School of Natural Resources & Agricultural Sciences

Agricultural & Forestry
Experiment Station

# Annual Report 2005

*Kahiltna Glacier from about 10,000 feet, with Denali in the background. The Kahiltna is one of the longest glaciers in the Alaska Range. This area was photographed extensively by Brad Washburn over a period of more than sixty years, starting around 1936. Like other glaciers around the world, the Kahiltna is melting. In a climate change photographic survey, Washburn's historic photos of glaciers are being compared with new photographs taken at the same locations (see page 9).*

—PHOTO BY BRUCE MOLNIA, UNITED STATES GEOLOGICAL SURVEY

This report is published by the Agricultural and Forestry Experiment Station, University of Alaska Fairbanks. For more information about our research and education programs, please contact us at:

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UAF UNIVERSITY OF ALASKA FAIRBANKS



# Contents:



# Letter from the dean:

September 30, 2006

The Honorable Frank Murkowski
Governor of Alaska
P.O. Box 110001
Juneau, Alaska 99811-0001

Dear Sir:

I submit herewith the annual report from the Agricultural and Forestry Experiment Station, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks, for the period ending December 31, 2005. This is done in accordance with an act of Congress, approved March 2, 1887, entitled, "An act to establish agricultural experiment stations, in connection with the agricultural college established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and also of the act of the Alaska Territorial Legislature, approved March 12, 1935, accepting the provisions of the act of Congress.

The research reports are organized according to our strategic plan, which focuses on high-latitude soils, high-latitude agriculture, natural resources use and allocation, ecosystems management, and geographic information. These areas cross department and unit lines, linking them and unifying the research. We have also included in our financial statement information on the special grants we receive. These special grants allow us to provide research and outreach that is targeted toward economic development in Alaska. Research conducted by our graduate and undergraduate students plays an important role in these grants and the impact they make on Alaska.

Very respectfully,

Carol E. Lewis
Dean and Director

# AFES Statement of Purpose:

The Alaska Agricultural and Forestry Experiment Station (AFES) provides new information to manage renewable resources at high latitudes, and to improve technology for enhancing the economic wellbeing and quality of life at these latitudes. While foresters, farmers, and land managers use our research results, all Alaskans benefit from the wise use of land resources. Our research projects are in response to requests from producers, industries, and state and federal agencies for information in plant, animal, and soil sciences; forest sciences; and resources management.

Experiment station scientists publish research in scientific journals, conference proceedings, books, and in experiment station bulletins, circulars, newsletters, research progress reports, and miscellaneous publications. Scientists also disseminate their findings through conferences, public presentations, workshops, and other public information programs.

Administratively, AFES is an integral part of the School of Natural Resources and Agricultural Sciences at the University of Alaska Fairbanks. This association provides a direct link between research and teaching. Scientists who conduct research at the experiment station also teach, sharing their expertise with both undergraduate and graduate students.

*Bog blueberries* (Vaccinium uliginosum), *above, are among the two most popular wild-harvested Alaska berries (the other being lingonberries). Research has shown that these berries are extremely high in health-promoting antioxidants.* *See page 20.*

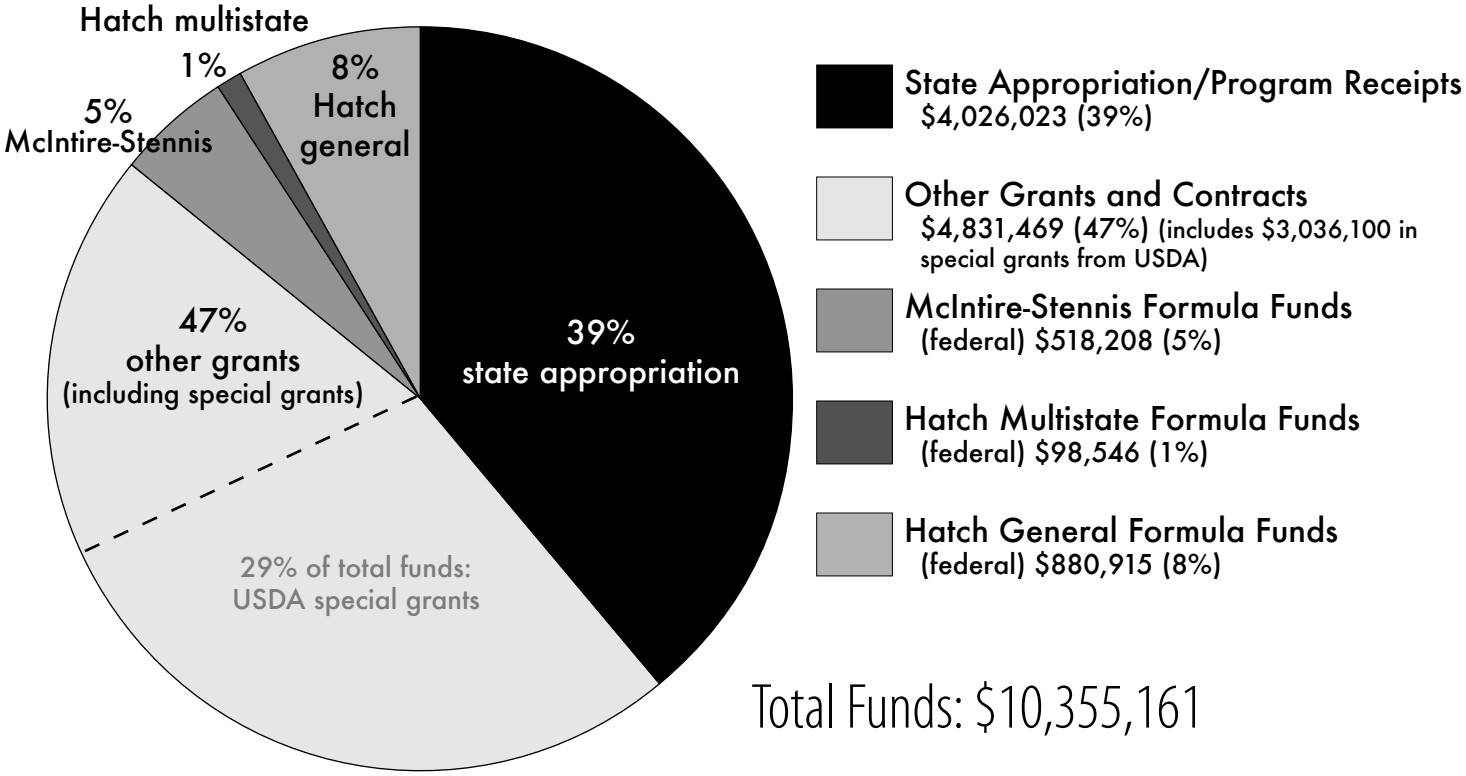
—PHOTO BY PATRICIA HOLLOWAY



# Financial statement

## Expenditures: July 2005 through June 2006

The following statement of expenditures of federal and state funds for the fiscal year beginning July 1, 2005 and ending June 30, 2006 (FY 06) is not an accounting document.




Total Funds: $10,355,161

# Grants

| GRANTS & CONTRACTS/SPECIAL FUNDS | | |
|---|---|---|
| Southeast Forest Products Program IV, V, and VI | Barber | USDA/CSREES |
| Alaska's Changing Boreal Forest (LTER) | Chapin | Forest Service |
| Interaction of Multiple Disturbances with Climate In Alaskan Boreal Forests (LTER) | Chapin | NSF |
| BP Liberty SEIS | Cronin | British Petroleum |
| Natural Resource Mgnt. FY07 | Cronin | Off. of Governor |
| Yr 3 Higher Ed - Reindeer Curriculum | Finstad | USDA/CSREES |
| Food Product Development | Finstad | USDA/CSREES |
| Seasonal Habitat & Diet Composition | Finstad | BIA |
| NRCS Cooperative Agreement | Finstad | NRCS |
| CESU, BLM Recreation Study | Fix | BLM |
| Alaska Resident Statistics Program | Fix | BLM |
| Alaska Residents Statistic Program | Fix | National Park Service |
| Alaska Resident Statistic program #2 | Fix | Forest Service |
| CESU | Fix | Forest Service |
| Regional Economic Data | Geier | NOAA |
| Regional Economic Models | Geier | NOAA |
| Near-Earth Remote Sensing | Harris / Wurtz | Forest Service |
| Predicting Ecosystem Trajectories | T. Hollingsworth | JFSP, IAB |
| GBG Children's Garden | Holloway | UA Foundation |
| Food Product Development | Holloway | USDA/CSREES |
| Drew Amphitheater Foundation | Holloway | UA Foundation |
| GBG Foundation | Holloway | UA Foundation |
| Environmental Changes 2 | Juday | Columbia University |
| Alaska Berry Research I and II | Karlsson | USDA/CSREES |
| Greenhouse Crop Production I and II | Karlsson | USDA/CSREES |
| IGERT | Kofinas | NSF |
| Alaskan Berries | Lewis | USDA/CSREES |
| Ethnobotany I and II | Lewis | USDA/CSREES |
| Fairbanks Task Order | Lewis | ARS |
| Potato Task Order | Lewis | ARS |
| Palmer Task Order | Lewis | ARS |
| Alaska Seed Grower's Assistance II and III | Lewis | USDA/CSREES |
| Alaska EPSCOR Research Initiative | Lurman | NSF |
| Biocomplexity | Ping | NSF |
| Flux and Transform of Carbon | Ping | NSF |
| Fire-Mediated Changes -- Rupp | Rupp | NSF (IAB) |

| | | |
|---|---|---|
| Understanding Fire Severity Pattern | Rupp | Murdock Trust |
| Joint Fire Science Project | Rupp | Fish & Wildlife Service |
| FRCC Implementation | Rupp | Forest Service |
| Impacts of Climate Change | Rupp | NSF |
| Effects of fuels reduction treatments | Rupp | JFSP, AFS |
| UA Integrated Geography Program | Sfraga | UA Foundation |
| Weather-Related Vectors | Smeenk | ARS |
| Integrated Phenology | E. Sparrow | Utah State Univ. |
| Field Course in NRM - CSEU | S. Sparrow/Pierson | NPS, CESU |
| Geospatial Science Learning | S. Stephens | NSF |
| Remotely Monitor Ice | Verbyla | National Park Service |
| White Sweetclover | Wurtz (Spellman) | Mont. State Univ. |
| AK Whitefish By-Products | Zhang | ARS |



## FORMULA FUNDING, FEDERAL Oct 1 to Sept 30 Fiscal Year

### Hatch Multistate

| | | |
|---|---|---|
| Regional Administration W-106 ALK #99-05 | Lewis | USDA/CSREES |
| Rural Communities & Public Land W-192 ALK #05-01 | Lurman | USDA/CSREES |
| Soilborne Plant Pathogens W-1147 ALK #94-01 | McBeath | USDA/CSREES |
| Domestic Ruminants W-112 ALK #00-11 | Shipka | USDA/CSREES |
| Livestock Production W-112 ALK #06-06 | Shipka | USDA/CSREES |
| Assessing Nitrogen Mineralization NC-1032 ALK #05-02 | Zhang | USDA/CSREES |

### Hatch General

| | | |
|---|---|---|
| Reindeer Production & Meat Quality ALK #04-07 | Finstad | USDA/CSREES |
| AK Natural Resources ALK #01-10 | Greenberg | USDA/CSREES |
| Spatially Modeling Dist of Beef Cattle ALK #03-03 | Harris | USDA/CSREES |
| AFES Horticulture Crop ALK #01-11 | Holloway | USDA/CSREES |
| Natural & Supplemental Light ALK #00-09 | Karlsson | USDA/CSREES |
| Cultivar Selection, ALK #01-02 | Leiner | USDA/CSREES |
| Production Practices ALK #01-09 | Leiner / Smeenk | USDA/CSREES |
| Laws Affecting Environment ALK #05-01 | Lurman | USDA/CSREES |
| Forage & Turfgrass ALK #02-05 | Mitchell | USDA/CSREES |
| Palmer Administration ALK #99-01 | Mitchell | USDA/CSREES |
| Black Spruce Forest Soils ALK #03-02 | Ping | USDA/CSREES |
| Domestic Ruminants ALK #00-01 | Shipka | USDA/CSREES |
| Livestock Production ALK #06-06 | Shipka | USDA/CSREES |
| Potential Forage Crops ALK #02-01 | Sparrow | USDA/CSREES |
| Enviromental Decisions ALK #02-07 | Todd | USDA/CSREES |
| Yield & Quality of Barley ALK #04-03 | Zhang | USDA/CSREES |
| Variety Testing ALK #02-06 | Zhang/Sparrow | USDA/CSREES |

Continued on the next page

| McIntire-Stennis | | |
|---|---|---|
| Boreal Forest ALK #05-04 | Fox | USDA/CSREES |
| Foresty Ecology ALK #01-08 | Juday | USDA/CSREES |
| Soil Carbon Balance ALK #01-07 | Valentine | USDA/CSREES |
| Remote Sensing to Investigate Fire ALK #05-03 | Verbyla | USDA/CSREES |
| Forest Ecosystem Monitoring ALK #01-01 | Yarie | USDA/CSREES |
| Forest Growth ALK #06-04 | Yarie | USDA/CSREES |
| Forest Stand ALK #03-12 | Yarie | USDA/CSREES |

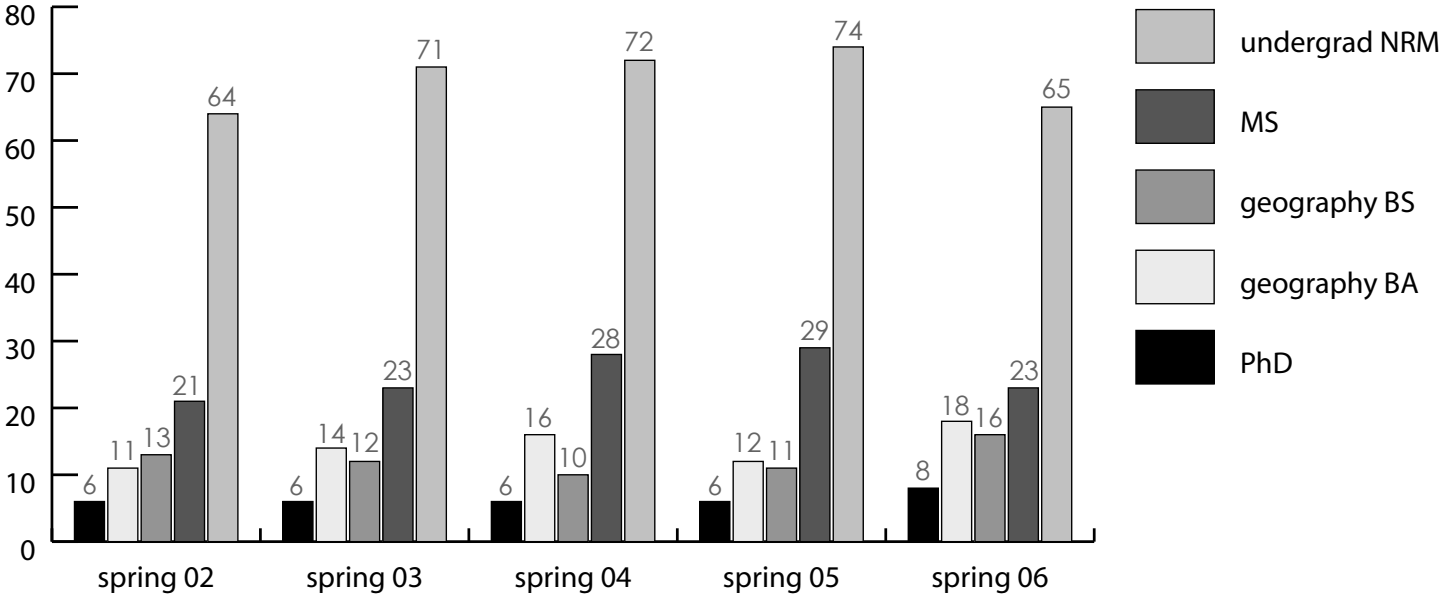


| Animal Health | | |
|---|---|---|
| Mineral Flux in Reindeer ALK #03-07 | Finstad | USDA/CSREES |

*Students and faculty birling at the Farthest North Forest Sports Festival, held every October on the UAF campus and sponsored by SNRAS's Forest Sciences Department and the Resource Management Society. Events include feats of ingenuity, dexterity, balance, and strength, such as the axe throw, the two-person crosscut, the pulp toss, the one-person bowsaw, the Jack & Jill crosscut, fire building, and log rolling. Birling, the last event, is held at Ballaine Lake (hot drinks are prepared and a toasty bonfire built so that dunked participants can dry off and warm up).*
—UAF photo by Todd Paris, 2005

# Students

## five-year statistics: number of students enrolled, 2002-2006



# Graduates as of May 2006

## Baccalaureate degrees

**Maria Anastario**, BA, Geography

**Carol A. Archuleta**,* BA, Geography

**Carrie Janette Brown**, BS, Natural Resources Management: Forestry

**Emily A. Brown**,** *cum laude*, BS, Natural Resources Management: Forestry

**Shannon L. Christensen**, *cum laude*, BA, Northern Management Resources: Interdisciplinary Program

**James E. Connors**,** BA, Geography

**Owen Avery Coskey**, *cum laude*, BA, Geography

**Steven Grimes**, BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**James E. Hazlett**, BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Christian Hendrickson**, BA, Art; Geography

**Justin Hogrefe**, BS, Geography: Environmental Studies

**Jordan Houghton**,** BS, Natural Resources Management: Resources

**Heide Lingenfelter**,* BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Lorene A. Lynn**, BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Mark McCart***, BS, Geography: Environmental Studies

**Jennifer Lynn Miller**, *cum laude*, BS, Natural Resources Management: Plant, Animal, and Soil Sciences. *Golden Key Honor Society, Honors Program*

**Brian Mork**, BS, Natural Resources Management: Forestry

**Matthew Neville**,* BS, Natural Resources Management: Resources

**Jeremiah R. Nill**,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**William M. Plunkard**,** BS, Natural Resources Management: Forestry

**Richard D. Ranft**,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Taj Harrison Shoemaker**, BS, Natural Resources Management: Resources

**Daniel Slakey**,** *cum laude*, BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Tim Walsh**,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Donna L. Wixon**,** BS, Natural Resources Management: Resources

**Donald F. Zigga**, BS, Geography: Environmental Studies

## Masters degrees

**Patrick William Borden**, MS, Natural Resources Management
*BA, Montana State University, 1998*
*BA, University of Alaska Fairbanks, 2002*

**Alina Cushing**,* MS, Natural Resources Management
*BS, University of Arizona, 1996*
*MA, James Cook University (Australia), 1999*

**Thomas A. Kurkowski**,* MS, Natural Resources Management
*BS, University of Wisconsin, 2002*

**Matthew Macander**,* MS, Natural Resources Management
*BS, University of Buffalo (New York), 1996*
*BA, University of Buffalo (New York), 1996*

**Heather Oleson**,** MS, Natural Resources Management
*BS, Mary Washington College (Virginia), 2000*

**Scott E. Sink**, MS, Natural Resources Management
*BS, Northern Arizona University, 2004*

**Thomas St. Clair**, MS, Natural Resources Management
*BS, University of Idaho, 2001*

**Stephen C. Taylor**,** MS, Natural Resources Management
*BS, University of Colorado, 1999*

**Chunhao Xu**, MS, Natural Resources Management
*BS, Xiamen University (China), 2002*

*Summer degree recipient

**December degree recipient

## Summary

26 undergraduate degrees conferred
- BA, Geography: 5
- BS, Geography: 3
- BA, interdisciplinary degree: 1
- BS, Natural Resources Management: 17
  - Forestry: 4
  - Plant, Animal, and Soil Sciences: 9
  - Resources: 4

9 graduate degrees conferred (MS in Natural Resources Management)



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# Research Reports

*The school and experiment station pursue their missions with faculty in four departments: Plant, Animal, and Soil Sciences; Forest Sciences; Resources Management; and Geography. Research is also done in cooperation with the Agricultural Research Service and the Boreal Ecology Cooperative Research Unit. Crossing departments and units are five areas of emphasis: 1) geographic information; 2) high-latitude agriculture; 3) high-latitude soils; 4) management of ecosystems; and 5) natural resources use and allocation. Reports are organized within these major areas of emphasis, by project title under experiment or subject focus.*



***Agricultural Research Service***

*The Subarctic Agricultural Research Unit of the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) was re-established in the winter of 2002–2003, hosted at the School of Natural Resources and Agricultural Sciences. Several ARS scientists and staff were located in Alaska prior to that time.*

***Boreal Ecosystem Cooperative Research Unit***

*This unit (BECRU) facilitates conservation and informed management decisions by conducting research to improve knowledge of high-altitude and high-latitude ecosystems. It provides support and coordinates and organizes research at the Bonanza Creek LTER and other research programs. Major research areas are biodiversity, climate/disturbance interactions, hierarchical scaling of processes, and improved forest harvest outcomes.*

## Report Subject Index



*Note: SNRAS/AFES student and faculty names are indicated in bold in each report's author listing.*

# Geographic Information

## geography

### Do community mapping efforts strengthen the ability of citizens to shape their environment and build community?

**Susan Todd**

#### purpose

In the past ten years, as geographic information systems (GIS) became more affordable and user-friendly, their use in less affluent communities has increased worldwide. Citizen activists, grassroots organizations and others are using GIS and other mapping techniques for individual and community empowerment and sustainability initiatives. The purpose of this study is to evaluate the extent to which one type of community mapping empowers citizens to take an active role. The proponents of community mapping make some bold claims about its potential. They contend that the process increases community engagement and citizens' influence on decision making processes; increases residents' awareness of what is good about their community and what requires improvement; strengthens local land use planning and control of sprawl; and protects fragile ecosystems, trails, and historic sites. Proponents credit mapping with increased recycling, sustainable building, and local efforts to conserve energy, water, and other resources.

While anecdotal evidence abounds, few empirical studies have evaluated these claims. This study will help to fill this gap.

#### approach

A literature review revealed many assertions regarding the capacity of community mapping to empower citizens. Using the review as a source of potential effects, this study developed an instrument to survey participants in one type of community mapping—Green Mapping. The primary purpose of Green Mapping is to take an inventory of environmental assets and liabilities and to encourage more sustainable lifestyles. The first Green Map was developed for New York City in 1992 to promote inclusive citizen participation in sustainable communities. Since then, 245 communities around the world have created and published Green Maps, and another 105 are developing maps. Each Green Map has an officially designated coordinator and, after initial testing of the survey instrument in 2006, the 245 coordinators who have completed their maps will be asked to complete the survey.

progress

An online survey has been developed and is being administered in 2006 as one tool to assess the effects of Green Mapping. A comprehensive review of the literature on the evaluation of public involvement efforts is also continuing.

impact

Global interest in sustainable communities has mushroomed in recent years. From the tropics to the Arctic, communities are looking for ways to live in greater harmony with the world around them. If community mapping is as powerful as its proponents claim, it is a process that the rest of the world should know about—and it is one that should be backed up by more than just anecdotal evidence. If, on the other hand, the claims for Green Mapping are not supported by empirical evidence, that information also is important.

## Bradford Washburn: climate change and repeat photography project

**Mike Sfraga;** Bruce Molnia (United States Geological Survey)

purpose

Alaska's glaciers continue to experience significant change—this can be documented over time through repeat (comparison) aerial photography. Utilizing the extensive aerial photographic collection of pioneer Alaska explorer Bradford Washburn, this study will retrace Washburn's early explorations of the glacial networks found in the Wrangell-St. Elias, Chugach, and Alaska Range glacial networks. The project will duplicate (from altitude) images taken primarily during the period 1933–1950. Because many of the aerial photographs were taken more than seven decades ago, Washburn's collection provides a rich baseline of images and scientific information for climate change researchers.

approach

Duplicates of each original photograph have been prepared for both real-time navigation and comparison. Flying above the aforementioned mountain ranges, including both the Bagley and Bering Icefields, researchers will direct the pilot to maneuver the aircraft to an altitude and angle that matches Washburn's original aerial photograph. For each image/photograph, GPS units will log the exact location and time, and altitude will be documented. The project will be conducted in five summer field seasons, with the first occurring in 2006.

progress

An extensive review of Washburn photographs was completed and more than 200 images were selected for the repeat photography phase. Factored into the selection of images and glaciers were availability of quality historical images, geographic location, and researchers' familiarity with the glacier or region and with Washburn's expedition-related routes or techniques. The Hubbard, Bering, Columbia, Miles, Childs, and Nunatak glaciers are examples of glaciers selected for phase one. Repeat photography is planned during the summer 2006 field season.

impact

Bradford Washburn's early glacial photography provides the scientific community and general public a rich visual record of Alaska's dynamic glaciers dating back more than seventy years. By comparing images of the same glaciers we can assess differences in the glacial environment and crossreferences these images with available glacier-specific measurements and characteristics. This information will add significant understanding of and appreciation for Alaska's ever-changing glacial environment.

## Mount Fairweather: geographic exploration and first ascent

**Mike Sfraga**

purpose

Throughout Alaska's rich history of geographic exploration, the mountainous regions of southeast Alaska have long lured mountaineers and field scientists. This research initiative is based on previously unavailable first-person accounts of the first ascent of Mount Fairweather in 1931. Historical data, notations, and maps will be published.

approach

Documents were given to the researcher from one of the four members of the 1931 expedition team, and included team diaries and photographs. This data was digitized for both research use and preservation purposes. Although the 1931 expedition alone is a compelling account of early exploration, research on regional history, including geographic and scientific explorations, was completed to provide a comprehensive perspective and overall context for the Mt. Fairweather expedition.

progress

A draft book-length manuscript has been prepared and further refinements are in process. The manuscript will be submitted for publication in the near term.

impact

The 1931 Mount Fairweather Expedition was a landmark accomplishment in the annals of U.S. mountaineering and will further add to our understanding and appreciation of Alaska's early history of geographic exploration.

## The 1937 Mount Lucania expedition

**Mike Sfraga**

purpose

Using first-person accounts from the 1937 first ascent of Mount Lucania, as well as selected photographs by expedition leader Bradford Washburn, the researcher will make available the first-person narrative of the expedition. The expedition team was abandoned on the Walsh Glacier in the Saint Elias Mountain Range and forced to navigate through the heart of the range to safety at Burwash Landing, Canada.

approach

Historical documents, maps, and early (pre-1936) accounts of geographic exploration in the Mount Lucania region have been secured and analyzed.

progress

A draft book-length manuscript has been prepared and further refinements are in process. The manuscript will be submitted for publication in the near term.

impact

The tale of the 1937 Mount Fairweather Expedition is a classic survival story. The text, with accompanying photographs, will provide insight into this unique story of geographic exploration in remote Alaska. This information will provide context for and appreciation of this first-person account of mountaineering accomplishments and survival in one of the most remote regions in Alaska.

10

## Perceptual geography of Alaska

**Cary de Wit**

purpose

This project explores how popular perceptions of Alaska affect national opinions on Alaska political and environmental issues.

approach

I collect imagery from advertising, postcards, films, television programs, and other sources of widely-disseminated images of Alaska, and categorize and analyze images according to source, intended purpose, location of production, and type of Alaska image portrayed.

progress

I continue to collect images for this project, and have begun to formulate an analysis structure and a set of perceptual themes in which to organize the images.

impact

This study will help those who are trying to educate the public on Alaska political and environmental issues to assess whether accurate perceptions of those issues are being conveyed to state and federal lawmakers and to the voting public, whether the citizens of Alaska or of the United States.

## Place-based geospatial science learning and applications in rural Alaska (MapTEACH)

**Sidney Stephens**

purpose

This project provides geospatial information technology (GsIT) science and technology education to teachers and students in rural Alaska. The information is directly applicable to understanding the local geographic context and problems; it also relates modern science and information technology to traditional knowledge.

approach

MapTEACH is a three-year informal science education project to develop a place-based educational program for middle- and high-school students in Alaska that emphasizes hands-on experience with geology and spatial technology in conjunction with traditional activities. It will draw upon the combined expertise of teachers, education researchers, remote sensing specialists, and geoscience professionals, as well as Native Elders and others with traditions-based knowledge. Interviews and recordings of local experts discussing landmarks, place names, and stories will serve as the basis for creating digital and hard-copy landscape maps that will be integral to the MapTEACH curriculum and experience. The program will be piloted in the Nenana, Nome, and Fairbanks areas in two separate but content-equivalent formats. This project involves three collaborating institutions with differentiated roles: the University of Wisconsin-Madison's Environmental Remote Sensing Center (GsIT infrastructure, web-serving, and interface), the Alaska Division of Geological and Geophysical Surveys (imagery and trail logs), and the University of Alaska Fairbanks (curriculum development and evaluation).

progress (UAF portion only)

A curriculum has been drafted and is scheduled for piloting at the Effie Kokrine Charter School in Fairbanks in 2006 and at the Nenana School in 2007.

impact

We expect the completed project to provide: A blueprint for region-specific educational modules that can be adapted for use elsewhere in Alaska; online data resources hosted by ADGGS and ERSC, accessible after the end of NSF support; a cadre of students who have proficiencies in GsIT and who can connect these understandings to local issues and local knowledge.

# hydrology

## Using satellite radar to monitor boreal pond water dynamics

**Dave Verbyla**

purpose

Previous research using aerial photography has shown a drying trend of Alaska boreal ponds and lakes since the 1950s. However, this research did not account for seasonal dynamics of surface water, which may vary substantially. Radarsat satellite data may be an excellent source for monitoring surface water, since radar penetrates through clouds and smoke and is available about once every ten days.

approach

I ordered all available fine-beam Radarsat images for the Michumina Basin region of Denali National Park from May through September of 2005. The radar data were processed using software downloaded from the Alaska Satellite Facility (www.asf.alaska.edu/) and then imported into a Geographic Information System (GIS) for spatial analysis.

progress

The use of traditional statistical tools for mapping of ponds and lakes resulted in poor map accuracy due to noise (speckle) that is inherent in radar data. An alternative approach was to use a spatial filter to separate land from

water, since land had substantially higher spatial variation of radar backscatter. A GIS was used to group all water areas that were greater than ten hectares, and then to produce shorelines for each water body that met this minimum area threshold. The resulting lake shorelines matched closely to a validation shoreline database.

impact

This research demonstrated that radar data can be used to monitor spring to autumn surface water changes of shallow lakes in boreal Alaska…a region where clouds and smoke hinder traditional mapping from aerial photography or Landsat imagery.

## invasive plant studies

### Quantification of the effectiveness of blackberry leaf rust (Phragmidium violaceum) as a biological control using remote sensing

**Norman Harris**; Amy Peters (Oregon State Coop. Ext.); Ken French (Oregon Dept. of Ag.)

purpose

Leaf rust is a viable biological control for blackberries in Australia, New Zealand, and Chile, but nothing is known of its effectiveness as an control agent in Oregon, where the rust was accidentally introduced in a coastal area. We will study the effect of blackberry leaf rust on the defoliation of Himalayan blackberry, an invasive weed.

approach

Blimp photography was used early in the season to detect blackberry leaf rust using remote sensing and to quantify blackberry coverage on our study site. More photos were obtained in October to quantify defoliation caused by the disease using time change analysis.

progress

Near-earth aerial photos of the study area were obtained in late June. The Oregon Department of Agriculture conducted helicopter photography of a larger surrounding area three weeks later. Additional imagery of defoliated plants was obtained in early October. We were unable to detect the rust infestation using remote sensing during its early stages in June. Imagery from October indicated that affected plants were severely defoliated by the disease, approximately 80 percent. There was indication that a few plants were not as severely affected as others, and may possess some resistance or immunity to the disease. Continued observation will document whether the disease weakens blackberry plants sufficiently to cause mortality.

impact

This study will help land managers determine if blackberry leaf rust can be an effective biological control agent for Himalayan blackberries in Oregon. This may lead to a cost-effective and efficient method for control of this noxious weed.

### Remote sensing techniques for the study of white sweet clover on the Matanuska River flood plain

**Tricia Wurtz** (USFS); **Norman Harris**

purpose

This study addresses issues of resolution and the types of spectral data necessary to accurately detect and map infestations of white sweet clover (Melilotus alba Desr.) on the Matanuska River flood plain.

approach

From June through October, spectral data were acquired monthly using a small, tethered, helium-filled blimp carrying two cameras, one collecting color imagery and the other collecting infrared. Shots were obtained of test plots at four different altitudes (approximately 30, 61, 122, and 183 meters). Photos were also photogrammetrically processed to create mosaics of the study area.

progress

2005 was the second year for this study. In early June, we established three new test plots to replace plots inundated through morphological changes caused by the previous year's peak flow. Using GPS technology, we were able to relocate four other plots that had been severely affected by the high water. Shots were obtained in the beginning of June and again in July. In between these dates, three of the relocated plots were flooded by high water, and the structure of the flood plain changed considerably. In October, we replaced the film camera used to shoot color infrared film with a digital camera that was modified to capture infrared imagery. Analysis of the 2004 data indicated that white sweet clover was easiest to detect on true-color imagery taken in late August when phenological differences between the target plant and other vegetation was at its greatest. However, in 2005 we were not able to separate sweet clover from other vegetation until October, indicating that phenological differences were not reliably linked to calendar dates.

impact

Land managers can effectively and cost-efficiently use remote sensing data to detect and monitor weed infestations, if the data has sufficient resolution for the project and ground-based observations are used to detect proper phenological stages for imaging.

## livestock and range management

### Spatially modeling the distribution of beef cattle and reindeer on ranges at high latitudes in Alaska

**Norman Harris, Beth Hall, Randy Fulweber, Greg Finstad**

purpose

Promoting meat animal production is culturally and economically important in Alaska. A better understanding of animal interactions with their environment will allow

producers to optimize feed rations and minimize adverse impacts to the landscape.

approach

Observational studies of domestic and semidomestic livestock will be analyzed using spatial/temporal analysis to develop parameters specific to Alaska for use with the KRESS predictive modeling program.

progress

In this ongoing study, observational data was collected using the UAF beef cattle herd at the Matanuska Experiment Farm. An additional study was implemented in 2005 examining the relationship between thermal patterns and reindeer calving sites on the Seward Peninsula.



impact

This modeling effort will give Alaska meat producers another tool for developing cost-effective management strategies. Consumers will benefit from the further development of an Alaska-based meat industry.

## An evaluation of the effectiveness of livestock distribution practices in grazed watersheds

M. George (UC/Davis); D. Johnson (Oregon State Univ.); D. Bailey (Montana State Univ.); D. Ganskopp (USDA ARS Burns, OR); **Norman Harris**

purpose

This is a multistate, collaborative effort to identify factors that control or influence livestock movement and landscape use. The information will be used to develop a comprehensive livestock distribution and forage utilization model.

approach

The study started in October 1, 2000 and continued through September 2005. Researchers in each state use global positioning system (GPS) collars and visual observations to track animal movements and quantify animal activities on the landscape.

progress

Positional data from GPS-collared animals is being used to validate the performance of various predictive models. The main product of this study, a multi-criteria modeling and validation software called KRESS, has been developed. We have written a technical manual and tutorial and have released the program to selected researchers for beta testing.

impact

Land managers can effectively predict landscape use patterns of livestock and model the effects of management actions to help them more efficiently manage public and private lands.

## Nutrient atlas of reindeer forage plants on the Seward Peninsula

**Greg L. Finstad**

purpose

Because reindeer have high growth rates during summer, small differences in forage nutrient qualities can dramatically affect growth and body size. It is important for reindeer producers to place their animals in locations with high-quality forage to maximize weight gain, which in turn produces heavier carcasses and higher profits.

approach

The vegetation communities of the Seward Peninsula have been inventoried and converted to digitized maps that are useable in a geographic information system. Biomass of vascular plants has been determined for plant communities or ecological sites. Samples of reindeer forage plants were collected across the Seward Peninsula from May until September and analyzed for concentrations of nitrogen, phosophorus, potassium, neutral detergent fiber, acid detergent fiber, and in-vitro dry matter digestibility.

progress

These values were integrated with forage biomass values in a mapping program that is capable of generating daily nutrient maps of reindeer ranges. This mapping program has been developed to be available to Seward Peninsula reindeer producers through the Internet via a designated website.

impact

Reindeer producers now have the use of a mapping tool that identifies grazing areas of high nutrient concentrations throughout the growing season on large diverse ranges. Animals can now be placed in areas of high nutrient availability to optimize growth and carcass yield.

## Satellite radiotelemetry and reindeer range management

**Greg Finstad**

purpose

Land managers must ensure that good conservation practices be followed by users of public lands. Proper range management requires that acceptable grazing distributions and utilization rates be followed by grazing land permittees. The Reindeer Research Program (RRP) has developed a web-based satellite telemetry mapping program for use by land managers to assist with reindeer distribution and range utilization checks.

approach

Location data were obtained from collared reindeer on the Seward Peninsula and St. Lawrence Island by the National Oceanic and Atmospheric Administration satellite system, via Service Argos, Inc. Maps were created using an automated mapping system developed by the RRP and placed on an agency-accessible, password-protected website. Agency personnel were able to view current and archived locations of reindeer on the website to supplement range use monitoring activities.

progress

Reindeer in eleven herds were equipped with thirty-six satellite collars and their movements monitored and mapped during 2005.

impact

Land managers and agencies are utilizing this web-based reindeer location mapping system to monitor the use of permitted grazing lands by reindeer producers to ensure that conservation practices are followed on public grazing lands of Alaska.

## wildland fire

### Remote sensing of burn severity in the Alaska boreal forest

**Dave Verbyla, Andy Ruth**

purpose

This project assessed the utility of a remotely sensed burn severity index for Alaska mapping application following wildfire.

approach

The normalized burn ratio is a remotely sensed index developed to map burn severity in the western region of the United States. Although it has been applied in Alaska, the utility of this burn severity index has not been well documented for boreal forest applications. We compared remotely sensed burn severity values with field-based burn severity measurements from two 2004 wildfires near Fairbanks.

progress

There was a strong correlation between the remotely sensed burn severity index and the field-based burn severity measurements at low to moderate burn severity. However, high remotely sensed burn severity values did not always correspond to high burn severity values in the field. We believe the remotely sensed index increased as the amount of pixel charcoal increased, but did not respond to high burn-severity conditions, such as reduction of stem shadows due to fallen trees and exposure of mineral soil from uprooting of trees.

impact

This research showed that the remotely sensed burn severity index is useful for mapping the perimeters of wildfires and unburned areas within wildfire perimeters. However, the index is not useful for delineating areas of high burn severity where trees are uprooted and mineral soil is exposed.

# High-Latitude Agriculture

## animal husbandry

### Cattle genetics (Chirikof Island)

**M.A. Cronin**; M.D. MacNeil (USDA); John Patton (Texas A&M)

purpose

Feral cattle on Chirikof Island, Alaska, have an uncertain ancestry. It has been hypothesized they are descended from ancient Russian cattle. If so, they may represent a unique germ plasm genetic resource. However, modern European breeds were imported to the island during the 1900s. Regardless of the source of the animals, the selection imposed under feral conditions, and genetic drift on the isolated island may have resulted in a unique and useful gene pool. We have quantified the genetic variation in the Chirikof Island cattle and compared them with other breeds.

approach

We quantified genetic variation at thirty-four microsatellite DNA markers from the cattle gene map in Chirikof Island cattle and from several other breeds. We calculated genetic distances and inferred relationships between the Chirikof Island cattle and other breeds. We are also generating DNA sequence for mitochondrial and nuclear DNA.

progress

We have data from twenty-four Chirikof Island cattle and from ten other breeds. Lab analysis is complete and a paper submitted to Animal Genetics.

impact

The Chirikof Island cattle may represent a valuable genetic resource either because of unique ancestry or because of the selection imposed under feral conditions on the isolated island. The data may affect management decisions regarding use of the cattle on the island as a livestock resource, and whether to leave them on or remove them from Chirikof Island. The U.S. Department of Agriculture rare breeds and germ plasm preservation program is very interested in this herd.

### Elk genetics

**M.A. Cronin**; M.D. MacNeil (USDA); J.C. Patton (Texas A&M University)

purpose

We sought to develop methods for molecular genetic assessment of domestic elk, and to assess genetic variation and genetic components of performance trait variation in elk.

approach

We emulated the USDA research program for assessing quantitative trait loci in cattle to assess molecular genetic variation in elk and to determine associations or genetic variation and performance traits.

progress

Molecular data quantifying genetic variation in domestic and wild elk was previously generated. During 2004, we analyzed the data for a manuscript written and submitted to Animal Genetics in 2005. This paper was rejected without review because the journal does not take papers reporting allele frequencies among herds as the primary objective. We will include analysis of molecular markers and performance traits in a revision.

impact

We have established a genetic database for Alaska domestic elk and begun work similar to that used to assess the genetics of cattle performance traits. This research and the resulting

database may allow use of molecular genetics in selection and breeding programs of domestic elk.

## Disease surveillance in Alaska reindeer

**Greg Finstad**

### purpose

Endemic Alaska diseases such as brucellosis, and emerging diseases such as chronic wasting disease (CWD) and Johne's disease, could affect the production and food safety of Alaska reindeer meat.

### approach

The Reindeer Research Program in collaboration with the Reindeer Herders Association and the Alaska State Veterinarian are collecting blood serum, brain stems, and feces from reindeer on the Seward Peninsula to monitor the effectiveness of a brucellosis vaccination program and to detect the presence of Johne's and CWD in reindeer.



### progress

The proportion of animals testing positive for brucellosis is dropping in all herds with an active vaccination program, and all slaughtered reindeer sampled and tested in 2005 were negative for CWD and Johne's disease.

### impact

Ensuring that Alaska livestock are free from disease is important for animal health and productivity. An effective vaccination and surveillance program for disease also ensures a safe food supply. Control and eradication efforts may be initiated if emerging diseases are detected early in Alaska livestock or game animals.

## Radiotelemetric estrous detection in reindeer

**M.P. Shipka, J.E. Rowell**

### purpose

We are continuing efforts to improve radiotelemetric estrous detection in reindeer.

### approach

Minor adjustments were made to the placement of radiotelemetric transmitters lower on the female's rump, coupled with shaving only the top 1.5 cm of hair. Recorded mounts were compared to progesterone profiles collected during the harem period.

### progress

Nadir progesterone was accompanied by a recorded mount only 65 percent of the time. False positive mounts (a mount recorded when progesterone is elevated) occurred in three individuals. We are currently working with the manufacturers (Cow Chips LLC, Denver, Colorado) to try and enlarge the trigger area on the transmitters in an effort to improve recorded mounts.

### impact

Even though success with radiotelemetric estrous detection in reindeer is currently only 65 percent, the information gained on breeding characteristics and estrus is extremely valuable. Radiotelemetric estrous detection has the potential to positively identify breeding dates in reindeer cows, increasing management information available to producers who are raising reindeer behind fencing.

## Use of modified CIDR-b for estrous synchronization in reindeer

**M.P. Shipka, J.E. Rowell**

### purpose

We have previously used a controlled internal drug releasing device designed for bovines (CIDR-b) as a part of an estrous synchronization protocol for reindeer cows. For those studies we modified the length of the CIDR body to fit the smaller vaginal length of reindeer (body weight ~ 100-150 kg). Excellent synchronization rates and fertility rates were achieved, but reindeer cows consistently exhibited moderate to extreme vaginitis characterized by copious purulent discharge. The current study was undertaken to evaluate further CIDR-b modifications.

### approach

Working with the EAZI BREED CIDR-b manufacturer (DEC International, Hamilton, New Zealand) and the US Distributor (Phizer Animal Health, Kalamazoo, Michigan), we modified CIDR-b for use in reindeer. The procedure required removal of 5 cm from the nylon body and 2.5 cm from each wing. In addition, the blue nylon string was replaced with finer catgut suture material.

### progress

The modified CIDR was used on seventeen reindeer females. Retention of the modified CIDR was 100 percent. Vaginitis was apparent in all cows by seven days, when the CIDRs were removed. The vaginitis was characterized as mild. Progesterone concentrations during the period of CIDR insertion ranged from 1.3–9.3 ng/ml, approximately equivalent to progesterone concentrations achieved during normal estrous cycles. No animal experienced a short cycle following synchronization, and the resulting fertility rate (88 percent) is considered high.

### impact

The CIDR is a highly effective tool for synchronizing and timing estrus. Until CIDR-g (goat) is approved for use in North American reindeer, the modified CIDR-b enables limited use for research purposes.

## Reindeer genetics

**M.A. Cronin**; M.D. MacNeil (USDA); J.C. Patton (Texas A&M University); **Milan Shipka, Greg Finstad, Jan Rowell**

### purpose

We sought to develop methods for molecular genetic assessment of reindeer, and to assess genetic variation and genetic component of performance trait variation in reindeer.

### approach

We emulated the USDA research program for assessing quantitative trait loci in cattle to assess molecular genetic variation in reindeer and to determine associations or genetic variation and performance traits.

progress

The project has established a genetic database for Alaska reindeer and begun work similar to that used to assess the genetics of cattle performance traits.

impact

The project will affect reindeer husbandry in Alaska by providing information for selection and breeding programs. Parents of calves can be identified, aiding open range management. In the long term, this will improve the efficiency of producing reindeer.

## Milk composition and growth rates of reindeer fed a soybean meal or fish meal supplemented diet

**Greg L. Finstad**

purpose

Fish meal is readily available in Alaska and can be used as a protein supplement in reindeer diets at a competitive price when compared to soybean meal. Research conducted by the Reindeer Research Program suggests that nonlactating reindeer have higher growth rates and improved nutritional quality of meat when fed fish meal. Fish meal has been shown to increase milk protein in dairy cattle, but may suppress milk fat when fed at higher levels. This experiment was conducted to determine the effect of fish meal supplementation on reindeer milk composition and calf growth rates.

approach

Eight cow-calf pairs were randomly divided into two groups and fed either a 16 percent crude protein diet based on soybean meal or fish meal. Milk samples were collected from each female at the start of the experiment and biweekly for twenty-one days. Calves and females were weighed biweekly during the course of the trial.

progress

Calves from both groups gained 3.9 kg during the twenty-one day period. Lactating females fed the soybean meal based diet lost 4.8 kg during the study period, whereas lactating females fed a fish meal based diet gained 0.5 kg. Milk composition analysis has not been completed at this time.

impact

Fish meal is a high quality, competitively priced protein supplement that may be used in reindeer diets with no negative effects on calf growth rates.

## Seasonal changes in body weight related to circulating levels of leptin, IGF-1, and GH in reindeer

**M.P. Shipka, J.E. Rowell,** M.C. Sousa

purpose

Reindeer undergo dramatic seasonal changes in body weight. We seek to document the seasonal weight changes and associated changes in circulating leptin, insulin-like growth factor-1 (IGF-1), growth hormone (GH), progesterone, and estrogens in both pregnant and unpregnant reindeer.

approach

Seasonal body weight changes and pregnancy status were recorded and will be evaluated for correlation with seasonal changes in plasma leptin, IGF-1, and GH. Data from the current year are combined with retrospective data collected in 2002 and 2003.

progress

Changes in body weight over the entire season were not different between groups bred early and late. The late group was losing body weight prior to harem formation and both groups gained body weight for eight weeks after harem formation before displaying typical seasonal body weight patterns of general weight loss throughout the fall until shortly after winter solstice, when weight began to increase and then stabilized for the duration of the project. Plasma will be analyzed for leptin, IGF-1, GH, progesterone, and estrogens.

impact

Understanding of seasonal endocrine physiology during pregnancy enhances the knowledge base about reindeer in general and allows better management of farmed reindeer during gestation. This knowledge will improve reproductive efficiency when raising reindeer behind fencing.

## Seasonal variation in sensory quality of reindeer meat from the Seward Peninsula

**Eva Wiklund, Greg Finstad**; Peter Bechtel (School of Fisheries and Ocean Sciences); Lisbeth Johansson (Sweden); Kristy Long (Cooperative Extension Service)

purpose

Reindeer producers on the Seward Peninsula want to enhance their operations by reliably delivering a high-quality product from animals slaughtered outside the midwinter months. In this study we want to determine reindeer body condition dynamics, carcass characteristics, and composition and yield of adult reindeer bulls and steers through a nine-month slaughtering season, July through March.

approach

Reindeer from the same herd on the Seward Peninsula were slaughtered at three different times: mid July, late November, and mid March. Samples from the loin muscle were collected from the carcasses for sensory evaluation by a trained panel. All sensory evaluation was conducted at the Cooperative Extension Service Food Product Development Facility Sensory Laboratory. The seven-member panel performed a descriptive test on the reindeer loin samples.

progress

No difference in any sensory attribute was found when comparing meat from the two animal categories (bulls and steers); however, the three different slaughter times affected the sensory quality of the meat. Total smell intensity of the meat tended to increase over the season, with lowest values for July and highest values for March. The meat from animals slaughtered in November was most tender and juicy compared with meat from the July slaughter. The gamey flavour of the

meat increased slightly from July (lowest values) through March (highest values). Reindeer slaughtered in November produced meat with the highest intensity of sweet flavor.

impact

The results from this study will generate information necessary for Alaska reindeer producers to develop an operational plan that will increase the value and expand the delivery of reindeer products demanded and accepted by upscale markets and consumers.

### Sensory quality of meat from electrically stimulated reindeer carcasses



**Eva Wiklund, Greg Finstad, George Aguiar**; Peter Bechtel (School of Fisheries and Ocean Sciences); Lisbeth Johansson (Sweden); Kristy Long (Cooperative Extension Service)

purpose

State regulation allows Alaskan Native producers to sell field slaughtered, uninspected carcasses to local retail outlets. The market potential for this product is limited. Electrical stimulation (ES) accelerates post-mortem glycolysis and rigor onset, so that carcasses can be rapidly cooled or frozen without risk of toughening the meat.

approach

Reindeer from the Seward Peninsula were shot in the field. Carcasses were electrically stimulated directly after bleeding. Shoulder meat was boned in the field and left to freeze in wax-lined boxes. Loin samples were collected from the carcasses for sensory evaluation using a trained panel. The frozen shoulder meat was thawed (tempered) and then diced, sliced, and ground before cooking. The different products made from the shoulder meat were evaluated in three consumer tests.

progress

The trained panel did not find significant differences in any of the measured sensory attributes when comparing loin samples from the ES and non-ES carcasses. Consumers judged the cubed and sliced shoulder meat of the ES carcasses to be more tender for both products. No difference was found between the two treatments for ground meat.

impact

The ES technique can be used in field slaughter systems for reindeer to increase significantly the quality and potential value of meat. It is possible ES will also have a role in enhancing reindeer meat quality in conventional USDA slaughter operations, but this requires further investigation.

### Pre-cooked Alaska reindeer meat products

**Eva Wiklund, Greg Finstad**; Peter Bechtel (School of Fisheries and Ocean Sciences [SFOS]); Kristy Long (Cooperative Extension Service)

purpose

Marketing of value-added reindeer meat products is of great interest to Alaska producers and processors. One type of value-added meat product is the precooked category, commonly found in supermarkets. Currently there are precooked red meat, poultry, and seafood products in the marketplace; however, there are no similar reindeer items available. This project will develop precooked reindeer products and assess their sensory and chemical properties, and evaluate these during product storage.

approach

Reindeer meat samples (M. semimebranosus, "inside" and M. biceps femoris + M. semitendinosus "outside") were collected from reindeer bulls and steers slaughtered on the Seward Peninsula. The meat samples were frozen and transported to SFOS Fishery Industrial Technology Center, Kodiak Island, where two types of products (a small boneless roast and a cubed product in gravy) were processed and cooked. The roasts were injected with water, or sodium, or phosphate, or with all three ingredients, and the gravy mixes included water, phosphate, or extra spices. A consumer test was performed to evaluate the various products.

progress

The consumers preferred the roasts that had been injected with all three additives (water, sodium, and phosphate) and they ranked the water-injected roast at the bottom of the preference scale. No difference in preference was found when comparing the cubed products in gravy. Storage effects have not been evaluated yet.

impact

Very limited work has been done on creating or evaluating precooked reindeer products; this study adds valuable knowledge on the chemical properties of the different products and their shelf life.

## bedding plants and garden crops

### Annual flower cultivar trials

**Patricia S. Holloway, Alfreda Gardiner, Grant E.M. Matheke, Jan Hanscom, Eileen Van Wyhe, Victoria Hill**

purpose

Annual flowers were evaluated for their usefulness in home and commercial landscapes.

approach

Three hundred thirty annual flowers were grown as bedding plants in a greenhouse (except direct seeded sweet peas and scarlet runner beans) and transplanted outdoors at the Georgeson Botanical Garden during the first week of June. Flowers were grown in unreplicated beds for three seasons and plants were evaluated weekly for flowering season, flower quality and quantity, plant height and spread, disease problems and frost tolerance.

progress

Outstanding cultivars for 2005 included ageratum Mexican Tall; China aster California Giant; wax begonia Harmony Scarlet; bidens Peters Gold Carpet; blue-eyed daisy Grandis; calendula Porcupine; California poppies Golden Tears and Ivory Castle; clarkia Passion for Purple; dahlias

Blue Angel, Hillcrest Fiesta, and Picotee Coral Beauty; dianthus Supra Purple; geranium Multibloom Red and Orbit Deep Salmon; impatiens Showstopper Burgundy Imorived; African marigold Capricio; French marigolds Disco Granada and Mars; signet marigold Starfire; melampodium Lemon Delight; nasturtiums Caribbean Cocktail and Whirlybird Cherry Rose. Few cultivars failed completely; those that did included all cultivars of alternanthera, begonia Baby Wing Pink, bunny tails (ornamental grass), penstemon Violet Dusk, phlox Peppermint Candy, lavatera Twins Hot Pink, poppy Cedric Morris, sunflower Peach Passion, and vinca First Kiss Blueberry. Cultivars of phlox and lavatera are very sensitive to the herbicide, Preen.

impact

The greenhouse/nursery/landscape industry is the largest agricultural industry in Alaska, and bedding plant production is the most important component of that industry. These trials provide basic information on adaptability of flowers to interior Alaska gardens for home and commercial use.

### Herb species and cultivar trials

Herb Bunch Volunteers, **Patricia S. Holloway, Grant E.M. Matheke, Alfreda Gardiner**

purpose

Annual and perennial herbs were evaluated for adaptability to Alaska home and market gardens.

approach

Herbs were grown in raised beds containing Fairbanks silt loam soil amended with plant-based compost. Perennials were planted annually beginning in 2003, and annuals in June 2005 in unreplicated beds according to recommended commercial spacing or design specifications. Plots were evaluated during the third week of August and included evaluation of height, spread, flower and foliage color, presence of disease and insect pests, winter survival of perennials, and overall subjective comments on growth, usefulness as a culinary or medicinal herb, and ornamental appeal.

progress

One hundred five annual and perennial herbs were evaluated during 2005. Specialty gardens included a fragrance garden, culinary herbs, a sage garden, perennial herbs, and new cultivars. The fragrance garden included anise hyssop, lavender, lemon balm, signet marigolds, rosemary, sweet pinks, thyme, and golden and pineapple sage. The lavender and rosemary grew poorly because of damage during shipping from Canada. The sweet pinks did not bloom. Outstanding herbs in the remaining gardens included Blonde de Lyon and Profusion sorrels, Gorizia rosemary, Purple Ruffles basil, gold sage, chocolate lily, sweet cicely, costmary, and Magnus lovage. Only two plants were complete failures as culinary herbs, Tabasco peppers and Rhubarb Pie garden sorrel.

impact

This research helps local market gardeners and home gardeners evaluate the usefulness of herbs, mostly for culinary purposes. It also identifies herbs that will overwinter in interior Alaska.

### Temperature for parsley production

**Jeffrey Werner, Meriam Karlsson**

purpose

Parsley is a commonly used fresh culinary herb. Uninterrupted year-round production of fresh parsley may be a lucrative local greenhouse crop.

approach

Curly and flat leaf (Italian) parsley was grown in four-inch pots at temperatures from 46 to 75°F.

progress/result

The curly parsley produced more with increasing temperature. After a four-week growing period, 18 marketable stems were harvested at 46°F and 32 stems at 75°F. The flat leaf parsley was less sensitive to temperature. Around 34 saleable stems were harvested for plants grown at 54°F to 75°F; at 46°F, the number of stems decreased to 20.

impact

These results provide information on selecting temperatures for controlled production of parsley. Because temperature has an observable effect on production, this research benefits herb growers who want to extend the production season.

## controlled environments

### Greenhouse cucumber production

**Jeffrey Werner, Meriam Karlsson**

purpose

Cucumber of the long English type is a potential Alaska greenhouse crop. Recommendations are needed for cultivars that produce high yields of good quality cucumbers under local conditions.

approach

The two cultivars Grendel and Langley were chosen because they have performed well in other production areas, including British Columbia. A production system with plants trained to eight feet above the floor to an overhead wire was used. The main stem was cut as it reached the wire to allow side branching.

progress/result

Over a two-month harvest period, Grendel produced 5.5 lbs per plant and Langley 6 lbs per plant of high-quality cucumbers with minimal harvest and marketing loss. The average length was 12.4 inches for Grendel and 12.1 inches for Langley. Individual cucumber weight averaged 11.5 ounces for both cultivars.

impact

Grendel and Langley both produced high yields of good quality cucumbers and can be recommended for local greenhouse production.

## Geothermal powered greenhouse production

**Jeffrey Werner, Meriam Karlsson**

purpose

Greenhouse management techniques suitable for northern conditions are required as year-round production becomes feasible using geothermal energy for greenhouse heating.

approach

In a collaborative partnership with the Chena Hot Springs Resort, greenhouse techniques suitable for year-round northern greenhouse production are being developed for tomatoes and lettuce. Currently several tomato cultivars are evaluated in a trellising system allowing continuous growth and production over many months. Growing techniques are fine tuned to allow expansion to large volume greenhouse production with thousands of tomato plants.



progress/result

Cluster, beefsteak, and cocktail type tomatoes are currently produced. A critical factor for uninterrupted tomato production is the amount and timing of irrigation. To ensure proper crop management and continued productivity, automated irrigation is required. Preliminary lettuce production has been tested in a recirculating hydroponic system. With a few adjustments in the setup, continuous year-round production of lettuce and other leafy greens is anticipated. Geothermal heat is supporting the greenhouse facility adequately to maintain acceptable production temperatures throughout the year.

impact

Geothermal energy technologies work well for continuous controlled environment and greenhouse applications. The experience and knowledge gained at Chena Hot Springs Resort will benefit people who pursue local greenhouse production at geothermal sites and other remote areas.

## Leaf and romaine lettuce production using high tunnels

**Heidi Rader, Meriam Karlsson**

purpose

Temporary high-tunnel plastic greenhouses offer opportunities to extend the production season, increase yield, and elevate the quality of field-grown horticulture crops.

approach

Ten sequential plantings were made one week apart of leaf and romaine lettuce from late May to August. Two Star was the chosen cultivar of leaf lettuce and Parris Island Cos of romaine lettuce.

progress/result

During the 2005 field season, the high-tunnel environment did not generally support or improve lettuce yield. Still, the added protection of a high tunnel resulted in high quality lettuce with limited required preparation and reduced marketing loss in comparison to the field grown lettuce.

impact

Although the yield did not improve, quality advantages suggest high-value specialty lettuce such as baby greens and warm season crops may be more suitable for high tunnel production than leaf or romaine lettuce.

## Potatoes, mulch, and high tunnels

**Jeffrey Werner, Meriam Karlsson, Heidi Rader**

purpose

The protective environments of mulch and high tunnels were evaluated for a well-adapted field crop.

approach

The three potato cultivars Nordonna, Yukon Gold, and Swedish Peanut were evaluated in a high tunnel and the field, with and without black mulch.

progress/result

Both the plastic mulch and the high-tunnel environment increased yield. Highest yield was recorded in the tunnel using plastic mulch. The most limited yields were in the field without mulch. Yukon Gold had the highest yield for a 9.8 ft long row (approximately twelve plants) of 27.3 lbs in the tunnel; the smallest yield (6.6 lbs) was for Swedish Peanut fingerling potatoes in the field.

impact/implications

Even crops well adapted to northern conditions can benefit from a high-tunnel environment with improved growth, higher yields, and increased crop dependability.

## High tunnel production of snap beans

**Heidi Rader, Meriam Karlsson**

purpose

High tunnels are versatile structures for improving and extending the production of field grown crops. Although snap beans of the slender, French-cut type often have higher fresh-market quality, less fiber, and improved taste, the smaller diameter bean cultivars are often more cold sensitive, less vigorous, and less productive than larger seeded snap beans.

approach

Chosen for this study were Provider, a proven high-latitude cultivar with 0.3- to 0.41- inch diameter pods, and Concesa, developed for more southern climates, with extra-fine pods of less than 0.24-inch diameter. Both cultivars were grown in a high tunnel and the adjacent field to compare yields.

progress/result

The well-adapted Provider did not benefit from high-tunnel production. For Concesa, the high tunnel more than doubled the yield.

impact

High tunnels are a viable northern production alternative for more cold-sensitive cultivars with slender pods like Concesa. The use of a tunnel increases crop dependability and complements field-produced snap beans.

## Snap bean variety trials using high tunnels

Meriam Karlsson, Heidi Rader, Jeffrey Werner

### purpose

Temporary high-tunnel plastic greenhouses offer opportunities to extend the production season, increase yield, and elevate the quality of field-grown horticultural crops.

### approach

The bean cultivars Dusky, Embassy, Roma II, Stayton, and Venture were evaluated in a high-tunnel environment and the adjacent field during the summer of 2005.

### progress/result

Dusky, Roma II, and Venture produced similar yields in the high tunnel and field environments. For a 3.3 foot row, yield was approximately 4.63 lbs for Dusky, 5.07 lbs for Roma II and 5.73 lbs for Venture. In the high-tunnel environment, the harvest was 14.1 oz larger for Embassy and 28.2 oz larger for Stayton.

### impact/implications

These results suggest high-tunnel greenhouses positively alter the growing environment for high-quality snap beans with small diameter pods, such as Embassy and Stayton.

## Trellising greenhouse tomatoes

**Jeffrey Werner, Meriam Karlsson**

### purpose

Trellising to allow continuous plant growth, rather than the traditional approach of limiting production to three or four clusters, was evaluated for extended greenhouse tomato production.

### approach

Tomato plant stems were supported with twine and trained to an overhead wire stretched eight feet above the floor. As the plants grew and reached the wire, the plants were lowered, letting the stems lie horizontally while keeping the growing shoot upright into the light. Lower leaves were removed to facilitate stem storage, harvesting mature fruits, and increasing air circulation around the plants. The tomato plants were routed around the end of the row to allow continued growth along the opposite side. To evaluate the trellising system, cultivars of three different types of tomato developed for greenhouse production were selected: beefsteak (Blitz), cluster (Clarance), and grape (Dasher) type tomatoes.

### progress/result

The trellising system worked well for continuous production. Even with no prior experience or knowledge, the technique was quickly learned, and plant management was fast. Over the three-month harvest period, Blitz produced 5.8 lbs per plant with an average tomato size of 4.4 ounces. The tomatoes of Clarance were on average 3.1 ounces and 5.4 lbs were produced per plant. The smaller grape type tomatoes of Dasher weighed on average 0.3 ounces and 2.3 lbs were produced per plant. At the end of the relatively short three-month experimental period, plants were healthy, actively growing with production of tomatoes expected to continue for several additional months. The advantage of this type of a continuous growing system increases with the length of the culture, but is still beneficial for a more limited production cycle.

### impact

Training tomatoes to grow and produce continuously is an efficient method that can be recommended for northern climatic conditions using cultivars identified for greenhouse production.

# field crops and field management



## Nitrogen mineralization in soil: How much do we know?

**M. Zhang, R.M. Van Veldhuizen**

### purpose

Release of soil indigenous organic nitrogen (N) is important for crop production and in environmental N management. Fertilizer costs increase as energy prices rise, so estimating N released from soil and adjusting fertilizer applications accordingly can reduce production costs. A variety of methods are available for estimating potential N release in soil, but their applicability in a subarctic environment is still unknown. Those include acid or alkaline hydrolysable N, neutral salt hydrolysable N, and extractable mineral N in soil.

### approach

In June and August 2004, soil samples were collected from fields of different N fertilization rates and were incubated in aerobic and anaerobic conditions for 0, 2, and 4 weeks. The samples were then extracted by 1) 2 M KCl; 2) 2 M hot KCl (100°C); 3) 1 M HCl (100°C); and 4) deionized water. We determined ammonium in HCl extraction, both NH4-N and NO3-N in KCl and hot KCl extractant. We determined total nitrate N in deionized water (including N in dissolved organic matter).

### progress

Ammonium and nitrate in extraction solutions were determined in two- and four-week aerobic and anaerobic incubations. Regression analysis indicated that deionized water, hot KCl extracted, and NaOH-hydrolysable mineral N (ammonium or nitrate) was significantly (probability [p] $< 0.05$) related to mineral N released in aerobic incubation in two weeks. In comparison, only mineral N extracted with deionized water extracted mineral N was significantly ($p < 0.05$) related to N released over two weeks in anaerobic incubation. Mineral N extracted by hot KCl and deionized water was related to bromegrass N uptake.

### impact

The results provided information on the best soil N test method for soils that develop in a cold environment. This information will help to improve soil N test method and fertilizer recommendation in Alaska. The improvement of N

fertilizer recommendation will reduce the fertilizer cost for crop production and will reduce the risk of environmental contamination from fertilizer applications.

## Antioxidant levels in frozen and processed lingonberries and bog blueberries

**Patricia S. Holloway, Roxie Rodgers Dinstel**

### purpose

This project aimed to identify the health benefits of frozen bog blueberries *(Vaccinium uliginosum)* and lingonberries *(V. vitis-idaea)* and identify how antioxidants change when frozen berries are processed into recipes recommended by the Alaska Cooperative Extension Service (CES) for such foods as jam, sauce, and fruit leather.



### approach

Frozen lingonberries and bog blueberries were harvested from wild stands during summer 2005. They were frozen at 0ºC, then processed using CES recipes into jam, freezer jam, jelly, sauce, dried fruit, fruit leather, canned whole berries, and syrup. Products were analyzed for total water soluble antioxidant capacity (ORAC), total phenolics, total anthocyanins, quercetin, vitamin C and p-coumaric acid.

### progress

For frozen bog blueberries, the overall antioxidant activity (ORAC score) was 71 umol Trolox equivalents per gram (TE/g); for frozen lingonberries it was 160–165 umol TE/g. Both scores are extremely high when compared to cultivated fruit, including commercial blueberries (ORAC score approximately 20). Processing into fruit leather increased antioxidant levels of bog blueberries to 260–430 umol TE/g; the lingonberry ORAC score increased to 457–939 umol TE/g. All antioxidants increased significantly with drying and processing into fruit leather, but they decreased with nearly all other processing methods when compared to frozen berries. Although fruit leather and drying were the best processing methods to retain the highest antioxidant levels and freezing was second best, antioxidants including total phenolocs, anthocyanins, quercetin, vitamin C and p-coumaric acid were not completely destroyed by any processing method.

### impact

This project showed that the two most popular wild-harvested Alaska berries are extremely high in health-promoting antioxidants, and processing using popular Extension recipes does not completely destroy these antioxidants. This basic information on phytochemicals for consumers and commercial processors could have important health benefits for Alaskans.

## Peonies as field-grown cut flowers

**Patricia S. Holloway, Janice T. Hanscom**

### purpose

The purpose of this project was to learn methods of field-grown cut flower production and marketing to establish a peony cut flower industry in Alaska.

### approach

During 2005 we conducted trials to determine maturity stages of field grown peonies, learn methods of harvesting and processing, and to explore market opportunities on the West Coast.

### progress

Most books on peonies recommend harvesting peonies at the "marshmallow stage." We learned that the optimum harvest stage varies with each cultivar, and growers on the West Coast use a variety of indicators, depending on their storage methods and distance to markets. We documented digitally the stages of flower bud development for Sarah Bernhardt and Duchess de Nemours peonies. We shipped 140 cut stems to a wholesale distributor in Los Angeles who rated our stems for quality. We also visited the wholesale flower markets in San Francisco and Seattle and visited peony growers near Portland, Seattle, and Vancouver, Canada. Every distributor we contacted was willing to purchase Alaska-grown peonies. They provided information on shipping methods and harvest time that will help Alaska growers. We were contacted by a wholesale flower grower in the United Kingdom who was interested in purchasing 100,000 stems per week. The distributor reiterated the unique market position of Alaska peonies. Currently, peonies are not available as cut flowers in July and August anywhere in the world. The combination of unique timing and the availability of world cargo service provides a promising outlook for an Alaska peony industry.

### impact

Alaska has a unique opportunity to develop a significant peony cut flower market for export. We centered our work on West Coast markets, but there is interest in Europe as well. This project could potentially be very big for Alaska growers. Presently the largest potential grower in Alaska is in Homer. One grower planted 10,000 peonies in spring 2006.

## The effects of compaction during baling, color of plastic wrap, and preservatives on the quality of haylage in Alaska

**Charlotte Lussier, Norman Harris, Beth Hall**

### purpose

In some years there is insufficient dry weather to produce good quality hay. The production of haylage, fermented hay, is a viable solution that has never before been studied in Alaska. Haylage is forage that is baled at a higher moisture content than dry hay and then stored in a sealed plastic wrap. Because of the high moisture level and air-tight environment, the forage ferments and is preservd by acid production during fermentation.

### approach

Haylage was baled using different levels of compaction, colors of plastic wrap, and with or without preservative. Self-recording thermistors were inserted into bales. At various times, bales were cored and samples removed for chemical analysis using a carbon/hydrogen/nitrogen analyzer and high-performance liquid chromatography.

progress

This was the second year of a two-year study. Bales were cored at two weeks and one month after baling. Samples are currently undergoing chemical analysis. Statistical analysis is underway for the 2004 data. Initial indications are that black-colored bales reach significantly higher temperatures than white-colored bales, but the effects on haylage quality are still unknown.

impact

The economical production of quality livestock feed is critical to the Alaska dairy and meat industries. Haylage can supply quality feed that will foster increased milk and meat production.

## Selection, variety testing, and evaluation of cultural practices for alternative agronomic crops in Alaska

**R.M. Van Veldhuizen, M. Zhang, S.D. Sparrow**

purpose

This ongoing research provides information for yearly updates on new and better adapted agronomic crop varieties (small grains such as barley, wheat, and oats, and oilseeds such as canola and sunflowers) and on the response of these crops to dryland farming conditions at Fairbanks, Delta Junction, and Palmer.

approach

Variety trials: Comparisons of five 2-row, three 6-row hulless barley varieties, and two 2-row hooded forage barleys (*Hordeum vulgare* L.), four hulless oat varieties (*Avena sativa* L.), and three hard red spring wheat varieties (*Triticum aestivum* L.) were selected from northern Canadian and US sources for evaluation against standard Alaska varieties (Thual hulless barley, Weal hooded forage barley, Toral yellow oat, and Ingal hard red spring wheat). Replicated trials of all varieties were planted at all three locations. There was a new 2-row feed barley from Iceland that was tested at Fairbanks this year. Seed produced from this year's plots will make it possible to test this Icelandic variety at all three locations next season.

Agronomic crop breeding selections: One final selection from a hulled feed barley cross was planted in replicated trials at all three locations for comparison with three adapted varieties (Otal, Albright, and Finaska feed barley). This selection exhibited the best plant growth characteristics (early maturity, high yield, and good standability). This variety will be released as an officially named cultivar, Wooding, in 2006. The name Wooding was chosen to recognize the agronomic contributions of the late Dr. Frank J. Wooding, professor emeritus of agronomy of the UAF School of Natural Resources and Agricultural Sciences (formerly the School of Agriculture and Land Resources Management).

Six selections from a hulless barley cross that have shown the best characteristics for standability, yield, early maturity, and hulless seed were planted in replicated trials at all three locations for continued comparison with an adapted hulless variety (Thual hulless barley). From these six selections, one was chosen at the end of the 2005 season that exhibited the best plant growth characteristics for further evaluation. This variety will result in an eventual release as a named variety.

In 2005 continued selections from the dwarf, open-pollinated Sunwheat (*Helianthus annus* L.) were made, primarily for early maturity. The seed from the 2004 harvest was distributed to local gardeners in the spring of 2005 for testing and evaluation as a horticultural seed crop. An eventual release as a named variety is expected after local evaluations have been completed.

progress

Summer growing conditions (precipitation and growing degree days) at all three locations were excellent compared with the long-term averages. This resulted in heading and maturity occurring three to five days earlier than the long-term average. Plant height characteristics were slightly above the long-term average. As a result, there was a significant increase in lodging at Fairbanks. At all locations, all varieties were matured and ripened at harvest. Overall yields were as high or higher than the long-term averages. Average yields for 2-row hulless barley yielded greater than 6-row barley at the Fairbanks and Palmer locations and close to the same at the Delta Junction location. Both types of hulless barley surpassed the standard Thual yield, except at Fairbanks, where they were almost equal to the other 6-row hulless varieties. At all three locations, the average yields from the final selection of the hulled feed barley cross was comparable to or better than the standard test feed barley varieties. The new 2-row feed barley from Iceland was tested at Fairbanks only. Yields were slightly lower than the 6-row feed barleys, although it matured 3–5 days earlier than the 6-row varieties. Because of its semi-dwarf plant height characteristic, it had no lodging. Yields for the 2-row hooded forage varieties at all three locations were slightly greater than the standard Weal. Yields for hulless oat varieties were higher than the long-term average, but still lower than the standard Toral. However, even with the extra heat units for plant growth during the 2005 season, hulless oats are a marginal crop for Alaska. Yields for hard red spring wheat varieties were greater than the standard Ingal at Fairbanks and nearly equaled Ingal at the other two locations.

The final selection of the hulless barley cross will be tested again in 2006, and the seed lot will be increased for eventual release as an officially named variety. The hulless oat variety testing will be replaced with an increase in the number of varieties of hard red spring wheat. An additional eight varieties of hard red spring wheat from Montana and Saskatchewan will be tested at all three locations. Testing done by the local gardening community with the open-pollinated Sunwheat selection will be compared with long-term data collected at the Fairbanks Experiment Farm. This will, we hope, result in an eventual release of an adapted dwarf oilseed sunflower for Alaska. Additional oilseeds to test for the 2006 season will be two Argentine canola varieties at the Fairbanks and Delta Junction locations and two new oilseed crops, Crambe and Camelina, at Fairbanks.

impact

This ongoing study provides a yearly update of information on new and better adapted agronomic crop varieties, as well as the response of these varieties to dryland farming conditions. The seeds of dwarf sunwheat are used as bird feed, which in Alaska is currently all imported. The development of an Alaska sunwheat variety will promote seed production in Alaska, fitting a niche market.

## Production of quality smooth bromegrass hay for reindeer

**M. Zhang, G. Finstad, R.M. Van Veldhuizen**



purpose

We seek to identify the optimal cutting frequency and rate of nitrogen fertilizer for bromegrass hay yield and quality for reindeer.

approach

The research started in May 2004 and will end in September 2006. There are three nitrogen fertilizer rates (0, 50, and 150 kg N/ha) and two cutting regimes (one and two cuttings over the growing season). Each plot size is 9.1 m x 182.8 m. Five plant and soil samples were collected from every treatment at each sampling time in 2005. Hay samples were taken on July 11 for one cutting treatment, and June 13 and August 9 for two cutting treatments. Plant samples were analyzed for their nitrogen, phosphorus, potassium, and sulphur concentration, and for neutral detergent fiber and acid detergent fiber concentrations. Mineral nitrogen from soil samples was determined.

progress

A high nitrogen application rate can significantly (probability = 0.007) increase hemicellulose concentration in hay in comparison with the control, but only when hay was cut in the first half of June. Delayed harvest time decreased hay quality despite a high rate of nitrogen application. A two-cutting management system is better than a one-cutting management system in terms of producing high yield and good quality hay.

impact

The outcome of the research will fundamentally affect hay management practice for reindeer. Optimal nitrogen application rate and two-cutting regimes are the keys for producing high yield and good quality hay for reindeer consumption.

## Cicer milkvetch, galega, and lupinaster clover as forage crops for interior Alaska

**Stephen D. Sparrow, darleen t. masiak**

purpose

We hope to determine the potential of cicer milkvetch *(Astragalus cicer)*, forage galega *(Galega orientalis)*, and lupinaster clover *(Trifolium lupinaster)* as forage crops in Alaska's Tanana Valley.

approach

We seeded Gale forage galega (Gale is the only released variety of this crop) and six varieties of cicer milkvetch at Delta Junction, Fairbanks, and Nenana in 2002. We were unable to obtain enough seeds of lupinaster clover to plant full plots so we planted individual rows with various small seed lots at Fairbanks. We collected mature seeds from the lupinaster clover rows which we planted in small plots in subsequent years.

progress and results

These crops were slow to establish at all sites, thus plant growth was too meager to obtain harvests at any locations in the establishment year. Stands were so poor after one year at Nenana that we abandoned the plots. At Delta Junction, none of the crops survived the winter of 2002/2003, so we reseeded in 2003. Again survival was too poor to produce harvestable yields, indicating these crops are not suitable for the soil and climate conditions there. At Fairbanks, yields for all varieties were quite low (less than 1.5 ton/ac) in 2003; in 2004, Gale galega produced 3.0 tons dry herbage per acre and cicer milkvetch produced an average of 2.9 tons per acre. Stands were poor in some of the cicer milkvetch plots in 2004. In 2005, average yields for gale galega decreased to 2.5 tons/acre and to 1.8 tons/acre for cicer milkvetch. The yield decrease experienced in 2005 was due to stand deterioration and weed infestation. Due to the heavy weed infestation, we destroyed the plots after the final harvest in 2005. We hope to obtain yield results from the lupinaster clover plots at Fairbanks in 2006.

impact

This research will aid interior Alaska farmers in selection of forage crop species to include in their cropping regimes. Results so far indicate cicer milkvetch and forage galega may have potential as alternative forage crops in some areas in interior Alaska, but careful management will be required to maintain high productivity.

## Forage grass variety trials

**Stephen D. Sparrow, darleen t. masiak**

purpose

We are comparing the potential of various native and introduced grasses as forage crops in Alaska's Tanana Valley.

approach

We established sixteen varieties representing nine species of grasses at the Fairbanks Experiment Farm, the Delta Junction Field Research Site, and Bill Spencer's farm near Nenana in 2001, 2002, or 2003. The grasses tested represented both introduced and native species.

progress and results

At Fairbanks, some varieties were harvested three times in 2005, other were cut twice. Highest yields were obtained for smooth or meadow bromegrass varieties, which averaged 4.7 tons dry herbage per acre. Native species yielded lower than most introduced species and the average herbage yield

across all purely native species was 3.1 tons per acre. Forage quality was generally highest for the first harvest, and did not vary greatly among species. We harvested some varieties at Nenana three times in 2005; others were harvested twice. As at Fairbanks, highest yields were obtained for smooth and meadow bromegrass varieties, which averaged 4.9 tons dry herbage per acre. Overall, we obtained lowest yields for native grass species at Nenana, with an average forage yield of 3.4 tons per acre. Stands were so poor in the plots at Delta Junction that we did not harvest there.

### impact

This research will aid interior Alaska farmers in selection of forage grass species and varieties to use in their cropping regimes.

## Harvest management practices to maximize forage production and quality in interior Alaska

**Stephen D. Sparrow, darleen t. masiak**

### purpose

The purpose of this project is to determine optimum cutting height and time of second seasonal harvest for several forage crops in interior Alaska.

### approach

We initiated a harvest trial on smooth bromegrass at Delta Junction in 2002, on smooth bromegrass and alfalfa at Fairbanks in 2003, and on forage galega and cicer milkvetch at Fairbanks in 2004. We harvested all plots in mid-June and then imposed different harvest treatments for the second harvest. Treatments consisted of harvesting at different times (every two weeks from early July until late September) and three clipping heights (low, 2 inches; medium, 4 inches; and high, 6 inches above ground level). Plots were again harvested the following June to determine residual effects of previous harvest management. Treatments were imposed for two consecutive years at each location.

### progress

Preliminary results indicate yields generally increased and forage quality decreased as the season progressed, and yields decreased and forage quality increased with increased cutting height. Late season second harvests usually resulted in highest subsequent year yields; second harvests done in late July to mid August generally resulted in lowest yields in June of the following year. This study will be completed in 2006.

### impact

This research will aid farmers in determining best harvest management practices for forage crops in interior Alaska.

## Storage cabbage trials

**Roseann Leiner, Jeff Smeenk, Kate Brainard**

### purpose

In Palmer field experiments, four varieties of green storage cabbage were compared for size and quality after several months of storage.

### approach

For the second season, field trials on green storage cabbage compared three spacing treatments. Month-old seedlings were transplanted at 12, 14, and 16 inches apart in rows. The cabbage trials were planted at two locations and harvested in late September and early October for storage. Cabbages were stored with refrigeration for three to six months and observed for changes in quality.

### progress

As in the 2004 trial, the variety Gideon had larger head size than the other three varieties. Gideon and Survivor stayed green in storage through December and then had unmarketable yellow leaves with longer storage. The other two varieties stayed green in storage past March. Although these varieties, Arena and Safekeeper II, were smaller, they tended toward increased head size with increased spacing between plants.



### impact

Cabbage varieties for storage grow more slowly in the field and grow longer than fresh market varieties. Cabbage sales can be extended into the winter season by choosing varieties and cultural practices that lead to storage quality and marketable size. A marketable storage cabbage weighs from 2.5–3.5 lbs and has good green color with a solid head.

We are learning management strategies for storage of cabbage that can increase cash flow for cabbage growers. While fresh market cabbage stores for days, Gideon is good for weeks of storage, and Arena and Safekeeper II can store well for months.

## Head lettuce variety trials

**Roseann Leiner, Jeff Smeenk, Kate Brainard**

### purpose

Because seed companies change the varieties that are available to farmers and gardeners, it is important to evaluate these new selections of lettuce for their performance in the long days and cool soils of Alaska.

### approach

Eleven varieties of crisphead lettuce were grown in replicated trials on two commercial farms in the Matanuska Valley. In mid-season and late-season plantings, month-old seedlings were transplanted twelve inches apart in rows and harvested approximately two months later. Up to ten marketable heads from each of four replicates were weighed, measured for diameter, and rated for internal tipburn damage.

### progress

As in 2004 trials, the variety Sniper performed well, similar to Alpha that was commonly planted on commercial farms in Alaska. Prestige and Victory were new in 2005 and also performed well. Varieties ranged widely in incidence of tipburn damage, from 22 percent in Grand Max to 86 percent in Calicel, a variety that is susceptible to tipburn and is planted only for comparison. Tipburn damage was common on larger heads and occurs when the margins of

inner leaves die. Tipburn is probably caused by a localized lack of calcium related to uneven water transport during Alaska's long summer days.

impact

Alaska growers produce thousands of cartons of head lettuce to supply the market during the summer season. Lettuce varieties with medium head size and low frequency of defects like tipburn are desirable. Some new varieties show good potential for crop production in Alaska, while other varieties are not adapted to the local growing conditions.

## Mineral levels in some salad greens

**Roseann Leiner, Jeff Smeenk, Kate Brainard**



purpose

Leaves of greens in the cabbage family are grown for specialty salad mixes and have nutritional value that includes the minerals calcium and iron. The 2005 trials evaluated young and older leaves of *Brassica* greens for total yield and mineral levels.

approach

In field experiments we compared seven types of Brassica greens: two Asian greens, four kales, and red giant mustard. Baby leaves were harvested when leaves were 4-6 inches long, and large leaves were harvested when leaves were big enough to put in bunches. Samples of leaf tissue were analyzed by Laurie Wilson at the Palmer Laboratory for calcium, iron, magnesium, copper, zinc, sulphur, and percent dry matter.

progress

The dry matter was high in kale: 10–13 percent in Toscano, 11 percent in Winterbor and Redbor, and 7–11 percent in Red Russian. Dry matter was 6–7 percent in red giant mustard and the Asian greens mizuna and tatsoi. Calcium levels (on a dry matter basis) were similar in these greens, usually around two percent, and slightly lower in Red Russian kale. Although the levels of iron were usually higher in baby leaves than older leaves, baby leaves often produced about half a pound per foot of row, which was much lower than the yield from bigger plants.

impact

Salad greens are a wonderful crop suitable for most climates in Alaska, and related nutrient information is of value to home gardeners and commercial growers. Both cooked and salad greens are a good source of minerals in the human diet, though few differences in mineral levels were found between types. Mostly, nutrient levels are maintained as plants mature.

## Potato field experiments in Palmer

**Jeff Smeenk, Roseann Leiner, Gregg Terry, Kate Brainard**

purpose

We compared weather-related factors, cultural practices, and potato varieties for yield and quality in field trials on the Matanuska Farm.

approach

In 2005, potatoes were planted and harvested in ten replicated trials and several demonstration trials at AFES in Palmer.

progress

Twenty-two varieties were included in the irrigated potato yield trial. The varieties Green Mountain and Ida Rose had high yields for marketable potatoes of twenty tons per acre. Swedish Peanut had the lowest yield at three tons per acre, partly because many small tubers fell through the harvest chain. The rest of the varieties ranged from seven to nineteen tons per acre. In the experiment on weather-related factors, the yield of Russet Norkotah was compared to five treatments that changed temperature and moisture conditions in the plant canopy. As expected, nonirrigated plots had significantly lower yields. Oat and canola cover crops may have weed control benefits but may lower yields slightly. Management trials evaluated the effects of plant spacings on marketable yield of seven varieties. The trend was higher marketable yield at spacings less than eleven inches between seed pieces in a row. Closer spacing can increase yields, but net profit is also affected by greater cost for seed when plant density is greater. Potato production in southcentral Alaska was affected by late blight disease in 2005, and plants in these trials were treated with fungicide, vine kill, and early harvest as necessary.

impact

Fresh potatoes produced in Alaska are marketed on multiple fronts, such as organic, specialty, and wholesale. Management strategies such as calculated plant spacing allow specialty growers options to maximize profits within their specific market. For example, tight spacing in Shepody and Yukon Gold counteracts the Alaska tendency to grow oversize tubers and pushes a greater percentage of the tubers into marketable size range.

## Turfgrass research

**Allen Mitchell, Tim Evers**

purpose

We sought to evaluate turfgrass cultivars and management practices that reduce winter damage and improve overall playability to golf greens and fairways in southcentral Alaska.

approach

Over the past five years of this project, we constructed two US Golf Association specification sand-based greens and a large soil-based set of fairway plots at the Matanuska Experiment Farm, and one research green at the public Settler's Bay Golf Course. Each site is used to evaluate different cultivars and turf management practices for winter hardiness, early greenup, and overall playability.

progress

The potential loss of available seed of Nugget Kentucky bluegrass for home lawns, golf course fairways, and sports fields in 2004 prompted us to introduce replacement

cultivars into the soil-based fairway trials. New cultivars tested beginning in 2004 included Northstar and Avalanche. In an evaluation in late June 2006, Northstar was judged equal to Nugget in winter survival and overall quality, color, and texture. The 2006 season is the final evaluation of the sand-based green variety trials that were established in 2001. At the Matanuska Farm location, cultivars showing superior survival, early greenup, and overall quality through the 2005 season included Nugget Kentucky bluegrass, 18th Green and Penn G-6 creeping bentgrasses, and Laser roughstalk bluegrass. Similarly, at the on-site research green at Settler's Bay, 18th Green and Penn G-6 creeping bentgrass, along with Velvet bentgrass (SRO7200), have consistently shown best overall quality and early greenup. A second sand-based green constructed in 2005 was seeded to best performing varieties, 18th Green, Penn G-6, and Laser bluegrass in individual 1,200 square-foot plots to be used for development of best management practices in 2006.

impact

Golf course superintendents are using the information generated by this project to change their turf management practices. At Settler's Bay and Palmer Fishhook golf courses they will seed their greens to Penn G-6 and 18th Green, respectively. We expect other courses in southcentral Alaska to follow. Alaska Mill and Feed, which is the largest marketer of grass seed in Alaska, has followed our research and is marketing cultivars that do well in our research plots. In view of the large number of Alaskans who utilize turfgrass for home and recreation, the research will affect a large population over the next few years.

# plant pest and disease control

## Herbicides for grass weed control in native grass seed production

**Brian E. Jackson, Stephen D. Sparrow**

purpose

We did a preliminary field experiment in summer 2005 to test effectiveness of multiple herbicides and application rates for controlling grass weed species in tufted hairgrass (*Deschampsia caespitosa*), alpine bluegrass (*Poa alpina*), and slender wheatgrass (*Elymus trachycaulus*) seed fields.

approach/progress

Based on results of these tests, we selected three herbicides that may provide control of foxtail barley (*Hordeum jubatum*) and other grass weeds. We are conducting tests with these herbicides on six grass species in a greenhouse experiment and we plan to continue the fieldwork in a more controlled field setting in summer 2006. A presentation entitled "Preliminary Results of Foxtail Barley *(Hordeum jubatum)* Control in Native Grasses Grown for Seed" was made at the Noxious and Invasive Plants Management Workshop in Fairbanks, Alaska in October 2005.

impact

This work will help Alaska grass seed producers improve weed control effectiveness.

## Integrated pest management strategies for Alaska agriculture

Alberto Pantoja, Dennis Fielding, Jeffrey Conn, Loretta Winton, Steve Seefeldt, Aaron Hagerty (Agricultural Research Service)

purpose

Since 1973, winter temperatures in Alaska have increased by 2-3ºC, renewing interest in agricultural expansion in circumpolar regions and increasing the incidence of pest insects and plant diseases. Information on biological properties of high-latitude pests (weeds, diseases, and insects), pest interaction with crops, and knowledge of best pest management practices for agricultural and natural areas in the region is lacking, poorly documented, or not well developed. More research is needed to improve management and to understand the biology of invasive plants, diseases, and insect pests in subarctic regions.

approach

The Alaska distribution of invasive sweetclovers (*Melilotus alba* and *M. officinalis*) was determined by Alaska ARS researchers and collaborators from the University of Alaska and the U.S. Forest Service. Grasshopper biology, development, and damage was studied under field and laboratory conditions. A survey was completed to identify lady beetle species associated with Alaska agriculture. Whitemold infestations in Alaska were also studied.

progress/impact

The northward limit for *M. alba* and *M. officinalis* was 67.15°N and 64.87°N; both species were strictly associated with soil disturbance. *Melilotus alba* extended no farther than 15 meters from road edges, except where *M. alba* on roadsides met river floodplains and dispersed downriver. Populations on floodplains were most extensive on braided sections. On the Nenana River, soil characteristics did not differ between *M. alba* growing sites and similar areas where it was not yet present. Upland taiga plant communities grow on acid soils that may protect them from invasion by *Melilotus*, which prefer alkaline soils; however, early succession communities on river floodplains are susceptible because soils are alkaline.

There has been very little research on herbicide control measures for bird vetch, a perennial invasive exotic weed that is expanding along roadsides and into open forests in Alaska. In a greenhouse study, researchers from the Alaska ARS and the University of Alaska, determined that 2,4-D, triclopyr, and clopyralid are effective herbicides for controlling seedling bird vetch. Integrated management strategies for the control of bird vetch along Alaska roadways and Native-owned lands may require a herbicidal component because the infestation now covers tens of thousands of acres. Selecting appropriate herbicides and determining rates and times of use are critical to obtaining the best results at the lowest costs; these results

will become part of Best Management Practices for the control of bird vetch in Alaska.

The prevention of grasshopper outbreaks through habitat management is preferable to suppressing outbreaks with pesticides. Warm soils promote early egg hatching, which may be crucial in Alaska's short growing season. ARS scientists at Fairbanks examined the influence of temperature and moisture on oviposition by grasshoppers in a laboratory microcosm. Temperatures below 20°C greatly inhibited oviposition. This supports the idea that Alaska grasshopper populations may be managed by practices that lower soil temperatures in fallow fields, such as establishing dense grass cover and allowing brush growth to shade the ground.



Diet choice may be a key factor influencing grasshopper growth and development, a major pest of crops and rangeland in North America. Fairbanks researchers compared diet choice in grasshoppers from Alaska and Idaho. Grasshoppers were given a choice of high-protein or high-carbohydrate foods and allowed to self-select optimal diets. Alaska grasshoppers tended to regulate their consumption of the two foods so that the protein:carbohydrate ratio of their overall intake was about 1.2:1.0. In contrast, the grasshoppers from Idaho were much less selective, and the protein:carbohydrate ratio of their overall intake varied with the availability of the two food choices. The results suggest that the rapid growth of Alaska grasshoppers demands a more exacting diet.

The presence of biocontrol agents is important in the development on integrated pest management programs (IPM). Thirteen species lady beetle were identified in a survey conducted by ARS scientists in Alaska; one species, *Coccinella septempunctata*, has been reported to be invasive in some areas, displacing native species, and its populations should be monitored. Of the species collected, *Hippodamia tredecimpunctata tibialis, Hippodamia quinquesignata quinquesignata*, *Coccinella transversoguttata richardsoni,* and *Coccinella trifasciata perplexa* were collected in greatest numbers and have the most potential for use as naturally occurring biocontrol agents and IPM programs.

White mold is the major disease problem limiting vegetable production in Alaska. ARS scientists in Fairbanks and University of Alaska collaborators determined that white mold in Alaska is caused by two visually indistinguishable *Sclerotinia* species occurring in nearly equal frequencies. One species is a common introduced agricultural pathogen, while the other is putatively a native, circumpolar fungus previously found only in Norway, mainly on wild plant species. Studies indicate that the two fungal species are capable of hybridizing in Alaska agricultural fields. The results of this study are important to vegetable producers because disease management strategies depend upon correct identification of the pathogens involved in disease.

*Sclerotinia sclerotiorum*, the primary cause of white mold in temperate regions, overwinters easily in Alaska. ARS scientists in Fairbanks and University of Alaska collaborators studied two isolates of the fungus collected from Alaska. The data show that hundreds of new propagules, called sclerotia, can form on a single head of lettuce or cabbage that decomposes completely. One isolate was more successful at colonizing both cabbage and lettuce and was also more successful at producing large and numerous overwintering propagules, yielding about three times more biomass than the other isolate. These results are important to vegetable producers in Alaska because the data suggest that one part of cultural control for white mold is to minimize the time that crop debris is left in the field before tillage.

## Arctic plant germplasm research and introduction

Alberto Pantoja, Joseph Kuhl, Nancy Robertson (USDA)

### purpose

The primary mission of the Arctic Plant Germplasm Introduction and Research Project (APGIR) is the acquisition, propagation, storage, and distribution of plant germplasm for agricultural and nonagricultural plant species from arctic, subarctic, and alpine regions of the world. APGIR serves as a grow-out site for seed and clonal samples for certain cool-season accessions from other plant germplasm repositories within the National Plant Germplasm System.

The mission includes research on certain diseases and physiological features of germplasm of arctic, subarctic, and alpine crop and noncrop species. Plant diseases in Alaska, both indigenous and introduced, are not well documented. Comprehensive plant disease surveys in agricultural and nonagricultural plant species are few, especially for plant viruses, although viral and other contagious diseases can have a significant negative impact on agricultural and nonagricultural crops adapted to arctic, subarctic, and alpine environments. Physiological aspects of plant adaptation and these environments also require more research.

### approach and progress

For the first time in Alaska, we documented barley yellow dwarf disease and determined the causal agents Barley yellow dwarf virus-PAV, Barley yellow dwarf virus-MAV, and Cereal yellow dwarf virus-RPV in barley and oats. Sequences obtained from clones of over 100 isolates identified a unique cluster of six RPV isolates. The Alaska PAV and RPV populations have different spatial and temporal population genetic structures. The MAV isolates are unique and genetically different from all other MAV isolates including those from the United States, China, and Europe. This suggests that they are affected by different agroecological factors.

We described a new virus tentatively named Nootka lupine vein-clearing virus that occurs in native lupine plants and is confined to a site in the Hatcher Pass region. This is one of the few carmoviruses found in Fabaceae in a temperate climate. Although natural infections do not appear to reduce lupine vigor, experimental innoculations to chickpea *(Cicer arietinum)* results in death. Detection and characterization of viruses in native plants is especially important as they may be a threat to economically important plant species.

We identified a potyvirus, Turnip mosaic virus (TuMV) and another unknown virus from symptomatic rhubarb plants in the germplasm collection. This is the first report of TuMV in Alaska, and is especially important since TuMV infects a large number of economically important plants species in Alaska.

We identified a unique virus member in the family Potyviridae and another virus in the genus *Carlavirus* from native *Streptopus amplexifolius* plants. The carlavirus has serological relatedness and sequence similarity to several carlaviruses. Diseased plants occur in forests, along roadsides near crops, and are either doubly or singly infected with each virus. Nearly all the documented sites contain over fifty percent incidence of infection. This is the first report of viral infection(s) in *S. amplexifolius* (claspleaf twistedstalk of the lily family).

We identified viruses or virus-like agents in the following native plants for the first time: 1) *Delphinium glaucum* (Sierra larkspur, pale larkspur) 2) *Pyrola asarifolia* (pink Pyrola, common pink wintergreen, or bog wintergreen), 3) *Angelica lucida* (seacoast angelica, member of the carrot family), and 4) *Sorbus scopulina* (mountain ash). The significance of this study is the added biological knowledge of plant pathogens in native plants found in both isolated sites and near agricultural and residential sites.

### Late blight on potatoes

Lori Winton (ARS); **Roseann Leiner**

#### purpose

To better understand the outbreak of late blight disease of potatoes that occurred in the Matanuska Valley in 2005, we studied some isolates of the pathogen. This was only the third occurrence of the disease in Alaska, and the outbreaks of 1995 and 1998 were much less damaging.

#### approach

Leaf tissue from infected potato and tomato plants was collected, and the pathogen was cultured and described using several lab tests.

#### progress

Late blight disease is caused by a water mold, *Phytophthora infestans*. In 2005, *P. infestans* was collected from symptomatic plant tissue from ten commercial potato fields and two greenhouse tomato plants grown in the Matanuska Valley, Alaska. All isolates were consistent with the US-11 isozyme genotype, IIB mitochondrial haplotype, and mating type 1 that are described in worldwide literature on populations of *P. infestans*.

#### impact

Because potatoes are an important commercial crop in Alaska, producers want information on disease outbreaks that occur. Alaska's elaborate system for preventing late blight disease includes plant quarantines and seed certification for potatoes. Obviously, the 2005 outbreak showed a failure in prevention. Since all isolates tested were a single type of P. infestans, the data imply as few as one breach in the prevention system, whereas multiple types would have suggested multiple breaches.

### White mold on vegetables

Lori Winton (ARS); **Roseann Leiner**

#### purpose

We studied white mold disease, caused by the fungus *Sclerotinia sclerotiorum*, which is common in cultivated fields and gardens, where it overwinters as sclerotia.

#### approach

A field collection of *S. sclerotiorum* was made during August and September from eleven sites where vegetables are cultivated. Samples included three forms of the fungus: white mycelium on decomposing plants, vegetative resting propagules called sclerotia, which have black rinds and white internal mycelia, and sexual fruiting bodies called apothecia, which produce airborne ascospores after self-fertilization or outcrossing.



#### progress

More than 500 isolates of *Sclerotinia* were collected and cultured. Dr. Winton's lab used data on microsatellite markers to describe populations of *Sclerotinia* in Alaska. The data revealed that these populations of *S. sclerotiorum* are predominantly non-recombining clonal lineages. Surprisingly, many diseased plants were found to be infected by the unnamed and closely related *Sclerotinia* "species 1" that previously has been found only in Norway, on wild plants and cultivated potato. In some fields "species 1" was the only pathogen involved in disease. However, white mold in most fields was caused by both "species 1" and *S. sclerotiorum* together, and these fungal species are capable of hybridizing.

#### impact

White mold disease can devastate vegetable yields in Alaska and worldwide. Our research has two components: scientific study of population ecology and, for practical horticulture, determination of whether various fungal populations exhibit different characteristics that may lead to different crop management strategies for different species of *Sclerotinia* in Alaska.

## High-Latitude Soils

### Biocomplexity of small patterned-ground ecosystems: Soils associated with patterned ground

**C.L. Ping, G.J. Michaelson, D.A. Walker**

#### purpose

This project studies the complex linkages between frost heave, soil biogeochemical processes, and vegetation patterns in small patterned-ground ecosystems along an arctic bioclimate gradient from treeline to the coldest portions of the Arctic. The project focuses on how climate influences the interactions between vegetation, soils, and patterned ground formation.

#### approach

The field studies were conducted along the Dalton Highway of northern Alaska and at four sites in Canada:

Inuvik, Green Cabin (Banks Island), Mould Bay (Prince Patrick Island), and Isachsen (Ellef Ringnes Island). This transect spans five major arctic bioclimate subzones. The transect has a sharp boundary in the southern part that separates essentially middle-arctic nonacidic soils with abundant nonsorted circles from low-arctic acidic soils with few apparant nonsorted circles. To the north are low-arctic sites dominated by small frost polygons. Vegetation plots were established at each of the study sites to represent typical major landscape components along a toposequence. Soil pits were excavated alongside each vegetation plot and other landform units of interests.



At each site, a soil pit was excavated to a 1x1 m square and to at least one meter deep to reach the substratum, ice wedges, or bedrock. Soil profiles were described according to the *Soil Survey Manual* and soil samples were taken from each genetic horizon. Samples were kept in a cooler for transportation to the lab. All samples were characterized according to USDA National Soil Survey Laboratory procedures.

progress

Numerous small patterned-ground features are unique to permafrost regions—the most common in the Low to Middle Arctic are nonsorted circles and hummocks. These patches are small, 1 to 3 m diameter, often circular, that are caused by frost heave and are spaced from 1 to 10 m apart. They occur in regular patterns of "spotted tundra" that cover large landscapes of the northern Low Arctic. Soils associated with the non-sorted circles are highly cryoturbated (layers mixed by freeze-thaw processes) and store large quantities of organic carbon, higher than previously reported. The most common features in the High Arctic are frost polygons.

Parent material has a strong influence on soil properties because of the weak weathering in the High Arctic, but such influence decreases from Bioclimate Subzone A to E following decreasing latitude. The thickness of organic horizons increases following the subzones southward due to increased biomass production. Soil organic carbon accumulation increases southward following the subzones, but the cryoturbated carbon accumulation reached its maximum at sites showing the greatest frost heave, which again reinforces the observation that cryoturbation plays the controlling role in carbon sequestration in arctic tundra soils. Topography plays a controlling role in redistribution of solar energy and precipitation, thus hydrology. Permafrost acts as a barrier to water movements, creating a saturated zone above that resulting in reducing conditions. Gleying is a common feature at the lower active layer in soils affected by ice-cemented permafrost.

impact

This project added new knowledge to artic tundra soils in the following ways: 1) First complete physical and chemical characterization analysis contributed to the National Soil Survey Center database on permafrost-affected soils; 2) The first systematic study of arctic tundra soils following the bioclimatic zone transect that covers the High, Middle, and Low Arctic; 3) although polar desert soils were described before, this project is the first to provide detailed field description and lab data to characterize the salt crust on these soils in the High Arctic; 4) study sites along the transect provided field lab locations and data for education programs at the University of Alaska and other universities.

## Black spruce forest soils in boreal regions of Alaska

**C.L. Ping, E.C. Packee**

purpose

This study is designed to provide information on the morphological, chemical, and physical properties of soils associated with black spruce forest stands on different landforms.

approach

The physical environment and properties of soils formed under black spruce in the boreal region of Alaska were investigated. The study sites were selected jointly with forest management specialists for representative sites for black spruce growing in different environments. We selected study sites associated with existing Permanent Sample Plots and the Site Index Plots of the ongoing Growth & Yield Program so the results of both studies can be tied together.

There are two categories of soil sampling sites: paired-sampling in the soils of the burned and unburned black spruce forest stands, and soils associated with Permanent Sample Plots in interior Alaska. Soils pits are excavated at each site and morphological properties studied. Soil samples are collected according to the *Soil Survey Manual*. Characterization soil samples will be shipped to the USDA-NRCS-National Soil Survey Laboratory in Lincoln, Nebraska, for full characterization according to procedures of the USDA Soil Survey Investigation Report No. 42. Analyses include pH, EC, TOC, TIC, TN, CEC and extractable cations; particle size distribution; bulk density; water retention at 1/3, 1, 10, and 15 Mpa; DCB extractable iron, aluminum, and manganese; pyrophosphate-extractable iron and aluminum; and clay mineralogy.

At each site, soil samples are subsampled and sent to the Palmer Research Center Laboratory for analysis of organic carbon, charred organics, and soil fertility. For soils with permafrost, core samples with known volume are taken with a permafrost drill from the permafrost or frozen horizons for determining bulk density and ice volume or water content.

In cryoturbated soils where the soil horizons are warped or broken, the pedon carbon storage is calculated according to percentages of each horizon in the profile. Soils at each study site are classified according to *Soil Taxonomy*. The quantity of charred organic carbon or black carbon is determined by removal of soluble salts and hydrolysable organic matter, followed by thermal oxidization of the free residue in a muffle furnace at 340-375°C for twenty-four hours. The samples are weighed directly in tared cups, combusted, and analyzed with a high-temperature elemental analyzer to obtain weight-percent organic carbon and nitrogen. Selected samples are carbon-14 dated.

progress

A total of thirty-three soil pits have been sampled. Black spruce plots were located on nearly all segments of landform (including ridge top, shoulder slope, back slope, footslope, and flood plains) with drainage from somewhat excessive to poor. Slopes ranged from steep to level. Although black spruce grows on all slope aspects, they were predominantly found on the back slopes to the north, where the cold soils contain permafrost. The parent material included loess or volcanic ash over weathered Birch Creek schist or granite, volcanic ash over loess or sand dune deposits, and retransported loess. Soil morphological, physical and chemical properties were characterized. Organic horizon thickness ranged from 4 to 18 cm on well- drained sites to > 30 cm on poorly drained sites. Generally, soil pH increased with depth: from 4.0 to 6.0 in O horizons, 4.0 to 6.0 in A horizons, 5.0 to 7.0 in B horizons, and 7.0 to 8.0 in C horizons. Total soil carbon, generally, decreased sharply with depth from about 30 to 50 percent in O horizons to <1.0 percent in BC and C horizons. Wildfire is a common and frequent disturbance feature in black spruce forests in the western boreal region; charcoal was found throughout the soil profiles with a concentration in surface and subsurface horizons. Charred material often leads to an overestimation of soil organic matter and yields a wide carbon:nitrogen ratio.

impact

This study is the first study to characterize the soils associated with black spruce in the boreal regions of Alaska. Contrary to the common belief that black spruce only grows in cold and wet sites, this study shows that black spruce grows on almost all landforms of interior Alaska and in soils with a wide range of properties. Thus management practices may be considered in the optimum sites. Based on the value of the preliminary results of this study, the UAF Growth & Yield Program may expand studies to include aspen sites in the summer of 2006.

## Soil carbon stabilization along climate and stand productivity gradients in black spruce forests of interior Alaska

**Evan Kane, David Valentine**; Ted Schuur, Koushik Dutta (University of Florida)

purpose

How do soil carbon chemistry and accumulation vary with forest productivity? Answering that deceptively simple question is the objective of this research. Specifically, we are looking at how the stability of soil organic carbon (SOC) (i.e., its resistance to microbial degradation) varies with how rapidly and densely nearby trees are growing.

approach

To determine how the complex interplay between stand production, nutrient mineralization, and soil temperature affects soil carbon stabilization, we investigated total SOC along four replicate gradients in black spruce productivity and climate in interior Alaska. Because turnover of soil pools is faster in warmer, more productive sites, we hypothesized: 1) total SOC decreases as stand productivity and soil temperature increase because productivity depends on the nutrients released with soil organic matter turnover, which also increases with temperature, the net result being that 2) SOC content in more stable soil pools is proportional to the amount of actively cycling SOC in surface soil pools.

progress

Across all sites, for every degree-day increase in heat sum within the organic soil, total SOC harbored in mineral soil horizons decreased by 4.4 g carbon m². With increased stand productivity and soil temperature, the proportion of relatively labile light fraction (density <1.6 g cm-3) soil organic matter decreased significantly. Mean residence times of SOC (as determined by carbon-fourteen dating) in dense fraction (>1.6 g cm-3) mineral soil ranged from 282–672 years. The oldest SOC occurred in the coolest sites, which also harbored the most carbon and had the lowest rates of stand production. This paper is currently in press, in the *Canadian Journal of Forest Research*.

impact

Will carbon storage in boreal forest soils increase or decrease as a result of changing climate? This research is a step in the direction of answering that question. We found that the interactions between increased stand productivity, organic matter accumulation, and soil heat sum have altered the quality and quantity of different SOM pools through differences in decomposition environment and plant carbon inputs, even though total SOC appeared insensitive to temperature in some cases. These data suggest that projecting the effects of changing climate and primary production on soil carbon balance requires examination of temperature responsiveness of organic matter decomposition within discrete soil pools, and not just total soil carbon stocks.

## Controls over pathways of carbon efflux from soils along climate and black spruce productivity gradients in interior Alaska

**Evan Kane, David Valentine, Gary Michaelson, John Fox, Chien-Lu Ping**

purpose

Many streams in Alaska are tea-colored because of dissolved organic acids that derive from the partial decay of soil organic matter. We are evaluating whether soluble organic carbon losses from soils represent a major component of carbon export from soils when compared to other components, such as soil respiration.

approach

To examine the factors controlling water-soluble organic carbon (WSOC) fluxes, we estimated them based on measured carbon concentrations along four replicate productivity and soil temperature gradients in upland black spruce (*Picea mariana* [Mill.] B.S.P.) forests in interior Alaska and compared them to concurrent measurements of soil $CO^2$ efflux.

progress

As of fall 2004, we had measured in early spring, summer, and late fall the WSOC concentrations in organic and mineral soil horizons at all twelve sites. The WSOC was separated into four fractions: humic acid, fulvic acid, hydrophilic neutrals, and low molecular weight fulvic acids (based on sorption to and desorption from the exchange resins and sequential acid and base treatments). In colder, low-productivity stands, the proportions of relatively bioavailable organic fractions (hydrophilic organic matter and low-molecular-weight acids) contained the most WSOC. In warmer, high-productivity stands, the more degraded products of microbial activity (fulvic acids) were highest. Annual WSOC flux increased with annual soil $CO^2$ efflux across all sites, with higher fluxes occurring in warmer, more productive stands. Although annual WSOC flux was relatively small compared to total soil $CO^2$ efflux across all sites (2–6 percent), its relative contribution was highest in warmer, more productive stands. This paper was revised and submitted to *Soil Biology and Biochemistry* in summer 2005.



impact

Small changes in carbon cycling in boreal forests can change the sign of their carbon balance from the terrestrial perspective (i.e., negative = loss of soil carbon, positive = gain of soil carbon). Consequently, incorporating heretofore largely ignored fluxes of water-soluble organic carbon from soils, and the factors controlling them, is potentially important to understanding carbon balance in these systems. These results suggest that WSOC should be accounted for in order to determine accurately the sensitivity of boreal soil organic carbon balance to climate change.

## Sensitivity of soil organic carbon dynamics to long-term throughfall exclusion in interior Alaska

**Sarah Runck, David Valentine, John Yarie**

purpose

Our study addresses the question of how excluding summer throughfall (rainfall that passes through the forest canopy to the ground) influences key components of soil organic carbon (SOC) storage, particularly in surface soils, where soil moisture content closely tracks weather and where a substantial proportion of soil organic matter is stored. We hypothesize that dryer surface soils (1) shift rhizodeposited (i.e., root-derived) carbon downward in the soil profile and (2) slow decomposition in surface soils.

approach

Throughfall was excluded using a 10 x 15 m sloping shelter made from translucent fiberglass (1989-2004) or transparent PVC (2004-present) panels erected under the forest canopy every spring and removed every fall. Yarie has reported the consequences of these treatments to tree growth elsewhere. To detect changes in rhizodeposition, we are analyzing soil cores sampled in August 2005 for root biomass and SOC content. Soil cores are being analyzed by the following depth intervals: at O horizon and at 0–5, 5–15, and 15–30 cm mineral soil beneath the O horizon. To determine if throughfall exclusion has altered the decomposition environment of surface soils, we initiated a common substrate decomposition experiment in July 2005. We placed tongue depresssors made from paper birch at two depths in the soil profile: the O horizon and in the top 15.25 cm of mineral soil beneath the O horizon.

progress

Throughfall exclusion has consistently reduced soil moisture in upland and floodplain sites, especially near the soil surface, yet mean annual aboveground litter inputs remain unchanged by throughfall exclusion. Total aboveground net ecosystem productivity (estimated as total aboveground biomass in 2005 minus total aboveground biomass in 1989) declined only in upland throughfall exclusions. Throughfall exclusion has not affected mass, depth, or bulk density of the O horizon in uplands or floodplains. However, it has reduced O horizon coarse root (2–5 mm) biomass in uplands by 50 percent and floodplains by 80 percent, while not altering that in 5–15 cm mineral soil. In both landscape positions, throughfall exclusion has not affected large root (>5 mm) biomass in the O horizon or 5–15 cm mineral soil. To date, our results indicate that chronically reduced surface soil moisture negatively affects coarse root biomass in the O horizon. If this reduction corresponds to reduced rhizodeposition in the O horizon, then the lack of difference in O horizon mass and aboveground litter inputs implies slower carbon turnover in surface soils, which the common substrate decomposition experiment is testing.

impact

Previous work on this project and others has shown that moisture limitation is a key constraint on boreal forest growth, especially in a warming climate. The results of this study will enhance our understanding of how predicted future soil moisture deficits, independent of increased soil temperature, will affect SOC storage in mid-successional boreal forests and will identify possible mechanisms by which these potential changes will occur. These results will improve assessment of the overall effect of climate change on boreal forest carbon storage.

## Flux and transformation of organic carbon across the eroding coastline of northern Alaska

**C.L. Ping, Torre Jorgenson, G.J. Michaelson**, Laodong Guo, Y. Shur

purpose

The objectives of this National Science Foundation project are to monitor erosion rates, estimate the amount and fate of the organic carbon in the tundra soils and underlying permafrost eroded into the Arctic Ocean, and involve coastal communities in awareness and partnership development in research and land-use planning. This is a collaborative research project between the University of Alaska Fairbanks and ABR, Inc., Fairbanks, Alaska.

approach/progress

The 2005 field season of the Carbon Flux and Transformation across the Arctic Coast of Alaska project started at Barrow, August 12, and ended at Helmerick's Camp in the Colville River Delta, August 20, 2005. This is the first field season of a three-year project to study carbon flux and transformation along the arctic coastline of Alaska caused by erosion due to thawing of permafrost.

A total of fifty study sites were selected from detailed study and sampling to represent the major coastline types along the Beaufort Sea coast. These sites include coastal marshes/tidal flats and bluffs with elevation up to eighteen meters, and locations from the Eilson Lagoon north of Barrow east to the Canadian boundary. At each site, the physiographic characteristics, including landform, microtopography, GPS position, coastal bluff elevation, and vegetation community were recorded. Along the coastal bluff and coastline, permafrost, ice content, and soil morphological characteristics were studied and recorded. Sediment samples were taken on the beach and in shallow waters, and wave monitoring cameras were installed on three intensive-sampling sites at Barrow, Prudhoe Bay, and Kaktovik.

impact

**Soil science:** The cryoturbated organic matter on the coast, found to reach a depth of 2.5 meters, is nearly 150 percent deeper than observed in the Arctic Foothills of northern Alaska. This means that the carbon storage in the arctic tundra is much more than has been estimated from the studies in the National Science Foundation's Land-Atmosphere-Ice Interactions (LAII) Program.

**Geocryology:** This study provides the first comprehensive description of ground ice of typical terrain units along Beaufort Sea coast.

**Geochemistry:** Methodology was developed to analyze the size fractionation of organic matter in soils, permafrost, and shallow water sediments.

**Geomorphology:** Descriptions of soil stratigraphy along the coast from Barrow to the Colville Delta have confirmed the general classification of marine silts, eolian sands, and slightly pebbly sand deposits. Our descriptions and stratigraphic analyses, however, will be the most comprehensive dataset developed to date. Based on these analyses we will likely substantially revise the standard interpretations of genesis of the marine sands and slightly pebbly sand deposits in terms of glaciation of the continental shelf of the Beaufort Sea coast.

**Erosion:** The estimated average erosion rate along the 1,800 miles of Beaufort Sea coast from Pt. Barrow to the Alaska-Canadian boundary is six feet per year. This transforms to about 2,000 acres of land lost to the Arctic Ocean per year. Based on first year's measurements, the average ice content of the soils measured to six-foot depth is 55 percent ice with a carbon content of 120 pounds per cubic yard, which amounts to 750,000 tons of carbon entered each year into the biogeochemical processes and cycling in the Beaufort Sea and Arctic Ocean.

**Partnership Development:** A good model of partnership with the native community has been established in the project. Residents of communities of Barrow, Nuiqsut, and Kaktovik have participated in the monitoring of the coast erosion, provided logistic support, and the researchers present their findings to the local schools and communities.

**Education:** The project provided a rare opportunity to train one graduate student and one postdoctoral student in arctic tundra ecology, permafrost landscape, and field techniques. It also provided arctic tundra research experience for three graduates and one undergraduate student from other universities, and for incollegiate cooperative research among UAF, Tarleton University, and Hohenheim University in Germany. Ecologists, soil scientists, and geocryologists were able to work together to look at the common topic—coastal erosion—and to coordinate their effort and discuss the whys and hows of the relationships between permafrost and coastal erosion.



# fire-related studies

## Fire impacts on boreal forest soil carbon bioavailability

**Sarah Masco, David Valentine, Steve Sparrow**

purpose

This study aimed to evaluate whether and how wildfire changes the quality of organic matter remaining at the soil surface following wildfire.

approach

Soil samples were obtained from the lower two sub-horizons (F and H layers) of the organic surface horizon. Sub-samples were incubated at three temperatures for six months. Respiration rates, total amounts of respired $CO^2$, and temperature sensitivity of respiration rates were determined, then compared with chemical analyses of the soil organic matter, for which we used pyrolysis gas chromatography/mass spectrometry (GC/MS) and a proximate fiber analysis of cellulose and lignin content.

progress

Incubated soil organic matter from burned sites initially respired more slowly than soil organic matter from unburned control sites, but for most of the incubations the respiration rates were indistinguishable. Initial differences in respiration rate and temperature sensitivity did not correlate well with bulk soil organic components determined through pyrolysis GC/MS or through fiber analysis. Burned soils had higher net nitrogen mineralization rates than unburned soils. This could have resulted from more rapid gross nitrogen mineralization in burned soils or from more rapid gross nitrogen immobilization

(higher nitrogen demand) in the unburned soils. We interpret these results as suggesting that the only major difference between burned and unburned organic soils is the presence in the unburned soils of a rapid turnover pool from recently dead roots that is not present in the unburned soils. Ms. Masco successfully completed and defended her thesis in spring 2005, and plans to submit it for publication in 2006.

impact

In the wake of the slowed heterotrophic respiration observed in the Frostfire project, we hypothesized that pyrogenic changes in soil organic matter following fire might slow heterotrophic respiration, which would imply that fire may stabilize remaining soil organic matter and thereby slow post-fire carbon losses. Ms. Masco's thesis showed that this is not the case, at least in the Frostfire experiment. Instead, reductions in heterotrophic respiration likely arose from the reduced amount of recently senesced plant material, especially root-derived. Another consequence of this finding is that it blurs the distinction between autotrophic (i.e., from plants) and heterotrophic sources of respired $CO^2$ because much of the heterotrophic component is based on very recently senesced plant parts. In other words, carbon losses declined largely because carbon inputs declined, not because of a change in rate at which most of the soil carbon decomposes.



## Soil respiration following wildfire in lowland interior Alaska forests

**David Valentine**

purpose

We aimed to extend our understanding of fire impacts on soil respiration to lowland black spruce forests.

approach

Following the Survey Line Wildfire in 2001, we tracked soil respiration in burned and unburned lowland black spruce stands near the Tanana River in the Bonanza Creek Experimental Forest. We used static chambers of a more robust design than in the Frostfire project, and tracked soil temperatures and moisture contents in tandem with the respiration measurements.

progress

Results were consistent with those of the Frostfire project, a substantially similar project (reported earlier) that took place in upland black spruce forests. Soil respiration from burned soils quickly declined by half, and that difference persisted through 2005, the final year of this project. We continued to measure root-free (heterotrophic) respiration in the unburned stands. Burned soil respiration rates—which had few or no live roots, although now are recolonizing—were 30 percent lower than unburned heterotrophic respiration rates measured in root-exclusion collars in 2005. These results reinforce the pattern found in the Frostfire project: fire reduces $CO^2$ evolution rates both through elimination of root respiration and through slowing of heterotrophic respiration.

impact

In response to the Kyoto Protocol, "carbon credit" markets have been established in the United States and throughout the world. The Alaska legislature currently is considering bills that would authorize investigation of carbon credits in boreal forests and elsewhere as potential sources of revenue for state coffers. Our results will assist such efforts by shedding light on key dynamics governing carbon balance following the major disturbance type in interior Alaska.

## Topographic influences on wildfire consumption of soil organic matter in black spruce forests of interior Alaska: implications for the long-term accumulation of black carbon

**Evan Kane, David Valentine**; Eric Kasischke (University of Maryland); Merritt Turetsky (Michigan State University)

purpose

It is not yet clear whether fire suppression may diminish or enhance carbon storage in boreal forest soils. A crucial first step in managing for increased carbon sequestration is to determine the lasting effect of variations in the fire cycle on soil carbon accumulation. How charcoal accumulation varies with stand production or landscape position is unknown, as is the net effect of fire on carbon stabilization via charcoal production. We sought to 1) gain a better understanding of how landscape physiographic factors control patterns of organic matter consumption, and 2) ascertain what the lasting effect of wildfire is on soil organic carbon (SOC) balance in black spruce forests of interior Alaska. The overall objective of this study was to develop empirical relationships between physiographic features, burn severity, and their interaction in determining the long-term accumulation of burn residues.

approach

We measured characteristics of residual organic matter and quantified black carbon in surface mineral soil horizons along opposed north- and south-facing toposequences in recent (2004) and old (~1850–1950) burn sites throughout interior Alaska. Since duff moisture exerts major control over the severity and extent of burning within a given wildfire, and north-facing aspects are often colder and wetter than south-facing aspects, we hypothesized that organic matter consumption would be higher on southerly slopes compared to north-facing aspects. We expected to find greater black carbon accumulation at the organic/mineral soil interface on south-facing aspects, as a byproduct of more biomass burned over time, than on north-facing aspects. Residual organic matter depths and characteristics were measured along opposed north- and south-facing toposequences in two distinct burn units (the Porcupine Unit fire, Taylor Highway, and the Boundary Unit fire, Steese Highway). Black carbon at the organic/mineral soil interface was quantified along opposed north- and south-facing sites that burned 60–150 years ago.

progress

The fraction of organic matter depth consumed in wildfires was lower on the flat toe-slopes (39 percent) than on the north-facing (56 percent) or south-facing (69 percent) slopes.

Total pre-fire organic matter depths estimated from residual tree root collars were significantly higher on flat and north-facing aspects than on southerly slopes. Generally, the fraction of total SOC consumed by the Boundary and Porcupine unit fires was inversely related to total SOC present. On average the amount of soil organic carbon combusted (expressed as kg $m^2$ ± standard error of the mean), was 4.9 ± 0.3 on south-facing slopes, 4.0 ± 0.3 on north-facing slopes, and 3.2 ± 0.3 on flat areas. Residual SOC was mostly contained within the moderately decomposed Oe horizon, and north-facing and flat areas harbored approximately 2.2 times the SOC in this horizon after wildfires than did south-facing slopes.

Black carbon concentrations (mostly charcoal) in south-facing forest soils were nearly twice as high than on north aspects. In the A horizon, black carbon stocks were higher in the warmer, drier forests where turnover rate of other carbon fractions was higher; mean carbon turnover rates were lower in the cooler (wetter) forests. As turnover rates of dense-fraction carbon increased, the ratio of black carbon to total organic matter also increased.

### impact

One of the few options available to manage black spruce forests of interior Alaska for carbon emissions trading is through some form of fire management. In this study, black carbon comprised more of the total SOC pool on warmer, drier, south-facing slopes than in wetter forests with greater organic matter accumulation. While the relationship between total SOC stocks and the size of their most labile pools still requires explorationn, these findings suggest that fire may stabilize some soil carbon even as it releases soil carbon to the atmosphere. The relative magnitudes of these are important in considering the sensitivity of SOC balance to changing climate and increasing fire extent.

# Management of Ecosystems

## climate research and global change

### Alaska climate change

**Glenn Juday**

### purpose

This project continues to examine the influence of climate, especially climate extremes and climate change on agriculture and forestry in the far north. The history, risks, and opportunities of climate change and climate variability as they affect natural and managed forest were identified.

### approach/method

Long-term records of daily, seasonal, and yearly temperature and precipitation data were compiled with the help of the Alaska Climate Research Center and analyzed. Alaska climate databases were compared to significant events affecting forests, land management, and agriculture in Alaska.

### progress/result

The strongest and steadiest trend in Alaska climate records (80 to 100 years in length) is the rise of daily low temperatures, especially in the warm season (May through August) in interior Alaska stations with a continental type of climate. Another major trend in all of Alaska is an increase in mean winter temperatures and a decrease in episodes of extreme winter cold since the late 1970s. Date of snowmelt is earlier and frost-free season length has increased 50 percent to 100 percent during the twentieth century in Interior station records. At Fairbanks in 2005, 69 days had maximum temperatures of 70°F or higher, the eleventh-highest total in a 101-year record, and the mean daily low from 1 May to 31 August was 50.0°F, the fifth-highest total in the record.



### impact/implications

The large number of warm days in 2005 was directly associated with extensive wildland fires that burned the third-highest area in the fifty-five-year Alaska fire record. Acute drought stress symptoms appeared in birch trees in 2005. Increased growing season length and high warmth improved growth resources for some crops, but the resulting moisture stress limited a few. Insect survival and reproductive success were enhanced by recent mild winters and warm summers, and a number of tree and shrub species were subject to insect outbreaks in 2005.

### Global change education using western science and Native observations

**Elena B. Sparrow, Sidney Stephens, Martha R. Kopplin, Leslie S. Gordon**

### purpose

Our main objectives are 1) to provide Alaska K-12 teachers and their students opportunities to engage in climate change research based on local observations and western science, and 2) to translate such research into meaningful classroom activities and learning.

### approach

Rural and urban Alaska K-12 teachers and their students participated in this Global Change Education program, also known as the "Observing Locally, Connecting Globally" (OLCG) program. The teachers were provided professional development through a summer institute, a December followup workshop, and ongoing support programs that use Native knowledge to scaffold and enhance local environmental change studies; scientific measurements developed by the Global Learning and Observations to Benefit the Environment (GLOBE) program and by Alaska climate change scientists; and best teaching practices. Teacher support for implementing the program in classrooms included a website (www.uaf.edu/olcg). Attitude and achievement assessments, including teacher and student journals, were used to evaluate the program. This five-year project was funded by the National Science Foundation mainly through the OLCG program with collaborative support from the Alaska EPSCoR, Long Term Ecological Research, and GLOBE projects.

progress

The program model and results have been disseminated through presentations at various national and international professional conferences. A symposium was devoted to this project at the American Education Research Association.

Results of pre- and post-institute assessment showed an increase in teacher comfort level with teaching science and integrating Native knowledge in the classroom. Teacher journals indicated the program's positive influence on their math and science teaching methods and curriculum. Student attitude and achievement assessments showed a significant increase in post-test (end of school year) scores from pre-test (beginning of the school year) scores.



impact

Teachers participating in the OLCG program included in their teaching more Native knowledge, student engagement in scientific research, and performance assessments. Their students showed the greatest improvement in their ideas about the water cycle, weather, plants, and animals, and in their perceptions that they learned a lot about science from the local environment, and from having a Native elder visit the classroom. Parts of the program model have been used in other Alaska, national, and international professional development workshops for teachers. More than 70 teachers and 2,300 students were involved in the project. A book chapter was published in the National Science Teachers Association Press publication on Exemplary Science: Best Practices in Professional Development. Papers about this project have been published in conference proceedings, journals, and newspapers. Project dissemination has gone beyond Alaska and the United States.

## Resilience and Adaptation Program / IGERT

**Gary Kofinas** (SNRAS/IAB); Terry Chapin, David McGuire (IAB); **Glenn Juday, Joshua Greenberg, Scott Rupp**; Craig Gerlach (Anthropology), Mark Herrmann (School of Management); and other UAF faculty

purpose

The University of Alaska Fairbanks offers a graduate training program in Resilience and Adaptation (RAP) to train scholars, policy makers, and managers to address issues of regional sustainability in an integrated fashion. RAP prepares students to address a major challenge facing humanity: to sustain the desirable features of Earth's ecosystems and society at a time of rapid change in all of the major forces that shape their structure and functioning. The Resilience and Adaptation Graduate Program is sponsored by the National Science Foundation (NSF) through the Integrated Graduate Education Research Traineeship (IGERT) program. As directed by NSF, IGERT programs are intended to change the culture of graduate education in the United States by encouraging interdisciplinary research by PhD students. This goal is motivated by the belief that questions at the intersection of two or more disciplines are the most critical to the future of our society. The IGERT at UAF meets this objective by focusing on issues of sustainability through the study of social-ecological resilience and adaptation.

approach

Students are supported with an IGERT fellowship during their studies, and are expected to integrate social and natural science as a part of their dissertation research. Students take core classes—Regional Sustainability and Integrated Assessment, and the Resilience Seminar. All courses are team taught by faculty with expertise in anthropology, natural resource management, ecology, and economics. Students participate in summer internships after their first year of studies to gain experience and insight outside their home disciplines. Along with hosting guest scholars and visiting lecturers, RAP sponsors special programs that build a community for interdisciplinary enquiry.

progress

In 2005–06, 37 graduate students were enrolled in RAP, with 30 at the PhD level. SNRAS has assumed a lead role in RAP through faculty participation and the involvement of interdisciplinary PhD and natural resources management graduate students. Examples of current research topics of SNRAS graduate students in RAP include:

- Sustainability and the effectiveness of co-management for Alaska marine mammals
- Motivation of businesses that participate in an Alaska green certification program
- Ecological and economic dimensions of Alaska's non-timber forest products
- An integrated assessment of lodgepole pine in Alaska

impact

2005–06 was the fourth year of the five-year IGERT grant. It has strengthened interdepartmental cooperation across campus and generated a greater drive to consider sustainability in the Alaska context. Other related programs on campus include a new undergraduate course on sustainability.

## Community-based ecological monitoring in arctic Canada and Alaska

**Gary Kofinas**

purpose

Community-based ecological monitoring emerges as an important strategy for integrating local and science-based knowledge to assist resource users and decision makers on ways to respond to rapid global change. The Arctic Borderlands Ecological Knowledge Co-op is a monitoring program focused on the range of the internationally migratory Porcupine Caribou Herd and its near-shore environment. Climate change, industrial development, and contaminants are monitored. Seven communities in Alaska and Canada participate in the program, along with U.S. Fish & Wildlife Service, Environment Canada, the Wildlife Management Advisory Council of the North Slope Yukon, Yukon Renewable Resources Department, and others. The objective of the collaborative monitoring program is to understand what is changing and why (see www.taiga.net/coop).

approach

The monitoring program conducts annual interviews with active subsistence users in each participating community, using a standard questionnaire developed in collaboration with the communities. Interviews document local observations on fish, caribou, weather, berries, and other ecological and social aspects of community homelands. Special attention is given to documenting unusual observations, changes in trends, and local interpretations of changing conditions. The program uses a database of spatially referenced local observations. Science-based indicators of change are posted on the web for public access, and together with local knowledge, serve as the basis for discussions at annual gatherings of agency managers, researchers, resource users, and community leaders.

progress

The cooperative serves as an early warning signal of change, providing researchers with insights not available through remotely sensed and plot-based data. Links are being developed between Alaska's two Long Term Ecological Research programs and the co-op's community-based monitoring to understand changes in ecosystem services and human responses to those changes. This involves a ten-year trend analysis of local knowledge and science-based indicators and fostering greater participation of Alaska Native communities.

impact

The Ecological Knowledge Co-op serves as a model for nascent-stage community-based monitoring programs, and for the National Science Foundation's SEARCH (Study of Environmental Arctic Change) and other International Polar Year observation system initiatives. Several planning and co-management groups of the region are drawing on co-op findings to assess land-use alternatives.

## Collaborative Research: An integrated approach to understanding the role of climate-vegetation-fire interactions in boreal forests responses to climatic change

**T. Scott Rupp, Mark Olson**; Linda Brubaker, Patricia Anderson (Univ. of Washington); Feng Sheng Hu (Univ. of Illinois)

purpose and approach

Scientists trying to predict responses of northern landscapes to climatic change need to know the extent to which the distribution of the boreal forest is driven solely by climatic factors or by feedbacks among climate, vegetation, and fire. Palynological records (related to spores and pollen) from central Alaska reveal a perfect natural experiment to explore this issue. During the early Holocene, white spruce expanded rapidly into Alaska from northwest Canada, reaching its western limit in central Alaska approximately 9,000 years ago. Within 500 to 1,000 years, spruce populations declined or disappeared across an area of one million square kilometers. Spruce did not recolonize the region until 2,000 years later. An integrated data-model approach will be applied to understand the mechanisms that caused a complex shift in spruce treeline in central Alaska during the early-to-mid Holocene.

progress

This project is nearing completion and numerous model simulations have been conducted. A manuscript describing our conceptual approach is in press at Mitigation and Adaptation Strategies for Global Change. The manuscript will appear in a 2006 special issue resulting from the International Boreal Forest Research Association conference held in Fairbanks in May 2004. Two additional manuscripts are in preparation and will be submitted to peer-reviewed journals in fall 2006.

impact

Improved understanding of boreal forest-tundra dynamics in Alaska is important for understanding processes and mechanisms controlling circumarctic ecosystem responses to climate change. The research also provides an example of insights that can be derived from explicitly linking paleo-data and modern ecological modeling. This approach can be used as a template for other northern areas or adapted for more temperate regions.



## Fire-mediated changes in the Arctic System: interactions of changing climate and human activities

**F. Stuart Chapin, III, T. Scott Rupp, A. David McGuire**

purpose and approach

When spruce stands burn in the boreal forest, they usually go through an extended phase of deciduous vegetation before succeeding back to spruce forest. This deciduous phase acts as a negative feedback to regional warming. The new vegetation keeps things cooler because of differences in how deciduous plants absorb solar energy and transpire water. So, from purely a climate perspective more fire is good. Fire suppression will serve as a positive feedback, which could lead to increased warming.

Human-fire interactions are characterized by increasing fire suppression: fewer fires, less deciduous vegetation, and a probable positive feedback to regional warming.

The proposed research program will document how the changing role of fire, particularly as affected by human activities, affects the Arctic-Boreal Climate System and its human residents. To add an understanding of human effects on the fire regime, a regional analysis of past and present human-fire interactions is underway. The analysis of past and current patterns of human-fire interactions will stratify first by country (United States versus Canada) and then by predominant cultural influence (indigenous communities along rivers versus western communities along road systems). Regional patterns of variation associated with climate and vegetation will then be assessed.

progress

Modeling scenarios have been completed that examine how gold miners affected the fire regime. These are being used to develop a manuscript for submission in fall 2006.

Other scenarios have been assembled for the final year of this project, culminating in multiple manuscript submissions.

impact

Research effects will extend well beyond immediate results. This first consideration of the overall consequences of human activities on climate feedbacks at high latitudes, including both global warming and local land-cover change induced by changes in fire regime, will enable us to compare the magnitude of climate feedbacks between arctic and boreal regions and between trace-gas fluxes and water/energy exchange. If, as is hypothesized, enhancing boreal fire is the only large negative feedback to high-latitude warming, this research is the first step in determining whether fire manipulation is a plausible mechanism to reduce the magnitude of high-latitude warming.



### CARMA – Circum-Arctic Rangifer Monitoring and Assessment network

**Gary Kofinas, Greg Finstad**; Brad Griffith, Robert White, Perry Barboza, Kris Hundertmark, (UAF); Don Russell (Canadian Wildlife Service/Environment Canada) with other country partners

purpose

CARMA was established in November 2004 to monitor and assess the effects of global change on the Human-Rangifer System of the Circum-Arctic through geographic and interdisciplinary cooperation. The CARMA network formed in response to the Arctic Council's call to monitor arctic biodiversity in the face of dramatic global changes, and as part of a series of networks being implemented by the Biodiversity Working Group of Conservation of Arctic Flora and Fauna. CARMA is also a project of the International Arctic Science Committee and an initiative of the International Polar Year (IPY).

approach

CARMA involves 35 partners, representing all arctic countries (see www.rangifer.net/CARMA). Initial work of CARMA is focused on wild reindeer/caribou. During the IPY period, intensive monitoring will be undertaken by partners of CARMA. Monitoring and assessment are undertaken regionally and coordinated by leaders in each country. Monitoring and assessment are undertaken at three scales of analysis: community-based monitoring; field-base biological research; and remote sensing, including subsistence harvesting patterns, Normalized Difference Vegetative Index analysis of green-up as related to caribou reproductive success, caribou energetic budgets, and availability of caribou to hunters.

progress

We are implementing the program by developing common monitoring protocols, building a circum-arctic database and web-based reporting system, and completing a synthesis through retrospective analyses of select regional case studies.

impact

CARMA is identified as a lead initiative of the IPY, and has the potential to leave an important legacy in international research and cooperation. SNRAS and the Institute of Arctic Biology at UAF, with Environment Canada, have assumed the lead role in the program as network coordinators.

## fire-related studies

### Managing forests to market carbon credits: How does fire fit?

**Evan Kane, David Valentine**; Bruce Finney (Institute of Marine Science, UAF); **Tim Quintal**

purpose

It is not yet clear whether fire suppression may diminish or enhance carbon storage in boreal forest soils. A crucial first step in managing for increased carbon sequestration is to determine the lasting effect of variations in the fire cycle on soil carbon accumulation. We sought to assess the historic relationship between fire frequency and soil carbon storage at various sites in interior Alaska. For the purposes of sequestering carbon, fire suppression in boreal forests would only be indicated if more fires lead to less carbon storage.

approach

We are assessing this historical relationship through analysis of forest soil carbon contents in areas adjacent to lakes in which fire histories have already been determined through carbon-fourteen dating of charcoal found in sediment cores.

To determine the implications of fire as a source of carbon to slowly turned over pools, charcoal will be quantified in the surface mineral soil, which contains the products of past fires, at different landscape positions that exhibit high, medium, and low stand-productivity levels. This was done in an attempt to vary the historic frequencies of fire.

These sites consist of twelve black spruce stands along four replicate gradients in climate and stand production across interior Alaska. Organic matter fractions and charcoal pieces have been quantified along the gradients, and changes in their composition (element ratios like hydrogen to carbon and oxygen to carbon as well as isotopic ratios like $\delta^{13}C$, a measure of the relative amounts of two stable isotopes of carbon) have been used to shed light on the degree of black carbon incorporation into bulk soils and density separates.

progress

Stable isotope analyses have indicated that light fraction soil organic matter (SOM) from the A horizon (<1.6 g $cm^3$) has an isotopic signature influenced by char; therefore, it is enriched relative to denser SOM, despite being composed of organic matter that is less decomposed. Char material had an approximate $\delta^{13}C$ of -25.5, whereas light-fraction SOM had a mean $\delta^{13}C$ value around -26, and dense fraction SOM had a mean value around -26.5. This indicates that light fraction SOM may most closely reflect changes in soil char.

Since char material is significantly less hydrated and oxidized than other SOM fractions, these ratios may indicate the relative degree of char incorporation into discrete soil fractions. Warmer, more productive black spruce stands

contained light fraction SOM that was less hydrated and less oxidized than did cooler, low-productivity stands, which may indicate that warmer and more productive stands harbor more black carbon (mostly charcoal).

Preliminary results from cores obtained around three lakes in interior Alaska vary widely in their black carbon concentrations, from 7.5 ± 3.0 g kg-1 (Dune Lake) to 32.9 ± 2.1 g kg-1 (Deuce Lake). While the analysis of corresponding lake sediment charcoal records is not complete, initial data suggest that lake record charcoal does not track terrestrial accumulation of black carbon.

### impact

One of the few options available to manage black spruce forests of interior Alaska for carbon emissions trading is through some form of fire management. It is not yet known how charcoal accumulation varies with stand production or landscape position, and the net impact of fire on carbon stabilization via charcoal production is unknown. Preliminary data in this study suggest that increased fire frequency (as determined from long-term lake charcoal records) does not beget increased soil charcoal accumulation (as determined from the long-term accumulation of black carbon). When complete, this study will help provide justification for efforts to optimize wildfire frequency and severity to maximize carbon sequestration over the long term.

## Understanding fire severity patterns in Alaska's boreal forest

**T. Scott Rupp**

### purpose and approach

Record wildland fires in 2004 burned 6.7 million acres and cost over $120 million in direct suppression expenditures. Climate is changing rapidly in Alaska, and fire seasons like 2004 will likely become more common. In this regime of changing climate, we need better data to support fire management planning. Although fire managers cannot directly influence climate, they can initiate management strategies that aim to reduce the extent of severe burning. Efforts to predict ecosystem response to changing disturbance regimes in boreal forests are hampered by gaps in our knowledge of how stand age, stand structure, and environmental factors affect fire severity.

The specific objective of this study is to first identify whether or not a relationship between stand age (an easily measurable index) and fire severity exists, and second, to further our understanding of other potential controls over fire severity: biotic (e.g., forest structure) and abiotic (e.g., slope and aspect). Our research focuses on the black spruce forest type—the dominant cover type in interior Alaska and the most flammable.

### progress

We sampled burn severity at 392 plots from ten different fires distributed across interior Alaska in the summer of 2005. Across all ten burns, we found a statistically significant, negative relationship between stand age and the understory fire severity rating, but no model prediction power. The relationship between stand age and the overstory fire severity rating was not significant and showed no trend. None of the environmental covariates (slope, aspect, elevation) were statistically significant with either understory or overstory severity rating. However, burn timing (early-season versus late-season) was significant between two of the fires (the early-season Boundary fire and late-season Granite Tors fire). In both the early-season Boundary fire and the late-season Granite Tors fire, we found a strong relationship between pre-fire organic horizon depth and the understory burn severity score and between post-fire organic horizon depth and the understory Composite Burn Index burn severity score. Details of this research are described in a peer-reviewed journal article in preparation.



### impact

Our results suggest that burn severity is temporally and spatially complex and is not easily explained using simple post-fire observations. It also suggests that sites that burned severely in 2004 will be highly susceptible to more severe burning in future fires. This is an important result given that projections of future climate suggest more severe fire weather over the next century, a period less than or equal to documented fire frequencies (i.e., the time between successive fires) for many black spruce systems. These results have management implications because they imply that recently severely burned sites are more likely to burn severely again and climate projections suggest severe fire weather within a condensed period (in terms of black spruce life history), and so may result in profound changes to both the structure and function of the forest—as radical as switches to novel ecosystems.

## Development of a computer model for management of fuels, human-fire interactions, and wildland fires in the boreal forest of Alaska

**T. Scott Rupp, Daniel Mann, Paul Duffy, Tom Kurkowski;** Randi Jandt (BLM Alaska Fire Service); Larry Vanderlinden (USFWS); Layne Adams (USGS Alaska Biological Science Center); Bruce Dale (ADF&G)

### purpose and approach

Interior Alaska contains 140 million burnable acres and the largest national parks and wildlife refuges in the country. On average, wildland fires burn one million acres in interior Alaska each year and threaten the lives, property, and timber resources of Alaska's sparse but growing population. Although wildland fires threaten human values, they also are crucial for the maintenance of forest ecosystems. To better manage wildland fire in Alaska for the mutual benefit of humans and natural ecosystems, we undertook the development of tools for creating fire management plans. Under development is a computer model to assist land managers who design and implement fire-management plans in the boreal forest of interior Alaska. This model will integrate fuel buildup,

vegetation, climate, and fire-management policy with real geography over time scales of years, decades, and centuries.

progress

Model development was completed and used for various manuscripts. MS student Tom Kurkowski graduated in summer 2005 and PhD student Paul Duffy plans to complete his research and graduate in summer 2006. Duffy's first thesis chapter was published in *Ecological Applications* in 2005. Duffy has submitted his second thesis chapter to *International Journal of Fire Research* and plans to submit his final chapter to *Canadian Journal of Forest Research*. Kurkowski has also submitted a manuscript to *Canadian Journal of Forest Research*. A manuscript looking at the effects of changing fire regimes on caribou winter grazing habitat by Dr. Rupp was accepted to *Ecological Applications* and is scheduled to be published in October 2006.



impact

The model will produce mapped depictions of changes in wildland fuels, fire risk, and vegetation under multiple future scenarios of fire management, climate change, and human development. It will serve as an integrative and adaptive planning tool for land managers designing fire-management plans that can safeguard both human and natural values.

### Post-fire studies supporting computer-assisted management of fire and fuels during a regime of changing climate in the Alaska boreal forest

**T. Scott Rupp, Daniel Mann, Mark Olson**; Karen Murphy (USFWS)

purpose and approach

Land managers face unique challenges in Alaska. Most of the boreal forest is currently managed as wilderness. Though largely free of direct human impacts, the boreal forest grows in a region that is now experiencing significant climate changes. Also, the fire ecology of Alaska is relatively poorly understood, and these data gaps hinder effective fuel and fire management there. To meet these challenges, we have developed the computer model Boreal ALFRESCO for use as a multidisciplinary planning tool and as an operational tool for assessing fuels and fire hazards. Boreal ALFRESCO simulates the responses of boreal forest vegetation on real landscapes to changes in fire management, ignition frequency, and climate.

progress

Initial model development has focused on modeling fire severity patterns and the influence of climate on fire activity and fire severity.

impact

This project will provide land managers with the ability to simulate the response of future fire regimes to a changing climate. These model simulations also will provide potential natural vegetation groups and estimates of fire return intervals required for federally mandated Fire Regime Condition Classes (FRCC) mapping. These combined capabilities will enable Boreal ALFRESCO to simulate the impacts of climate change on FRCC—a novel ability that has important ramifications for long-term forest management.

### Classification and modeling for FRCC implementation in Alaska

**T. Scott Rupp**; Karen Murphy (USFWS)

purpose and approach

Determining accurate fire regime condition classes (FRCC) for Alaska is critical for identifying areas that may have experienced potentially dangerous regime shifts due to anthropogenic drivers, and for identifying areas where it is vital to prevent any shifts away from the natural regime. This is a difficult challenge due to our lack of understanding of vegetation transition rates and the large variation in fire regime (i.e., frequency, extent, and severity) across the Alaska landscape. Success in this venture requires a well-parameterized and tested Vegetation Dynamics Development Tool (VDDT) model for Alaska. We propose coupling a spatially explicit model of transient vegetation change (ALFRESCO) with VDDT to develop these required parameterizations. ALFRESCO also will produce simulated reference landscapes for testing and comparison with the VDDT model. Because ALFRESCO explicitly simulates climate, we also propose investigating potential changes in FRCC in response to directional climate forcings.

progress

Initial model parameterization has been completed along with cross-walk methodology to map potential natural vegetation types and seral stages from current remotely sensed vegetation classifications.

impact

This pilot study will provide important information required for the further development of VDDT calibrations and FRCC classification of Alaska. The federal land mangers in Alaska require and have expressed the need for this information. Incorporation of climate forcings holds great potential for application statewide, as well as application potential in the Intermountain West.

## forests

### Evapotranspiration from boreal forest landscapes

**John D. Fox, Jr.**

purpose

The project goal is to assess which of several methods for estimating potential evapotranspiration (PET) and actual evapotranspiration (AET) are most suitable for management purposes in the boreal regions of Alaska.

approach

1) Review methods used and values obtained for PET and AET reported for Alaska in the literature. 2) For simple

to complex PET methods, assess their sensitivity to net radiation estimation methods and the wind functions used. 3) Use water balance accounting models to estimate AET and sensitivity to data sources and assumptions. 4) Estimate open-water evaporation from a closed lake via short-term water balance measurements.

progress

1) Preliminary literature review reveals many methods used and values obtained for annual, seasonal, and daily PET and AET. These range from simple temperature-based methods to detailed field measurements associated with energy budget, Bowen Ratio, and eddy covariance approaches. Although Alaska's varied landscapes, weather, and locations (latitude/longitude) explain some of this variability, part of it appears due to data quality, the nature of assumptions, and some errors in applying techniques or in understanding the evapotranspiration process. Since relatively few PET or AET estimates have been published for Alaska, it is tempting for managers and scientists alike to use inappropriate or even erroneous published values for their specific needs. This can lead to a "chain of citations" in which one study, in the face of uncertainty, will patch a knowledge gap with a cited value from a previous study, which, in turn, has cited a previous study without being critical of the methods or data. Over time, the cited value becomes "truth."

2) Local functions describing the relationship between atmospheric transmissivity and solar altitude have been derived that explain a large percentage of the variance between measured and calculated values of clear-sky global irradiance. This will allow better locally calibrated estimates of net radiation that are needed for many methods of PET estimation.

3) Modifications have been made to a simple local water budget technique to capture the relative influence of topographic slope and aspect on temperature based estimates of PET.

4) Data collected on lake surface decline under the winter ice cover has revealed significant net groundwater outflow is occurring. This rate of outflow can now be subtracted from the gross rate of lake level decline during the summer, to get a field estimate of lake evaporation.

impact

Information gained to date has contributed directly to one PhD graduate student project and improved two others. The local water budget technique modifications will be directly useful in at least one undergraduate senior thesis. These modifications have been incorporated into an easy-to-use computer program (using Microsoft EXCEL) that should allow managers and researchers to obtain a broad view of variations in the local water budget. The discovery of major lake level decline under the winter ice cover is a major piece of the puzzle of how to model lake level fluctuations for a closed lake in interior Alaska and should help establish a "known value" of lake evaporation to which estimation methods can be compared.

## Effects of moisture limitations on forest ecosystem dynamics in interior Alaska: comparison of field studies and modeling results

**J. Yarie**

purpose

To better understand how climate change affects forest growth in interior Alaska, the importance of precipitation distribution is being studied on both upland and floodplain sites associated with the Bonanza Creek Long Term Ecological Research program.

approach

Seasonal covers that exclude rainfall from experimental plots were constructed in upland and floodplain mid-successional forest types in interior Alaska. The effect of limiting summer rainfall on tree growth is being monitored.

progress

Based on average yearly tree basal area growth over the past fifteen years, no effects of rainfall elimination were found in upland locations; however, tree growth was significantly reduced in floodplain locations.

impact

Study results differ according to upland or floodplain location. This improves our understanding of the effect of precipitation distribution on vegetative growth and our ability to predict the effects climate change on forest dynamics.

## Log decomposition in interior Alaska

**J. Yarie**

purpose

In natural forest ecosystems logs represent a significant carbon and organic matter input into the forest floor. This input affects the carbon, organic matter, and nutrient dynamics of forest soils. This study will document the decomposition dynamics of logs within interior Alaska.

approach

For observations of long-term decomposition, a series of logs are being positioned on the forest floor and will be resampled at intervals during the next 100 years. Fifteen four-meter logs are placed on the forest floor in six replicate stands for each major upland and floodplain vegetation type. Sampling of the logs that have been in place for ten years was started in 2004 and will be completed in 2007.

progress

Currently all time-zero, two-, and five-year samples have been collected. Chemical analysis is continuing on the collected samples. Additional sites that represent floodplain black spruce sites and burned white and black spruce sites in both upland and floodplain locations have been established.

impact

It is not clear what effect coarse woody debris has on the carbon dynamics of the taiga forest in interior Alaska. The results of this study will help clarify how log decomposition dynamics affect the carbon balance of interior Alaska forests.

## Relationship of tree growth to environmental and fertility factors for thirty-five years in interior Alaska

**J. Yarie, K. Van Cleve**

purpose

Starting in the 1960s, fertilization and thinning studies were developed in birch, aspen, and white spruce forest types representing young, middle-, and old-age classes in interior Alaska. Both climatic and tree growth monitoring has continued through 2006. These measurements represent a long-term record of tree growth and climate data for an age sequence of forest stands.



approach

The fertilization and thinning studies are monitored annually to create a long-term data set related to tree growth and the effects of fertilization and thinning on a number of age classes of the common forest types found in interior Alaska.

progress

Five manuscripts are in the final stages of preparation. These papers will detail the thirty-five-year results of eight separate studies and include the fifteen-year results of the Bonanza Creek Long Term Ecological Research sites. The major finding of the eight long-terms studies was that moisture deficits are a primary control of tree growth in interior Alaska, except for permafrost-dominated black spruce stands.

impact

The completion of the five manuscripts will yield a significant long-term perspective on forest growth dynamics within interior Alaska. This prespective indicates that climate-related changes in annual and seasonal precipitation dynamics will substantially affect tree growth and forest ecosystem dynamics in interior Alaska.

## East-to-west changes in Alaska treeline growth

**Martin Wilmking, Glenn Juday**

purpose

Recent studies have identified drought stress (along with cold temperatures) as an important limiting factor for tree growth at treelines. Three growth responses to warming are now known to occur in Alaska treeline trees: increased growth, decreased growth, and no significant correlation with temperature. This study examined the relationship between change in white spruce tree ring growth and temperature along an east-to-west gradient spanning the entire Brooks Range.

approach/method

Tree ring measurements were compared to mean monthly temperatures of long-term climate stations. High-density forest, low-density forest, and floodplain forest were sampled.

progress/result

Tree cores from 687 trees were collected at seven treeline sites. All samples included some trees with each of the three responses. In the eastern Brooks Range, trees responding with reduced growth to recent warming are predominant. In the western Brooks Range trees responding with increased growth to recent warming are the most abundant. Within a given site, trees reacting positively to warming generally grow on site types characterized by low tree density.

impact/implications

These patterns coincide with precipitation decreases from east to west and local water availability gradients, pointing to drought stress as the likely controlling factor for the distribution of growth responder types to warming. Further warming would likely increase drought stress at treeline, possibly preventing a generally assumed treeline advance into tundra.

## Threshold changes in circumpolar treeline growth

**Martin Wilmking, Rosanne D'Arrigo, Glenn Juday**

purpose

Tree rings of trees at the cold limits of tree growth have been used around the world to reconstruct past climates based on the way in which current climate predicts the growth of these trees. But recent findings of drought stress in Alaska treeline trees raises the questions of whether a low-growth year in a treeline tree is always a predictor of cold, as assumed until now, or whether hot years may limit growth at some level, both now and in the past, and carbon storage in the future may be less than currently estimated.

approach/method

Tree-ring measurements from the International Tree Ring Data Bank and the authors' collections were assembled for eight sites located at the edge of the boreal forest and tundra around the circumpolar north. Instead of assuming that all tree responses to warming were the same at each site, we used cluster analysis to test growth trends during recent warming.

progress/result

Large groups of trees of the different dominant tree species within widely-distributed circumpolar forest sites show opposing growth trends (increasing and decreasing growth) during recent warming. These opposing growth trends are present within what was assumed to be a single mean response typical of the site that was used to reconstruct past climates and estimate carbon uptake. The opposite responses are only present above certain temperature thresholds.

impact/implications

Recent warming has exceeded the temperature threshold at which some treeline trees grow a bigger ring with greater warmth. Averaging the ring widths of trees increasing and decreasing in growth in response to recent warming appears to have contributed to a widely reported decrease in the ability of all northern tree rings to accurately reconstruct climate. Actually, by using our approach of clustering and averaging only the same responder types, more accurate reconstructions than ever can be developed. Past temperature reconstructions should be re-examined and estimations of global warming impacts and carbon uptake projections should be re-evaluated.

# invasive species and revegetation

## Natural regeneration of white spruce

**Glenn Juday**

purpose

This is a long-term study of white spruce that have regenerated naturally following the 1983 Rosie Creek Fire. Data from 2005 growing season are the seventeenth year of measurement in the study and the twenty-third growing season since the fire. In boreal Alaska, this is the longest and most detailed look at the exact amount of tree regeneration and what conditions are associated with successful natural tree regeneration and early growth.

approach

All seedling white spruce in a 100 m by 100 m plot in the Bonanza Creek Experimental Forest LTER, Reserve West were mapped and measured at the end of the 2005 growing season.

progress/result

Mean height growth of 1983 seed crop seedlings in 2005 (17.8 cm) was the lowest since 1999. Unprecedented hot, dry weather in 2004 and 2005 was clearly associated with termination of white spruce height growth early in the season, resulting in reduced total height growth. By contrast, broadleaf trees and shrubs sustain height growth longer or restart growth in the same season after dry periods, putting white spruce at a severe competitive disadvantage with broadleaves during hot, dry summers. For the 1983, 1987, and 1990 seed crops, the number of spruce seedlings taller than 100 cm (fully established within grass, herb, and low shrub competition) amounted to 87 percent, 45 percent, and 11 percent of all stems, respectively; mean total height was 239 cm, 102 cm, and 53 cm, respectively. Only about 12 percent of mapped seedlings have died between the time of their discovery and the end of 2005.

impact/implications

Data from this study are calibrating models and calculations of how much growth to expect in regenerating trees on typical managed forest sites in central Alaska. At the end of 2005 only the 1983 and about half of the 1987 seed crop seedlings were tall enough and free of competition to have real potential to become new canopy-dominant trees on the site. Projections of future white spruce growth depend critically on the number and severity of hot, dry years. The low level of seedling mortality during the study is surprising, and suggests that managers may have opportunities to eventually enhance the spruce dominance of stands over time, even if initial goals are not met.

## Revegetation of a gravel-extraction operation

**Norman Harris, Beth Hall, Dot Helm**

purpose

While many studies have dealt with revegetation of mining operations, little work has been done on revegetation of gravel-extraction operations in southcentral Alaska. This study addresses that lack of information.

approach

Time series aerial photography using our blimp platform and ground-based plot frame photography are being used to study revegetation of a gravel-extraction site on the Matanuska Experiment Farm. The photography will be used to document and quantify progress in the establishment of vegetation and bare-ground cover.

progress

Aerial photos were obtained prior to revegetation, July and October 2004, to document the impact of gravel extraction on the landscape. Aerial photography was obtained monthly from May through October to track the progress of revegetation efforts. Plot frame photos were also obtained monthly. Time series analysis is currently being conducted on the imagery.

impact

This study will help land managers to develop effective revegetation strategies and cost-effective methods to monitor the progress of remediation efforts.



# policy and planning

## Foreign policy implications of arctic warming

**Glenn Juday**

purpose

The Arctic has been a region with a high degree of international cooperation and traditional arrangements across national borders, with a few specific foreign policy and security issues generally related to the Cold War. Because of climate warming and other changes interacting with climate warming, arctic nations are being forced to reevaluate traditional policies.

approach/method

A Washington, DC workshop was conducted with subject matter specialists and representatives of the US and other arctic nations on the implications of climate warming as it has occurred or will occur simultaneously with various types of social, demographic, economic and other change underway or likely in the arctic region. Focus was on the implications for US foreign policy, but with consideration of major issues for other arctic nations.

progress/result

Participation took place under Chatham House Rules (no individual attribution of statements to specific governmental representatives to foster free exchange and examine possibilities when no official policy has been formulated). Proceedings were published as a US Geological Survey Open File Report.

impact/implications

Recommendations for future action and policy development were highlighted in the areas of science, foreign policy (relations between states), and national security. Increased

access and transportation options are likely to force action on issues of boundary delineation, marine transport, ownership of resources, and enforcement of sovereignty. Changing conditions of forest and wildlife resources is affecting the ability to obtain access to them, harvest them, or produce them. Agriculture in the Arctic is now less limited by climate and more under economic and policy controls.

### Global Environment Outlook (GEO) – Polar Regions scenario

**Glenn Juday**

purpose

The United Nations Environmental Programme sponsors the production of the Global Environment Outlook (GEO) every two years. GEO is the result of a workshop process with input from subject matter specialists, government officials and planners, and technical specialists in modeling. The polar regions are one of the seven analysis and reporting regions for GEO.

approach/method

The GEO process is based on developing scenarios of distinct, but internally consistent, policy choices and feeding the results back into likely trends of environmental developments, opportunities, reactions, and constraints. Scenarios are developed by regional teams and supported by analysis models.

progress/result

The 2006 GEO process was launched with a workshop in Bangkok, Thailand. The polar regions scenario development team was formed and developed four draft scenarios. The team also developed a section for inclusion in the GEO 2006 Yearbook, a report of major environmental events on a yearly basis.

impact/implications

Evidence of accelerating climate change continues to accumulate in both the north and south polar regions. Other regions of the globe either are currently being affected or are likely to be affected by polar changes in access to energy and mineral resources, global carbon balance, world sea level, animal migrations, and weather patterns. International cooperation mechanisms are more active in the polar regions than elsewhere on earth, but under the scenarios of change, this polar cooperation is likely to either be strengthened and formalized, or increasingly replaced by national sovereignty and international competition.

## wildlife studies

### Caribou genetics and management

**M.A. Cronin**; M.D. MacNeil (USDA), J.C. Patton (Texas A&M University); S. Haskell, W.B. Ballard (Texas Tech University); L.E. Noel, M. Butcher (Entrix Inc.); W. Streever (BP Exploration Alaska, Inc.)

purpose

This project assesses caribou (Rangifer tarandus) demography, including interactions among herds, and effects related to oil field development. Understanding ultimate and proximate causes of animal behavior can help wildlife managers develop and employ effective mitigation measures without overregulation when potential adverse impacts from human disturbance are of concern.

approach

To assess herd interactions, genetic variation will be determined. Field work, including observations of caribou distribution and behavior in and around northern Alaska oil fields, has been done to assess potential effects.

progress

During 2005–2006 several manuscripts on different aspects of our study progressed: two are submitted and in review, one is in press, and one was published.

Elevated oil field pipelines may alter caribou movements. Using time-lapse videography, we quantified caribou crossing of the Badami pipeline and habitat use at three river crossings. The results indicate that pipelines elevated >1.5 m above the tundra did not cause changes in caribou habitat use or block movements to and from coastal insect relief habitats (paper in review by *Canadian Field Naturalist*).

Previous research led to the a priori hypotheses that calving caribou in north Alaska oilfields habituated to human activities: 1) across years, or 2) within years. We used several variables to test for these hypotheses. The snowmelt index explained most of the variation in calf percentage among years. Among *a priori* hypotheses, we found no evidence for habituation across years or a response to local caribou density by itself. We did find evidence for habituation within years during the calving period that was dependent on the timing of spring snowmelt. *Post hoc* models were more compelling and indicated not only habituation during calving, but also a tolerance response exhibited by caribou when snow melted progressively later; caribou would prefer not to be near roads when they first arrived in the oilfields in spring, but persistent snow cover limiting forage availability away from roads may compel them to move near roads to feed in the dust shadow. We believe that the behavioral adaptability of calving caribou exhibited in existing oilfields is contingent on a no-hunt policy (paper in review by *Rangifer*).

We conducted road-based surveys of caribou in oilfields on Alaska's Arctic Coastal Plain during the late-calving and post-calving periods of June 2000–2002. We recorded location, composition, and behavior of caribou groups located <1 km from active gravel roads and production pads. Caribou groups with calves were on average distributed farther from oilfield infrastructure than were groups without calves, but habituation to oilfield activities, indicated by decreased distributional avoidance, occurred at similar rates for groups with and without calves. During the calving period, sighting rates were greater in areas of low human activity, and calf percentages tended to be greater at night when oilfield activity was reduced. Caribou groups were on average closer

to infrastructure during the post-calving periods than during the calving periods of 2000 and 2001, but not 2002. In 2002, when snow melted early, caribou groups were closer to infrastructure during the calving period than in 2000 and 2001 when snow melted later. This emphasizes the importance of examining environmental variables when investigating the dynamic interactions of caribou and oilfields.

impact

On Alaska's North Slope, understanding caribou demography is an integral part of the multiple-use management of oil and gas and wildlife. Overall, caribou appeared to habituate to active oilfield infrastructure after the calving period in 2000, during the late-calving period in 2001, and likely prior to our sampling period in 2002. The timing of annual rehabituation was positively correlated with timing of spring snowmelt (paper published in *Arctic*). Land and wildlife managers can use this study to develop more effective and flexible calving-period-specific mitigation measures for industry.

### Grizzly bear genetics

**M.A. Cronin**; R. Shideler (Alaska Department of Fish and Game); J.C. Patton (Texas A&M University); S.C. Amstrup (U.S. Geological Survey)

purpose

This project assesses grizzly bear demography in the area of the Alaska North Slope oil fields.

approach

Molecular genetics technology is used to quantify the family relationships of bears, numbers of bears contributing to breeding, and comparison of bears at Prudhoe Bay with bears in adjacent areas.

progress

The lab work and data analysis were completed during 2004. A manuscript was submitted to the journal *Ursus* in 2004, and subsequently published in 2005. Assessment of grizzly bear demographics and genetics is continuing with analysis of additional genetic markers, including function genes (k-casein and major histocompatibililty complex).

impact

The project provides a good review of the factors influencing the demography of grizzly bears in Prudhoe Bay oil field areas: immigration and emigration, mortality, recruitment, reproductive rates, and access to anthropogenic food.

### Polar bear genetics

**M.A. Cronin**; S.A. Amstrup (U.S. Geological Survey); K. Scribner (Michigan State University)

purpose

This project aims to improve understanding of polar bear demographics.

approach

Molecular genetics is used to assess the level of differentiation of bears in the Beaufort Sea and Chukchi Sea in northern Alaska.

progress

Existing lab data was analyzed in 2004, incorporated into a manuscript that was submitted in 2005, and published in 2006 in the *Canadian Journal of Zoology*. We are continuing assessment of polar bear genetics with analysis of family level relationships and parentage and genetic variation at nuclear gene loci related to fitness (k-casein and major histocompatibility complex).

impact

This study shows that bears in the two study areas are not genetically differentiated, which may reflect immigration, emigration, or both, information that is of importance to wildlife management.



## Natural Resources Use and Allocation

### Environmental ethics and natural resources management

**John D. Fox, Jr.**

purpose

My intent is to explore and better understand the connections between human use and management of the earth's resources and ethics. Of particular interest is trying to reconcile the reality of human beings as part of nature, the different theories of the foundations of human ethics, the various domains of environmental ethics, and the concepts of the "is-ought" dichotomy and the "naturalistic fallacy."

approach

This is largely a project involving reading past and current theories and arguments for the basis of ethics and environmental ethics. Included are works reflecting perspectives of evolutionary psychology, sociology, anthropology, biology, and philosophy.

progress

Humans' moral sense appears to be an evolved, generalized capacity, analogous to the capacity for language. It is a universal part of human nature but manifested in a wide variety of specific rules and operational norms. Development of this moral sense in the individual is influenced early by the presence or absence of care and affection in childhood , and throughout life by social context and culture.

While many equate Hume's notion of the "is-ought" dichotomy with Moore's concept of the "naturalistic fallacy," I find these two ideas to be distinct.

The only convincing argument I have found for an environmental ethic that is not anthroprocentric is a theocentric one.

impact

I have shared the evidence and arguments with colleagues and students while encouraging dialogue and thought. I have made a presentation at the Fifth Biennial Conference on University Education in Natural Resources in 2004 at Flagstaff, Arizona. My findings perhaps provide a counterpoint to contemporary movements for animal and ecosystem rights and

environmental protection rationales that are ill-founded and destined to crumble under the attack of logic and consistency. Ultimately, the wise use and sustainable management of the earth will require an ethical foundation that will hold up to the scrutiny of both science and philosophy.

# fisheries

## Alaska snow crab markets

**Joshua Greenberg, Mark Herrmann**

### purpose

Alaska snow crab fisheries have been plagued in recent years by declining harvests and soft prices. Diminished revenues have raised considerable concern over the sustained economic health of this historically important fishery. This project's purpose is to help industry participants better understand the linkages between price formation dockside and in international markets, and to document the pre-crab rationalization performance of the Alaska industry on the eve of the historic implementation of both harvester and processor quotas.



### approach

An econometric model of the international Alaska snow crab markets was developed that represents the allocation of snow crab from the two primary producers, Alaska and Canada, to the principal markets in Japan and the United States. It also links price formation at the wholesale level to the dockside (exvessel) level in both producing nations. The model was estimated using Three Stage least squares.

### progress

The project was completed in 2005. Model simulations were conducted to examine the responsiveness of prices and revenues to different scales of the Alaska snow crab fishery. The inspection of scale effects was extended to the Canadian snow crab fishery, where through simulations we examine how its growth to prominence has affected Alaska snow crab prices and revenue.

### impact

The simulation results portray an international snow crab market that is driven by Canadian production. Huge Canadian snow crab landings have substantially hurt Alaska crab prices. Given current market conditions, any biologically supported increase in Alaska snow crab harvests will raise industry revenues.

## Converting Alaska fish byproducts into value-added ingredients and products

Peter Bechtel, Cinthia Bower, Ted Wu (Agricultural Research Service)

*Note: This project has several components, all involving the utilization of fish processing byproducts.*

### purpose

The total Alaska harvest in 2003 of pollock, cod, and salmon was estimated at 2.1 million metric tons and the fishing industry annually produces over one million metric tons of byproduct and waste. Although this material has potential value as a protein and natural products source, much of it is not utilized. This project seeks to characterize the various fish processing byproducts and existing secondary products and to develop new and higher-valued ingredients for use in animal (agriculture and aquatic) feeds. Greater utilization of this material will also reduce waste disposal problems.

### approach and progress

**Salmon livers and other viscera**

In Alaska, salmon livers and other viscera are not utilized in the production of human food and are often discarded. ARS scientists in Fairbanks, in collaboration with researchers at the University of Alaska Fairbanks (UAF), the Hagerman Fish Culture Experiment Station in Idaho, and the Oceanic Institute in Hawaii have developed industrial-scale methods for processing these livers and have chemically characterized the resulting meals. The high cholesterol concentrations will be helpful in dietary formulations for shrimp and possibly as a feed ingredient for younger fish. There has been significant interest from European feed manufacturers in these meals.

**Milt and viscera meals from pollock and pink salmon**

This research seeks to enhance the performance of soy-based diets by adding meals made from selected fish byproduct components. ARS scientists in Fairbanks in collaboration with researchers at UAF, the Hagerman Fish Culture Experiment Station, and the Oceanic Institute found that pollock viscera and salmon milt meal contain biologically active components that stimulate growth of salmonids fed soybean meal-based diets. The study was a trout feeding trial in which meals made from different byproducts, including salmon gonad and pollock viscera, were used with a soy protein diet. This demonstrates the validity of our project goal of developing high-value feed additives from seafood processing waste, although further work to refine and characterize the products is needed.

**Alaska pollock and salmon oils in shrimp diets**

The results of an eight-week feeding trial indicated that Alaska pollock and salmon oils can replace menhaden oil in diets for shrimp. Scientists from UAF, the Oceanic Institute, and ARS scientists in Alaska collaborated to provide pollock and salmon oils that were used to replace menhaden oil for in a shrimp growth diets. After the feeding trial, shrimp fed diets containing the pollock and salmon oils had excellent growth, feed efficiency, and survival. This finding will be useful to feed manufacturers who are looking for high quality replacements for standard sources of fish oil for aquaculture feeds.

**Salmon biodiesel is comparable to vegetable biodiesel**

In Alaska there is potential for increasing the recovery of fish oil from underutilized salmon byproducts. Studies by ARS scientists in Albany, California, and Fairbanks indicate that Alaska salmon oil can be converted to biodiesel. Biodiesel from salmon oil was characterized and found to have comparable

properties to biodiesel derived from vegetable oils, such as soybean and corn. Results suggest that waste salmon oil could be a viable source for biodiesel production.

**Stability of long chain n-3 polyunsaturated fatty acids**

The demand for salmon oil is increasing as the health benefits of n-3 long-chain polyunsaturated fatty acids (PUFA) gain recognition. ARS scientists in Alaska preserved salmon by five different processing methods and then evaluated the PUFA content of the products. High n-3 PUFA values were found in smoked or pressure-cooked samples, while salting, freezing, or acidifying significantly decreased n-3 PUFA levels. Salmon heads contained over 300 percent more total fatty acids than fillets, losing only 15 percent when heat-processed. Results of this study provide direction for handling and storage of underutilized fish by-products in order to retain the maximum levels of high-value n-3 long-chain polyunsaturated fatty acids.

**Fish-skin gelatin with antimicrobial enhancements**

Collagen-rich fish skins can be used to produce food-grade gelatin films and gels. ARS scientists in Albany, California, and Fairbanks incorporated lysozyme, a food-safe antimicrobial protein, into fish-skin gelatin films and gels then evaluated them for antimicrobial properties and other useful characteristics. Both films and gels retained their lysozyme activity. Fish-skin gelatin, when formulated with lysozyme, may provide a unique, functional barrier to increase the shelf life of food products.

**Films from fish skin gelatins**

Currently in Alaska fish skins are either used to make fish meal or discarded. Studies by ARS scientists in Albany, California, and Fairbanks evaluated the unique permeability and tensile properties of films made from cold-water fish-skin gelatins. Studies focused on using dehydration to stabilize fish skins, developing gelatin extraction methods, and determining the oxygen permeability of cold-water fish-skin gelatin films. There are potential food applications for gelatin films from cold-water marine fish.

**Changes in proteolytic-enzyme levels in spawning salmon**

Hydrolysates result from the decomposition of chemical compounds by reaction with water, such as the dissociation of a dissolved salt or the catalytic conversion of starch to glucose. Hydrolysate production can be a low-cost method for preserving high-quality fish by-products discarded by Alaska's fishing industry. However, endogenous proteolytic enzymes must be controlled in the raw material to ensure a consistent hydrolysate product. To evaluate changes that occurred as salmon moved from salt water to their freshwater spawning grounds, ARS scientists in Alaska compared the proteolytic activities among pink salmon harvested at three different stages of spawning maturity. This variation has implications for reduced-heat processing of hydrolysates when different maturity levels of pink salmon are used.

**Salmon hydrolysates**

A Cooperative Research and Development Agreement was initiated with a company to research and develop new and improved processing technologies that add value to fish protein hydrolysates made from Alaska byproducts. ARS scientists in Albany, California, and Fairbanks sought to improve salmon hydrolysate production by changing the acidification agent and using drum drying to stabilize hydrolysates. Results showed that drum drying is feasible and characterized the dried hydrolysates. These studies indicate value can be added to fish protein hydrolysates made from Alaska byproducts.



**Attractant properties of hydrolysates from Alaska by-product for shrimp**

Scientists from the Oceanic Institute, UAF, and ARS in Alaska collaborated on shrimp feeding studies. They found that protein hydrolysate meals made from byproducts of the Alaska fishing industry exhibited positive attractant properties in diets for shrimp. A series of diets containing the prepared protein hydrolysate ingredients were produced for the shrimp trial. The voluntary consumption rates of the shrimp of all hydrolysates except one were significantly higher than the control. For most of the hydrolysates, the consumption rate was similar to that of menhaden fishmeal used in shrimp feeds. This finding is useful to feed manufacturers who are looking for alternatives to traditional sources of fishmeal.

## Resilience theory and Alaska salmon

**Joshua Greenberg, Martin Robards**

### purpose

Alaska commercial salmon fisheries have recently suffered severe economic setbacks. There has been much effort toward developing strategies that will renew these fisheries that are so important to Alaska and its coastal communities. In this study, resilience theory is applied to the case of the Bristol Bay salmon fisheries in an assessment of various policy alternatives.

### approach

The study employs a theoretically grounded systems approach. Empirical data for the Alaska Bristol Bay salmon fishery is used with a heuristic model to demonstrate feedbacks between global preferences toward salmon and the resilience of wild salmon fisheries.

### progress

The project was completed in 2006. Among the strategies reviewed are access restrictions, development of wild niche markets, economic subsidies, and infrastructure development and harvest allocations.

### impact

Alaska salmon fisheries are at a threshold where current reorganization strategies will determine their future role in Alaska and its rural communities. However, future policy decisions might be driven by the evolution of new underlying social or cultural values focusing on local management and governance toward rural livelihoods. Solutions that foster a

balance between social vitality and economic efficiency might be attainable.

## forests and trees

### Physical and chemical properties of Alaska herb, shrub, tree components

**Valerie Barber**

purpose

We seek to develop information relative to green moisture content, drying schedules, and chemical properties of selected herb, shrub, and plant components used by Erika Merklin of SuperNatural Teas. This project was designed to use her dehumidifying kiln to do research that would benefit her and other nontimber forest product businesses. The economics of this business will also be explored.

approach

At least five (and as many as twenty) different plants or plant parts used for making teas will be targeted in this study. Green and dry weights, moisture content, and antioxidant capacities will be determined on each of these. Using the dehumidifying kiln, which was designed for drying wood, drying schedules for the plant materials will be determined.

The economics will also be explored by determining harvesting times (manhours), electrical costs for drying, handling costs, etc.

progress

An undergraduate at UAF and two harvesters were hired for summer 2005. The student wrote a senior thesis on the project titled "Preliminary Investigation into the Use of a Dehumidifying Kiln for Drying Wild Herbal Teas in Southeast Alaska." The student's first task was to get the dehumidifying kiln operating and functional, which required much modification of the original kiln design and the drying racks. About twenty different plant parts were collected, wet and dry weights determined, and preliminary drying schedules established. A collection of dried plant parts will be sent to Brunswick Laboratories for analysis of antioxidant capacities and phenolics, and duplicates will be sent to Fairbanks, where total antioxidant capacities will be determined. We will also send some samples to the United States Department of Agriculture Laboratory in Albany, California.

impact

Certain nontimber forest products have a $72 million annual unmet market demand in Alaska. We hope to use this study as a demonstration project for economics and marketing of a small nontimber forest products business in Alaska.

### Yarn swift market study and test marketing

**Terry Lavallee, Kristie Sherrod** (**Valerie Barber**, Program Manager)

purpose

This was a project to conduct a market study and test market an umbrella swift. The umbrella swift is a premium-priced value-added forest product, used to hold a skein of yarn. This project will provide a model to demonstrate test marketing that can be used by manufacturers interested in creating premium-priced value-added forest products.

approach

Bluster Bay Woodworking is a manufacturer of specialty forest products in Sitka. The proprietors advertised in several craft magazines and attended a couple of trade shows. They designed a product brochure that was distributed as a result of magazine advertisements and ended up selling swifts to one in seven people who requested a brochure.

progress

The project is complete and the final report has been written.

impact

The report can serve as a model for marketing other high-quality, premium-priced products intended for specialty markets. A publication will result from this study and the marketing approach used here will be included in marketing workshops scheduled for 2007. A ready supply of birch is now available from some of the smaller mills. Gross sales of the swift continue to be high.

### Alaska yellow cedar New Crop Opportunities

**Scott Sink, Colin Beier, Glenn Juday**

purpose

Alaska yellow cedar is Alaska's most valuable timber species, and occurs in the coastal rainforest of southeast Alaska, with minor amounts in southcentral Alaska. A yellow cedar decline has resulted in some level of dead trees on over 500 thousand acres. The cause of yellow cedar decline was not known at the time of this study, but a biological agent (insects or disease) has been ruled out as a cause.

approach

This project is a background study to help forest managers decide the risk of yellow cedar decline, especially whether long-term tree vigor as affected by climate could predict risk. Yearly ring widths were compared to seasonal and annual temperature and precipitation data for four climate stations within the sampled area to identify significant climate predictor variables. Ring-width measurements were completed for 359 live yellow-cedar trees cored at eighteen sites, mostly located below 200 m in elevation and within three kilometers of a road on islands with extensive logging road networks. Climate data were compiled, and correlation analysis completed.

progress

Climate indices that were created explained 25 percent of growth variability in five distinct yellow cedar populations, and the consistency of the climate factors used across four weather stations suggests a real relationship between growth and climate. Best growth came with high monthly temperatures in August, the previous January, and the previous December, and low levels of May and December precipitation.

impact/implications

This was the first region-wide tree-ring and climate study of any species conducted in southeast Alaska. Overall climate trends during the time of cedar decline were favorable for growth, not unfavorable. The overall ring-width pattern of sampled trees revealed some specific periods of tree death followed by acceleration in the growth of survivors. A study of the possible climate factors that cause tree death at specific periods is underway. An explanation of cedar decline will allow managers to develop forest management strategies: identifying where the species can be grown and sustained as a crop and determining the levels of risk.

## Development of new design standards for Alaska species (Alaska cedar, Alaska hemlock, Sitka spruce, and white spruce)

**Kevin Curtis**, Ketchikan Wood Technology Center (**Valerie Barber**, Program Manager)

purpose

The project evaluated and compared selected physical and mechanical properties of Alaska grown species to develop new design standards.

approach

Following American Society for Testing and Materials standards, we conducted in-grade testing and evaluation of full-size dimension lumber of Alaska wood species at the Ketchikan Wood Technology Center.

progress

Project funds have been expended and project deliverables have been accomplished. The Board of Review for the American Lumber Standards Committee, which oversees all softwood lumber standards in the United States, has created three new species designations with associated design strengths for National Grading Rule lumber. The new species designations are: Alaska Hemlock, including both mountain and western hemlocks grown within the state of Alaska; Alaska Yellow Cedar, which includes ONLY yellow cedar grown within the state of Alaska; and Alaska Spruce, including both Sitka and white spruces grown within the state of Alaska. Work during this period consisted primarily of preparations of manuscripts for publication of the data obtained during the testing program. "Alaska Yellow Cedar Strength Data" from the in-grade testing program will be the first of the publications, with the remainder of the manuscripts for hemlock and spruce to be finished by December of 2006.

impact

It is anticipated that the extraction of the Alaska species from the mixed species designations in which they had previously been included will have a significant positive effect on market prices for these species. All three species designations resulted in increases to the previous design allowables under which the Alaska species had been graded. This will also provide a positive boost to Alaska-produced dimension lumber.

## Western hemlock and yellow cedar small clear testing projects

**Kevin Bannister** (KWTC) (**Valerie Barber**, Program Manager)

purpose

Small clear testing of lumber is necessary to evaluate the physical and mechanical properties of small clear specimens. Due to the great variety of species, variability of the material, continually changing conditions of supply, factors affecting test results and ease of comparing variables, this need will always exist. This project will establish mapping between test results obtained from in-grade and small clear testing to reduce the cost of periodically re-assessing the strength of the National Grading Rule (NGR) resource as it changes due to changes in the harvesting operations of most mills.

approach

A relatively unique opportunity presented itself during the in-grade testing of the Alaskan hemlock and yellow cedar resources. In-grade, or full-size, testing required that 16-foot-long 2x4, 2x6 and 2x8 boards be tested to destruction in order to establish new structural design allowables for the Alaska-produced NGR lumber. It was decided to order twenty-foot lumber from the mills so that a four-foot, end-matched piece of each board tested in the in-grade program could be saved for subsequent small clear testing. Small clear testing is preferable over the more intensive in-grade testing because the harvest required is a smaller number of very much smaller samples to establish design allowables, and the testing apparatus for small clear testing is readily available in most structural testing laboratories, while the testing apparatus for in-grade testing exists only in a few dedicated testing facilities. This makes small clear testing much less expensive than in-grade testing.

progress

Most testing has been completed on the samples in hand. Additional hemlock and yellow cedar logs will be purchased and the remainder of the testing completed in 2006. Data analysis has been initiated on the material tested to date to look for a relationship between the modulus of rupture (MOR) and ultimate tensile stress (UTS) values obtained from testing the end-matched full-size boards during the in-grade testing and the corresponding MOR and UTS values from the small clear testing program initiated here. Final analysis of data will attempt to define a relationship between the testing techniques and will continue until anticipated project end in September 2006.

impact

If it becomes possible to predict, or supplement and reduce, the number of in-grade tests required in future through less expensive small clear testing, then a significant amount of money might be saved during periodic strength reassessments. If small clear testing can be correlated with in-grade testing, much time and money will be saved.

## Phase II: Wood/plastic composite project

Luftii Raad (**Valerie Barber**, Program Manager)

### purpose

We are studying the potential of using Alaska wood for wood composite construction.

### approach

Wood/plastic composite material boards were made from spruce flour and plastic milk jugs. These were used to construct six raised garden beds in Fairbanks, Sitka, and on the Kenai Peninsula in October 2003. These were pulled out in fall 2005 for testing to see how they held up in different Alaska climate regions. Both the control and field-tested boards will be tested using American Society for Testing and Materials Standards D 1037, D 4761-02a and D 790-037, standard test methods for evaluating properties of wood-based fiber and particle panel materials, for testing mechanical properties of lumber and wood-based structural material, and for flexural properties for unreinforced and reinforced plastics, respectively.



### progress

Wood composite boards were collected from dismantled raised beds (2003 construction) at the Georgeson Botanical Garden, University of Alaska Fairbanks, and the Kenai Peninsula site. Both used and control boards where taken to Superior Hardwoods in Fairbanks, Alaska, to be cut into testing samples. The experimental setup for testing of the wood-composite samples under axial loading and bending has been completed. Static four-point bending, tensile strength parallel to surface, and compression strength parallel to surface tests were conducted on the control and used samples from the botanical garden. Test data were evaluated and documented. The design of a compatible test jig for the shear strength in the plane of the board test was finalized and the assembly process was started. The rough draft of a final report was partially completed. Additional samples of both control and botanical garden boards are required for the static four point bending test and the tensile strength parallel to surface test. When the used boards from Sitka are received this winter, they will be taken to Superior Hardwoods to be cut into test samples and then tested. When the test jig for the shear strength in the plane of the board test assembly is completed, all samples (control, botanical garden, Kenai, and Sitka boards) must be tested and evaluated. After all the necessary testing is completed and evaluated, a final report will be issued.

### impact

Wood/plastic composites could provide a way to use lower-value wood residuals in Alaska to make value-added products. A future project will determine the current Alaska market for such composites.

## Managing small diameter forest stands in interior Alaska: an analysis of the fiber supply generated through multiple natural resource objectives

**T. Scott Rupp**; Tom Paragi (Alaska Dept. of Fish & Game)

### purpose and approach

In recent years, federal agencies in Alaska have been assisting communities with thinning treatments that remove ladder fuels and increase spacing of trees by hand to reduce potential for fire spread near developments. The State of Alaska has been experimenting with vegetative response and cost efficacy of mechanical treatments since the late 1990s to enhance wildlife habitat where prescribed fire is difficult to achieve for social reasons. The larger scale of fuel reduction possible with shearblading could have a major effect on the visual landscape near communities. Thus, municipal and tribal governments have a desire to understand how fuel breaks may influence fire risk, how frequently breaks must be maintained, and how they influence habitat for wildlife, such as moose browse production. Although markets for small diameter wood do not currently exist in interior Alaska, chip fuel has economic potential in cogeneration of municipal heat and power and as a means to offset costs of fuel treatments. We propose to modify an existing spatially-explicit model of forest stand dynamics (ALFRESCO) for predicting changes in forest stand type and age class from silvicultural treatments in the greater Fairbanks area.

### progress

We have undertaken field sampling to define state-transition functions for the revised model. In summer 2005 we also estimated density of late-seral features (snags, cavity trees, and spruce rust brooms) in several stand types to understand potential loss of nesting and denning habitat for songbirds and smaller mammals.

### impact

The model would serve as a vehicle to assess the potential fiber supply for industry at different output scales, including social acceptability of transportation networks and how the viewshed of forest development would appear. Model outputs would provide some of the economic, ecological, and social data of interest to capital investors for three scales of fiber supply (small, moderate, large) over a given period.

## Medium-density fiberboard plant feasibility project

Len Gus Associates, Allen Brackley (**Valerie Barber**, Program Manager)

### purpose

We sought to determine the feasibility of building a medium-density fiberboard (MDF) plant in southcentral Alaska.

### approach

Len Gus Associates of Washington state was selected to lead the study, which involved touring relevant facilities

in China and Japan and then using an economic model developed by Allen Brackley and others, along with current data on costs.

progress

The project has been completed. Gus toured sixteen facilities in China and met with furniture manufacturers, flooring manufacturers, importers of MDF, MDF manufacturers, furniture designers, and materials specifiers, trade magazine editors, trade associations, and government officials in industrial zones. The enormous Chinese furniture industry is still growing. Sales worldwide in 2004 were $8.047 billion, up 33.83 percent in one year. China also imports furniture, amounting to $633 million in 2004, up 36 percent over 2003. The Chinese and Japanese are very concerned over the new US tariffs and quotas, but did express interest in high-grade MDF from Alaska. The required power demand of the proposed plant will probably exceed the amount available from local utilities, and the plant design will need to incorporate on-site power generation. However, if a sufficient amount of power is available from utilities, a combination of purchased and on-site generated power would result in the need for less power capacity and reduced capital cost for the on-site equipment.

impact

Building a medium-density fiberboard plant in southcentral Alaska could stimulate the economy; there could be a ready market in Alaska as well as in Asia.

## Hemlock and red alder drying with a dehumidifying kiln

**Kevin Curtis** (**Valerie Barber**, Program Manager)

purpose

For red alder and western hemlock lumber, use a dehumidifying (DH) kiln at the Ketchikan Wood Technology Center (KWTC) to develop drying schedules for all four seasons and determine preliminary grade yields. Note: this grant proposal was neither written nor submitted by KWTC, which assumed the work and project control in December of 2004 when Dr. Allen Brackley departed from the University of Alaska. This report concentrates only on work performed since KWTC assumed project control.

approach

The first task was to get the DH kiln functioning properly. Drying schedules will be determined in each of the four seasons by filling the kiln with one type of wood at a time and replicating three times. To better calculate "cost per million board feet dried," the DH kiln was electrically isolated from the rest of the center.

progress

The DH kiln from Sitka is finally operative after approximately 500 man hours of work and almost $10,000 in replacement equipment (new kiln motors and fan assemblies, track system for kiln in-feed and outload operations, DH compressor and compressor circulating fan, etc.). Work included gutting inoperable, broken and/or improper equipment; replacing all five circulating motors and fan assemblies; building and installing a new heat exchanger for hot water; DH startup operations (installing and troubleshooting a Delmhorst KilMoTrol remote kiln monitoring system to allow accurate, real-time moisture content determinations and kiln process modifications); installing radius-bend circulating air transitions to increase air flow and minimize wall surface roughness due to spray-on foam; and installing a new compressor and compressor circulating fan, etc.). The winter replicates have been completed. Using the newly instrumented kiln, three runs were completed where outdoor temperature and relative humidity were measured along with the corresponding moisture content in the wood in the dry kiln chamber. This will eventually provide some correlation between exterior weather conditions and the rate of DH drying in southeast Alaska. As of this writing, the projected schedule for obtaining the necessary replicates is as follows: winter (done); spring (April 15); summer (June 30); and fall (September 30). We have instrumented the kiln so we can monitor the moisture gradient within each instrumented board. It initially appears that another advantage of the DH drying is that the gradient is much less with DH than conventional drying. This would explain why the degrade we have seen in a relatively large number of loads, including both second-growth hemlock and Sitka spruce, is coming more from our low-pressure steam kiln than from the DH kiln. The final project report is not done yet due to circumstances outlined in last year's progress report.



impact

DH drying is working well: drying lumber at a rate equal to or slightly faster than our low-pressure steam kiln and with a very low downfall rate due to drying-induced defect. It now appears that the final conclusion will be that DH produces less degrade than traditional high-temperature drying, but is 1) too expensive for most lumber except high-end products such as wood for musical instruments, and 2) will not be able to be Heat Treat certified without external heat sources that will make it even more expensive.

## The New Markets study

Allen Brackley, **Joe Roos, Valerie Barber**

purpose

This study was designed to solicit responses from consumers at trade shows on reaction to using wood from Alaska and more specifically from old-growth trees in the Tongass National Forest, and to introduce Alaska producers of wood products to trade shows.

approach

More than 200 consumers were polled at three trade shows in Anaheim, California, and Las Vegas, Nevada. The Association of Woodworking & Furnishings Suppliers (AWFS) met in Las Vegas in July 2005, the largest woodworking trade event in North America. Final surveys were conducted there. Producers of Alaska lumber and wood products were also invited to attend the show. Although funding was available for ten, only six attended. They each brought products to

display, distributed brochures and information, and generated contacts at a booth funded through this project.

progress

Results from the three surveys show that consumers are very interested in Alaska wood products. The project is complete. A paper in preparation on the results will be presented at a Forest Products Society meeting by Allen Brackley.

impact

All Alaska producers who attended the AWFS trade show were extremely pleased with it and said that although timing was bad (held in the middle of the summer), it was worth attending and they would attend more shows if given the opportunity. Many of them generated sales from the contacts they made.



### International marketing lumber project

**Valerie Barber, Joe Roos**

purpose

We sought to assess the Japanese perspective on Alaska wood products.

approach

More than 120 surveys were completed by people attending the Japan Home and Building Show in Tokyo in November 2004.

progress

Data from surveys collected have been compiled and graphed. Unlike United States consumers, the Japanese understand the environmental friendliness of wood as compared to steel, concrete, plastic, and brick and mortar. At least 95 percent considered themselves environmentalists. Over 66 percent of those polled said they would like to purchase lumber and other forest products from Alaska, and 77 percent said they used wood for construction (39 percent post and beam and 38 percent 2 x 4 construction). Structural integrity was the most important attribute to prospective home builders/buyers, followed by earthquake resistance. Nontoxic materials and environmentally friendly materials were also very important to them.

impact

The attitudes reported by the Japanese in the surveys should begin to open doors to marketing value-added forest products to Japan. A trip is planned to China in October 2006 and another to Japan in November 2006. We will conduct more surveys at trade shows in both countries and continue exploring new markets.

## policy and planning

### When laws affecting the environment conflict: focus on public lands

**Julie Lurman**

purpose

This study examines the potential for direct conflict between the state's Intensive Management statute and the enabling legislation for certain federal land management agencies.

approach

I am identifying situations in which laws or policies with conflicting purposes or methodologies are in place. I will analyze that legal conflict in order to understand how it manifested and what its practical consequences are, and perhaps recommend changes.

progress

An analysis of the applicable statutes and case law, as well as the current methods of implementation of the statutes in question, is underway in preparation for an eventual manuscript.

impact

This analysis may keep federal land managers from running afoul of the law and risking expensive and time-consuming legal challenges. It should provide federal land managers with a clearer understanding of their duties and responsibilities and provide state managers with a better understanding of the laws that constrain their federal counterparts.

### Geyser decline and extinction in New Zealand—energy development impacts and implications for environmental management

**Kenneth A. Barrick**

purpose

The project was undertaken to describe the environmental management of geysers and hot springs in New Zealand, including the management implications of the extinction of over 100 geysers from various energy development projects.

approach

Library and field research in New Zealand was used to describe the history of hydrothermal management in New Zealand.

progress/results

Analysis suggested that the increasing recreation, economic, and scientific importance of geyser basins makes it imperative that the world's remaining geysers be permanently protected. The extinction of more than 100 geysers in New Zealand is convincing evidence that strong regulations are required at the outset to prevent the consumptive use of geothermal water or heat near geyser basins. A manuscript was prepared and submitted for publication to *Environmental Management*.

impact

The lessons learned in New Zealand regarding the potential effects on hydrothermal features from nearby energy development can be used to enhance the protection of the remaining geysers in New Zealand, and at other geyser basins around the world, including Yellowstone National Park in the United States.

## Lake level changes at Harding Lake

**John D. Fox, Jr.**

### purpose

Harding Lake is an important recreational lake in interior Alaska that has experienced periods of declining lake levels due to the divergence of a major feeder stream. This study focuses on reconstructing historic lake levels and lake level changes, measuring current levels, and developing a model that might be useful in developing operational rules for a control structure on the divergent stream.

### approach

Historic lake levels are being explored through aerial photography and imagery and ground photographs of the lake and lakeshore, and by finding original survey meander corners. A recording lake level gauge and rain gauges have been installed to better understand the within-season and between-season lake dynamics. An interactive model has been created that captures the general dynamics of the lake water balance.

### progress

Many historic photographs have been collected, including both ground and aerial images. These have allowed a qualitative or relative record of lake levels to be reconstructed, leading to the tentative conclusion that Harding Lake began to decline in the late 1960s or early 1970s. Exploring the north shore of the lake, its ice-shove ridges, and elevation gradients has yielded evidence that, contrary to conventional wisdom, there has been surface water outflow from Harding Lake in the past. Two summers of detailed lake level monitoring (continuous recording at fifteen-minute intervals throughout the summer) have documented progressive lake decline and rendered insight into water input sources and net rates of water loss. Water level measurements taken this past winter under the ice cover documented a significant net groundwater seepage component to overall lake level declines. A simulation of historic lake levels using historic climate data indicated that the lake level should have risen in the mid 1980s even without diverting Roggee Creek back into the lake. It also indicated that the lake would respond more rapidly than previously expected to rechanneling Roggee Creek into the lake.

### impact

Information that I have collected has been shared with members of management agencies and the Harding Lake Watershed Council. This information is being used by the Alaska Department of Fish & Game, the Natural Resources Conservation Service, and the Salcha-Delta Soil and Water Conservation District in designing and planning for a control structure on the divergent stream. Two senior theses were produced this past year, one documenting evidence of the past and potential future outflow threshold on the north side of Harding lake, and the other implementing the Harding Lake model with historic data. These studies have already proven useful to managers who are planning to construct a diversion control structure on Roggee Creek during the winter/spring of 2006–2007.

# recreation and subsistence use

## Alaska residents statistics program

**Peter J. Fix, Quinn Tracy**

### purpose

This study will assess travel and recreation patterns of Alaska residents, barriers to participation in outdoor recreation, desired recreation development (or lack thereof), and attitudes and values regarding natural resource management. This study is in cooperation with several federal and state agencies (US Dept. of the Interior Bureau of Land Management, National Park Service, and Fish & Wildlife Service; US Dept. of Agriculture Forest Service; Alaska Dept. of Transportation, State Parks, Fish & Game). The resulting information will be incorporated into their planning processes.

### approach

Information will be gathered using a mail survey. The state will be stratified into five regions and samples drawn from each region.

### progress

During 2005 we pretested and finalized the survey instrument and submitted the survey to the Office of Management and Budget for approval.

### impact

The study will assist participating agencies with their natural resource planning, result in a common dataset to be shared among the agencies, and provide baseline information to monitor trends.

## Assessing generalizability of study results at Wrangell St. Elias National Park

**Steve C. Taylor, Peter J. Fix**

### purpose

This project followed up on the 2004 visitor preferences for interpretation at Wrangell St. Elias National Park (WRST) study to assess consistency in results from 2004 to 2005. The goal of the study was to assess generalizability of study results in the short term.

### approach

Study methods from 2004 were replicated in 2005. Overall consistency in visitor groupings emerging from the cluster analysis in 2004 and 2005 was first confirmed. Relationships among visitor groups and other key defining variables were examined in the context of generalizability analysis.

### progress

The study was completed in fall 2005.

### impact

Information from the study provided WRST managers with information that the visitors appear to remain relatively stable in the short term and visitor preferences found in 2004 were also present in 2005. The results also have implication for researchers using cluster analysis; including interpretation of cluster analysis results, the modification of existing scales as input in cluster analysis, and use of reliability analysis.



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