABA Implementation Plan for the Arctic Council Ministerial Meeting in 2015;
- Highlight the work of CAFF and the Arctic Council in circumpolarbiodiversity conservation and sustainable development; and
- Mainstream biodiversity and ecosystem services ensuring that the recommendations of the ABA are implemented by not just government, but many organizations and people, and across sectors.

The Arctic Biodiversity Assessment is available to be downloaded as individual chapters or as a full report here (http://www.arcticbiodiversity.is/the-report/chapters).

The nine key findings of the assessment are available here (http://www.arcticbiodiversity.is/the-report/report-for-policy-makers/key-findings).

A synthesis of suggested research and conservation priorities are available to be downloaded here (http://www.arcticbiodiversity.is/the-report/synthesis/suggested-conservation-and-research-priorities).

Hans Meltofte, Chief Scientist and Executive Editor of the Arctic Biodiversity Assessment, is Senior Scientist at the National Environmental Research Institute, Department of Arctic Environment and the Department of Bioscience, University of Aarhus. He has volunteered at a number of NGOs including positions as board member of the Danish Ornithological Society and Wetlands International.

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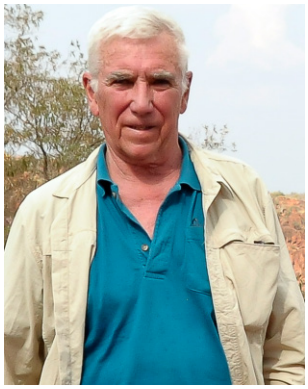
ARCUS Board of Directors Welcomes New Members

I am pleased to welcome five new members to the ARCUS Board of Directors. Our new members were elected by the ARCUS membership earlier this fall along with Jay Gulledge, who was elected for a second three-year term. Carolina Behe, Craig Dorman, Gunnar Knapp, Maribeth Murray, and Audrey Taylor bring a wide range of experience and perspective to the board as we work to implement our new vision and mission statements.

Below are brief biographical sketches of the new ARCUS board members.

Carolina Behe is the Traditional Knowledge/Science expert for the Inuit Circumpolar Council-Alaska (ICC-AK) (http://www.iccalaska.org/servlet/content/home.html). Within this position, she represents ICC-AK on various topics, which engage in both Traditional Knowledge and science, from resource management, to methods of conducting research and community engagement, to acting as the principle investigator on research projects. Carolina is currently the acting ICC board member for the Conservation of Arctic Flora and Fauna, a working group under the auspice of the Arctic Council, and sits on the steering committees of multiple task forces within the Arctic Council. Additionally, Carolina sits on the advisory committee for the Exchange for Local Observations and Knowledge of the Arctic (ELOKA).



Craig Dorman

Craig Dorman, Fairbanks, Alaska, received his PhD in oceanography from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institute and had a long career in the U.S. Navy from which he retired in 1989 at the rank of Rear Admiral. Among other appointments since his retirement from the Navy, Craig has served as Director of the Woods Hole Oceanographic Institute, Technical Director of the Office of Naval Research International Field Office, visiting professor at Imperial College, and Vice President for Research for the University of Alaska System.

Gunnar Knapp (http://www.iser.uaa.alaska.edu/people/knapp/personal/), an economist, is Director and professor at the Institute of Social and Economic Research, University of Alaska Anchorage. Gunnar teaches courses in economics including "The Economy of Alaska" and "Introduction to Fisheries Economics and Markets." He has extensive research experience in seafood, aquaculture, and fisheries management. Gunnar's recent research focuses on the economics of the Bristol Bay salmon industry and trends in Alaskan and global salmon markets.

Maribeth Murray (http://www.ucalgary.ca/news/utoday/april17-2013/maribeth-murray-appointed-director) is Director of the Arctic Institute of North America, University of Calgary and professor in the Department of Anthropology and Archaeology at the University of Calgary, Alberta. Maribeth was previously at the International Arctic Research Center and Northern Studies Program at the University of Alaska Fairbanks. She has also held positions as the Executive Director of the International Study of Arctic Change and has served on the advisory panels of several Arctic-related initiatives in Sweden, the European Union, and the U.S.

Audrey Taylor

Audrey Taylor (http://www.uaa.alaska.edu/ges/faculty/audrey-taylor.cfm) is an assistant professor in the Department of Geography and Environmental Studies, University of Alaska Anchorage. Audrey earned her PhD in wildlife biology from University of Alaska Fairbanks and has conducted field-based research across the U.S., Central and South America, and China. Her current research focuses on Arctic-breeding shorebird populations with particular focus on the impacts of climate change and industrial development along Alaska's coastlines.

Finally, I want to thank our retiring board members, Rick Coffin, Marianne Douglas, John Tichotsky, Hans Verlinde, and Barry Zellen for their dedication and hard work on behalf of ARCUS over the past few years.

Mike Retelle
President, ARCUS Board of Directors

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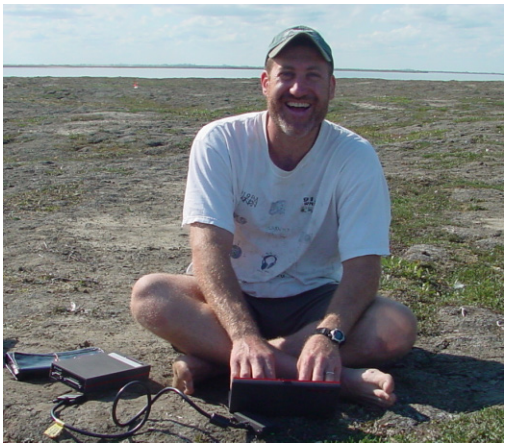
Meet the Board of Directors - Howard Epstein



Howard Epstein

Howard (Howie) Epstein was elected to the ARCUS Board of Directors in 2013. His three-year term will end in 2016.

Howie is a Professor and Director of Graduate Studies in the Department of Environmental Sciences (http://www.evsc.virginia.edu/), as well as a co-Director of the College Science Scholars Program (http://sciencescholars.clas.virginia.edu/), at the University of Virginia (http://www.virginia.edu/). He received his PhD in Ecology from Colorado State University (http://www.colostate.edu/) in 1997 and conducted postdoctoral research at the Institute of Arctic and Alpine Research (INSTAAR) (http://instaar.colorado.edu/) at the University of Colorado Boulder (http://www.colorado.edu/). He took his current position at the University of Virginia in 1998.

Howie is an ecosystem and plant community ecologist, with a focus on vegetation-soil-atmosphere interactions and uses a combination of fieldwork, remote sensing, and simulation modeling in his research. He studies the recent dynamics of Arctic tundra vegetation in response to changing climate and disturbances, and the effects that these vegetation changes have on other Arctic ecosystem properties. His current Arctic-related projects include the development of an Alaska Vegetation Archive; as well as synthesizing vegetation, soil, and climate data across numerous tundra locations from North America and Russia. Since 2002 Howie has returned to the field nearly every year to visit tundra sites in northern Alaska, the Canadian Archipelago, and Siberia. In addition to his research in the Arctic, Howie works in temperate ecosystems of the U.S. Mid-Atlantic. In these systems he is examining vegetation dynamics, and carbon and nitrogen cycling, along successional gradients from old-field to old-growth, as well as carbon-water interactions in topographically complex watersheds. He is also presently working on a project to examine vegetation-climate-fire interactions in the Klamath Region of the Pacific Northwest.

Howie notes that "the changes that we have seen in the Arctic over the past several decades have already begun to elicit both positive and negative feedbacks in these systems, making observations of change and inferring mechanisms for these changes challenging prospects. ARCUS has a notable history of facilitating and synthesizing Arctic research, providing tangible benefits to the scientific process. ARCUS is poised to not only continue but to strengthen these efforts over the coming years. I am happy to be serving on the ARCUS Board during this exciting time that should see the expansion of ARCUS contributions from both disciplinary and geographic perspectives."

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Meet the Board of Directors - Timo Koivurova

Timo Koivurova was elected to the ARCUS Board of Directors in 2012. His three-year term on the Board will end in 2015.

Timo Koivurova. Photo courtesy of Arto Liiti.

Timo is a Research Professor and the Director of the Northern Institute for Environmental and Minority Law for the Arctic Centre (http://www.arcticcentre.org/InEnglish/RESEARCH/The-Northern-Institute-for-Environmental-and-Minority-Law) at the University of Lapland (http://www.ulapland.fi/InEnglish). He is also a Docent of International Law for the Faculty of Law, Economics and Business Administration at the University of Eastern Finland (http://www.uef.fi/en), and for the Faculty of Law at the University of Turku (http://www.utu.fi/en/Pages/home.aspx).

Timo has specialized in various aspects of international law applicable in the Arctic and Antarctic regions. His research work addresses the interplay between different levels of environmental law, the legal status of indigenous peoples, the Law of the Sea in the Arctic waters, integrated maritime policy in the European Union (EU), the role of law in mitigating/adapting to climate change, and the role of the Arctic Council in view of its future challenges and the possibilities for an Arctic treaty. He has been involved as an expert in several international processes globally and in the Arctic region. Timo is a member of the International Union for Conservation of Nature's (IUCN) (http://www.iucn.org/)World Commission on Environmental Law (WCEL) (https://www.iucn.org/about/union/commissions/cel/) and has been invited by the Norwegian Research Council (http://www.forskningsradet.no/en/Home_page/1177315753906) to serve as a member in the steering committee, which oversees large research programs. He was recently elected as a co-chair of the international environmental law interest group of the American Society of International Law.

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Contributors: K. Andersen, S. Arms, L. Booker, J. Bradley-Cook, M. Cutler, H. Eicken, H. Epstein, T. Koivurova, T. Martin, C. Mattmann, H. Meltofte, C. Mishler, E. Nienhouse, L. Raines, M. Retelle, T. Rosati, J. Scannell, M. Steele, D. Stott, H. Wiggins, L. Yarmey, J. Zhang

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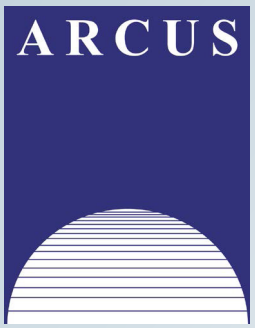

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