School of Natural Resources & Agricultural Sciences

Agricultural & Forestry Experiment Station

# Annual Report 2006

*Controlled environment: a greenhouse with tomato trellises at Chena Hot Springs (see page 20).*
—PHOTO BY MERIAM KARLSSON

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UAF UNIVERSITY OF ALASKA FAIRBANKS



# Contents:



# Letter from the dean:

August 31, 2007

The Honorable Sarah Palin
Governor of Alaska
P.O. Box 110001
Juneau, Alaska 99811-0001

Dear Madam:

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, 2006. 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

*Fireweed is being investigated as a forage crop (p. 24) and has potential in the Alaska herbal products industry.*
—PHOTO COURTESY ALASKA SUPERNATURAL TEAS



## 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.

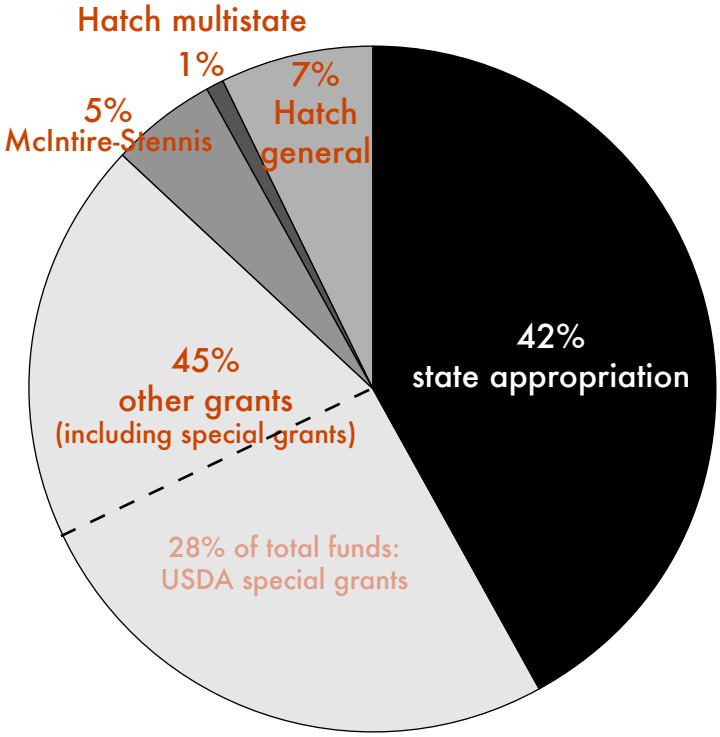
Experiment station scientists publish research in scientific journals, conference proceedings, books, and in experiment station bulletins, circulars, newsletters, research progress reports, and miscellaneous publications. Scientists also disseminate their findings through conferences, public presentations,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

# Financial statement

## Expenditures: July 2006 through June 2007

The following statement of expenditures of federal and state funds for the fiscal year beginning July 1, 2006 and ending June 30, 2007 (FY 07) is not an accounting document.




**State Appropriation/Program Receipts**
$4,430,016 (42%)

**Other Grants and Contracts**
$4,776,860 (45%) (includes $2,991,196 in special grants from USDA)

**McIntire-Stennis Formula Funds**
(federal) $534,174 (5%)

**Hatch Multistate Formula Funds**
(federal) $152,509 (1%)

**Hatch General Formula Funds**
(federal) $747,192 (7%)

## Total Funds: $10,640,751

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# Grants

## GRANTS AND CONTRACTS / SPECIAL FUNDS

| | | |
|---|---|---|
| Forest Wood Products Program V, VI, VII | Barber | USDA/CSREES |
| LTER V and 2007, Alaska's Changing Boreal Forest | Chapin | National Science Foundation |
| BP Liberty SEIS | Cronin | British Petroleum |
| Year 3 Higher Education - Reindeer Curriculum | Finstad | USDA/CSREES |
| Food Products Development | Finstad | USDA/CSREES |
| Seasonal Habitat & Diet Composition | Finstad | Bureau of Indian Affairs |
| NRCS Cooperative Agreement | Finstad | National Resource Conservation Service |
| CESU, BLM | Fix | Bureau of Land Management |
| CESU - NPS | Fix | National Park Service |
| Alaska Resident Statistics Project | Fix | Bureau of Land Management |
| Alaska Residents Statistic Program | Fix | National Park Service |
| Alaska Residents Statistics Program Analysis | Fix | Forest Service |
| FS, CESU Startup | Fix | Forest Service |
| Visitor Satisfaction Survey & Alaska Recreation Travel Study | Fix | Bureau of Land Management |
| MMS, CESU Startup | Fix | Minerals Management Service |
| Fish & Wildlife CESU Startup | Fix | Fish and Wildlife Service |
| NRCS, CESU Startup | Fix | National Resource Conservation Service |
| NOAA Alaska Data Collection Project | Geier | OAK Management Inc |
| Regional Economic Data | Geier | NOAA |
| Near-Earth Remote Sensing | Harris / Wurtz | USDA Forest Svc |
| Education Technology Project | Heiser, Sfraga | UA Foundation |
| Predicting Ecosystem Trajectories | Hollingsworth | Joint Fire Science, IAB |
| GBG Children's Garden | Holloway | UA Foundation |
| Food Products | Holloway | USDA/CSREES |
| Drew Amphitheater Foundation | Holloway | UA Foundation |
| GBG Foundation | Holloway | UA Foundation |
| Dorothy Biestine Memorial Garden | Holloway | UA Foundation |
| Alaska Berry Research II | Karlsson | USDA/CSREES |
| Greenhouse Crop Production I and II | Karlsson | USDA/CSREES |
| FFA Foundation | Karlsson | UA Foundation |
| IGERT (IAB) | Kofinas | National Science Foundation |
| Oil/Gas Development Impacts | Kofinas | Minerals Management Service |
| On-Farm Variety Trials | Leiner | Seed Alliance |
| UA Integrated Geography Program | Lewis | UA Foundation |
| Ethnobotany I and II | Lewis | USDA/CSREES |
| New Crops V, VI, and VII | Lewis | USDA/CSREES |
| AK Seed Grower's Asst. III | Lewis | USDA/CSREES |
| Alaskan Berries I and II | Lewis | USDA/CSREES |
| DNA Task Order | Lewis | Agricultural Research Service |
| ARS Support Task Order | Lewis | Agricultural Research Service |

| | | |
|---|---|---|
| ARS Utilities Task Order | Lewis | Agricultural Research Service |
| ARS Telephone Task Order | Lewis | Agricultural Research Service |
| Dean Discretionary Account | Lewis | UA Foundation |
| Development of Virus-Free Potato | McBeath | Agricultural Research Service |
| Lab Testing for Import/Export FY07 | McBeath | Division of Natural Resources |
| Biocomplexity Associated with Biochemical Cycles | Ping | National Science Foundation |
| Flux and Transformation of Carbon | Ping | National Science Foundation |
| Joint Fire Science Project | Rupp | Fish and Wildlife Service |
| Impacts of Climate Change | Rupp | National Science Foundation |
| Effects of Fuels Reduction Treatments | Rupp | Bureau of Land Management |
| Scenarios Network for Alaska Planning, SNAP FY08 | Rupp | BP/Conoco Foundation |
| Field Course in Natural Resource Management - CESU | S Sparrow/Pierson | National Park Service |
| Geospatial Science Learning & Applications in Rural Alaska | Stephens | National Science Foundation |
| Barnett Lecture | Sfraga | UA Foundation |
| Alaska Geographic Alliance Education Network | Sfraga | Alaska Geographic |
| Collaborative Work on Virus Free Potato I, II, and III | Smeenk | Agricultural Research Service |
| Remotely Monitor Ice and Surface Water Dynamics | Verbyla | National Park Service |
| Monitoring Seasons through Global Learning Communities | Verbyla | National Science Foundation |
| White Sweetclover | Wurtz (Spellman) | Montana State University |
| Evaluating Alaska Whitefish By-Products | Zhang | Agricultural Research Service |



## FORMULA FUNDING

### Hatch Multistate

| | | |
|---|---|---|
| Integrating Components for Greenhouse, NE1017, ALK# 07-10 | Karlsson | USDA/CSREES |
| Regional Administration, W-106 ALK #99-05 | Lewis | USDA/CSREES |
| Economic, Social, & Eco Issues, W 1192, ALK# 07-07 | Lurman | USDA/CSREES |
| Livestock Production, W 1112, ALK #06-06 | Shipka | USDA/CSREES |
| Characterizing Soil Organic Matter, NC 1032, ALK #07-08 | 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 |
| Controlled Environment Horticulture for AK, ALK #07-06 | Karlsson | USDA/CSREES |
| Production Practices, ALK #01-09 | Leiner / Smeenk | USDA/CSREES |
| Laws Affecting Environment, ALK #05-01 | Lurman | USDA/CSREES |
| Potato Phytoplasms ALK #07-13 | McBeath | 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 |
| Livestock Production, ALK# 06-06, W-1112 | Shipka | USDA/CSREES |
| Potential Forage Crops, ALK #02-01 | Sparrow | USDA/CSREES |
| Enviromental Decisions, ALK #02-07 | Todd | USDA/CSREES |

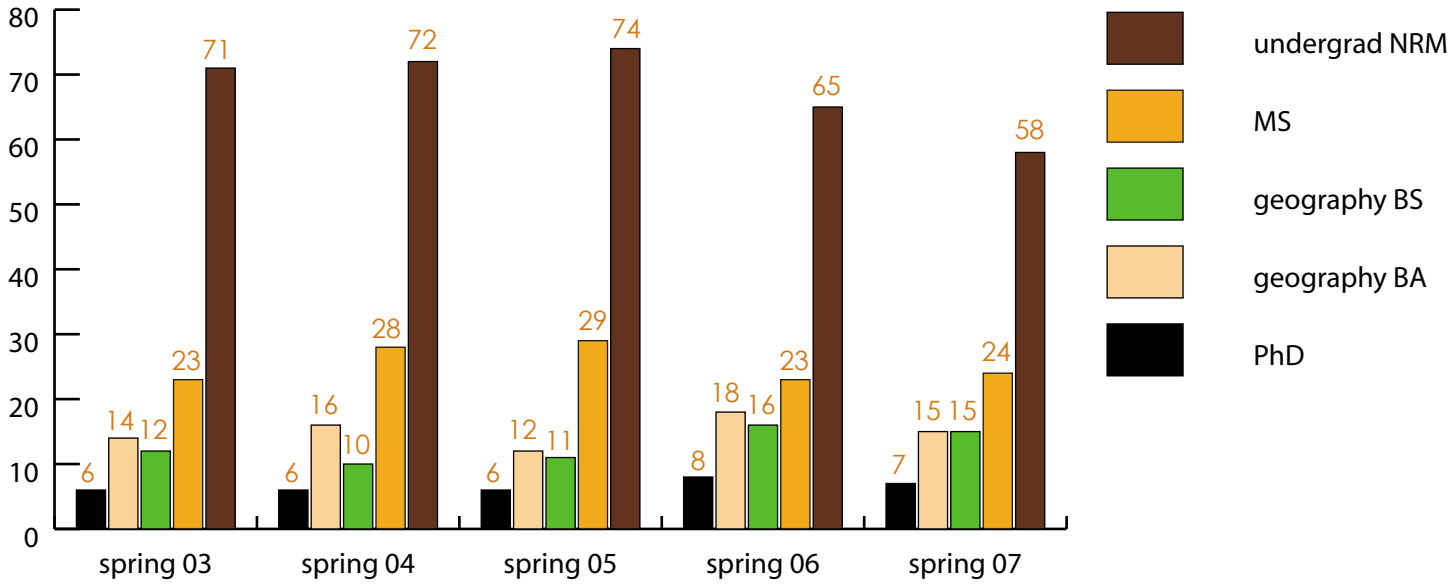
Continued on the next page

| | | |
|---|---|---|
| Yield & Quality of Barley, ALK #04-03 | Zhang | USDA/CSREES |
| Variety Testing, ALK #02-06 | Zhang/Sparrow | USDA/CSREES |
| **McIntire-Stennis** | | |
| Forest Ecology, ALK #01-08 | Juday | USDA/CSREES |
| Boreal Forest, ALK #05-04 | Fox | USDA/CSREES |
| Sensitivity of Carbon, ALK #07-11 | Valentine | USDA/CSREES |
| Remote Sensing to Investigate Fire, ALK #05-03 | Verbyla | 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

## five-year statistics: number of students enrolled, 2003-2007




## Graduates as of May 2007

### Baccalaureate degrees

**Richard J. Ackerman,** BA, Geography

**Zachary Larion Baer,**** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Benjamin D. Christian,**** BA, Geography

**Janelle Curtis,**** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Darcy Denton Davies,** *cum laude,* BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Theodore DeLaca,**** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Andrea Raye Devers**, BA, Geography; Russian Studies. BS, Geography: Environmental Studies. *Student Leadership Honors*

**Faye-Lynn S. Gallant,**** BA, Geography

**Kimberly Sue Garner,**** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

## Baccalaureate degrees, continued:

**Kindra Roza Geis,** BA, Geography

**Jacquelyn Denise Goss,** *cum laude,* BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Nate Green,**** BA, Geography

**Holly Lehr Jones,** BA, Geography

**Allison Clayton Kadarauch,**** BS, Geography: Environmental Studies

**Jerri Ann Layman,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Mary Marple,** BS, Geography: Environmental Studies

**John Allen Martin, Jr.,**** BA, Geography

**Jason J. Mercer,** *cum laude,* BS, Natural Resources Management: Forestry. *Student Leadership Honors. Golden Key Honor Society*

**Elizabeth Diana Nakanishi**, BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Kawa Ng,*** BS, Natural Resources Management: Resources

**David Daniel Panait,**** BA, Geography

**Katie M. Schollenberg,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Emily Elice Sousa,** BS, Geography: Environmental Studies

**Alex Strawn,**** BS, Natural Resources Management: Plant, Animal and Soil Sciences

**Christopher Swisher,*** *cum laude,* BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Dragos Augustin Vas,** *magna cum laude,* BA, Geography. *Phi Kappa Phi Honor Society*

**Andrew Thaddeus Weaver,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

**Ozie West, Jr.,**** BA, Geography

**Alden Richard Wilbur**, BS, Natural Resources Management: Resources

**Erik Ryan Wood,** BS, Natural Resources Management: Plant, Animal, and Soil Sciences

## Master's Degrees

**Jean M. Doherty-Guzzetti,** MS, Natural Resources Management
*BS, Rowan University (New Jersey), 2002*

**Charlotte Lee Lussier,** MS, Natural Resources Management
*BS, University of Alaska Anchorage, 2003*

**Heidi B. Rader,**** MS, Natural Resources Management
*BA, University of Colorado, 2004*

## Doctoral Degrees

**Paul Arthur Duffy,*** PhD, Forest Science: Interdisciplinary Program
*MA, University of Montana, Missoula, 1998*
*BA, University of Colorado, Boulder, 1995*

Thesis: Interactions Among Climate, Fire, and Vegetation in the Alaskan Boreal Forest
*Abstract: To assess the impact of climate change on the Alaska boreal forest, interactions among climate, fire, and vegetation were quantified. This work shows that climatic signals exert the dominant influence on the area burned. These results inform a simulation model to assess the historical and future states of the Alaska boreal forest.*

Major Professor: Dr. Scott Rupp

**Evan Scott Kane,*** PhD, Forest Ecology: Interdisciplinary Program
*MS, Michigan Technology University, 2001*
*BS, Michigan Technology University, 1999*

Thesis: Mechanisms of Soil Carbon Stabilization in Black Spruce Forests of Interior Alaska: Soil Temperature, Soil Water, and Wildfire
*Abstract: This thesis addresses: 1) How stand production and temperature affect soil carbon stabilization, 2) the quantity and composition of water soluble organic carbon across gradients in productivity and climate, and 3) physiographic controls on wildfire and the legacy of wildfire in stable soil carbon formation (black carbon accumulation).*

Major Professor: Dr. David Valentine

*Summer degree recipient

**December degree recipient

## Summary

31 undergraduate degrees conferred
- BA, Geography: 11
- BS, Geography: 4
- BS, Natural Resources Management: 16
  - Forestry: 1
  - Plant, Animal, and Soil Sciences: 13
  - Resources: 2

5 graduate degrees conferred
- MS in Natural Resources Management: 3
- PhD, Interdisciplinary Program
  - Forest Ecology: 1
  - Forest Science: 1



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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.



## Partners

### Agricultural Research Service

*The Subarctic Agricultural Research Unit of the US 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.*

### Boreal Ecosystem Cooperative Research Unit (BECRU)

*This unit 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.*

## Programs

### Bonanza Creek Long-Term Ecological Research (LTER) program

*This research program is located in the boreal forests of interior Alaska. Ecological research is conducted at two main facilities, Bonanza Creek Experimental Forest and Caribou-Poker Creeks Research Watershed. The LTER program is supported and hosted by the University of Alaska Fairbanks and the USDA Forest Service, Pacific Northwest Research Station in Fairbanks, Alaska. Major funding is provided by the National Science Foundation. The LTER program focuses on improving our understanding of the long-term consequences of changing climate and disturbance regimes in the Alaska boreal forest by documenting the major controls over forest dynamics, biogeochemistry, and disturbance and their interactions in the face of a changing climate.*

### Global Learning and Observations to Benefit the Environment (GLOBE) program

*GLOBE is a worldwide hands-on, primary and secondary school-based science and education program. It promotes and supports students, teachers, and scientists to collaborate on inquiry-based investigations of the environment and the dynamics of the Earth system, working in close partnership with NASA and National Science Foundation Earth System Science Projects. The Alaska GLOBE franchise was established in 1996 through the Center for Global Change and Arctic Systems Research at the University of Alaska Fairbanks.*

### Reindeer Research Program

*The Reindeer Research Program is dedicated to the development and promotion of the reindeer industry on the Seward Peninsula and throughout Alaska. Researchers work closely with producers to develop and conduct research projects that can be applied directly to their operations. Outreach is a significant part of the program, which has strong ties to communities and schools across Alaska. Research includes meat science, animal health, range management and nutrition, use of satellite telemetry in herding, and many other production and management issues unique to the far north.*

### Resilience and Adaptation Program (RAP)

*This program integrates several disciplines to address the question of sustainability, emphasizing ecology, economics, and culture: three critical factors for understanding interactions between people and their biotic environment in a regional system. It is part of a national effort to produce new models for graduate learning, the Integrative Graduate Education and Research Traineeship (IGERT) program of the National Science Foundation. RAP trains scholars, policy makers, and managers to address regional sustainbility issues in an integrated fashion.*

### Scenarios Network for Alaska Planning (SNAP)

*SNAP is a collaborative network of University of Alaska personnel and stakeholders from state, federal, and local agencies, industry and business partners, and nongovernmental organizations. The SNAP team, consisting of people with expertise in computer programming, database management, GIS and remote sensing, statistical analysis, and public communications, provides direct support to researchers and collaborators to create scenarios of future conditions in Alaska for more effective planning.*

### UAF Sitka Forest Products Program

*The long-term objective of the Forest Products Program is to help Alaska become competitive in the value-added forest products industry by providing specific technical, business, and marketing assistance. Proposals for new markets and new value-added products must take into account such economic factors as high costs of labor and transportation. Program research can potentially increase the volume of wood and nontimber forest products produced and marketed from Alaska's forests.*

## Research Sites

### Delta Junction Field Research Site

*This 300-acre site near Delta Junction provides space for research on tillage practices, soil fertility, cereal grains, oilseed crops, forage crops, insects and weed management, and forestry.*

### Fairbanks Experiment Farm

*The farm was established in 1906 and operations began in 1907. It includes 260 acres of cropland and 50 acres of forest land for research and demonstration projects. The farm houses a red barn, a 65-foot high grain handling facility, a small stationary sawmill used to cut rough lumber for farm structures, feed mill, maintenance shop, combination greenhouse and agronomy lab, a controlled environment agriculture lab, a visitors' center with a small gift shop, two residences, and several storage facilities. Researchers conduct experiments on soil fertility, nutrient cycling, grains, grasses, and other agronomic crops, and new crops such as canola, camelina, and sunflowers.*

### Georgeson Botanical Garden

*This nationally recognized botanical garden is part of the Fairbanks Experiment Farm, and is a member of a national network of educational and research institutions dedicated to plant culture and conservation. The GBG is one of five botanical gardens in the nation to be a satellite*

*test garden for the International Hardy Fern Foundation. Its staff test more than 1,000 trees, shrubs, and herbaceous perennials for hardiness each year, including Alaska native plants and those collected from trips to China, Russia, and Iceland. The garden serves as a location for variety trials of annual flowers, vegetables, herbs, and fruits, and researchers there conduct experiments on new horticultural crops for Alaska's conditions, such as peony.*

### Matanuska Experiment Farm

*This farm provides a site in southcentral Alaska for research in sustainable agriculture, land reclamation, and other environmental issues. It includes 260 acres of cultivated land and 800 acres of forest land for research or demonstration purposes, including barns, feed storage facilities, and pasture land. The experiment farm has a complete complement of farm equipment to produce and harvest grain, forage (both hay and silage), and other crops. There are also field and laboratory facilities for research on soils, plants, and livestock, and an adjacent greenhouse facility, operated by the Alaska Department of Natural Resources. This facility includes a modern headhouse and physical plant capable of supporting six greenhouse units. The Palmer Research and Extension Center is located on the Matanuska Experiment Farm.*

# Report Subject Index



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

# Geographic Information

## cultural geography

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

**Susan Todd**

#### purpose

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 determine if such community mapping efforts empower citizens to take a more active role in decisions that affect their community and their environment.

#### approach

Proponents of community mapping believe it can build public awareness of the environment and strengthen local support for more sustainable policies. I developed and administered an online survey of project leaders of an international community mapping effort—Green Mapping—to see if there is empirical evidence to support these assertions.

#### progress

Twenty of 245 project leaders responded. To increase the response rate, the survey is being administered using telephone and Skype interviews. Projects in Stockholm, Zurich, Dublin, San Francisco, Chicago, and smaller communities in Indonesia, Colombia, the Netherlands, and Wales have responded thus far. Results to date indicate that most project participants are now more likely to be involved in local decision-making processes, and they developed new skills in data collection and analysis, communication, and community organizing. Half the leaders believe the project created a focal point for discussing sustainability issues and increased communication between diverse community groups. Most felt that the projects increased community awareness of cultural resources, local history, and environmental assets and problems. Only 20% of respondents felt the projects had actually changed local policies, but others felt it might be too early to tell.

#### impact

Preliminary results indicate that these projects can increase public awareness of local environmental assets and risks. They also increase the level of involvement of the participants in local decision-making processes. Communities interested in increasing public awareness of the local environmental assets and problems may find this an excellent means of doing so.

### 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.



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### 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 for teachers and students in rural Alaska that is directly applicable to understanding the local geographic context and that relates modern science and information technology to traditional knowledge.

### approach

MapTEACH is a four-year informal science education project to develop a place-based educational program for middle and high school students in Alaska. It emphasizes hands-on experience with geology and spatial technology in conjunction with traditional activities. It draws upon the combined expertise of teachers, education researchers, remote sensing specialists, geoscience professionals, Native elders, and others with traditions-based knowledge. This project involves three collaborating institutions with differentiated roles: the University of Wisconsin-Madison's Environmental Remote Sensing Center (ERSC) (GsIT infrastructure, web-serving, and interface), Alaska Division of Geological & Geophysical Surveys (ADGGS) (imagery, GIS, and geoscience expertise), and the University of Alaska Fairbanks (curriculum development and evaluation).

### progress (UAF portion only)

The MapTEACH Curriculum has been piloted in four different sessions during the 2006-2007 year. Three pilots were held with eighth-grade students at the Effie Kokrine Charter School in Fairbanks and one was held with high school earth science students at the Nenana Living Center, in Nenana. Evaluation of pre- and post-surveys of knowledge and abilities shows that students gained confidence in all areas evaluated, including IT, local knowledge, and geoscience. No students had any prior experience using GIS. All students could make maps with GIS at the end of the pilots, a significant and highly applicable skill for many future career endeavors.

### impact

Web-based curriculum and data resources hosted by ADGGS and ERSC is accessible after the end of National Science Foundation support. A blueprint for region-specific educational modules was produced and can be adapted for use elsewhere in Alaska. Also, a cadre of students now have rudimentary proficiencies in geospatial technology and who can connect these understandings to local issues and local knowledge.

# invasive plants

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

**Norman Harris** (SNRAS), Tricia Wurtz (USFS)

### purpose

This study is directed at mapping over time infestations of white sweet clover (*Melilotus alba* Desr.) on the Matanuska River floodplain using near-earth remote sensing to detect changes in the population dynamics between sweet clover and native vegetation.

### approach

From June through October, spectral data is acquired monthly or as weather permits, from an altitude of 122 meters using a small, tethered, helium-filled blimp carrying two cameras, one collecting color and the other collecting infrared imagery. Images from both cameras are processed to create four-band spectral imagery that is then subjected to unsupervised and supervised classification techniques to identify targeted species. Photos are also photogrammetrically processed to create orthorectified mosaics of the study area using a dense ground control network.

### progress

Analysis of data indicates that white sweet clover is easiest to detect using visible-light spectral bands taken late in the growing season when phenological differences between the target plant and other vegetation were at their greatest. However, these phenological differences are not strongly linked to calendar dates. It is easiest to detect sweet clover at the end of the biennial cycle when the plants die and turn pink-brown in color. Our current analysis is focusing on time series analysis using three years of imagery to develop a probability model identifying the likelihood of sweet clover establishment on the flood plain.

### impact

If the data is supported with ground-based observations to detect proper phenological stages for imaging, land managers can effectively and cost-efficiently use remote sensing data to detect and monitor weed infestations. A probability model

will allow land mangers to better use scarce resources to combat the establishment of invasive species in critical habitats.

## livestock & 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

The promotion of 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 tracking-collar data from semidomestic livestock are analyzed using spatial/temporal techniques to develop parameters specific to high-latitude areas for use with the KRESS predictive modeling program.

progress

Initial analysis indicates that cattle in Alaska show similar distribution and activity patterns as cattle in other locations. These patterns seem to be independent of the prolonged photoperiod experienced at higher latitudes. A related study, in its second year, examines the relationship between thermal patterns and reindeer calving sites on the Seward Peninsula. Analysis of thermal data indicates that solar insolation models do not show a strong correlation to thermal patterns measured across the landscape. Current efforts will focus on whether insolation models or thermal data help create more accurate predictive models.

impact

These modeling efforts will give Alaska meat producers more tools for developing cost-effective animal management strategies that also will benefit consumers by fostering further development of an Alaska-based meat industry.

### Satellite telemetry for reindeer herding and range management

Suzanne Worker, Darrell Blodgett, **Greg Finstad**

purpose

Reindeer herding on the Seward Peninsula is conducted on large, remote, inaccessible ranges with sporadic herder contact. Inability to locate and track movements of grazing reindeer presents challenges for both animal husbandry and range management. Continued presence of migrating caribou on the Seward Peninsula disrupts typical reindeer movements and causes difficulties in herding and losses to outmigration. Good range management requires that animal locations and grazing patterns are monitored, and that overgrazing is avoided. Satellite telemetry has proven to be a useful tool for managing reindeer over vast, remote grazing ranges, as well as for monitoring range utilization.

approach

Reindeer were fitted with satellite collars and location data was collected by National Oceanic and Atmospheric Administration polar orbiting satellites and then downlinked and processed by CLS America, Inc. (formerly Argos, Inc). This data was sent to the Reindeer Research Program, where an automated system has been developed to create location maps and post them to a herder- and agency-accessible website. These maps allow the herders to locate their animals before herding and when caribou are on ranges. In collaboration with Natural Resources Conservation Service (NRCS), these maps are used by herders and land managers to facilitate prescribed grazing plans and to monitor seasonal grazing patterns and compliance in Environmental Quality Incentives Program grazing exclusion programs.

progress

A total of forty-three collars in eleven herds were deployed. Forty-one collars were deployed on the Seward Peninsula and neighboring islands in 10 herds with established telemetry and mapping programs. Two collars were deployed on Nunivak Island and a mapping program established. Location maps of the island, including NRCS Land Unit overlays, were created and made available to herders and land managers. Along with existing map formats, KML (Keyhole Markup Language) file types were added to allow quick three-dimensional viewing of location data using Google Earth software. Several database tools were also added, allowing RRP staff to more efficiently monitor collar performance to ensure data collection integrity.

impact

When combined with existing strategies, satellite telemetry has the potential to increase the efficiency of both reindeer herding and range management. The system allows herders to locate their animals when it might otherwise be impossible and improves their ability to avoid losses from intermingling with migratory caribou. It is also a resource for land managers to monitor the utilization of permitted grazing lands and compliance in conservation programs.

### Habitat suitability map of reindeer calving areas on the Seward Peninsula, Alaska

R. Fulweber, **N. Harris, G. Finstad**, B. Griffith

purpose

Using Geographic Information Systems (GIS), we are developing and evaluating the predictive performance of a habitat suitability model/map of reindeer calving areas for Native Alaskan reindeer herders on the Seward Peninsula. This model could be used by herders to evaluate new calving areas within their grazing allotments.

approach

The reindeer herd and grazing allotment of Thomas Gray of White Mountain was used for this study. Six habitat factors

are hypothesized to determine the suitability of an area for reindeer calving: slope, elevation, aspect, temperature, vegetation, and snow cover. Each factor appears as an individual GIS map layer and contributes to the development of an overall habitat suitability map for reindeer calving areas. This map is evaluated by overlaying location points from satellite-collared pregnant reindeer from the Gray reindeer herd during the calving season (generally, April 4 to May 5) for the years 2000–2006. Using a relative operating characteristic (ROC) analysis, the area under the ROC curve (AUC) will assess the performance of the map/model. A map that identifies areas where collared reindeer have and have not been during the calving season will generate a high AUC value, indicating a highly predictive and reliable map/model.



### progress and results

We have focused on developing the temperature map layer of the study area. A linear regression correlation analysis comparing two distinct methods used to develop this layer (modelling incoming solar radiation vs. empirically collected temperature data) yielded poor initial results due to: 1) suspected scale and image resolution issues, and 2) partial shading of some temperature thermistors by vegetation during data collection. We created revised temperature maps to address the scale and resolution issue, and a new correlation analysis is underway. Digital aerial photographs of snow cover within the study area during the 2005 calving season remain to be incorporated. All other habitat factor map layers are complete.

### impact

A highly predictive habitat suitability map/model will help herders identify new areas on their range where they can move their pregnant reindeer during the calving season to prevent overgrazing, improve access to high-quality vegetation, position their herd in localized, warm areas on their grazing allotment, and improve herd management. This could lead to improved herd productivity and increased economic income.

## Reindeer Research Program: new website design and content

Suzanne Worker, Darrell Blodgett

### purpose

The Reindeer Research Program (RRP) website receives heavy traffic from those who seek information about reindeer. It is often the initial (and sometimes only) point of contact for the public. The audience ranges from children to scientists and includes a growing contingent of reindeer producers across the United States. The existing website was outdated both in terms of content and navigation. An updated website with more complete and relevant content and improved navigational features not only serves our clientele better, but also provides a platform for the distribution of existing and emerging knowledge of reindeer and reindeer husbandry.

### approach

The new design emphasizes several major research areas, including range management and nutrition, meat science, and animal health. Space was also dedicated to educational outreach and to production issues unique to reindeer and subarctic animal husbandry. Each of these areas includes a basic introduction to the topic as well as internal links to past and ongoing project descriptions and/or full-text articles. Rounding out the design are pages popular with the younger or general interest reader. These include updated and annotated photo galleries, information about the farm and our captive herd, a historical account of reindeer in Alaska, and information about the biological and physiological features unique to reindeer. Also included are extensive links to other reindeer resources and publications.

### progress

The website was built over the course of 2006. Although a few topic areas are still lacking detailed content, the website is an improvement over the previous one and provides a wealth of information to various audiences.

### impact

The website includes much information not previously available on the internet for stakeholders in the reindeer industry. It provides a platform for the dissemination of information generated and compiled by the RRP, making available to a wider audience past and current publications, including peer-reviewed articles, and allowing communication of research not published in refereed journals. Though much of the content is detailed and directed toward an informed audience, navigational features and variety make the site appealing to those, including young students, who seek general knowledge about reindeer.

## Reindeer research in Northern Mongolia

**Greg Finstad**

### purpose

The Reindeer Research Program investigated production of two isolated populations of Northern Mongolian reindeer under different management strategies. The Tsataan are a community of reindeer herders that are divided into two geographically separated groups; a traditional and nomadic Western Taiga population and a sedentary Eastern Taiga group that caters to the tourist industry.

### approach

The Western Taiga group is divided into subgroups of two to eight families that herd 20–250 reindeer per group and tend to move every five or six weeks from high elevation grazing areas in summer to camps below treeline in winter. The Eastern Taiga population is subdivided into larger groups of ten to fifteen families, herd fewer reindeer, and are more sedentary, moving only four to six times per year. Eastern herders will often graze their animals at lower elevations near villages or in areas that are more accessible to tourists. Evaluation of style of management, selection of grazing areas, nutritional

analysis of forage, and condition of reindeer among the two populations was conducted in August 2006.

### progress

More species of forage plants were found in the Eastern grazing area. Crude protein concentrations and digestibilities of forage plants tended to be higher in the Eastern camp, which is likely related to differences in phenology. Sodium concentrations were very low in all forage except for mushrooms. In both groups, there were no significant differences in jaw and tail length of all sex and age classes of reindeer, but girth (132.2 ± 2.8 cm) was significantly less in females of a Western camp. Body length of adult females was significantly greater in Eastern camps (168.3 ± 2.6; 165.7 ± 2.4 cm) than in Western camps (161.6 ± 1.5; 161.5 ± 1.1 cm); shoulder height was significantly greater in Eastern (119.1 ± 1.5 cm) than in Western adult steers (112.2 ± 1.1cm). Body condition scores were significantly higher in Eastern adult females and male calves (2.4 ± 0.1; 2.4 ± 0.1) than in those of Western camps (1.0 ± 0.0; 1.3 ± 0.3). Milk yield was significantly higher in Eastern females (243.1 ± 14.5 ml/animal-1) than in Western females (140.2 ± 22.4 ml/animal-1). Reindeer from the Eastern camps were in better body condition, had higher milk yields, and may have experienced better long-term nutrition than reindeer from the Western camps.

### impact

The existence of two distinct populations of reindeer herders and their animals presents an opportunity to compare management strategies and the consequences of decisions on the herd productivity. Reindeer raised in a less traditional, but more sedentary manner were more productive. The results of this study will help to clarify the role of human decision making in the optimization of use of local range resources in different reindeer production systems.

# High-Latitude Agriculture

## agricultural markets & products

### Antioxidants in frozen and processed lingonberries and bog blueberries

**Patricia S. Holloway**, Roxie Dinstel

### purpose

We sought to learn the fate of antioxidants when frozen lingonberries and bog blueberries were processed into jams, jellies, and other products using recipes developed by the Alaska Cooperative Extension Service.

### approach

Wild lingonberries and bog blueberries were purchased from commercial sources in late summer 2005. They were frozen immediately, then after two months processed into jam, jelly, syrup, fruit leather, dried fruit, freezer jam, sauce, canned juice, and canned fruit. Frozen products (control) as well as samples of the processed products were analyzed at Brunswick Laboratories within two months of processing for total water-soluble antioxidants, total phenolics, anythocyanins, quercetin, vitamin C, and benzoic acid using the Overall Antioxidant Activity (ORAC) assay techniques and high performance liquid chromatography.

### progress

For frozen bog blueberries, overall antioxidant activity was 71 micro mole TE/g, and for lingonberries, 160–165 micro mole TE/g. Processing into fruit leather and drying increased levels in bog blueberries to 260–430 micro mole TE/g and in lingonberries to 457–939 micro mole TE/g. Leathers and dried fruit had significantly higher levels of total anthocyanins, total phenolics, and quercetin. Bog blueberries did not have detectible levels of p-coumeric acid or benzoic acid, but lingonberries showed a significant increase in dried fruit and leather when compared to frozen berries. Frozen and processed lingonberries had little or no vitamin C. Bog blueberries had detectible levels of vitamin C in all treatments (highest in leather). ORAC, total anthocyanins, total phenolics, and quercetin were detected in all other processing methods (canned fruit, syrup, canned juice, jam, sauce, frozen juice, freezer jam). Levels were similar to or lower than frozen fruit.

### impact

Alaskans harvest a lot of wild berries, some for commercial production of jams and jellies, but mostly for home consumption. This research showed that lingonberries and bog blueberries provide very high levels of antioxidants in frozen fruit. Processing into jams and jellies reduces antioxidant levels, but quantities are high relative to other processed products because levels are high in the frozen fruit. This research shows Alaskans that frozen and processed products are high in antioxidants and can be a part of a healthy diet.

### Market survey of Fairbanks restaurants using fresh culinary herbs

Jacquelyn Goss, **Meriam Karlsson**

### purpose

The survey estimated the demand and opportunities to supply locally grown fresh culinary herbs to restaurants in the Fairbanks area during the growing season.

### approach

Thirteen restaurants and three local producers were interviewed to assess use and availability of local fresh culinary herbs during the summer growing season.

### progress/result

Twelve of the thirteen surveyed restaurants indicated purchase and use of fresh culinary herbs. The combined restaurant purchase was 68 pounds per week with 56 percent being grown and acquired locally. The herbs in highest demand were basil, parsley, and cilantro. Sixty-two percent of the chefs expressed a preference for locally grown products, including herbs. The local producers stated that they are able to meet the current demands as well as additional future



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requests from local restaurants for fresh culinary herbs during the growing season.

### impact

These results suggest the restaurant market for locally produced fresh culinary herbs is limited but lucrative. Especially if the fresh herbs can be complemented with locally grown produce, restaurant accounts can be a viable marketing venue for small growing operations and farms.

## Meat cutting workshops across the Seward Peninsula, Alaska

**Greg Finstad, Eva Wiklund**



### purpose

Throughout the United Sates different methods are used to ensure optimum meat quality and to best utilize carcasses and cuts from cattle, goats, sheep, or swine. Reindeer and game animals harvested in Alaska represent a unique and exclusive product that must be processed in ways that complement the special qualities of particular species and cuts of meat. Workshops were conducted by members of the Reindeer Research Program to demonstrate the proper pre-slaughter handling, slaughtering, processing, and cooking of reindeer and game meat.

### approach

Large differences exist in the tenderness and juiciness from the various cuts of a reindeer carcass. Within each carcass there are variations between muscles that dictate how they should be cut and prepared to give an optimal eating experience. Because of differences in tenderness, juiciness, and flavor, meat should be cut according to its final preparation as steaks, roasts, stew, or ground meat. Aging schedules, cutting guidelines, and cooking recommendations were demonstrated and discussed during the workshops.

### progress

There is a widespread interest across Alaska for the proper harvesting and processing of local meat resources. Workshops were conducted in Stebbins and Nome, Alaska, and were well attended. Other communities across the Seward Peninsula and urban areas have requested future workshops.

### impact

Harvesting and processing of local meat resources is important in Alaska. Providing the public with the proper methods to harvest, process, and cook particular species and cuts of meat will ensure the production and consumption of wholesome and high-quality meat products.

## Carcass management and processing to improve quality in reindeer meat

**Eva Wiklund, Greg Finstad**, George Aguiar (SNRAS); Peter Bechtel (School of Fisheries and Ocean Sciences)

### purpose

This study compared carcass suspension technique on tenderness in three reindeer cuts, and for two types of lower quality reindeer cuts determined consumer preferences for products made by different processing techniques.

### approach

Meat samples were collected from eight reindeer steers raised at the Reindeer Research Program facility at UAF. The animals were transported to Delta Meats in Delta Junction, and slaughtered according to normal protocol. Each carcass was split in half and one half was randomly assigned to be hung by the pelvic bone, the other half hung as normal by the Achilles tendon. One day post-slaughter, carcasses were boned and the meat samples collected. From the Achilles-hung sides, lower quality cuts were sorted into two categories; good quality (including the cuts outside, knuckle, rump, and chuck roast) and lower quality (including meat from the shank, neck, ribcage, and shoulder). The batches were split in three and packaged, frozen, and transported to the Fishery Industrial Technology Center in Kodiak for processing into sliced stir fry meat, cubed meat, and ground meat. Three products (hamburgers, stewed meat in gravy, and stir fry meat) were prepared in the CES kitchen at UAF, frozen, and transported to Anchorage for a consumer preference test (142 participants).

Three cuts were collected from both the pelvic-suspended and Achilles-hung carcass sides: topside, striploin, and shoulder. These meat samples were evaluated for tenderness both mechanically (shear force) and by a trained sensory panel.

### progress

The consumers showed a significant preference for hamburgers made from the lower quality cuts, possibly related to the higher fat content in these cuts. For the other two products (stewed meat in gravy and stir fry meat) no difference in preference was detected between high quality and lower quality cuts.

Pelvic suspension significantly increased tenderness in the topside and striploin of reindeer carcasses, but no effect was found in the shoulder meat. These results were the same for both treatments according to the shear force measurements and the evaluation by the trained sensory panel.

### impact

This study clearly demonstrated the importance of using the right processing technique to increase palatability and marketability of lower quality reindeer cuts. Pelvic suspension was confirmed to be an effective technique to increase tenderness in high quality cuts like the striploin and topside from the reindeer carcass.

## Pre-cooked Alaska reindeer meat products

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

### purpose

The potential for production of premium reindeer meat in Alaska is high, and pre-cooked reindeer meat products are of great interest to producers and processors. There has been limited work on process, development, and consumer

acceptance of pre-cooked reindeer meat. Our objective was to assess the effect of phosphate on thiobarbituric acid-reactive substances (TBARS, chemicals that cause rancidity) and biogenic amine levels during storage in vacuum packaged pre-cooked diced reindeer meat in gravy.

### approach

In a balanced experiment design frozen reindeer M. biceps femoris and M. semitendinosus were diced into approximately 1 cm x 0.75 cm cubes. Diced meat (400 g) and 200 ml of gravy was placed in a vacuum bag, sealed, and heated in a water bath to an end temperature of 74°C, cooled and frozen at -20°C. There were two gravy treatments; water or added polyphosphate (WP) at 0.5%. Storage study samples were stored at + 3–5°C, sampled after 1 day, 4 weeks, and 7 weeks and analyzed for moisture, TBARS, and biogenic amines.

### progress

Moisture contents of all samples were similar. TBARS values for the water samples were slightly higher than for WP samples after one day and four weeks of storage, but after seven weeks the water samples had significantly higher TBARS values. Concentrations of the detected biogenic amines tryptamine, spermine, and histamine were not different between treatments.

### impact

Very limited work has been done on creating or evaluating pre-cooked reindeer products, so this study adds valuable knowledge. Previous work in this project demonstrated that consumers did not show a preference for water or WP products. However, the storage study showed that the WP treatment decreased TBARS levels after seven weeks at +3–5°C, indicating that the added polyphosphate reduced lipid oxidation.

## animal husbandry

### Cattle genetics (Chirikof Island, University of Alaska herd, private Alaska cattle)

**M.A. Cronin,** M.D. MacNeil (USDA); John Patton (Purdue Univ.); **Milan Shipka**

### 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 Chirikof Island cattle and compared them with other breeds, including Alaska cattle at the Matanuska Experiment Farm and those from private producers.

### 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 is in press in *Animal Genetics*. Additional samples were collected in 2006 from the university's cattle herd in Palmer and Larry DeVilbiss' Galloway cattle. These samples are being prepared for analysis. Also, Cronin has become a participant in the WERA 001 Multistate Research Project: Beef cattle breeding in the Western Region. A presentation, "An Overview of Phylogenetics," was given at the annual meeting of the American Society for Animal Science in Minneapolis, summer 2006.

### impact

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 US Department of Agriculture rare breeds and germ plasm preservation program is very interested in this herd. Addition of other cattle will allow modern genetics to be applied to livestock in Alaska.

### Use of enclosures to reintroduce reindeer to vacant Seward Peninsula ranges

**Greg Finstad**

### purpose

Many Seward Peninsula reindeer herders have lost their herds due to changing migratory patterns of the Western Arctic Caribou Herd. Some wish to re-establish their herds but the possibility of caribou returning to their rangelands calls for increased control of their animals. Use of enclosures has been suggested as a way to periodically control animal movements.

### approach

In January 2006 a reindeer herder of Koyuk acquired one adult female, nine female calves, and one male calf. The reindeer were transported to the vacant Koyuk range by aircraft and released into the enclosure where they were fed a formulated conversion pellet.

### progress

They quickly socialized to humans and habituated to intensive husbandry practices. The animals developed a strong site fidelity and remained in the general area when released for grazing. The enclosure became a refuge for the reindeer: when threatened by predators or disturbed, the reindeer attempted to return and re-enter the enclosure. The animals were allowed to freely graze during summer and early fall after which they were placed back in the enclosure when caribou migrated onto the Seward Peninsula.



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impact

Reintroduced reindeer will be managed primarily in a free ranging system, but an enclosure will be used on a needs basis to house reindeer in a controlled environment to avoid commingling with caribou or to reduce predation loss. The familiarization and bonding of reindeer to an enclosure will allow additional control of animal movements and provide a refuge site or comfort area for disturbed reindeer.

## Reindeer genetics

**M.A. Cronin**; M.D. MacNeil (USDA); J.C. Patton (Purdue Univ.); **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

We have established a genetic database for Alaska reindeer and begun work similar to that used to assess the genetics of cattle performance traits. Samples from the UAF reindeer herd were collected in 2006 and are being prepared for lab analysis. A paper on reindeer genetics was published in 2006 in *Journal of Heredity*.

impact

The project will provide information for reindeer husbandry selection and breeding programs in Alaska. Parents of calves can be identified, which will aid in open-range management. In the long term, this will contribute to more efficient reindeer production.

## Assessment of genetic markers in reindeer: association of DNA polymorphisms with milk yield, milk composition, and calf growth rate

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

purpose

The identification of genetic markers and their association with performance traits allows the selection of breeding livestock early in life. This removes the need to wait for animals to mature before assessing performance and selecting breeding stock. A genetic marker-assisted selection system has the potential to enhance the reindeer industry in Alaska.

approach

Estrus in 24 female reindeer was synchronized during the fall breeding season using established techniques and the cows were bred over a short time frame. Following parturition, cow/calf pairs were used in the genetic analysis.

progress

Milk samples were collected from reindeer cows at 10, 40, and 70 days after calving. Milk samples were analyzed for percent milk protein, milk fat, and lactose. The total dry matter and total energy content were calculated using the above values in published formulae. All calves were weighed at birth and weekly thereafter until weaning, and average daily gain was calculated.

impact

This is the first analysis of genetic variation and performance traits of individual reindeer. This approach is especially appealing for reindeer because of the unique and potentially valuable characteristics of reindeer milk, and because this technology will fit seamlessly into current reindeer herding practices on the Seward Peninsula and for reindeer farmed behind fence along the Alaska road system.

## Variability of gestation length in reindeer

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

purpose

Gestation length in Alaska reindeer has ranged from 198–240 days. This exceeds mean estrous cycle length (24 days; range 16–28 days) and limits our ability to predict calving. Variable gestation length was reported in Norwegian reindeer as long ago as 1980 and recently another Norwegian team of researchers reported that reindeer cows bred early in the breeding season had a longer gestation period than did reindeer cows bred late in the breeding season.

approach

We investigated the implication of the negative correlation:

Females bred early in the season have a longer gestation;
Females bred late in the season have a shorter gestation.

Historical data were combined with a trial that separated breeding dates for two groups of reindeer by approximately one month. Historical data included only individuals that had known breeding dates confirmed by systemic progesterone analysis along with recorded date of parturition. These data include 39 individual females from two separate reindeer facilities at UAF. In the breeding trial, 17 reindeer cows were divided into two groups balanced for age and weight as of mid-August 2005. An early-breeding group was put with two fertile bulls August 24. A late-breeding group was put with two fertile bulls September 21.

progress

**Historical data** – This includes the 2006 study. Reindeer cows bred earlier in the breeding season exhibited a longer gestation length than did reindeer cows bred late in the breeding season.

**Breeding trial** – Gestation length of reindeer cows placed with breeding bulls on August 24 averaged 227 days while gestation length of reindeer cows placed with breeding bulls on September 21 averaged 217 days and the difference between the two groups was not significant:

- Gestation length did not differ significantly for male calves (215.1 days) compared to female calves (219.1 days).

• Calf birth weight did not differ between males (6.8 kg) and females (6.7 kg).
• Older reindeer cows tended to have longer gestation length

impact

Understanding the relationship of breeding date to gestation length will allow herders and reindeer farmers to better predict the time of calving. This will allow greater vigilance at calving time and improve calf survivability.

## Relationship of dam's body weight, milk components, and milk energy density to reindeer calf growth rate

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

purpose

Reindeer are an important livestock species in Alaska, although the level of reproductive management in reindeer herds is currently low. Nonetheless, rapid genetic improvements can be achieved through selective application of artificial insemination. Current efforts to develop artificial insemination require identification of traits related to calf growth rate worthy of selection. We sought to relate dam body weight at parturition to calf growth rate and to examine associations of reindeer milk components to calf growth rate.

approach

Twelve reindeer cows with calves were grouped according to whether the calves were born early or late in the calving season. There were six cows in each group. Calving dates ranged from April 6 to 11 for early calvers and from April 23 to 30 for late calvers. Milk samples were collected from cows at 10, 40, and 70 days-in-milk. Calf body weight was recorded coincident with milk sampling and average daily gain was calculated for each period and for the entire 70-day study. Milk samples were sent to a milk lab in Logan, Utah for component analysis. Milk energy density was estimated and correlation coefficients were calculated for average daily gain with dam body weight at parturition, milk components, and milk energy.

progress

Calf average daily gain did not differ between groups and averaged 0.66 ± 0.06 kg (range 0.53 to 0.89 kg). At 70 days-in-milk, cows with higher body weight had calves with higher average daily gain. In the early calving group, average daily gain was was higher when milk energy, percent fat, or percent total milk solids at 10 days-in-milk were higher.

impact

This study demonstrates that in early life, milk components are more important to early-born calves than late-born calves. Reindeer calves are precocious and nibble grass soon after birth. From this study, it appears that milk components play a larger role in early-born calves when snow cover prevents access to grass.

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

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

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 nonpregnant reindeer.

approach

Reindeer cows that produced calves during 2006 as a result of early estrous synchronization and breeding dates or late estrous synchronization and breeding dates were reversed, so that 2005 early breeders were bred late in 2006 and 2005 late breeders were estrous synchronized and bred early in 2006 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 previous years.

progress

Changes in body weight over the entire season were not different between groups bred early and late. The late group lost body weight before harem formation (preweaning) and both groups gained body weight for eight weeks after harem formation (postweaning) 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 fence. Understanding seasonal weight fluctuation of reindeer raised behind fence will assist in improving the health and wellbeing of farmed reindeer.

## The effect of different pasture grasses: Kentucky nugget bluegrass (*Poa pratensis*) and smooth bromegrass (*Bromus Inermis*) on intake rate and body weight of reindeer steers

George Aguiar, **Greg Finstad**

purpose

We sought to determine a daily consumption rate of a concentrate fed to reindeer under three feeding regimes: a milled ration exclusively, a milled ration with access to brome pasture, and a milled ration with access to nugget bluegrass pasture.



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### approach

The project was conducted at the Agricultural and Forestry Experiment Station with reindeer from the Reindeer Research Program. In June 2006, eighteen two-year-old reindeer steers were randomly allocated into three groups of six and fenced in a bromegrass pasture, a nugget bluegrass pasture, or a control pen. They were fed a 16% crude protein milled feed free choice for seven weeks. Daily dry matter intake of feed was determined for each group. Ten random enclosures were placed in each pasture and sampled at the beginning and the end of the project to determine pasture biomass production. The pastures were randomly sampled every two weeks to determine offtake by reindeer and the nutritional composition of pasture grass. All three groups were weighed weekly.



### progress

Dry matter mean intake of milled ration was significantly different among treatments, although there was no significance in mean weight gain between groups. The control group consumed 33.6g ± .004 per kg of body weight with a weight gain of 20.06 kg ± 2.6. The nugget bluegrass group consumed 22.4g ± .0005 per kg of body weight with a weight gain of 18.8 kg ± 2.8. The smooth bromegrass group consumed 21.9 g ± .0004 per kg of body weight with a weight gain of 14.3 kg ± 2.6.

### impact

This study shows that pasture can be used to reduce the amount of milled ration eaten by farmed reindeer without compromising weight gain. Producers can use this information to decide which combination of pasture/milled ration will be most economical for raising reindeer without compromising animal growth.

## Supplemental feeding of reindeer on the Seward Peninsula, Alaska

**Greg Finstad**

### purpose

Use of enclosures and supplemental feeding has been suggested as a way to periodically control animal movements. Free-ranging reindeer would be moved into the enclosure when caribou move into the area and fed a supplemental ration if held for an extended time.

### approach

In January 2006 a reindeer herder of Koyuk, Alaska, acquired one adult female, nine female calves, and one male calf, and released them into an enclosure where they were fed a formulated conversion pellet. The pellet, produced at the University of Alaska Fairbanks, was composed of 45% barley, 45% brome hay, and 10% lichen. Nutritional characteristics of the pellet were: In Vitro True Dry Matter Digestibility 81.74%, Neutral Detergent Fiber 35.8%, Acid Detergent Fiber 15.5%, lignin 1.52%. crude protein 11.9%, phosphorus 0.2%, potassium 1.01%, calcium 0.15%, magnesium 0.11%, sodium 250 µg/g, S 0.1%, copper 7.84 µg/g, zinc 55.0 µg/g, manganese 71.8 µg/g, iron 289 µg/g, cobalt 0.36 µg/g, and 0.78 µg/g of molybdenum.

### progress

All animals were consuming pellets by the third day after introduction with no apparent metabolic difficulties. After the animals converted over to a pelleted ration, they were fed pellets for three months, which they consumed at a rate of 1.7 kg animal-1 day-1. The reindeer were allowed to free range during summer. The females were weighed the following October (17 mo. of age) and were significantly heavier (77.9 ± 1.9 kg) than females of the same age from the Alaska Agricultural and Forestry Experiment Station (63.3 ± 1.7 kg).

### impact

Data suggests the body condition of young reindeer can be increased with a combination of free grazing and supplemental feeding. Supplemental feeding can be used in combination with enclosures to increase control of animals and the productivity of reindeer herds.

## Feed and forage—effects on reindeer meat quality

**Eva Wiklund, Greg Finstad**, George Aguiar (SNRAS); Peter Bechtel (School of Fisheries and Ocean Sciences)

### purpose

Fenced reindeer cannot survive on pasture alone but require diet supplementation with a concentrate. The concentrate, which usually consists of cereal grain and supplemental protein and minerals, is costly in Alaska and the amount fed influences profitability of a reindeer operation. We evaluated different pasture grasses for their effect on unlimited intake rates of concentrate and on meat quality.

### approach

The project was carried out with the Reindeer Research Program reindeer herd. Two adjacent pens (100m x 100m) were constructed; one planted with smooth bromegrass (*Bromus inermis*) and one with Kentucky bluegrass (*Poa pratensis*). As a control treatment, a pen covered with gravel to prevent vegetative growth was used. Eighteen yearling reindeer steers were allocated to the three treatments, six animals in each group. Animals in all treatment groups had unlimited access to the standard RRP summer reindeer ration (16% crude protein) throughout the eight-week experiment period, after which all reindeer were slaughtered at Delta Meats, Delta Junction. Meat pH values and temperature decline were measured in M. longissimus during the first 24 hours post mortem, and meat samples were collected for sensory evaluation and measurements of water-holding capacity and meat color.

### progress

The trained sensory panel could not find any differences between the treatment groups in any of the measured attributes of the meat; smell intensity, tenderness, juiciness, game flavor, blood flavor, and sweet flavor. Meat from the control animals had lower ultimate pH values and higher drip loss in samples stored for three weeks at +2°C compared with meat from the brome and bluegrass treatment groups.

### impact

The results demonstrate good and similar quality of meat from reindeer raised in an intensive feeding regime using a concentrate feed mixture and two pasture grasses (bromegrass or Kentucky bluegrass) commonly grown in Alaska.

## bedding plants & garden crops

### Annual flower cultivar trials

**Patricia S. Holloway**, Alfreda Gardiner, Grant E.M. Matheke, Janice T. Hanscom, Katie Bosch, Lindsay Douglas, Valerie Lemens, McKenzie Payne, Judy Weber

#### purpose

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

#### approach

Three hundred fifty-six annual flowers were grown as bedding plants in a greenhouse (except direct-seeded sweet peas) and transplanted outdoors at the Georgeson Botanical Garden during the first week of June. The trials included 46 past and current award winners from the All America Selections Program. 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

For the three-year trial period only six of the 77 cultivars tested showed consistently excellent performance with an overall rating of 4 (outstanding quality, best of its kind). They included: the annual flower mix Colorscape Mixture, California poppy Golden Tears, geranium Orbit Deep Salmon, marigold Perfection Mixture, salvia Gruppenblau, and zinnia Magellan Coral. More than three-quarters of the plants grown for three seasons showed good or better ratings that would make them suitable for Alaska gardens. The notable exceptions were plants such as celosia Glow Pink and several cultivars of Vinca that do not grow well even in raised beds. The plants do not fill in well, do not branch, and grow so slowly that there is little ornamental show. One cultivar of penstemon, Violet Dusk, consistently died out each season. Plants were evaluated weekly for the amount of deadheading necessary to maintain a good display. Season-long deadheading was required with all cultivars of calendula, dianthus, verbena, zinnia, and petunia, as well as gazania Kiss Mixture, marigolds Little Hero Gold, Queen Sophia, and Disco Granada, and nicotiana Perfume Deep Purple.

#### 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.

### Herbs, greens, berries 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, greens, berries, and other edible plants were grown in raised beds containing Fairbanks silt loam soil amended with plant-based compost. Perennials were planted 2003–2006 and annuals in June 2006 in unreplicated beds according to recommended commercial spacing or design specifications. Plots were evaluated during the third week of August for 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

Eighty-six herbs, greens, berries, and other edible plants were evaluated in 2006. Most herbs received a fair-to-good rating and would be acceptable in Alaska's gardens. Truly outstanding herbs included: Italian parsley, Chinese garlic chives, common chives, ginger mint, Welsh onion. Plants that were unacceptable included: butterfly weed, cat germander, dwarf germander, silver germander, chervil (eaten by voles), Tres Fin and Marchiere Frissee endive (bolted early), garden cress, spearmint, lovage (winter damaged), and chocolate mint (winterkilled).

#### impact

Nearly all commercial greenhouse businesses in the Tanana Valley offer herbs in their mix of products for spring and summer sales. This research will assist local market gardeners and home gardeners in evaluating the usefulness of herbs mostly for culinary purposes, and identifies herbs that will overwinter in interior Alaska.

### Vegetable cultivar trials

Grant E.M. Matheke, Janice Hanscom, **Patricia S. Holloway**, Alfreda Gardiner

#### purpose

Vegetables are grown to evaluate their usefulness in home and market gardens and to compare new cultivars to standards that have been grown in the Tanana Valley for many years.

#### approach

Each vegetable cultivar is tested for three years and where possible, compared to long-term standard cultivars that have proven valuable over many years. Warm season vegetables, celery, leeks, and cole crops were started as greenhouse bedding plants and transplanted outdoors during the last two weeks of May. All other vegetables were direct seeded into Fairbanks silt loam soil following fertilization with 10-20-20S



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(10 nitrogen, 20 phosphate, 20 potash with a trace of sulfur, at 4 lb per 100 sq ft, 195 g per sq meter). Plots were irrigated as needed, and harvest began with spinach the third week of Juneand continued three times weekly through September. Data consisted of yield as well as observations on disease, insect pests, off-type plants, and deformities.

### progress

The following cultivars received a very good to excellent rating following three years of evaluation: artichoke Imperial Star, beans Contender, Romano, and Rocdor; beet Chiogga; broccolis Marathon and Shogun; cabbage Earliana; cauliflowers Andes and Snow Crown; cucumbers H-19 Little Leaf, Northern Pickling, Sweet Success, and Sweeter Yet; eggplant Orient Express; kale Red Russian; kohlrabi Kolibri; leeks Arena and King Richard; pea Snow Green; peppers Fajita Bell, Gypsy, and Blushing Beauty; pumpkins Connecticut Field, New England Pie, and Rock Star; radishes Easter Egg and Sora; spinaches Melody and Tyee; summer squashes Papaya Pear, Sunray, Eight Ball, and Raven; Swiss chard Bright Yellow; and turnip Tokyo Cross. Unacceptable performers bolted early and included all cultivars of Oriental and Asian greens; Joan rutabaga(also susceptible to root maggot damage), and Shogoin turnip.

### impact

The vegetable cultivar trials provide information for home and market gardeners to identify appropriate high yielding, good quality vegetables for the Tanana Valley.

## controlled environments

### Crop production in a greenhouse powered with geothermal energy

Jeffrey Werner, **Meriam Karlsson**

### purpose

Greenhouse management techniques suitable for northern conditions are required as year-round production becomes feasible using power and heat from geothermal or waste energy sources.

### approach

In a collaborative partnership with the Chena Hot Springs Resort, growing techniques are developed for year-round crop production in a greenhouse powered by geothermal resources. Large natural variations in day lengths, light intensities, temperatures, and levels of moisture and humidity require continuous adjustments of the greenhouse environment. A strategy of best management with special attention to irrigation, nutrition, and humidity in combination with integrated pest management is developed for use throughout the year.

### progress/result

Moisture and nutrient control is critical for crop health and uninterrupted production. Automation with programming adjusted to crop stage and type throughout the seasons is necessary because manual operation is too unreliable, irregular, and labor intense. Air humidity is challenging as levels frequently fluctuate rapidly, from naturally low to extremes. Management includes coordinated control of air humidity, irrigation, rate of nutrients, cooling, ventilation, heating, and air humidification. The greenhouse provides an ideal environment not only for plants but also pests and diseases. Many pests appear naturally in the summer and may migrate into the greenhouse as outside conditions change. Constant crop inspections are necessary to detect troublesome pests early. Sanitation, use of commercially available natural enemies (beneficials), along with materials approved for food crops such as soaps and oils, are used for an integrated pest management approach.

### impact

Geothermal energy technologies work well for year-round controlled environment and greenhouse applications. The experience and knowledge developed at Chena Hot Springs Resort will benefit people who pursue local greenhouse production at geothermal sites or at remote areas using waste energy resources.

### Hoophouse construction in Palmer

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

### purpose

We are constructing a set of solar-heated hoophouses to evaluate their potential for season extension. Hoophouses are used in many states to warm the soil with trapped solar heat early in the spring and allow earlier planting of crops for earlier harvest, production of longer-season crops, or production of selected warm-season crops such as tomatoes, peppers, or cucumbers. Hoophouses also extend the growing season at the end of summer by preventing frost damage.

### approach

A suitable site with access to water and electricity was prepared for hoophouse construction in summer 2006. The thin layer of topsoil was amended with several inches of additional topsoil and several inches of aged cattle manure. The new topsoil was incorporated to form a homogenous soil across an area of about 150’ x 150’. On the northern side of this new field a 30’ x 96’ gothic-style hoophouse was installed to facilitate comparisons of crop production in the house to that of the unprotected plots south of the house.

### progress

Assembly of the 25 bows that are the heart of the structural system was simplified by making a large jig to hold the pieces in the proper position during the fastening process. Using an assembly-line process in the jig allowed a person to build two bow assemblies per hour. After all of the upright posts were set into the ground the bow assemblies were set on the uprights. Using a forklift and two workers, all of the bows were installed in a morning. Installation of the perlons that hold the bows in their proper position took several days. The house was covered with two layers of 6-mil plastic and a blower was installed to create an insulative air space between the

layers. Late fall weather indicated the solar gain the structure could provide: condensation was dripping in the house while outside temperatures hovered at less than 20°F for the day. Unfortunately, a windstorm took advantage of a construction defect and destroyed both layers of plastic. The plastic was replaced in spring 2007; the trial begins in 2007.

### impact

Getting a crop to market earlier than other growers often enables a farmer to command the highest prices at the market. Adding a week or two to the beginning of the season could pay for the cost of the hoophouse in a few seasons. At the harvest end of the season, the frost protection a hoophouse provides could continue production several weeks after outside crops have been damaged by frost. Hoophouses are relatively easy to ship and may contribute to solving food supply issues faced by remote communities.

## High tunnel production of snap beans

Heidi Rader, **Meriam Karlsson**

### purpose

Since snap bean is a warm-season crop and sensitive to cold and wind at all stages of growth, the protection of a high tunnel is expected to result in faster maturity and higher yields, improving midseason productivity. High tunnels may also shield the crop from frost, extending the harvest season.

### approach

The two cultivars Provider and Concesa were grown during the 2005 and 2006 seasons in high tunnels and adjacent fields. Provider is well adapted and recommended for northern field conditions; Concesa is developed for warmer climates and produces extra-fine pods with high palatability and consumer appeal.

### progress/result

More Concesa beans were harvested in the high tunnel than the field. Slightly earlier maturation and continued production after first fall frost contributed to the higher yields in the tunnel environment. Despite a cold 2006 season with frost on June 4, the harvest of Concesa beans was similar in high tunnels during the two growing seasons. The yield of Provider was also higher in the tunnel than the field, although when years were combined, the difference was not statistically different.

### impact

High tunnel use to lengthen and optimize seasonal northern growing conditions for fresh market snap beans is promising. The high-tunnel environment is especially favorable for producing crops of small-seeded beans, such as Concesa, that are desirable on the fresh market.

## Bell peppers grown using high tunnels

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

### purpose

Bell peppers are warm-season crops and are usually not field-produced in Alaska. A high-tunnel structure may sufficiently enhance the field climate to support bell peppers as a specialty crop.

### approach

The bell pepper cultivars Ace, King Arthur, Jumbo Stuff, Minibelle Red, Sweet Pimento Lipstick, and Tequila were evaluated in a high tunnel and adjacent field during summer 2006.

### progress/result

King Arthur and Jumbo Stuff produced twice as many peppers in the high tunnel: Jumbo Stuff developed 21 mature fruits on four plants in the high tunnel while the corresponding number for field-grown plants was 11. The combined weight of bell peppers averaged 10 ounces in the field but 29 ounces in the tunnel. Minibelle Red, Sweet Pimento Lipstick, and Tequila produced comparable numbers of peppers, but at maturity, fruits were smaller in the field. The development and productivity of Ace were similar in the high tunnel and field.

### impact

These results suggest high-tunnel greenhouses positively alter the environment for growing most bell peppers. Cultivar choice is critical because some selections did not benefit from the protected climate of high tunnels.

## Growing potatoes in high tunnels

Jeffrey Werner, **Meriam Karlsson**

### purpose

Depending on the season, a high-tunnel environment may provide advantages over an open field location for well-adapted traditional field crops.

### approach

The five potato cultivars Alaska Redeye, All Blue, NorDonna, Swedish Peanut, and Yellow Finn were grown and evaluated in a high tunnel and the field.

### progress/result

In contrast to the 2005 season, in 2006 there were no differences in productivity between the field and the high tunnel locations. The highest yield for a five-foot-long row was recorded for Alaska Redeye at 4.5 lbs. All Blue and Yellow Finn both averaged 4 lbs, NorDonna 3.5 lbs, and Swedish Peanut 3.2 lbs.

### impact

Crop response to a high tunnel compared to concurrent field production varies from season to season depending on weather conditions. Although improved productivity has been recorded, reserving the managed high tunnel space for specialty niche crops such as small gourmet "new potatoes" harvested from immature plants is expected to be a more sensible approach.

## Tomatoes produced in controlled environments

Jeffrey Werner, **Meriam Karlsson**

### purpose

In year-round greenhouse production, light conditions are highly limited during the winter months, with crop

growth entirely dependent on supplemental irradiance. Opportunities to produce trellised tomatoes using solely artificial lighting were therefore examined.

approach

Tomato plants were supported to an overhead wire and grown exclusively under artificial light in an enclosed environment. As the plants grew and reached the wire, they were lowered, letting the stems lie horizontally while keeping the growing shoot upright into the light. The performance of beefsteak (Trust), cluster (Clarance), and cherry (Conchita) tomatoes was recorded and evaluated.

progress/result



The trellised tomatoes grew and produced well in the enclosed environment. Over the three-month harvest period, Trust produced 9 lbs per plant with an average tomato size of 4.7 ounces. The tomatoes of Clarance were on average 3.4 ounces and 8.9 lbs were produced per plant. The smaller cherry type tomatoes of Conchita weighed on average 0.6 ounces and 6.2 lbs were produced per plant.

impact

The results suggest selections of beefsteak, cluster, and cherry tomatoes grow and produce well in a trellised system under artificial light. Using an affordable power source such as waste heat or geothermal energy, tomatoes can successfully be produced with artificial irradiance in an enclosed growing area or a greenhouse with limited natural light.

## Seasonal container-grown raspberries

**Meriam Karlsson**, Jeff Werner, Jerri Layman

purpose

Long cane raspberries with the chilling requirement for flowering already completed can be grown in containers to produce raspberries during the first season. During the summer of 2006, the productivity of container-grown raspberries was evaluated in high tunnels and field locations.

approach

Tulameen, a well-adapted red raspberry cultivar for container production, was used for the study. Long raspberry canes were planted in three-gallon containers, allowed to produce leaves, and then transferred to a field or high tunnel location. The containers were positioned directly on the soil surface or buried to the upper rim of the container in field soil. As a comparison, raspberry canes were also planted directly into the soil.

progress/result

The largest yield of fresh raspberries was recorded for canes grown in the protection of the high tunnel. Canes planted directly into the ground of the high tunnel produced fewer berries than those in containers buried or placed on the surface of the soil. Under field conditions, a similar number of berries was picked from each plant independent of planting and container position. More than 21 ounces of high quality fresh raspberries were harvested from each plant grown in the high tunnel. Individual berry size approached 0.28 ounces.

impact

Container production is an efficient system for growing high-quality fresh market raspberries. Along with more reliable and larger yields in a high tunnel, the fruit quality often improves as the developing berries are protected from rain and other inclement weather conditions.

## Strawberries grown in high tunnels

Jeff Werner, **Meriam Karlsson**

purpose

We investigated the opportunities offered by high-tunnel plastic greenhouses to extend the production season, increase yield, and elevate the quality of field-grown strawberries.

approach

The strawberries Aromas, Diamante, Tribute, and Tristar were grown in raised beds in high tunnel and field environments.

progress/result

Harvest was initiated the last days of June and continued until the record late end-of-season frost on September 22. Fruit picked per plant in the high tunnel was 8.1 ounces for Aromas and 11.5 ounces for Tristar. The corresponding harvest in the open unprotected field was 6.3 ounces for Aromas and 7.2 ounces for Tristar. The growing environment did not affect the productivity of Diamante at 9.1 ounces per plant or Tribute at 9.3 ounces. Berry size followed expectations, averaging 0.72 ounces for Aromas, 0.84 ounces for Diamante, 0.4 ounces for Tribute, and 0.3 ounces for Tristar.

impact

Production advantages are often realized in high tunnels even though the yield may not always be larger. During rainy weather, strawberries are easier to pick in the protection of the high tunnel, and limited surface moisture increases fruit and keeping quality. A high tunnel also protects flowers and plants from cold temperatures and end-of-season frost. Although a protective cloth can be used to cover and uncover field-grown strawberries, the increased management is labor- and cost-intensive.

# field crops & field management

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

Robert M. Van Veldhuizen, **Mingchu Zhang, Stephen D. Sparrow**

purpose

This ongoing research provides information for yearly updates on new and better-adapted agronomic crop varieties (small grains and oilseeds), and on the response to dryland farming conditions at Fairbanks, Delta Junction, and Palmer.

### approach

Variety trials: Four 6-row and one 2-row feed barley varieties, five 2-row and three 6-row hulless barley varieties, three hulless oat varieties, nine hard red spring wheat varieties, two Argentine canola varieties, two Polish canola varieties, and two new oilseed crops, Crambe and Camelina, were selected from northern Canadian and US sources for testing of early maturity and high yields. Replicated trials of all varieties were planted at all three test locations. The exceptions are the canola Crambe and Camelina varieties, which were tested only at Fairbanks and Delta Junction. Six selections from 2005 of a hulless barley cross that have shown the best characteristics for adaptation were planted in replicated trials at all three locations for continued evaluation. The seed from selections from the dwarf, open-pollinated Sunwheat were distributed to local growers for testing and evaluation as a horticultural seed crop.

### progress

Summer growing conditions at all three locations were colder and wetter compared with the long-term averages, and included a late spring frost. This resulted in delayed maturity and increased lodging, but close to average yields for most varieties. Later-maturing varieties like wheat, oats, and canola had lower than average yields. The final selection from a hulled feed barley cross was officially released as the cultivar 'Wooding' in 2006. Wooding exhibited better plant growth in comparison with existing Alaska-adapted varieties. The percent green seed was acceptable from the Polish varieties of canola but not the Argentine ones. The Crambe and Camelina varieties did not reach maturity. The six hulless barley cross selections performed better than the standard hulless barley. They were also tested for milling and baking characteristics through the Alaska Cooperative Extension Service. Further selections will be made for eventual release as an officially named variety. Testing done by the local gardening community with the open-pollinated dwarf oilseed Sunwheat selection will result in an eventual release of an Alaska variety.

### 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 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

Hay producers often do not have sufficient dry weather to produce good quality hay in southcentral Alaska. The production of haylage, fermented hay, is a viable solution because it requires less time between the cutting and baling of forage. Techniques for producing good quality haylage in Alaska have not been studied previously.

### approach

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

### progress

This was the study's final year. All data have been collected and analyzed, and compiled into a master's thesis. Dense bales produced higher quality haylage. Data showed that black-colored bales reach significantly higher surface temperatures than white-colored bales under most, but not all, conditions. Black bales had significantly higher core temperatures than white bales, with temperature differences of 2° to 6°C. However, color of wrap only had minor and inconsistent effects on haylage quality. Preservatives had beneficial effects on haylage baled with a high moisture content, over 70 percent.

### impact

Haylage can supply a high-quality feed that will foster increased milk and meat production in Alaska benefiting producers. A secure local supply of meat and milk will benefit Alaska consumers.

## The effect of forage variety on haylage quality and quantity in Alaska

Susan Spencer, **Norman Harris**, Beth Hall

### purpose

Hay producers often do not have sufficient dry weather to produce good quality hay in southcentral Alaska. The production of haylage, fermented hay, is a viable solution because it requires less time between the cutting and baling of forage. This study examines techniques for producing quality haylage in Alaska and develops remote sensing techniques for estimation of biomass production.

### approach

Different types of forage are harvested at two times during the summer. Haylage is baled using two different colors of plastic wrap with or without preservative. Self-recording thermistors are inserted into bales. At the end of a six-month storage period, samples are collected for fiber analysis and high performance liquid chromatography. Thermistors are removed at this time. Near-earth remote sensing data using our blimp/camera platform is acquired before and after each harvest. The start and end of forage swaths forming each bale are positioned using a global positioning system (GPS) unit. Weights are obtained for all bales.

### progress

This was the first year of this research. Initially we planned to plant three different forage grasses. However, seed for the planting was not available in time for the study, so we substituted two existing fields at the Matanuska Experiment Farm that contained different grasses. Imagery is now being processed to produce vegetative indices and orthorectified mosaics.

### impact

Haylage can supply a high-quality feed that will foster increased milk and meat production in Alaska. A secure local supply of meat and milk will benefit Alaska consumers. Remote sensing technology will provide farmers with a way to better estimate production, allowing them to make informed decisions concerning their operations.

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

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

### purpose



We sought 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 that 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 in 2003, yields for all galega and cicer milkvetch varieties were quite low (less than 1.5 ton per acre); in 2004, Gale galega produced 3.0 tons dry herbage per acre and cicer milkvetch produced an average of 2.9 tons per acre. In 2005, average yields for gale galega decreased to 2.5 tons per acre and to 1.8 tons per 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. Lupinaster clover herbage samples collected in 2006 averaged 15.9% protein and yielded < 1.0 ton/acre. The sample size was quite small and we intend to sample larger lupinaster clover plot areas for yield in 2007. Preliminary results indicate that all these crops have limited potential as forage crops in interior Alaska.

### impact

This research will aid interior Alaska farmers in selection of forage crop species to include in their cropping regimes.

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

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

### purpose

We aim 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 at 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/results to date

As the season progressed, yields generally increased and forage quality decreased; with increased cutting height, yields decreased and forage quality increased. Late season second harvests usually resulted in highest subsequent year yields; second harvests done about 35–45 days after the first harvest generally resulted in lowest yields in June of the following year. Yields following late season yields usually did not differ significantly from control treatments (which did not receive a second harvest), except for alfalfa, for which yields for the control treatments were much lower than for late harvests. Subsequent year yields were usually not affected by second harvest cut heights, indicating that a farmer can harvest to a stubble height as low as two inches without damaging stands or plant health. Galega had very poor survival and cicer milkvetch was completely killed during the 2005–2006 winter, indicating that these crops may not be adapted to interior Alaska's environment, especially when subjected to intensive management.

### impact

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

## Fireweed as a potential forage crop for interior Alaska

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

### purpose

Tall fireweed, an indigenous herbaceous perennial plant in Alaska, often grows in thick stands and is known to be an important food source for some species of grazing animals. As such, it may be a useful forage crop for livestock producers in Alaska. We sought to determine the potential of tall fireweed

(*Chamerion angustifolium, Epilobium angustifolium*) as a forage crop in Alaska.

### progress and results

We collected and seeded tall fireweed at the Fairbanks Experiment Farm in autumn 2004, 2005, and 2006. We harvested small plots at approximately one-week intervals from early June until late August 2006. Yields ranged from 0.5 tons per acre for the earliest harvest to 3.0 tons per acre for the mid-August harvest. We did a second harvest on 24 August 2006 on plots which had been harvested before late June; regrowth yields were low (< 0.5 tons/acre). Tissue crude protein ranged from <14% for late season harvests to >20% for early harvests and regrowth, indicating that if harvested early in the season, fireweed may be a high quality forage plant. We will again evaluate fireweed plots during the 2007 growing season for survival and productivity. Results to date indicate that tall fireweed may have potential as a forage crop in interior Alaska, but much more research is needed to determined long-term productivity and best management practices.

### impact

Forage crop producers in interior Alaska are currently limited to a few introduced forage crop species. These crops do not always do well under subarctic conditions and some of them are considered potential invasive weeds. If fireweed proves to be a feasible forage crop, it will provide Alaska farmers with an option to produce a new crop that is well adapted to subarctic conditions and is not a potentially invasive weed.

## Forage grass variety trials

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

### purpose

We compared 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, or Bill Spencer's farm near Nenana in 2000, 2001, 2002, or 2003. The grasses tested represented both introduced and native species.

### progress and results

Stands were so poor at Delta Junction that we abandoned the plots there and did not obtain yield data. At Nenana, smooth bromegrass produced the highest yields, averaging 2.6 tons per acre per year among three varieties. Meadow bromegrass (two varieties) produced second-highest yields among introduced species, averaging 2.2 tons herbage/acre per year. Tufted wheatgrass (the only Alaska native species tested at Nenana) produced an average annual yield of 2.2 tons dry matter per acre. We terminated the trial at Nenana at the end of the 2005 growing season. At Fairbanks we obtained the highest overall average annual yields among all grasses with Polar bromegrass (a smooth bromegrass X pumpelly bromegrass hybrid; smooth bromegrass is an introduced species, pumpelly bromegrass is indigenous to Alaska), which averaged 4.2 tons herbage per acre. Smooth bromegrass produced the highest yields among introduced species, with Leif averaging 3.8 tons per acre. Siberian wildrye also produced high yields (mean yield was 3.6 tons/acre), but persisted for only two years. Timothy produced the lowest yields among the introduced species with a mean annual yield of 2.9 tons/acre. Of the species indigenous to Alaska, slender wheatgrass produced highest yields (3.3 tons/acre) and persisted with good stands throughout the study. Stands of other native species deteriorated after two or three years to the point we abandoned the plots. Most of the plots had become invaded with smooth bromegrass by the end of the 2006 growing season to the point we decided to terminate the study.

### impact

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

## Turfgrass research

**Allen Mitchell**, Tim Evers

### purpose

We seek cultivars that provide the best perennial qualities for golf greens, fairways, sports fields, and home lawns in southcentral Alaska.

### approach

Over the past six 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, a research green at public Settler's Bay Golf Course, and a newly planted research green at Moose Run Golf Course. Each site is used to evaluate different cultivars and turf management practices for winter hardiness, early green-up, and overall playability.

### progress

The sand-based cultivars from the first constructed green at the Matanuska Experimental Farm have been finalized. Two separate cultivars (18th Green and SRO 7200) from this study will form a standard for a new planting of six newly introduced varieties. The newly constructed green will continue with fertilization studies and management practices. A new variety trial was planted at Moose Run Golf Course and will reveal if the same superior varieties judged at the Matanuska Experimental Station will perform as well in the Anchorage bowl with consistent snow covering and increased traffic.

### 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 18th Green bentgrass. 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.

## Field production of bulb onions

Jeffrey Werner, **Meriam Karlsson**

### purpose

Bulb onions are considered a cool-season crop with high dependence on day length and temperature for proper development and formation of bulbs. Since our northern location offers seasons of extreme conditions, it is necessary to evaluate onion cultivars for their ability to produce bulbs under extended day length- and moderate temperatures.



### approach

Cultivars evaluated in 2006 were the yellow onions Ailsa Craig, Big Daddy, First Edition, Walla Walla, and Yellow Sweet Spanish; red onions Mars, Red Burgermaster, and Stockton. and the white onions Superstar and White Spanish Ringmaster.

### progress/result

The overall most productive onion was Ailsa Craig with 48 ounces per square foot. Walla Walla also grew well with a yield of 42 ounces. Red Burgermaster outperformed the other two red onions at 38 ounces. The yield for Superstar was also 38 oz/sq ft, and White Spanish Ringmaster, 33 ounces.

### impact

The results suggest several yellow, red, and white selections are suitable for bulb onion production at high latitudes.

## Peonies as field-grown cut flowers

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

### purpose

We sought to learn methods of field-grown cut flower production and marketing to establish a peony cut flower industry in Alaska.

### approach

Field plots were established from 2001–2003 at the Fairbanks Experiment Farm in three experiments: trials for 30 cultivars; plant spacings of 30, 45, or 60 cm within rows; soils amended with compost or peat; and fencing of 0, 15, or 60 percent shade to delay snowmelt and budbreak. Cut stems were sent to wholesale cut flower markets in Los Angeles to determine if Alaska-grown peonies meet production standards as cut flowers.

### progress

Thirty cultivars were evaluated for their potential as field-grown cut flowers in Alaska. After five years, six cultivars died or stem productivity was too low for commercial production: Better Times, Gardenia, Mos. Jules Elie, Nancy Nichols, Raspberry Sundae, and Vivid Rose. The cultivars producing the greatest number of US quality grade cut stems were Dr. Alexander Fleming, Duchess de Nemours, Sarah Bernhardt, Felix Crouse, David Harum, and Festiva Maxima. Amending soils with garden waste compost or Lemeta peat moss did not increase the number of flowering or vegetative stems in the first three years. A within-row plant spacing of 30 cm, 45 cm, or 60 cm showed no consistent difference in number of flowering and vegetative stems or stem quality in the first three years. Variation among individual plants in both experiments was so great it masked any treatment effects. No differences were recorded in flowering times or number of vegetative and flowering stems during the first growing season between Sarah Bernhardt and Duchess de Nemours with three levels of shade (0, 10, and 60 percent), used to delay spring snow melt and potentially delay flowering times.

A test market of Alaska peonies with a Los Angeles wholesale flower distributor affirmed that Alaska peonies meet market standards and may be sold for at least three times the value of peony stems sold during the major May–June market season. Alaska peony growers met for the first time and agreed to share information via the Internet at http://akpeonygrowers.blogspot.com.

### impact

Peonies as field-grown cut flowers have potential as a horticultural export from Alaska because harvest times occur in late June to August, when peonies from other world markets are not available. More than 30 Alaskans met in December and twelve indicated they had already planted peonies, most on a trial basis to identify hardiness and regional cultivation issues. Growers are located in Fairbanks, Delta Junction, North Pole, Nenana, Trapper Creek, Palmer/Wasilla, Anchorage, Kenai, Soldotna, and Homer.

## Potato field experiments in Palmer

Jeff Smeenk, Roseann Leiner, 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

Potatoes were planted and harvested in both replicated trials and single-observation demonstration plots at AFES in Palmer.

### progress

#### Aphid trial

Ten varieties or advanced breeding lines with suspected aphid tolerance/resistance were evaluated for marketable yield when grown under irrigated conditions in southcentral Alaska. The 2006 growing season had minimal aphid pressure. Several of the lines had comparable yields to those seen with Russet Norkotah. The variety Ivory Crisp had serious defect losses resulting in unacceptable marketable yields. The dark skin color of Stampede Russet generated quite a bit of grower interest but yields were unacceptably low.

#### Management spacing trial

Building on the results seen in the 2004 and 2005 trials, the increased spacing treatment was replaced with a higher-

density treatment for all varieties evaluated. In the 2006 growing season four varieties of white potatoes (BakeKing, Cal White, Russet Norkotah, Shepody), two red-skinned varieties (Cherry Red, Dark Red Norland), and the yellow-fleshed Yukon Gold were all grown under 7", 9", and 11" spacing. All varieties showed an increase in marketable yield (US #1 grade) with the higher-density plantings. At the 7" spacing yields were 7-30% greater than those seen with the standard 11" spacing. At the 9" spacing yields varied from no significant difference to a 30% yield increase. When averaged across the seven varieties, increasing plant density from 11" spacing to 9" spacing resulted in an 8% increase in yield of US#1 tubers. Increasing the plant density from 11" spacing to 7" spacing was associated with a yield increase of 14%. For the growers marketing B-sized gourmet potatoes, increasing the plant density also increased the yield of the small red potatoes and the small yellow-fleshed tubers that make up this specialty market. In the 2006 field season, under irrigated conditions, increasing the plant density from 11" spacing to 9" and 7" spacing increased yields of both US#1 tubers and the small B-sized tubers.

#### Late blight resistant material demonstration trial

Late blight was found in Alaska in the 2005 growing season. Potato breeders across the country were requested to send their late blight resistant advanced breeding material for horticultural evaluation. Luckily, late blight was not seen on the research farm and the nine varieties were evaluated for marketable yield under irrigated Southcentral conditions. Single plot yields indicated yield potentials ranging from 8-17 tons per acre. The marketable yields of the varieties Defender, NDA5507-3Y, and A00487-22 compared favorably to the station's potato standard, Russet Norkotah.

#### Horticultural management techniques affecting yield

Aphids, the vectors of several virus diseases of potatoes, are affected by crop conditions. Several irrigation and cover crop strategies were evaluated for their level of impact on marketable yield. Overall, the 10.2 T/A US#1 yield of the overhead irrigated control plot was lower than previous years for Russet Norkotah. The plots with canola, suspected to be an aphid antagonist, interseeded between the potato rows had yields about 10% lower than those of the control plots. The plots with oats, suspected to be an aphid attractant, had yields about 20% lower than the control plots. The plots that were irrigated with drip tape rather than overhead irrigation had yields about 10% lower than the control plots. The plots with no irrigation had yields that were about 30% lower than the control plots. The variety Green Mountain, which has a much larger canopy than Russet Norkotah, had yields that were comparable to the control plots. Collaborating entomologists are still compiling the aphid data associated with this trial.

#### Demonstration trials

About 240 varieties of potatoes were planted in single replicate observation plots. These were harvested, graded, and stored for most of the winter. The material was set out for display for a two-day Potato Demo Day. The growers and buyers that focus on the wholesale market tended to focus on the traditional varieties and were most interested in yield. The growers that focus of the public market were most interested in the novelty varieties.

#### Colored variety demonstration trials

About 200 selections of colored flesh breeding material from a USDA-ARS breeding program were grown for further evaluation. Manual evaluation of yield and flesh traits of this material identified 25 varieties to increase the amount of seed for further evaluation.



### impact

Fresh potatoes produced in Alaska are marketed on multiple fronts, including the organic, specialty, and wholesale venues. Management strategies such as varying plant spacing allow specialty growers options to maximize profits within their specific market. Genetic resistance is one of the best tools for combatting insects and plant diseases. By evaluating existing germplasm for Alaska conditions we can potentially identify varieties to recommend to Alaska growers when a specific insect or disease strikes. By observing many varieties growers and buyers have opportunities to see what is possible to grow under our conditions and to discuss marketing approaches to use with the different varieties of potatoes available.

## plant pest & disease control

### 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

### New virus affects native plants in Alaska

The genome of Nootka lupine vein clearing virus (NLVCV) was sequenced by collaborative efforts of the Subarctic Agricultural research Unit, Arctic Plant Germplasm Research Project and the University of Laval, Canada. NLVCV is taxonomically classified as a member in the family Tombusviridae and genus *Carmovirus*. The virus is closely related to three other pathogenic carmoviruses that may cause significant harm to plants. This research contributed to the technical aspects involved with species demarcation for carmovirus members, and impacted the list of new viruses that represent potential threats to crop plants.



### Rhubarb genetics

DNA analysis was conducted on rhubarb cultivars in the Palmer collection. Cultivar relationships were estimated, identifying a number of groups of related cultivars, a few cultivars appear to be distantly related. This information will help researchers to focus efforts to expand the genetic diversity of the collection.

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

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

purpose

Leaf rust is a viable biological control of blackberries in Australia, New Zealand, and Chile, but nothing is known of its effectiveness as an agent in Oregon. This study examines the effect of blackberry leaf rust on the defoliation of Himalayan blackberry at the Oregon coast, where the rust was accidentally introduced.

approach

Blimp photography is obtained during June for detection of blackberry leaf rust using remote sensing and to quantify blackberry coverage on our study site. Additional photos are obtained in October to quantify defoliation caused by the disease using time change analysis to evaluate the effectiveness of this biological control agent.

progress

When we returned for the second year of this study, we discovered that our site on private land had been listed for sale. The owner had mowed and bulldozed all blackberry plants. We found a new site on the Elk River. The Oregon Department of Agriculture withdrew funding because of a budget shortfall, so the October imagery was not obtained. However, other researchers confirmed our previous finding that some plants seem to possess some resistance or immunity to the disease. We are searching for alternative sources of funding to continue the work.

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.

## White mold species on vegetables

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

purpose

We studied white mold disease in Alaska, caused by fungi in the genus *Sclerotinia*, which is commonly found on broadleaved plants in flower gardens and vegetable fields.

approach

A field collection of *Sclerotinia* was made during September from five vegetable fields in Southcentral and three vegetable fields in interior Alaska,. Samples included three forms of fungi: white mold on decomposing plants, black sclerotia that survive the winter in soil, and cup mushrooms called apothecia, which produce airborne ascospores that can cause new infections on susceptible plants.

progress

The isolates of *Sclerotinia* were collected and stored frozen. We used microsatellite markers to collect genotype data on individuals of the two species of *Sclerotinia* in Alaska, which revealed that both populations of *Sclerotinia* species are predominantly non-recombining clonal lineages. While *Sclerotinia sclerotiorum* is known as a worldwide pathogen, *Sclerotinia subarctica nom. prov.* (provisional nomenclature) was previously unnamed and only reported from Norway on wild plants and to a very limited extent on cultivated potato. White mold in most fields in Alaska was caused by both *S. subarctica nom. prov.* and *S. sclerotiorum* together, and we have seen that these fungal species are capable of hybridizing. The experiments on survival black sclerotia indicate that the survival decreases to 75% in the first year on the soil surface, but remains higher when buried in soil.

impact

White mold disease affects vegetable yields worldwide. Our research brings information on two species in Alaska that may lead to more effective control of white mold in circumpolar climatic conditions.

## Foxtail barley (*Hordeum jubatum*) control with propoxycarbazone-sodium and fluazifop-p-butyl in three Alaska native grass species

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

purpose

For the Alaska native grass industry, foxtail barley is one of the most detrimental weeds. Its control is essential for improving seed production and stand longevity so producers

can meet statewide seed demands for revegetation projects. We sought to determine suitable chemical controls of foxtail barley for three different native grass species: 'Nortran' tufted hairgrass (*Dechampsia caespitosa*), 'Gruening' alpine bluegrass (*Poa alpina*), and 'Wainwright' slender wheatgrass (*Elymus trachycalus*), formerly (*Agropyron pauciflorum*).

### approach

Following preliminary field trials, greenhouse experiments were conducted during the winter of 2005–2006 at the Matanuska Experiment Farm in Palmer, Alaska, to determine the efficacy of propoxycarbazone and fluazifop. Final field experiments were conducted at the University of Alaska Fairbanks Experiment Farm and the Delta Junction Field Research Site during summer 2006. Plots were planted in fall 2005 using a randomized complete block design. Herbicide applications of propoxycarbazone and fluazifop were made in spring 2006 before shoot elongation. The plants were subjected to five different herbicide concentrations: 1X, ½X, ¼X, 1/8X and 0X, ranging from the highest level, the recommended field use rate from the label, to a control, which received no herbicide.

### progress

In field trials 'Nortran' tufted hairgrass was tolerant of propoxycarbazone. 'Gruening' alpine bluegrass and 'Wainwright' slender wheatgrass were not tolerant of either compound at the recommended field use rate, but showed greater tolerance of propoxycarbazone at the ½X rate. This experiment revealed that propoxycarbazone is a potential tool for foxtail barley control in 'Nortran' tufted hairgrass seed production.

### impact

Native grass seed is an important commodity for the continued ecological health of Alaska. Without suitable supplies of native grass seed, revegetation specialists will be forced to use nonnative plants in reclamation projects. The use of nonnative plants can be a source of invasive species. A stronger native seed production industry will ensure that native germplasm is being reintroduced in reclamation projects in Alaska.

## Integrated pest management strategies for Alaska agriculture

Alberto Pantoja, Dennis Fielding, Jeffrey Conn, Loretta Winton, Steve Seefeldt, Aaron Hagerty (ARS)

### purpose

Since 1973, winter temperatures in Alaska have increased by 2–3°C, 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, progress, and results

Bird vetch killed by herbicides in Alaska. Bird vetch (*Vicia cracca*) is a perennial invasive exotic weed that is expanding along roadsides and into open forests in Alaska. The herbicides 2,4-D, triclopyr, and clopyralid are effective for controlling seedling bird vetch. Selection of the appropriate herbicides and determining the rates and times of use are critical to obtaining the best results at the lowest cost, as the areas infested in Alaska have risen into the tens of thousands of acres.



#### Embryonic development rates in Alaska grasshoppers

The rate of development of grasshopper eggs in the soil is dependent on temperature, and differs among species and populations within a species. Developmental rates, from oviposition to diapause and from post-diapause to hatching, were measured at temperatures from 12° to 30°C in two populations of *Melanoplus sanguinipes* and in two other species. This information is necessary to evaluate the effect of vegetative ground cover on soil temperatures and grasshopper hatching dates, and to assess the effects of a warming climate on grasshopper population dynamics.

#### Cutworms in Alaska

Historically cutworms are known as damaging pests of vegetables in Alaska; however, the taxonomic identity of the species and their distributions was unknown. A three-year study identified the species present in an agricultural setting, and their population dynamics, distribution, and attraction to chemical lures. Ninety-four macro-Lepidoptera were identified from the three important agricultural areas of Alaska (Fairbanks, Delta Junction, Palmer); potential crop pests trapped include six cutworm species (*Apamea devastator, Xestia c-nigrum*, *X. smithi, Euxoa ochrogaster, Discestra trifolii*). The data on trapping methods, population density, and distribution will assist farmers, scouts, and integrated pest managers working on cutworms in the state.

#### New vegetable pathogen in Alaska

A new pathogen, *Sclerotinia subarctica nom. prov.* affected several vegetable crops in Alaska. The pathogen was first found in Norway on wild plants and later on potato but its ability to cause disease was not reported. Genetic markers from the DNA of *S. subarctica* were developed to examine the population structure and reproductive strategy of the new pathogen and to investigate possible hybridization with *Sclerotinia sclerotiorum*. The availability of these markers will be of use to researchers conducting population studies and developing management strategies for *S. subarctica*.

# High-Latitude Soils

## carbon

### Impacts of experimentally induced drought on soil respiration in interior Alaska

**David Valentine**

purpose

This study examines how experimentally induced summer drought affects the major process responsible for releasing carbon from ecosystems: soil respiration. We capitalized on the summer moisture exclusion sites (three replicate 10x15 m plots in both upland and floodplain landscape positions) that have been maintained by the Forest Soils Laboratory since 1989.



approach/methods

Soil respiration collars were established in July 2006 in three replicate summer drought and control sites in both upland (UP2A, UP2B, and UP2C) and floodplain (FP3A, FP3B, and FP3C) landscape positions. Soil repiration rates were monitored at biweekly intervals using a LiCor 6262 infrared gas analyzer, along with surface soil and air temperatures.

progress

Soil respiration rates were consistently and significantly lower in summer drought treatment sites than in the control sites in both upland and floodplain landscape positions. However, it is not clear yet to what extent differences in autotrophic respiration (root respiration) and heterotrophic (mostly microbial respiration) contributed to the overall difference in respiration. This will be addressed in subsequent growing seasons.

impact

Based on these results, we cannot yet conclude that drought has slowed soil carbon losses via respiration, as it is possible that much or all of the measured difference in soil respiration may be from changes in root respiration. However, a related study by Runck and others showed that drought has slowed the decomposition of standard substrates, strongly implying that at least some of the difference in soil respiration rates is due to changes in heterotrophic respiration, such that reduced soil carbon losses may in part ameliorate slowed aboveground productivity.

### Soils associated with pattern ground in arctic Alaska and Canada

**Chien-Lu Ping**, Gary Michaelson

purpose

We sought to characterize soils associated with pattern ground, especially nonsorted circles in arctic Alaska and Canada.

approach

A total of 65 soils were studied and sampled across the Arctic bioclimatic subzones from the Canadian High Arctic to arctic Alaska as a part of the National Science Foundation Biocomplexity project.

progress

We found the influence of nonsorted circles on soil formation appears to increase from north (Subzone A) to south (Subzone E) based on soil morphology. We also found that on close examination of soils in subzones D and E, nonsorted circles are more common but their appearance is masked at the surface by vegetation. They are closely packed under the surface organic mat, especially in Subzone E, where the vegetation includes significant amounts of low shrubs. Such a close packing of the nonsorted circle was noted by early researchers and it seems to be the end stage of nonsorted circle development. In addition to soil characterization, we studied the organic carbon stores in soils associated with the nonsorted circle landscape. Carbon distribution in a typical soil profile under an active nonsorted circle is not evenly distributed in the mineral matrix. Instead it appears as discrete chunks or bodies of organic material of different degrees of decomposition mixed in a reduced mineral matrix. The organic chunks taken from the lower active and the upper permafrost are of different C14 ages with maximum of 9,000 YBP. This suggests that surface organic matter was gradually frost-churned down and incorporated into the lower part of the active layer and then into the upper permafrost on a time scale of hundreds to thousands of years. However, most of the carbon deposited during the Holocene and cryoturbated onto the upper permafrost is within one meter depth and these carbon stores can be related to the biomass production.

impact

Soil characterization data provide the baseline soil data to the vegetation study group and also to the modelers. The total organic carbon stores measured in soils of the arctic tundra nearly double the early reported amount based on a rainfall model. This information means that the contribution of carbon from the Arctic in current global terrestrial carbon budget estimates should be increased. Results from the soil morphological study and chemical analysis suggest that cryoturbation mainly due to frost heave plays a controlling role in carbon sequestration in arctic tundra soils.

### Carbon flux and transformation across the arctic coast of Alaska

**Chien-Lu Ping**, Fugen Dou, Gary Michaelson

purpose

We sought to study the effects of arctic coastal erosion on carbon transformation across the shoreline.

approach

During the 2005 field season a total of 25 sites, including one intensive site, were studied and 285 soil/permafrost horizon samples were taken. During spring 2006, 68 sediment samples were taken from four sites near Barrow. During the 2006 summer field season, 272 soil/permafrost samples were taken from 29 study sites, including two intensive sites, one

at Prudhoe Bay and the second at Barter Island. These sites include coastal marshes/tidal flats, bluffs with elevation up to 10 meters, and sites ranged across the coast from the Eilson Lagoon north of Barrow to the coastal bluff east of Barter Island.

At each site, the physiographic characteristics (including landform, microtopography, GPS position, coastal bluff elevation, and vegetation community) were evaluated and recorded. Site characteristics, permafrost, ice content, and soil morphology were studied and recorded. In addition to sediments, samples were taken on the beach and in shallow waters. Wave-monitoring cameras were installed at one of the additional intensive sampling sites. A total of 289 soils and permafrost samples were taken for soil characterization analysis. Laboratory analysis underway includes carbon content, bulk density, and particle size distribution. There were 100 samples taken for the incubation experiment that was started at the BASC facility in Barrow and continued in the laboratory at the university. Sixteen additional samples were taken from seven sites for radiocarbon dating.

### impact

The project provided a rare opportunity to train a graduate student in terms of arctic tundra ecology, permafrost landscape, and field techniques. It also provided the opportunity for the ecologists, soil scientists, and geocryologist to work together to look at the common topic of coastal erosion, and to coordinate their effort and discuss the relationships between permafrost and coastal erosion. According to our preliminary estimates, annual erosion across 1,900 miles of the Beaufort Sea coastline (based on an average depth of five feet of coast bluff and an average of six feet of coastline) is causing the release of more than 400,000 metric tons of organic carbon into the Arctic Ocean and more than 500 tons of carbon dioxide and six tons of methane gas into the atmosphere. Annual loss of land to the Arctic Ocean is estimated to be 2,000 acres.

## Land use changes and properties of soil dissolved organic carbon

**M. Zhang, S.D. Sparrow**; S. Seefeldt (USDA-ARS Subarctic Agricultural Research Unit)

### purpose

Labile soil organic carbon (readily usable by microorganisms) is associated with soil nutrient status, and the most labile carbon source is water-extractable organic matter (WEOM). Although it represents only a small fraction of total soil organic matter content, WEOM affects soil biological activities, the fate of metals in soil, and soil formation. This research examines WEOM characteristics under different land uses. In the mid 1970s, forest land in the area of Delta Junction, Alaska, was converted to agricultural use. Later, under the USDA Conservation Reserve Program (CRP), some of this acreage was retired from production. This provided three types of land use from which samples were taken. Soils in the area developed from loess overlaid on stream outwash materials; they have less than 10% clay and are low in soil organic matter content.

### approach

Soil samples (Volkmar, Aquic Eutrocrepts) were taken in October, 2005 at 0 to 15 cm depth. To determine the size distribution of WEOM, fresh soil samples were sieved (<2 mm), and extracted with distilled water at a 1:10 of soil:water ratio. The extraction solutions were sequentially filtered through Millipore membranes of 1.6 µm (large), .45 µm (medium), and 1 kD (small). Solution pH and electrical conductivity (EC) were determined. Also measured were concentrations of alumninum (Al3+), iron (Fe3+), calcium (Ca2+), magnesium (Mg2+), copper (Cu2+), zinc (Zn2+), potassium (K+), and soluble carbon.



The quality (type of organic compounds) of WEOM in soil can be determined using a UV-Vis (ultraviolet through visible light spectrum) spectrometer. The spectra of UV-Vis were measured for each size fraction. Soil scientists use the ratio of E4/E6 (absorbance at 465 nm to that at 665 nm) to characterize the aromaticity of soil humic substances).

### progress

For the three land-use types, in each size fraction there was no statistical difference in solution pH (~6.3) and EC.

Land use affected trivalent and divalent cation concentrations in different size fractions of WEOM. For forest and CRP soil samples, most aluminum and iron was found in the large-size fraction and most calcium was found in the medium-size fraction. In the agricultural soil samples, more aluminum and iron was found in the medium-size fraction, and more calcium was found in the smallest-size fraction.

For all samples, the E4/E6 ratio for WEOM was similar in the large- and medium-size fractions. For the smallest size fraction, the E4/E6 ratio was smaller in forest samples than in CRP and agricultural samples, which demonstrates a high condensation of aromatic constituents. Among the three land uses, soluble organic carbon was highest in the agricultural land samples.

### impact

This ongoing study is providing information on the properties and status of dissolved organic carbon under different land uses in interior Alaska, which will help researchers understand soil development under these conditions and soil changes that result from the retirement of agricultural lands.

# fire-related studies

## Black spruce forest soils in boreal regions of Alaska

**Chien-Lu Ping**, Edmond Packee

### purpose

We are studying the morphological, chemical, and physical properties of soils associated with black spruce forest stands on different landforms.

### approach

To select representative sites for black spruce growing in different environments, we chose the study sites jointly with a forest management specialist. There are two categories of soil sampling sites; one is to pair-sample the soils in burned and unburned black spruce forest stands, and the second is to sample the soils associated with Permanent Sample Plots in interior Alaska. Soils pits are excavated at each selected site and morphological properties studied. Soil samples are collected according to Soil Survey Manual and shipped to the USDA-NRCS National Soil Survey Laboratory in Lincoln, Nebraska, for full characterization. At each site, soil samples are subsampled and sent to Palmer Research Center Laboratory for organic carbon, charred organics, and soil fertility analysis. For soils with permafrost, core samples with known volume are taken for bulk density and ice volume or water content determination. 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*, and the quantity of charred organic carbon or black carbon determined. Selected samples are radiocarbon dated.



### progress

The investigation of the physical environment and soil properties was extended beyond black spruce stands in the Northern Forest region of Alaska. During the 2006 field season, six aspen stands were added from the Permanent Sample Plots and the Site Index Plots of the ongoing Alaska Forest Growth & Yield Program. Soil descriptions from additional plots will permit results of both studies to be tied together. In the region's northern part, many aspen and birch stands occur as islands that occupy high knobs and terraces in the black spruce forest. Most of these mixed to pure stands grow in well-drained to somewhat excessively drained soils formed in either coarse to medium-textured glacial deposits, such as eskers, kame terrace, outwash, or in residuum from fractured bedrock. Dominant textures are sandy loam and loamy sand with a gravelly or cobbly modifier. Preliminary data indicate that soils associated with most aspen sites have nearly neutral to slightly alkaline reactions, whereas the birch sites have slightly acid reactions. Because of the coarse texture and the exposed positions of the aspen sites, most profiles have carbonate undercoating on rock fragments, evidence of strong evapotranspiration and net moisture deficiency. Some profiles have carbonate undercoating throughout the profile; this indicates modern soils formed in older deposits, presumably of Pleistocene age. Wildfire is a common and frequent disturbance feature in aspen stands as well as black spruce stands. Charcoal was found throughout the soil profiles with a concentration in surface and upper subsurface horizons.

### impact

Based on current climate models, the region will become warmer and drier. As this happens, the permafrost under the black spruce forest will gradually thaw and the soil will be warmer and drier; ultimately, aspen will expand at the expense of the black spruce.

## Soil black carbon stocks are not related to patterns of charcoal production from past wildfires in interior Alaska: a comparison of lake sediment and terrestrial records

Evan Kane, **David Valentine**, Bruce Finney

### purpose

A crucial first step in managing for increased carbon sequestration in boreal forest soils is to determine the lasting effect of variations in the fire cycle on soil carbon accumulation. We sought to assess the historical relationship between fire frequency (as indicated by charcoal amounts in lake sediment cores) and soil carbon storage at sites near those lakes in interior Alaska. Suppressing fires in boreal forests for the purpose of sequestering carbon would only make sense if there is a substantially negative relationship between historic fire frequency and carbon accumulation rates.

### approach

We assessed the historical relationship between fire frequency and soil carbon storage by analyzing forest soil carbon content in areas adjacent to lakes in which fire histories had already been determined through 14C-dating of charcoal found in sediment cores. To determine the implications of fire as a source of carbon to slowly turned over pools, charcoal was quantified in the surface mineral soil, which contains the products of past fires, at different landscape positions that exhibit high, medium, and low 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.

### progress/result

This study is now complete. We have quantified organic matter fractions and charcoal pieces along the gradients, as well as changes in their composition. From stable isotope analyses, we determined that light fraction soil organic matter (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.

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). These data suggest that lake record charcoal deposits do not track terrestrial black carbon accumulation across four lakes in interior Alaska.

### 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. As yet unknown is how charcoal accumulation varies with stand production or landscape position, and what the net impact of fire on carbon stabilization via charcoal production is. This study suggests that increased fire frequency (as determined from long-term lake charcoal records) does not necessarily relate to increased soil charcoal accumulation (as determined from the long-term accumulation of black carbon).

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

Evan Kane, Eric Kasischke, **David Valentine**, Merritt Turetsky, A. Dave McGuire

### purpose

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. Although the fraction of soil organic carbon (SOC) released to the atmosphere in boreal forest fires can be considerable (between 16%-100% of SOC stock), little is known about the amount or fate of fire-transformed carbon in soils. Pyrogenic carbon in soils exists along a continuum from partially-charred plant material to more graphitic black carbon particles, owing to microclimatic variation in burn temperature, burn duration, fuel type, and oxygen availability during a fire. While these factors make black carbon in soils difficult to consistently identify, its composition of highly aromatized components affords operational definitions based on its resistance to thermally and chemically oxidizing conditions. Decay-resistant black carbon therefore represents a sink for rapidly cycling carbon between the atmosphere and biosphere, and is thought to comprise a significant amount of net biome production in fire-prone ecosystems. The contribution of black carbon to very slowly cycling SOC pools should increase with successive fire cycles. However, black carbon stocks that have accumulated over time could be subject to combustion during severe fire activity, making it difficult to ascertain the carbon legacy of past wildfires.

### approach

We focused on processes that regulate the depth of burning, as well as SOC and black carbon accumulation in the soils of black spruce forests in interior Alaska. We capitalized on the extensive wildfires that occurred in Alaska during summer 2004, which burned a record 2.7 x 106 ha. Sites included opposing north- and south-facing toposequences and adjacent foot- and toe-slopes in forests affected by these recent as well as older (~1860–1950) fire events. Since duff moisture exerts major control over the severity and extent of burning within a given wildfire, we hypothesized that the relative amount of surface fuels consumed would be higher on southerly slopes compared to north-facing and toe/foot-slope forests.

Because organic horizon carbon stocks are vulnerable to burning, we looked at black carbon accumulation at the organic/mineral soil interface (A horizons) to investigate long-term pyrogenic carbon accumulation across sites. We expected to find greater black carbon accumulation in south facing forests because more complete consumption of shallower, dryer organic soils should increase the likelihood of black carbon integration with surface mineral soil, where it is more likely to be protected from consumption in subsequent fires.



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. Specifically, 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

This study is now complete. The fraction of the surface organic layer depth consumed in wildfires was lower on the flat toe-slopes (39%) than on the north (56%) or south (69%) facing aspects. Total pre-fire organic layer depths estimated from residual tree root collars were significantly higher on flat and north facing aspects (27.5 ± 1.5 and 24.5 ± 1.2 cm, respectively) than on southerly slopes (18.5 ± 1.1 cm). In the Boundary and Porcupine unit fires of 2004, a greater proportion of total SOC was consumed on south-facing aspects (4.9 ± 0.3 kg SOC m-2) than on both north-facing (4.0 ± 0.3 kg SOC m-2) and toe-slope (flat) (3.2 ± 0.3 kg SOC m-2) landscape positions. Residual SOC was mostly contained within the moderately decomposed mesic horizon, and north-facing and flat areas harbored approximately 2.2 times the SOC in this horizon after wildfires than did south-facing aspects.

The proportion of fire-derived black carbon to SOC varied significantly between aspects in accordance with measured fire consumption amounts, with south facing forest soils having a black carbon to total organic carbon ratio approximately 1.7 times higher than was measured in north-facing forests. Similarly, surface mineral soil black carbon stocks and black carbon: total organic carbon both decreased with increasing soil moisture content at all sites, except one permafrost-dominated site. The A horizon black carbon stocks were higher in the warmer, drier forests where turnover of other carbon fractions was higher. The A horizon mean carbon turnover rates were lower in the cooler (wetter) forests, and the ratio of black carbon to total organic carbon increased with increasing rates of of dense fraction carbon turnover.

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. However, it is not yet known how charcoal accumulation varies with stand production or landscape position, nor the net impact of fire on carbon stabilization via charcoal production. In this study, black carbon comprised more of the total SOC pool on warmer, drier, south-facing aspects than in wetter forests with greater organic matter accumulation. While the relativity between total SOC stocks and the size of their most labile pools still needs to be explored, these findings suggest that fire may be a mechanism of soil carbon stabilization that has otherwise been hard to quantify. These findings are important in considering the sensitivity of SOC balance to changing climate and increasing fire extent.



# phosphorus

## Characteristics of nitrogen and phosphorus release from fish meals and fish hydrolysate in subarctic soils

**M. Zhang, S. Sparrow**; P.J. Bechtel, A. Pantoja (ARS)

purpose

The expansion of organic farming in Alaska demands alternative nutrient sources for crop production. Annually, more than 1,000,000 metric tons of fish byproducts are produced by Alaska fishing industries. These byproducts are rich in nitrogen and can be processed and used as a nutrient source for crop production. The first objective of our research was to determine rates of nitrogen and phosphorus release from 1) protein hydrolysate made from salmon byproducts; 2) commercial fish meal made from Alaska pollock byproducts; and 3) commercial fish bone meal made from Alaska whitefish byproducts. The second objective was to develop simulation models for predicting fish meal nitrogen release in the field.

approaches

Two soils with or without fish meals at 100 ug N g-1 soil were incubated at 10 and 15°C for 56 days in the laboratory, or placed in plastic bags and incubated in the two fields. Soil samples were taken during the incubations and mineral nitrogen and Melhich 3 phosphorus were analyzed. Single, double exponential models were used to simulate mineral nitrogen release. Field experiments with barley were also conducted in the Delta Junction and Fairbanks areas. Plant tissues and soil samples were taken during the growing season. Plant biomass in response to fish meal application, and nitrogen and phosphorus concentration in plant and soil samples were determined.

progress

The cumulative mineral nitrogen release of three fish meal products followed a typical two-stage release pattern, i.e. a fast release phase until seven days followed by a slow release phase. In the laboratory, the amount of mineral nitrogen released in 56-day incubation was rather similar among the three fish meal products in two soils. The nitrification rate was faster in one soil than the other. There was very little phosphorus release during incubation. The single exponential model was suitable for simulating nitrogen release for fish meals, and that was validated by the field incubation results. Nitrogen and phosphorus concentration in plant tissues were analyzed and data analysis on plant biomass response to fish meal application and total nitrogen and phosphorus uptake is being conducted.

impact

Results from 2006 were presented at the Sustainable Agricultural Conference in Fairbanks, and were well received by producers. Fish meals are common nutrient sources used by organic growers in Alaska, yet their nutrient release characteristics are not fully understood. The research results from this project fill the information gap of nutrient release from fish meals, and will serve as a user guideline for fish meal applications.

## Soil phosphorus status under 23-year tillage and straw management in a subarctic soil of Alaska

**M. Zhang, S. Sparrow**, B. Van Veldhuizen, d. masiak.

purpose

Wind erosion is a problem for arable land in the Delta Junction area, and no till-practice has been promoted to preserve the soil. A management study started in 1983 to determine the impact of tillage, straw management, and nitrogen fertilizer application rate on soil properties and barley (*Hordeum vulgare* L.) grain yield. For more than twenty years, phosphorus was applied to land in the area, but the status of phosphorus was unknown. The amount of extractable soil phosphorus in soil is important, because phosphorus accumulation in soil creates a potential runoff risk that will cause fresh water eutrification.

approaches

In spring 2006, soil samples were taken at 0-5, 5-10, and 10-15 cm increments from no-tillage, disk-once, and disk-twice treatments with or without straw retention. We air-dried soil samples, extracted the phosphorus, and determined cation concentrations (Ca2+, Mg2+, Na+, Cu2+, Zn2+, Fe3+, and Al3+) and one-point phosphorus adsorption in soil of 0-5 cm depth. Since 1992, phosphorus concentration in grain has been measured and total uptake in grain samples calculated. Water-extractable phosphorus and the release of the absorbed phosphorus in water will studied.

progress

In the 0-5 cm depth range, phosphorus concentration tended to be higher at the 0-5 cm depth for no-tillage treatments than conventional treatments, indicating phosphorus stratification in the soil profile was due to no-tillage practice. Similar results have been reported in the literature.

The amount of phosphorus adsorption increased as the soil sampling depth increased. We are analyzing the relationship between total plant phosphorus uptake data and soil phosphorus status.

### impact

Information on soil phosphorus status after longtime application under different tillage conditions will be used to guide phosphorus applications in the farm soils in the Delta Junction area.

# Management of Ecosystems

## climate research & global change

### Alaska climate change

**Glenn Juday**

#### purpose

This project continues to examine the influence of weather, especially weather 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

Long-term records of daily, seasonal, and yearly temperature and precipitation 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

The Fairbanks Airport/University Experiment Station (UES) station has the longest continuous interior Alaska climate record. Fairbanks/UES is broadly representative of trends across much of central Alaska and correlates well with tree growth and other annual events. The steadiest temperature trends in quality-assured data at Fairbanks (First Order weather station from 1948) are the reduction in number of days colder than –20°F (from 57 to 34 days) and –30°F (from 35 to 15 days), and the increase (1.5°C) in the mean of daily low temperatures during the potential warm season of 1 April through 30 September. The strongest trend in daily high temperatures is the increase in number of days 71°F or warmer.

#### impact

The pattern of recent warming that has occurred in interior Alaska is particularly favorable for increased overwinter survival of organisms that are sensitive to extreme cold, organisms that benefit from longer average growing seasons with less risk of frost even in cooler years, and organisms that require the accumulation of a threshold number of days above 70°F for optimum development. Several insects species with such temperature sensitivities and which feed on trees have experienced high population levels in recent years in interior Alaska, and these insects are at outbreak population levels.

### Browning of boreal Alaska

**Dave Verbyla**

#### purpose

Over the past twenty years there has been a significant increase in satellite vegetation index values in arctic Alaska associated with climate warming. Some regions of boreal Alaska have experienced tree drought stress, increased insect and disease infestations, wildfire disturbance, and shrinking pond areas; the trend in satellite vegetation index values may differ in interior compared to arctic Alaska.

#### approach

I analyzed bi-month satellite vegetation index values from 1982 through 2003 by ecoregion across arctic and subarctic Alaska. For each 8-km pixel, the maximum vegetation index value was retained for each year and averaged for each ecoregion. The trend of these mean values from each ecoregion was recorded for the period of 1982–2003.

#### progress

The strongest increasing trend in this index was from the Arctic Coastal Plain. This may be due to increased vegetation growth associated with climate warming. For boreal Alaska, there was a decreasing trend in the vegetation index during the same period. Eastern interior Alaska had the strongest decreasing trend; this region has the warmest growing season and may experience the most drought stress. The decreasing trend in the vegetation index may be due to several factors associated with a warmer, longer growing season, including a decrease in leaf production and increase in root production in response to drought, and increased insect and disease infestations.

#### impact

Satellite-derived vegetation index patterns are dramatically different in arctic relative to boreal Alaska, with increasing values occurring north of the Brooks Range, and decreasing values occurring in interior Alaska. The regional trend in decreasing vegetation index values in boreal Alaska is important: a warming climate may lead to decreasing production and increased tree death in eastern boreal Alaska.

### Resilience and Adaptation Program / IGERT

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

#### purpose

The graduate training program in Resilience and Adaptation (RAP) trains 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 RAP is sponsored by the National Science Foundation (NSF) through its Integrated Graduate Education Research



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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 systems and their resilience and adaptation.

### approach

The program is open to masters- and PhD-level students of participating departments. PhD students are supported with an IGERT Traineeship 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, Adaptive Management & Integrated Assessment, and the Resilience Seminar. All courses are taught by faculty team with expertise in the social, economic, and ecological dimensions of sustainability . Students participate in summer internships after their first year 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 inquiry.



### progress

In 2005-06 more than 50 graduate students were enrolled in RAP, with 37 at the PhD level. SNRAS has assumed a lead role in RAP through faculty participation and the involvement of interdisciplinary PhD and natural resource management graduate students. Examples of current research topics of graduate students working with SNRAS faculty include: Regional climate, federal land management, and the social-ecological resilience of southeastern Alaska;

The effect of agency culture on institutional performance: a comparative study of marine mammal co-management regimes in Alaska; Use and implementation of community sustainability indicators in public decision making; salmon, suburbia, and sustainability: Can Kenai River Chinook Salmon survive watershed land-use changes?

### impact

The UAF IGERT has strengthened interdepartmental cooperation across campus and generated a greater drive to consider sustainability in the Alaska context. The 2005-06 was the fifth year of the five-year IGERT grant. A renewal of the IGERT grant was submitted in 2006 and the program has been recommended for five more years of funding.

## Monitoring seasons through global learning communities

**Elena B. Sparrow**, Jessica H. Robin, Leslie S. Gordon, Kim Morris, **David Verbyla**, Rebecca Boger, Elissa Levine, Martha R. Kopplin, Martin Jeffries

### purpose

Our main objectives are 1) to provide K-12 teachers and their students opportunities to participate in Earth system science research and the fourth International Polar Year (IPY) by conducting investigations on their biomes, and 2) to use such research and activities to teach and learn about the nature of science, inquiry, and science process skills, and to integrate use of technology to support classroom learning.

### approach

Rural and urban Alaska K-12 teachers, as well as teachers from other parts of the United States and the world, will be provided professional development (PD) workshops to engage their students in studying seasons and investigating their biomes using the "Earth as a system" approach. By monitoring the seasons, students will learn how interactions within the Earth system affect their local environment and how their local environment in turn affects regional and global environments. During the PD institutes, teachers will learn to use standardized scientific measurements developed by the Global Learning and Observations to Benefit the Environment (GLOBE) program and other Earth System Science research programs and best teaching practices in inquiry- and project-based learning. New protocols will be developed and other protocols adapted as needed to help teachers and students monitor seasons (internannual variability) in their biomes. Teachers and students will also be connected to scientists from three Earth systems science programs: the International Arctic Research Center at the University of Alaska Fairbanks, and the NASA Landsat Data Continuity and Terra Satellite Missions, and hopefully to other such programs in other countries.

### progress

A project website was established. Posted there were a project summary, description of land biomes, a biome questionnaire, and frequently asked questions (www.globe.gov/fsl/html/templ.cgi?seasons&lang=en&nav=1). The questionnaire on what type of biome students have close to their schools was sent out to get teachers, and students started in the Monitoring Seasons Through Global Learning Communities (MSTGLC), also called Seasons and Biomes project. Project materials have been translated into Spanish, French, and Arabic through the help of GLOBE Country coordinators. The first year of the project focuses on the taiga and tundra biomes to coincide with the International Polar Year. Application forms for the international PD workshops were also developed. In early August, 2006, a poster and an oral presentation/discussion about the MSTGLC project were given at the Annual GLOBE meeting in Phuket, Thailand. A poster paper was also presented at the American Geophysical Union Fall Meeting in San Francisco, Dec. 11-15, 2006.

### impact

The project is expected to help teachers teach students understand Earth as a system, and learn science through inquiries about their local environments, and to contribute to critically needed Earth system science data to help validate remotely sensed data, which are essential for understanding regional climate change and better understanding of polar and other regions.

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

**Gary Kofinas**

### purpose

Community-based ecological monitoring is 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 the issues of concern in monitoring. Seven communities in Alaska and Canada participate in the program, along with US 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 program is to understand what is changing and why (see www.taiga.net/coop).

### approach

The 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 adds to 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 have been developed between Alaska's two Long Term Ecological Research (LTER) programs and the Knowledge Co-op's community-based monitoring to understand changes in ecosystem services and human responses to those changes. The program provides a ten-year trend analysis of local knowledge and science-based indicators, which is fostering greater cooperation between researchers and Alaska Native communities.

### impact

The Ecological Knowledge Co-op serves as a model for newer 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 (SNRAS); 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 was completed and numerous model simulations were conducted. A manuscript describing our conceptual approach was published at Mitigation and Adaptation Strategies for Global Change. The manuscript appeared in a 2006 special issue resulting from the International Boreal Forest Research Association conference held in Fairbanks in May 2004. The results of this project were used to develop a new National Science Foundation proposal that was funded in 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.

## Collaborative research: impacts of climatic change on the boreal-forest fire regimes of Alaska: lessons from the past and prospects for the future

Feng Sheng Hu, Philip Higuera (Univ. of Illinois); **T. Scott Rupp**, Mark Olson (SNRAS)

### purpose and approach

This project confronts the currently poor understanding of fire responses to climatic change in Alaska by integrating paleorecords and computer modeling. The project centerpiece

is its innovative and rigorous approach to understanding patterns and mechanisms of climate-fire-vegetation interactions from the recent geological past through the near future. The researchers will monitor charcoal processes (dispersal, transport, and deposition) of contemporary and recent burns to parameterize a newly developed numerical model of charcoal-fire relationships (CharSiM), a tool that greatly enhances the rigor of fire-history reconstruction. The resulting knowledge will be applied to interpret fire histories of the past 6,000 years (focusing on the neoglacial transition and oscillations associated with the Little Ice Age). Sediment charcoal data will be collected with statistical criteria in two study areas that are characterized by contrasting fire regimes and recent climate anomalies. These fire records will be compared with climatic and vegetational reconstructions using state-of-the-art paleoecological and geochemical techniques. An iterative paleodata-modeling approach will be applied to elucidate mechanistic processes of climate-vegetation-fire interactions (e.g., lead-lag relationship, fuel dynamics) using ALFRESCO, a model developed and well tested for studying Alaska boreal ecosystems. The improved ALFRESCO will be used to simulate regional fire regimes for the next 100 years based on a suite of forecast climate scenarios.



progress

This project is just beginning, with a focus on coordinating field logistics and collecting paleodata. The modeling component (Principal Investigator Rupp's responsibility) of this study will not begin until fall 2007.

impact

This project promises to bring new insights into the variability of boreal fire responses to climatic change and to improve the robustness of a key model for predicting future changes in boreal ecosystems. The prognostic simulations of the twenty-first-century fire regimes will be directly relevant to fire management planning and policy.

### 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 2007. 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.

## fire-related studies

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

**Dave Verbyla**

purpose

I sought to assess the utility of a remotely sensed index for monitoring burn severity trends in Alaska.

approach

The normalized burn ratio (NBR) is a remotely sensed index developed to map burn severity in the western United States that is used in a national program to monitor burn severity over years and among wildfires. However, in Alaska the effect of sun angle on burn severity estimates may be significant because the solar elevation changes substantially from June through September. I used satellite images of the 2004 Boundary Burn, near Fairbanks, to assess the effect of changing sun angles on the NBR.

progress

When a time series of images of unburned areas in black spruce forests with similar stand characteristics were examined, I found that normalized burn ratios decreased from June through September. Since the differenced normalized burn

ratio is computed as prefire-postfire NBR, the magnitude of burn severity estimates can vary depending upon the timing of prefire image used. I assessed the effect of topography on burn severity estimates by computing a differenced NBR from two postfire images and examining the values across a computed solar radiation gradient. As computed solar radiation decreased, there was a negative bias in values. Thus, fire severity estimated from remote sensing would be underestimated for stands in valley bottoms dominated by topographic shading or on steep north-facing slopes oriented away from incoming solar radiation. This is especially important since highly flammable black spruce stands typically occur on such sites.

### impact

This research demonstrated that changes in solar elevation and topographic effects can substantially influence fire severity estimates from the NBR. If the satellite images used vary by date it would be difficult to monitor trends in burn severity in time or space among wildfires.

## 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 (SNRAS); 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. 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. Additional research has focused on statewide simulations of future fire regimes based on the Intergovernmental Panel on Climate Change's climate projections.

### 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.

## Quantifying the effects of fuels reduction treatments on fire behavior and post-fire vegetation dynamics

**T. Scott Rupp** (SNRAS); Roger Ottmar (USFS); Bret Butler (USFS); Robert Schmoll (AK Division of Forestry) Randi Jandt, Kato Howard (BLM Alaska Fire Service); Skip Theisen (BLM)

### purpose and approach

Concerns about wildland fuel levels and a growing wildland-urban interface have pushed wildland fire risk mitigation strategies to the forefront of fire management activities. Mechanical (e.g., shearblading) and manual (e.g., thinning) fuel treatments have become the preferred strategy of many fire managers and agencies. However, few observations exist that document the actual effect of different fuel treatments on fire behavior. Alaska's federal and state fire management agencies have identified this "data gap" as their most important fire science research need and priority. Our project will quantify the effects of different mechanical and manual fuel treatments on fire behavior and transfer that information to the federal and state fire management community through a series of technical reports and peer-reviewed journal articles.



### progress

Our study site at the Nenana Ridge Ruffed Grouse Project Area located 30 miles southwest of Fairbanks, Alaska represents an ideal location because of its proximity to Fairbanks, existing road network, and large area (600 acres) of homogenous black spruce fuels. In spring and summer 2006 two experimental burn units (approximately 200 acres each) were laid out. Within each burn unit four five-acre fuel treatment plots were established on which two shearblade treatments and two 8 x 8 ft thinnings pruned to 4 ft were carried out. We inventoried the existing vegetation, including ground vegetation, understory and overstory trees and tree crowns, organic layer, and dead-down woody surface fuels throughout the treatments and surrounding control vegetation matrix. Following treatments we re-inventoried the understory and overstory trees and tree crowns, organic layer, and dead-down woody surface fuels. In the 2007 fire season, provided favorable weather conditions and available fire operations resources, we plan to burn each unit separately—documenting fire behavior from the time of ignition until steady state behavior ceases—using a combination of cameras, video, direct observations, and thermal dataloggers. Consumption plots will be located in both treatment units (thinnings and shearbladings) and the control vegetation. Postfire vegetation recovery, following initial postfire vegetation measurements, will be documented in all treatments and the control vegetation matrix for the duration of the project.

### impact

We anticipate that this research will lead to the first quantified tests of the effects of fuel reduction treatments on fire behavior in Alaska. Our results will provide the data required by fire behavior models (FARSITE, BEHAVE, and NEXUS),

fuels characterization system (FCCS), and fire effects models (CONSUME). We also hope to develop guidelines directed at sampling design and methodology issues that can be used to assist in carrying out other experimental burns when the opportunity arises.

# forests

## Evapotranspiration from boreal forest landscapes

**John D. Fox, Jr.**



### purpose

My goal is to assess which of several methods for estimating potential evapotranspiration and actual evapotranspiration are most suitable for management purposes in Alaska's boreal regions. Evapotranspiration is the component of the landscape's water budget that is very sensitive to changes in vegetative cover and land use, including timber harvest, wildfire, and climate change. Since annual precipitation and annual lake evaporation are thought nearly equal in magnitude in Alaska's boreal forest, small changes in evaporation or precipitation can effect the net water gain or loss in a water body. This warrants a better understanding of the evaporative process and a more reliable method of calculating it under specific conditions. This project will help develop that capability.

### approach

I am reviewing methods used and values obtained for potential evapotranspiration and actual evapotranspiration reported for Alaska in the literature. For simple to complex PET methods, I am assessing their sensitivity to the methods for estimating net radiation and the particular wind function used. I will use water balance accounting models to estimate actual evapotranspiration and sensitivity to data sources and assumptions, and will estimate open-water evaporation from a closed lake using short-term lake level measurements.

### progress

A 2006 analysis of global solar radiation and sky cover led to a greatly improved statistical relationship that determines the mean monthly Kt value (the ratio between ground level, global solar irradiance, and top-of-the-atmosphere solar irradiance) as a function of mean monthly sky cover and an index of mean monthly optical air mass. This relationship has been tested with data from around the United States and, in most cases, shows improvement over regressions developed with sky cover alone. This should lead to improved estimates of global and net radiation values for use in characterizing the spatial and temporal variability of potential and actual evapotranspiration. I have reviewed the methods of Linacre (1993,1994), which have been used recently to analyze pan evaporation trends in Australia (Rotstayn et al, 2006); they should be useful in deriving locally based "pan coefficients" for Alaska. This "PenPan" method will be programmed and tested in 2007.

An evaporation pan was installed and equipped with a recording device that allows unattended readings of pan evaporation every 15 minutes. Preliminary readings show evaporative loss occurring throughout the night-time period under some conditions.

A second year of under-ice measurements of lake level showed an initial drop in lake level followed by a relative lack of decline during the latter part of winter. This represents a discrepancy between two winters' estimates of net groundwater flow, which may represent natural variability or may indicate that an equilibrium has been reached in 2006 with respect to subsurface inflow and outflow rates. More years of data are needed.

### impact

Progress in 2006 helped two undergraduate students with their senior thesis projects and will enable better estimates of energy inputs to ecosystems and landscapes, and in turn, better estimates of evaporative losses.

## Forest Management Community Types

Tom Malone, Edmond C. Packee, Sr.

### purpose

This project is an effort to provide an open-ended system of community type descriptions that can be expanded as new information becomes available. A Forest Management Community Type is a landscape description that includes overstory plant community, understory plant community, and soil units. The types are used to help make management decisions. There has been no comprehensive effort to develop these types for Alaska, although local characterizations of some or all of the community characteristics are available for some management units and local areas. Each community type describes what is there now and does not by itself imply a potential successional condition (climax or seral). Emphasis is on the forest, so the overstory unit is the forest cover type. Forest cover types developed for North America inadequately describe the cover types of the Northern Forest of Alaska.

### approach

We will identify and describe the forest cover types present in the Northern Forest, using existing Permanent Sample Plots (PSPs), other forest growth and yield plots, and published and unpublished community and soils information, to identify understory communities. Data will be entered into a spreadsheet and sorted using the appropriate computer program. Initially, only a catalogue of community types will be produced.

### progress

During 2006, data collected from permanent sample plots were placed in a matrix as an initial effort to develop community types. Potential forest cover types were identified.

### impact

Forest Management Community Types facilitate management decisions. Unit descriptions allow managers to extrapolate the results of management practices from one specific unit to similar units.

## 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. I sought to document the decomposition dynamics of logs at interior Alaska forest sites.

### approach

A series of logs are positioned on the forest floor to observe long-term decomposition. Fifteen 4-meter logs are placed on the forest floor in six replicate stands for each major upland and floodplain vegetation type, and will be resampled during the next 100 years. The field sampling of the logs that have been in place for 10 years was started in 2004 and was completed in 2007.

### progress

All time-zero, two-, five-, and ten-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. The five-year sample will be started on a number of the initial sites in 2007. The initial results indicate that alder displayed the highest decomposition rates with only 38% of its original weight remaining after 10 years, while floodplain white spruce and birch showed the slowest rates, with 70% remaining after 10 years.

### impact

At this time it is unclear what effect coarse woody debris has on the carbon dynamics of the taiga forest in interior Alaska. The results of this study will help to develop a clear picture of log decomposition dynamics on the carbon balance of forests in interior Alaska.

## Permanent Sample Plots (PSPs) for stand characterization

Thomas Malone

### purpose

Permanent Sample Plots (PSPs) characterize stand and community species composition, structure (tree height, diameter, cubic-foot volume, basal area, and number per acre), height of forest canopy, understory shrub species, tree regeneration, tree mortality, cover class of all species, and soils. Remeasurement at five-year intervals monitors change in these characteristics. Stands representative of different age classes, productivity, and communities are selected for PSP establishment so that community dynamics such as tree growth and succession can be applied to similar stand conditions across the landscape.

### approach

Three fixed-area, 0.1-acre PSPs are established per site within stands of native tree species. Present emphasis is on natural stands. Small size and replication allow estimation of stand variability. Data collected at time of establishment and at each remeasurement include: landscape information (landform, topographic position, aspect, slope, presence of permafrost, drainage class, thickness of organic horizon, and upper horizon soil texture). Each tree receives a numbered aluminum tag for future remeasurement. For each plot, plant species are identified and cover class is estimated. Tree data collected include: species, height, length of live crown, diameter at breast height (4.5 feet), crown position, crown condition, and stem defects; tree regeneration is also assessed.

### progress

Since inception of the program in 1994, 567 PSPs have been established in groups of three, equaling 189 stands. Five-year remeasurement have been completed for 402 PSPs (134 stands) and ten-year remeasurement for 84 PSPs (28 stands). PSP data are included in four MS theses and are providing support for one PhD dissertation. Soil description and sampling are conducted to USDA Natural Resources Conservation Service standards. Seven PSPs (two stands and part of third) were damaged by 2004 fires; these are not lost, but will provide ecological and forest recovery information.

### impact

PSP data are used to define and characterize vegetation community types, model and predict forest stand succession and growth trajectories (Forest Vegetation Simulator models), ground truth satellite imagery interpretations, assess wildlife habitat, and assess forest health conditions. PSPs also provide stand data, including basic inventory data, growth and mortality information, and stand condition data that are essential for developing forest management plans, timber management plans, and thus, sustainable multiple-use forest management plans.

## Effects of moisture limitation on tree growth in upland and floodplain forest ecosystems in interior Alaska

**J. Yarie**

### purpose

Potential changes in summer precipitation dynamics as a result of climate change could lead to reduced precipitation. By establishing a set of drought experiments in hardwood ecosystems, I sought to determine the influence of summer rainfall on tree growth in both upland and floodplain locations in interior Alaska. The initial hypotheses were: (1) forest growth in upland birch/aspen (*Betula neoalaskana* Sarg./*Populus tremuloides* Michx.) stands is strongly controlled by summer rainfall, and (2) forest growth in floodplain balsam poplar/white spruce (*Populus balsamifera* L./*Picea glauca* (Moench) Voss) ecosystems will show no relationship to summer rainfall due to the influence of ground water, linked to river flow dynamics, on soil moisture recharge.

### approach

I constructed a cover of PVC greenhouse panels under the overstory canopy in each replicate upland and floodplain

drought site. The covers were designed to prevent summer rainfall from entering the soil and recharging soil water during the growing season by draining rainfall off the plot. The covers were assembled in late May each year and taken down before the first snowfall in early September. Based on the average precipitation characteristics during the study period, the summer rainfall exclusion reduced the annual inputs by 46% with a range from 22.7% to 72.1%.

### progress

On the upland sites, summer rainfall exclusion significantly decreased growth for birch in 1992 and 1993 and for balsam poplar in 1992. In all other years birch, balsam poplar, and white spruce displayed an insignificant decrease in growth. Aspen showed no treatment effect. On the floodplain sites, tree basal area growth was significantly decreased for balsam poplar in 1992 and white spruce from 1990 through 2006.



### impact

In upland sites soil moisture recharge from melting snow pack is a major moisture supply for tree growth, although it is unclear if significant moisture limitation occurs during the summer even in the control plots. In floodplain stands, tree growth was highly dependent on seasonal rainfall, even though the ground water table was within the rooting zone and the soils were supplied with a spring recharge from snowmelt. A number of factors are probably causing this strong relationship, including rooting distribution, soil texture, and the electrical conductivity of the ground water.

## Sensitivity of boreal forest carbon dynamics to long-term throughfall exclusion in interior Alaska

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

### purpose

We studied the influence of long-term (~16 years) simulation of summer drought on key components of mid-successional boreal forest carbon balance. We focused on aboveground net primary production and carbon storage in surface soils, where a substantial proportion of soil organic matter is stored and moisture content closely tracks precipitation. We hypothesized that simulated drought has resulted in the following: (1) driven root-derived carbon downward in the soil profile, (2) slowed decomposition in surface soils, and (3) reduced aboveground net primary production of trees and other vegetation.

### approach

This study took place in three replicate drought and control sites in both upland (UP2A, UP2B, and UP2C) and floodplain (FP3A, FP3B, and FP3C) landscape positions. We monitored moisture using time domain reflectometry probes installed at four depths in the soil profile. To detect changes in root-derived carbon, we are analyzing soil cores taken in August 2005 for soil organic carbon content (not complete) and root biomass (completed). Soil cores were analyzed by the following depth intervals: O horizon, 0-5, 5-15, and 15-30 cm mineral soil. To determine if throughfall exclusion has altered the decomposition environment of surface soils, we initiated a common substrate decomposition experiment in July 2005, in which birch tongue depressors were placed at two depths in the soil profile: O horizon and 15 cm mineral soil below the O horizon. Half of the deployed tongue depressors were collected in July 2006 and remaining depressors are being collected in July 2007. To determine drought's effect on aboveground net primary production, we compared aboveground standing biomass of trees (response of all species, rather than individual species) in 1989 to that in 2003, when the most recent stand inventory occurred.

### progress

Simulated long-term drought has consistently reduced soil moisture in upland and floodplain sites, particularly near the soil surface in August and September. Despite reduced soil moisture at both landscape positions, drought's effect is more pronounced in upland forests, where it has resulted in reduced net primary production; increased root biomass further in the soil profile, especially of long-lived, coarse diameter roots (31% more root biomass in 15-30 cm depth compared to controls); compromised O horizon decomposition environment (82% lower tongue depressor decomposition compared to controls); and increased O horizon mass (14% greater O horizon mass compared to controls). In floodplain sites, the response of the decomposition environment to drought was similar to that of uplands (floodplain depressor decomposition was reduced by 84%); however, the responses of all other variables (i.e., net primary production, root biomass, and O horizon mass) were statistically similar between treatments.

In upland sites, tree mortality contributed to reduced stand-level net primary production. Increased O horizon mass with no concurrent increase in annual litter input amounts corresponds well to the observed reduction in depressor decay, suggesting an increase in soil organic matter mean residence time (uplands only). An increase in upland root biomass further down in the soil profile of drought treatments indicates that forest vegetation is investing belowground biomass deeper in the soil profile, where soil moisture extremes are less common.

### 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. Our results indicate that reducing moisture slows tree growth, retards decomposition, and also causes roots to be located deeper in soils. Thus, even though the overall impact of moisture reduction on carbon balance (i.e., decomposition vs. production) is still unclear, the turnover of roots deeper in the soil profile (where cooler growing season temperatures prevail) may tip the balance toward enhanced carbon storage under moisture stress in mid-successional boreal forests.

## Relationship of tree growth to environmental and fertility factors for 35 years in interior Alaska

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

### purpose

Fertilization and thinning studies were developed in birch, aspen, and white spruce forest types representing young, middle, and old-age classes in interior Alaska. The studies were started in the late 1960s. Both climatic and tree growth monitoring has continued through 2007. These measurements represent a long-term record of tree growth and climate data for an age sequence of forest stands.

### approach

These studies are being monitored on a yearly basis, resulting in 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

The comparative analysis of this large set of studies in the major forest types of interior Alaska indicates that nutrient limitations may only occur during the yearly spring growth period, after which moisture availability is the primary control of tree growth on warm sites. Temperature dynamics, both air and soil, set seasonal bounds on the nutrient/moisture dynamics. Both air and soil temperature limitations are the primary control of growth dynamics in the colder topographic locations in interior Alaska, which are usually dominated by black spruce vegetation types. A seasonal progression of growth-controlling factors occurs and is strongly tied to the environmental factors of the landscape.

### impact

The long-term perspective indicates that changes in the annual and seasonal precipitation dynamics as a result of climate change will have a substantial impact on tree growth and forest ecosystem dynamics in interior Alaska. The magnitude of these changes will be tied to growing season temperature dynamics.

## Monitoring white spruce forest health

**Glenn Juday**, Julie Morse, Steve Winslow

### purpose

This project measures the changes in growth and survival of trees in the productive old-growth white spruce forest type in Bonanza Creek Experimental Forest Long Term Ecological Research site twenty miles west of Fairbanks. Results here can be related to a variety of other long-term studies and monitoring projects at the site.

### approach

The first 1.0 hectare Parks Loop South plot was originally mapped and measured in the late 1986 and the early 1987 growing seasons, and a second hectare was mapped and measured in 1993. All woody stems larger than 2.0 cm were mapped and the diameter of each was recorded. The height and age of a subsample of white spruce were measured. The plot was re-measured in 1989, 1993, 1997, and 2006.

### progress

The stand probably originated following a fire in the late 1700s, possibly in 1783. At the time of first mapping from 1986 to 1988, there were 1,029 trees or distinct tree remains, with 743 live trees and 286 recognizable dead trees or logs in the first hectare. The live tree population was 87% white spruce, 11% Alaska birch, and 2% aspen and balsam poplar. Nearly all live trees were healthy. In early 1989 a moderately heavy snowfall caused stem breakage, killing 18% of white spruce alive at the time. Death primarily came from a small outbreak of spruce bark beetles (*Dendroctonus*) and engraver beetles (Ips) that killed trees with broken tops. In fall 1989, 526 white spruce trees and 76 birch trees remained alive. The winter of 1990-91 included the greatest snowfall total on record (since 1906) at Fairbanks. Stem breakage was severe, and a more severe spruce beetle outbreak occurred. Another 16% of white spruce trees died directly, and 30% of birch died. In 1989 and 1990 the first recorded outbreak of spruce budworm defoliation occurred in the stand, and some dieback of treetops occurred. Warm summers and limited moisture from the start of monitoring through 2005 caused the least favorable period of growth since the origin of the stand, resulting in high levels of stress to the trees. A moderate to severe outbreak of budworm occurred in 2004-2006. Fungi introduced into the stems of white spruce during the 1989 and 1991 beetle attacks have rotted and weakened trees, and trees have begun to snap off during the last decade.

By 2006, only 333 spruce trees, or 52% of the original mapped population, remained alive. No regeneration of white spruce healthy enough to become part of the new canopy took place. The former uniform moss ground layer was by 2006 a patchwork of vigorous alder shrubs, Calamagrostis grass, newly established birch saplings, and recently fallen logs. Nearly all the surviving white spruce have sustained heavy attacks from beetles, initiating wood decay which is likely to contribute to tree death within a few years to decades.

### impact

The older white spruce type is both commercially valuable for forest products and is very probably a limiting habitat for a number of specifically adapted elements of biodiversity, such as certain birds and tree lichens. The Parks Loop South old-growth white spruce stand is in terminal decline, and results from it are likely representative of the condition of a significant proportion of older white spruce forest on upland sites in eastern and central Alaska. Most of the processes that stressed or killed this age class of spruce trees in boreal Alaska were enhanced if not triggered by sustained warm weather. It appears probable that a majority of this forest type will not survive the next two to three decades across much of Alaska, particularly if warm weather characteristic of the last few decades continues.



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## Growth and growth history of Kuskokwim River white spruce

Claire Alix, Steve Winslow, **Glenn Juday**

### purpose

This study is the first phase of an examination of the growth and growth history of white spruce trees on the floodplain of the Kuskokwim River in southwest Alaska, a region with relatively few studies of forest resources and traditional forest uses. Stands of these trees are located close to the major villages, and are the most productive forest type in their regional landscape and the best source of wood for a variety of human needs.



### approach

Tree cores were collected and local residents interviewed in 2002. Tree cores are being analyzed at the UAF Tree-Ring Laboratory. Oral interviews are recorded, translated from the Y'upik language, transcribed, and deposited in the UAF Library Oral History collection. Tree cores are collected from 15 to 20 mature spruce trees per stand from well-spaced stands located along most of the length of the river to incorporate within-stand and between-stand variability in the results.

### progress

To date 115 radii have been measured from 58 trees that were sampled in four stands, covering the years 1712 to 2001. Mature trees (trees contributing a ring to the sample continuously from 1896 through 2001) grew at an average rate of 1.47 mm per year during the twentieth century. Old trees (rings continuous from 1800) grew an average of 1.14 mm per year during the last century. The growth rate of mature trees did not change after the 1976 climate regime shift, but old trees increased growth about 9 percent. Old trees grew least from 1810 to 1813 and the 1850s, known cold periods. Old trees grew at the highest rate in the mid-twentieth century, especially 1947 to 1953. Major, short-term growth reductions occurred in 1912, 1924, 1934, 1977–78, 1990, 1993, and 1998.

### impact

The high rate of growth of this forest type suggests that it can be sustainably managed. The reasons for growth reduction in specific years is are not known.

## Growth and growth history of Yukon River white spruce

Claire Alix, **Glenn Juday**

### purpose

This study is the first phase of an examination of the growth and growth history of white spruce trees on the floodplain of the Yukon River across all of Alaska. Stands of these trees are the most productive forest type north of the Alaska Range and the best source of wood for a variety of human needs. The stands are located close to the major population centers (villages) and travel route, which is along the river. These spruce are also potential contributors to the supply of driftwood that reaches the treeless Yukon-Kuskokwim Delta, the Bering Sea shore, and the coast of the Arctic Ocean.

### approach

Radial growth was measured in 147 large, dominant white spruce trees from seven sites on the floodplain of the Yukon River and one stand on the similar Tanana River. Measurement files were cross-dated with very high confidence of year-to-year correspondence, and both raw ring width and detrended, normalized ring width index values were examined.

### progress

Even though the sampled population was made up of large trees, because of the high productivity it is still a relatively young population. Only 3% of the sample formed rings before 1829, and 50% before 1875. Mean radial growth of all trees across all years was almost exactly 1 mm/yr. Year-to-year variability of radial growth was generally not significantly correlated with mean monthly temperatures, unlike nearly all dominant white spruce on uplands. However, a strong common signal was present in the floodplain sample, with distinctive regional patterns along the length of the river sampled. The common signal was predominately made up of major growth reductions in particular "pointer" years, especially 1827, 1845 or 1846, 1868:69, 1872, 1888, 1912, 1924, 1934:37, 1954, 1969:70, 1978, and 1987. Cell abnormalities consistent with mechanical trauma are present in some of the pointer years.

### impact

The explanation for the years of low growth common to all or to subregional populations is not established at this point. Some potential causes include low river stage, frost events, and floods among others. Since Alaska temperatures increased following the 1976:77 climate regime shift, the mean raw ring-width of the sampled population is lower than in the earlier part of the twentieth century. A large proportion of all trees have been attacked by spruce beetles.

# invasive species & revegetation

## Natural regeneration of white spruce

**Glenn Juday**, Steve Winslow, Julie Morse

### purpose

This is a long-term study of white spruce that have regenerated naturally following the 1983 Rosie Creek Fire. The 2006 growing season data was the eighteenth year of data collection in the study and 2006 was the twenty-fourth growing season since the fire. This is the longest and most detailed look in boreal Alaska at the amount, survival, and performance of natural tree regeneration following wildfire on a large plot basis.

### approach

Total height, annual height growth, and condition of the upper growing point (e.g. clipping, defoliation, shoot death) of all seedling white spruce in the previously-mapped 100m

by 100m Reserve West plot in Bonanza Creek Experimental Forest LTER are measured at the end of each growing season. Newly discovered seedlings are mapped.

progress

Major seed crops since the 1983 fire occurred in fall 1983, 1987, 1990, and 1998. Established seedlings belong strictly to these seed crops of 1983 (21%), 1987 (46%), 1990 (23%), and 1998 (0.01%). In fall 2006 2,217 seedlings were alive out of 2,531 seedlings ever discovered, including those which died (12%) since the study began. Mean height growth of 1983 seed crop seedlings in 2006 (21.1 cm) was a slight increase over 2005, but still lower than the level first achieved in 2000, reflecting the continuing effects of the hot summers of 2004 and 2005, and a dry 2006 growing season that began early. Crushing by fallen snags was the major mortality factor, but in 2006 severe spruce budworms killed the tops of about half of all seedlings.

impact

This study shows how white spruce regenerates, and how the species overcomes challenges it faces. This study represents a nearly complete life history of the stand so far, and data that are useful in growth modeling and calculations.

### 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 is 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 re-establishment of vegetation and coverage of bare ground.

progress

This was the third year of a long-term study. As a senior thesis project, ground-based photography obtained in June was classified into green vegetative material and bare ground using the VegMeasurement software developed by Oregon State University. A vegetation index was developed from near-earth remotely sensed images. Using the ground-based photography as ground-truthing, the normalized difference vegetation index (NDVI) produced a regression model for ground cover with an accurracy of 82 percent. Imagery for the other time periods is currently being processed to determine the best time to obtain imagery for monitoring revegetation efforts.

impact

This study will help land managers to develop effective revegetation strategies and cost-effective methods to monitor the progress of remediation efforts. The use of digital photography is a rapid and effective method for monitoring revegetation efforts.

## policy & planning

### Endangered Species Act Science and Management

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

purpose

This project aims to assess science used in policy formation and implementation of the Endangered Species Act (ESA).

approach

Scientific information is synthesized for assessment of ESA issues including designation of subspecies and distinct population segments (DPS) for ESA listing, assessment of threatened or endangered status, and possible management actions to achieve specific objectives. Information is translated for dissemination to policy makers and managers.

progress

From August 2004 to December 2006, information has been provided to the Alaska governor's office on several Alaska ESA issues, including polar bears, beluga whales, Steller sea lions, sea otters, eiders, loons, goshawks, wolves, and other species in the lower 48 states. Review and assessment of scientific and management documents has been done for several of these species. A draft multistate research project proposal was prepared in 2006 (WERA _Temp2041). A presentation with relevance to ESA issues was made at the Forest Genetics meeting in Girdwood, Alaska, summer 2006 ("Wildlife Genetics in Alaska"). A paper describing subspecies and DPS criteria was published in 2006 in *Wildlife Society Bulletin*, and another was submitted to *Animal Conservation*.

impact

This work allows policy makers and managers to better understand the science being used in ESA issues.

## wildlife studies

### Caribou genetics and management

**M.A. Cronin**; M.D. MacNeil (USDA); J.C. Patton (Purdue Univ.); S. Haskell, W.B. Ballard (Texas Tech Univ.); 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. Fieldwork, including observations of caribou distribution and behavior in and around northern Alaska oil fields, has been done to assess potential effects.

### progress

During 2006 several manuscripts on different aspects of our study were published or submitted: one on reindeer and caribou genetics was published in *Journal of Heredity*; another was published in Arctic on the distribution of calving caribou in North Slope oil fields. A response to a critique of a previous paper (Noel, L.E., K.R. Parker, and M.A. Cronin. 2004, *Wildlife Society Bulletin* 32:757-771) was also published in *Wildlife Society Bulletin*. Another paper was revised and resubmitted to *Canadian Field Naturalist*, following review by the journal.



### impact

On Alaska's North Slope, understanding caribou demography is an integral part of the multiple-use management of oil and gas and wildlife. Land and wildlife managers can use this study to develop more effective and flexible mitigation measures for industry.

## Elk genetics

**M.A. Cronin**; M.D. MacNeil (USDA); J.C. Patton (Purdue Univ.)

### 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. A manuscript rejected by Animal Genetics in 2005 is being revised to include analysis of molecular markers and performance traits.

### 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 domestic elk selection and breeding programs.

## Grizzly bear genetics

**M.A. Cronin**; R. Shideler (Alaska Department of Fish and Game); J.C. Patton (Purdue Univ.); S.C. Amstrup (US Geological Survey)

### purpose

This project assesses grizzly bear demography and genetic variation in North America.

### approach

Molecular genetics technology is used to quantify the family relationships of bears, numbers of bears contributing to breeding, and genetic variation in bears across western North America.

### progress

Assessment of grizzly bear demographics and genetics is continuing with analysis of additional genetic markers, including functional genes (k-casein and major histocompatibilty complex). Review of existing literature is providing comparative assessment of genetic variation.

### impact

The project provides a review of genetic factors influencing the demography of grizzly bears in Alaska and other areas of North America, particularly immigration and emigration.

## Polar bear genetics

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

### purpose

This project aims to improve understanding of polar bear demographics, with particular emphasis on potential changes due to climate change.

### approach

Molecular genetics is used to assess the level of genetic variation of bears in the Beaufort Sea and Chukchi Sea in northern Alaska and compare it with that in other worldwide subpopulations.

### progress

Existing data was analyzed in 2004 and incorporated into a manuscript that was 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). Data analysis is almost complete and a manuscript will be written in 2007.

### impact

This study is helping quantify genetic variation and subpopulation differentiation. Such information is potentially useful in population management and policy formulation at the national and international levels.

# Natural Resources Use and Allocation

## Development of a certificate program for the Northwest Campus, Nome, emphasizing high-latitude range management

Carrie Bucki, **Greg Finstad**, Lee Haugen

### purpose

We sought to develop a curriculum providing relevant coursework to residents of rural Alaska villages that will

contribute to an educated Alaska workforce for entry-level employment in natural resources management.

### approach

Many local people have a profound knowledge of their resource base but no formal training for participating or contributing to management decisions at the state or federal level. Students receiving the HLRM certificate will be trained in conventional field-based techniques used by agencies to inventory and monitor high-latitude plant and animal populations. Students will also be trained in the ecological concepts of sustained yield and the manipulations and management of animal populations in northern ecosystems.

### progress

The High Latitude Range Management (HLRM) certificate proposes a two-year academic program that includes the following courses: HLRM 120 - History of Domesticated Alaska Ungulates HLRM 130 - Research Field Logistics, HLRM 140 - High Latitude Range Management, HLRM 150 - Alaska Ungulate Husbandry, HLRM 160 - Meat Production, HLRM 170 - Health Issues in Domestic Herds, HLRM 201 - Field Techniques in Range Management, and HLRM 205 - Report Writing in Range Management.

An intensive week-long course focusing on reindeer range management was offered in June 2006 in Nome to expose students to the new curriculum.

### impact

This certificate will provide the training necessary for local entry-level natural resource jobs and serve as a bridge to a variety of natural science associate and baccalaureate programs.

## Reindeer Research Program Educational Outreach Program

Margo Griffith, **Greg Finstad**

### purpose

In 1998, the Reindeer Research Program initiated and implemented an educational outreach program in Alaska schools for elementary and junior high grade levels. The program was designed to increase awareness of the reindeer industry in Alaska, its history, economics, and the use of reindeer as a renewable resource. The program teaches the basics of reindeer biology and exposes students to current research projects at the Agricultural and Forestry Experiment Station and on the Seward Peninsula. This program was expanded in 2006, to include more local groups and many national and international educational institutions.

### approach

The outreach program is delivered in two ways: presentations given at local schools and tours of the reindeer research facilities at the Agricultural and Forestry Experiment Station. To engage students in the program, we bring a halter-trained reindeer from our facility to local schools. Tours of our captive reindeer facilities include observation of social interaction among the animals, animal husbandry, nutrition, and handling techniques used with reindeer.

### progress

The program has grown in popularity; in response, we expanded it in 2006. We revisited many schools that participated in the program in previous years and gave first-time presentations in other schools, adult learning programs, camps, and at educational events. We expanded our presentations to the high school level where we emphasize using math and science to conceptualize and possibly conduct research projects in schools. The curriculum used to support the outreach program is now being used throughout the United States and in foreign countries such as England, Finland, Sweden, Spain, New Zealand, and Australia.

### impact

The outreach program was used in 2006 to expose both Alaskans and students across the US to Alaska history and Native Alaskan enterprise. Through our curriculum we attempted to engage students to use math and science to conduct research either in a northern ecosystem or food production context. The program has quickly grown from a curriculum designed for use in Alaska schools, to one in great demand nationally and internationally. The program has not only reached younger students, but has expanded into the adult community, enabling us to create a stronger tie between our local community and the university, and fulfilling our responsibilities as part of a land grant institution.



# fisheries

## Alaska snow crab markets

**Joshua Greenberg**, Mark Herrmann

### purpose

This study was undertaken to provide an understanding of how various market determinants affect Alaska snow crab and king crab prices and revenues both at the wholesale and dockside (exvessel) levels. We wanted to estimate the relationship between crab landings and harvester revenues, and understand how the rise to prominence of Canada and most recently Russia has affected the Alaska crab industry. Finally, we were interested in setting a foundation for future economic analysis of the Alaska crab dedicated access privilege program (crab rationalization).

### approach

To determine the most important supply and demand factors influencing Alaska crab prices and revenues, we developed an integrated market model. This statistical model includes the major snow and king crab suppliers: Alaska, Canada, Russia, and Greenland; and the major markets: the United States and Japan. Our modeling effort was directed toward explaining long-term movements in snow crab and king crab prices.

### progress

The project model estimation was completed in 2005. In 2006 we completed the final report for the project and will

work toward developing academic publication for the completed work.

### impact

The model results show that the Alaska crab industry has moved from being a price setter to being a price taker in the international snow and king crab markets. Recent expansions of snow and king crab production from Canada, Russia, and Greenland have severely depressed industry revenues and present a major challenge to the industry in growing its future revenues. The developed model will be used in the future to evaluate the Alaska crab rationalization program.

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

Peter Bechtel, Cinthia Bower, Ted Wu (ARS)

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 unused. 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

#### Parameters for use of fish hydrolysates in diets of shrimp

Hydrolyzing seafood processing byproducts can be a cost-effective method for stabilization of byproducts, while not significantly reducing either the nutritional or palatability characteristics. However, little is known concerning how different hydrolysis production parameters will affect nutritional quality. An eight-week shrimp growth trial was conducted to determine the suitability of four experimental fish processing byproduct hydrolysates, manufactured under different conditions, as ingredients replacing fishmeal. It was found that fish hydrolysates produced under some conditions can replace up to 50% of the standard fishmeal in Pacific white shrimp (*Litopenaeus vannamei*) diets, with no significant diminishment in growth or survival. The results from this research will be useful in developing specific ingredients suitable for commercial shrimp aquaculture. This work was conducted in collaboration with a private company involved in production of hydrolysates.

#### Alaskan seafood processing byproducts in diets for sturgeon

A diet with the protein component based on Alaska pollock meal was found to promote growth and survival in Siberian sturgeon (*Acipenser baerii*) equal to that of standard commercial feeds. The experimental feed exhibited superior stability when immersed in water and reduced the effort required to achieve good water quality. A growth trial was conducted in which a series of four diets, including one containing Alaska pollock (*Theragra chalcogramma*) meal and three commercial products (Biodiet, Skretting, and Silvercup), were fed to sturgeon for six weeks. The findings from this work could be used to develop more cost-effective feeds for sturgeon culture, while providing a value-added opportunity for utilization of Alaska pollock seafood processing byproducts.

#### Replacement diets for lingcod grow-out

There is interest in developing better diets for lingcod (*Ophiodon elongatus*) and other species. In grow out experiments, forty percent of the diet was protein meal derived from one of four Alaska processing byproduct sources: pollock viscera meal, salmon livermeal, organic whitefish meal, whitefish meal, and a control diet containing anchovy meal. It was found that the lingcod performed significantly better in growth and feed efficiency on the diets containing the salmon livermeal, pollock viscera meal and the anchovy control than the diets containing either version of the whitefish meal. These results indicate the potential for using specialized meals made from individual byproduct components.

#### Alaska fish oils in finishing diets for rainbow trout

Studies were completed with 400g and 800g (market size) rainbow trout fed diets containing Alaska fish oils (pollock, salmon, rockfish) to enhance the omega-3 fatty acids (EPA and DHA) content in fillets. Alaska pollock oil was found to be more effective than menhaden oil in enriching fillets with EPA and DHA when fed during the final stages of grow-out to trout that had previously been fed diets containing either rendered poultry oil or canola oil as the major dietary lipid. These results are very relevant to the aquaculture industry as global fish oil supplies are fully utilized and alternative strategies to producing healthful farmed fish products must be developed.

#### Processing byproducts in diets for Pacific threadfin

A 12-week feeding trial was completed to ascertain the impact of utilizing Alaska pollock meal and pollock oil on growth and fillet quality of market size Pacific threadfin (*Polydactylus sexfilis*). The feeding trial was conducted in a recirculation aquaculture system to grow fish from 333g to 503g using an experimental diet containing pollock meal and pollock oil as major ingredients. The results of this study indicated no differences in fish growth and the sensory assessment from a trained taste panel for sashimi and baked samples did not show consistent differences in fillet color, texture and flavor between experimental and commercial diet. This indicates that these two Alaska byproducts are suitable ingredients in diets for grow-out of market size Pacific threadfin. The information will be useful in formulating cost-effective grow-out

diets that can ensure good growth and desirable fillet quality for Pacific threadfin.

### Weaning rock sole onto artificial feeds with chemical cues

The objective of this study was to determine whether chemical cues introduced to the culture water could stimulate the weaning of rock sole (*Lepidopsetta* spp.) larvae onto prepared feeds. We hypothesized that in rock sole, the voluntary consumption of microparticulate diets will be improved by the addition of odorants, such as stickwater, derived from Alaska seafood processing byproducts. L-alanine, *Artemia* culture water and red salmon stickwater were chosen as the chemical cues and inert metal oxides were incorporated at known proportions into the feeds. The fish were analyzed after feeding to determine the relative consumption rates of the various feeds. When red salmon stickwater was added to the culture medium before weaning, the fish were more likely to take up the microparticulate food on the first and second days post-weaning than fish that were not given the chemical cue.

### Antioxidant properties of pollock skin hydrolysates

Pollock skin is an abundant and under-utilized resource that can be used as a unique protein source to make hydrolysates with useful chemical and functional properties. The objective of this study was to investigate the antioxidant and solubility properties of pollock skin hydrolysates and evaluate their use as coating materials to suppress lipid oxidation in fish fillets during frozen storage. Results indicated that the edible coatings prepared from pollock skin protein hydrolysate enhanced the storage stability and quality of frozen salmon fillets. The edible hydrolysates coating may also provide a degree of protection against damage during transportation and handling of fish fillets.

### Fish oil purification and adsorption technology

In order to increase the quality and stability of crude fish oils there is a need for a rapid, low cost method of purifying oil extracted from salmon heads and other fish byproducts. The goal of this project was to develop a low cost adsorption technology that would remove fish oil impurities. Conventional fish oil refining is achieved in four steps: degumming, neutralization, bleaching, and deodorization; however, these processes are relatively complicated and expensive. Results of research conducted in Alaska indicate that a dual step differential adsorption process performs well in removing many of the impurities from crude fish oil and is likely to be cost effective. Due to the great interest in the high levels of the 3-omega fatty acids in salmon oil, many salmon processors are now evaluating the extraction and partially purification of oil from salmon heads.

### Gasification of salmon byproducts

Fish processing waste represents biomass that may be valuable for generating energy. Raw and treated salmon samples (heads, frames, and viscera) in combination with wood pellets (to reduce the moisture levels) were converted to combustible gases using an up-draft gasifier. Salmon byproducts were found to be too wet to undergo combustion using an up-draft gasifier, and therefore may not be practical for large-scale energy production. However, this technology can still provide a feasible energy source in Alaska if an inexpensive method of drying the feedstock is developed.

### Preservation of individual byproduct components

Fish byproducts are typically mixed together, even though some components may have adverse effects on others. Individual salmon byproducts (heads, viscera, and a mixture) were stabilized through fermentation by lactic acid bacteria and through ensilage by direct acidification. Viscera and heads that were preserved separately for 120 days maintained a lower, more desirable pH than when mixed together. This finding has major implications for how fish processing waste should be collected and stored if maximum nutritional value is to be preserved.



### Antioxidant activity in Alaska salmon oil

Salmon oil contains fat soluble vitamins and other compounds, which have antioxidant properties that are important in preventing oxidation and are beneficial to health. On occasion, raw byproducts are held unrefrigerated for several days until a sufficient quantity of byproduct has been received for processing. A study was conducted to evaluate the antioxidant activity in oils extracted from Alaska salmon byproducts stored for different amounts of time (0 to 4 days) and at two different temperatures (6 or 15°C). Results showed a linear decrease for antioxidant activity of the extracted oils during the four days of storage and no significant difference in the regression lines between the two storage temperatures. These data suggest that storage temperatures of 6 or 15°C were of less importance than the storage time for reducing the antioxidant activity in oils extracted from salmon byproducts.

### Volatile amines and trimethylamine oxide in byproducts

When storage time is prolonged and/or temperature increased in fish byproducts, the quality of the raw materials is decreased. ARS scientists in Alaska modified an existing technique to measure major volatile amines and TMAO simultaneously in under 10 minutes per sample. Several different parts, species and processed materials were analyzed. These values can be used as quality indicators of raw and processed material freshness and as indicators for the potential to spoil.

### Alaska byproducts as an organic fertilizer

The expanding of organic farming in Alaska demands alternative nutrient sources for crop production. One source of nutrients in Alaska is fish byproduct meals, bone meals and hydrolysates, which are all rich in nitrogen and can be used for crop production. A project was designed to evaluate plant

nutritional value of Alaska fish byproducts and consisted of laboratory incubation, field research plots, and on farm demonstration. The major findings from the project was nitrogen release from the three byproducts followed a two stage release pattern, a fast release phase until seven days and a slow release phase thereafter. In conclusion, even though the apparent nitrogen recovery from the fish meal and fish bone meal was higher than fish hydrolysate in the laboratory incubation study, there were no difference in crop biomass production in the field.

### Cross-linked fish gelatin films



Gelatin extracted from fish skin can be used to make biodegradable films and properties of these films can be altered by varying the amount of gelatin cross linking. The objective of this study was to evaluate properties of films made from cross-linked salmon and pollock gelatins. Varied crosslinker (glutaraldehyde) concentrations were used to crosslink the gelatins and used to make films. Film propertie evaluated including, oxygen permeability, water permeability, tensile properties, thermal properties, and biodegradability. Results indicated that cross-linked films had slightly reduced water permeability, but comparable tensile and thermal properties. New gelatin film products with different physical properties can be made from cross-linked cold water fish skin gelatins.

### Fish hydrolysates in weaner pig diets

Hydrolysates made from fish byproducts are good sources of digestible protein and have potential applications as feed ingredients for young animals with immature digestive systems. Two studies were conducted to evaluate the nutritional value of three fish based protein sources in weanling pig diets. The first study was conducted with four treatments: hydrolyzed pollock fish meal, hydrolyzed salmon fishmeal, hydrolyzed commercial fishmeal, and spray dried animal plasma to measure the apparent digestibility. The second study was conducted to investigate the effects on growth performance of diets based on two of the fishmeal plus a spray dried animal plasma diet. The results of these studies suggest that the fish based samples evaluated were inferior to spray dried animal plasma in terms of their effect on early post-weaning performance of piglets but may have a role as an ingredient later in the post-weaning period.

### Fish hydrolysates on the immune status of senior dogs

The objective of this experiment was to determine the effects of feeding diets containing fish protein substrates on total tract nutrient digestibilities and indices of immune status on aged dogs. Test diets contained pink salmon hydrolysate, white fish meal, and milt meal. There was a trend for higher apparent dry matter digestibility in dogs fed the milt meal and hydrolysate diets compared to those fed the control fish meal diet. Cytokine gene expression data showed a trend for a higher fold change from baseline of TGF-B (Transforming Growth Factor) in dogs fed diets containing milt meal and hydrolysate compared to those fed the control diet. Fold change of TGF-B was also higher in dogs fed the hydrolysate diet than for those fed the fish meal diet. Additional studies will be needed to further clarify the role of fish based protein ingredients on the immune system of older dogs.

### Protein meals and oil from arrowtooth flounder

In the past arrowtooth flounder has been an underutilized species; however, an increasing amount of this abundant fish is being harvested and the byproducts are becoming available for meals, oils and other products. The objective was to evaluate the protein, lipid and mineral components of meals made from arrowtooth flounder byproducts. Arrowtooth flounder byproducts consisting of heads and viscera were obtained from commercial processors and analyzed. Results indicate the protein to be of high quality and the lipid had more saturated fatty acids and lower amounts of long chain 3-omega fatty acids than found in other common Alaska cold water marine fish. Unique meals and oils can be made from arrowtooth flounder byproducts and used in aqua diets to alter the lipid profile of farm raised fish.

## Resilience theory and Alaska salmon

**Joshua Greenberg**, Martin Robards

#### purpose

The 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 for salmon and the resilience of wild salmon fisheries.

#### progress

Among the strategies reviewed are access restrictions, development of wild niche markets, economic subsidies, and infrastructure development and harvest allocations. The findings of the analysis are being prepared for publication.

#### 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, which focus on local management and governance, toward rural livelihoods. Solutions that foster a balance between social vitality and economic efficiency might be attainable.

## Marine mammal co-management in Alaska

Chanda Meek

### purpose

In this PhD dissertation project, I examine how the "culture" of federal agencies affects the way they manage subsistence use of marine mammals. I also examine institutional performance and the links between agency culture and policy effectiveness.

### approach

Using multiple policy research methods, I am comparing marine mammal management under two separate federal agencies: the US Fish & Wildlife Service and the National Marine Fisheries Service. I have observed collaborative meetings for two years and continue to interview subsistence hunters, other resource users, and managers from both agencies. A series of questions on communications allows me to describe the linkages between hunters at the local level, regional co-management boards, and federal agencies. The linkages form a map of policy implementation; I combine the policy maps with agency culture surveys to examine the interplay of culture and policy.

### progress

Analysis of the data to date suggests that agency culture affects the way federal agencies conceptualize resource management goals, partner with communities, and support local management capacity. Data suggest that US Fish & Wildlife Service policy networks reach more levels of social organization, but are less effective in monitoring harvests than is the National Marine Fisheries Service, which shares management authority more broadly with groups at regional and local levels.

### impact

Differences in agency culture could affect the likelihood that new federal rules will be effective. Results from this study will be shared with both agencies and local partners. My findings could help managers and Alaska Native partners determine why certain policy approaches are more likely than others to succeed.

# forests & forest products

## Alaska Birch Project

**Valerie Barber**, Nancy Bigelow, Janice Dawe, Kevin Curtis; Pavel Krasutsky (Univ. of Minnesota Duluth)

### purpose

In an interdisciplinary study on Alaska birch, we are targeting birch around the state to look at physical/mechanical properties, birch bark chemistry, dendroclimatology, genetics and systematics/evolution.

We are working with the Malone/Packee growth and yield sites around the state, and take trees from adjacent lands. Twenty-four sampling sites were identified for birch harvest prior to our field season in July. Most of our sites lie along the Fairbanks-Anchorage corridor, where we concentrated our efforts in the 2006 field season. Six sites were eliminated because they did not contain trees fitting our criteria. One site was not accessible due to road conditions. The remaining sites are to the east on the Steese, Alaska, and Tok Cut-Off highways, and will be visited in field season 2007 for sampling.

Species determination for Alaska birch is controversial. It's agreed that Alaska has a species largely confined to Beringia and distinct from eastern North American paper birch, *Betula papyrifera*, but the degree of relatedness is unclear. Most experts agree that Alaska has three tree species that hybridize and intergrade whenever they come in contact: *Betula neoalaskana* Sargent, *B. papyrifera* Marshall, and *B. kenaica* W.H. Evans, but it is not definitive. We are working on species determination; making reference collections of pollen, seeds, and macrofossils to help delineate the geohistory of birch in Alaska; looking at the physical and mechanical properties of Alaska birch; birch bark chemistry; and measuring growth from ring width and looking at climate relationships.

### approach

Potential sites were selected around Alaska based on information from the Malone/Packee sites. These sites were checked for appropriate size birch:trees with a diameter at breast height of at least 10 inches, and stands that contained at least three potential trees. Once a site was deemed appropriate, we selected the three trees based on size and quality, solid trees with no heart rot and, ideally, a straight trunk. These three trees were then felled and a GPS location denoted for each. We measured the height of each tree once it was down. A basal disk was cut for width analysis and dendroclimatology, denoting true north on the disk. A bark sample was collected as a taxonomic aid (size and density of lenticels), some sent to Minnesota for chemical analysis. Stems with leaves were collected from different heights of the tree to be used for leaf, seed, pollen, and DNA analyses. Leaves, reproductive material and two tree cores were collected from at least three other standing trees in each of the plots and catalogued. The trees were documented (and tagged) for location, stature, diameter, general health, and surrounding vegetation. A whole plot description was also done, noting elevation, aspect, vegetation, and site characteristics.

### progress

In July 2006, we chose four sites in the greater Mat-Su Valley and then obtained another three trees from a timber sale on Fort Richardson just north of Anchorage (without doing the rest of the protocols). We did all the collections as noted above for the four sites and collected a total of 15 trees. We identified four sites in the Fairbanks North Star Borough. We collected a total of 11 trees from this area for a grand total of 26. Butt diameters ranged from 9-24 inches.

Poppert Milling collected the trees and shipped them to the Ketchikan Wood Technology Center (KWTC), where they were milled into lumber and dried, for testing and grading purposes.



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Bark from each tree was sent to the University of Minnesota Duluth for chemical analysis. A bark sample of approximately 530 grams was collected from each of the 23 trees harvested. In total, 12.23 kilograms of bark samples were sent for chemical testing. Chemical extractives were performed to determine levels of key compounds important for nutraceutical, cosmetic, and pharmaceutical applications.

The disks and tree cores were processed and ring widths measured.

Since the project start, Bigelow and Dawe have identified and marked trees for leaf, seed, pollen, and DNA collection. Leaves and reproductive material from at least three standing trees in each of the plots has been vouchered and the trees documented for location, stature, diameter, general health, and surrounding vegetation. Seeds and winter buds were collected in early September and then again in late October/early November to collect fully mature seeds. Pollen from these trees was collected during pollination in the spring of 2007. Two new plots on the Kenai Peninsula were selected in early September to assist in understanding the relationship between B. *neoalaskana, B. papyrifera,* and *B. kenaica*. One plot contains a probable *B. kenaica* tree, while the other contains a hybrid swarm of shrub and tree birch, some of which is most likely *B. kenaica* or a hybrid between *B. neoalaskana* and *B. glandulosa* Michx.



Analyses over the course of the next nine months included leaf, seed, bract, and pollen measurements. Leaf and bract analysis (measurements and other characteristics) are, (among others such as bark color and stature) key features that should help separate *B. neoalaskana* from *B. kenaica* and *B. papyrifera*; seed and pollen measurements may also be characteristic, but this is still untested.

### impact

We are seeing clear differences between trees and regions. The chemistry of the bark clearly delineates the northern samples from the southern, with some exceptions: similar differences, north and south of the Alaska Range, are seen in some leaf characteristics, including the number of veins and length of leaf stalk (petiole). People at the KWTC were extremely impressed with the quality of the birch.

## Birch bark use in Alaska

Tom Malone, Edmond C. Packee, Sr.

### purpose

People of the circumboreal north historically used birch bark to make baskets, plates, and pails. Current emphasis is on the production of items for sale to tourists as art objects. More lucrative is the use of the bark as a supply for pharmaceuticals. The purpose of this project has shifted to bark as a source of phytochemicals, especially, but not exclusively, to pharmaceuticals and health care products.

### approach

The project is a cooperative effort with the University of Minnesota Duluth (UMD) Natural Resources Research Institute. Bark samples previously provided to UMD were analyzed with specific emphasis on betulin and betulinic acid content. More samples from more locations in Alaska were needed to improve the analyses, so in 2006, more bark samples (five sites in each of three regions—Kenai, Matanuska-Susitna Valley, Tanana Valley) were provided to UMD for analysis.

### progress

Bark chemical content of the first set of samples submitted to UMD indicate that three species of tree birch occur in the Northern Forest of Alaska: *Betula kenaica, B. neoalaskana*, and an unknown. The quantities of betulin and betulinic acid are higher in the Alaska samples than in eastern North American paper birch. The extraction techniques had to be modified for the Alaska birches. Taxonomic literature reports four tree species of birch in Alaska: *Betula papyrifera* only in Southeast Alaska; *Betula neoalaskana* on the northern portion of the Kenai Peninsula and dominant throughout the rest of northern and southcentral Alaska; *Betula kenaica* dominant on the southern two-thirds of the Kenai Peninsula and scattered throughout the rest of Alaska; and *Betula occidentalis* found locally in northern and southcentral Alaska.

### impact

There are higher concentrations of betulin and betulinic acid in Alaska birch than in birch found in the Midwest (Minnesota-Wisconsin). There does exist a small industry in the Midwest and in Europe for these phytochemicals in cosmetics and for treating herpes outbreaks. According to the US Forest Service inventory of the United States, Alaska has 38 percent of the nation's birch, so the state could supply much more bark than it does now.

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

**Valerie Barber**

### purpose

This project ended in September 2006 and was designed to develop information relative to green moisture content, drying schedules, and chemical properties of selected herb, shrub, and plant components used by Erika Merklin and Supernatural Teas. This project was designed to use her dehumidifying kiln, obtained through a mini-grant with the UAF Sitka Forest Products Program to do research that would benefit her and other nontimber forest product businesses. The economics of this business was also explored and harvesting and processing times per unit weight documented for different plant parts.

### approach

Two interns were hired in summer 2006 to help collect, process, and document different plants and plant parts. Eighteen different plants and several different parts (leaves, bark, flowers, roots) used for making teas were collected. Green and dry weights, moisture content, and antioxidant capacities (ORAC values) were determined on each of these. Using the dehumidifying kiln, designed for drying wood, drying

schedules for the plant materials were determined. Harvesting and processing times (manhours) were documented for many of the plants, and electrical costs for drying were also noted to aid in an economic analysis.

### progress

About twenty different plant parts were collected, wet and dry weights determined, and preliminary drying schedules established. A collection of dried plant parts, plus three different tea blends used by Merklin were sent to Brunswick Laboratories for analysis of total antioxidant capacities. A premeasured weight of each sample was brewed in 4 oz. of water for four minutes. About 45 samples were measured. ORAC values ranged from a low of 86 to a high of 10,059 (blueberry leaves). Two of the tea blends had some of the highest ORAC values, of 6,000–8,000.

### 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. ORAC values established here can also be used by Merklin to promote her teas, as 'antioxidant' has become a household word.

## Sitka Tribe harvesting study part 2

**Valerie Barber**; Helen Dangel-Lorrigan (Sitka Tribe)

### purpose

Sitka Tribe has 17 different tribal groups under its jurisdiction in southeast Alaska. We are surveying these groups' annual harvesting practices (past and present) of nontimber forest products. Sitka Tribe is also conducting interviews with elders to record and preserve harvesting practices information. UAF-Sitka Forest Products Program is using the survey to assess interest and resources in potential nontimber forest product businesses. This is Part 2 of a three-part project. Part 1 surveyed the communities of Sitka, Kake, Hoonah, Yakutat, and Craig. Part 2 surveys the communities of Ketchikan, Hydaburg, Kasaan, Klawock, and Saxman. Part 3 will include the rest of the communities.

### approach

Surveyors were hired in each community to gather information from the local inhabitants with a readymade survey. A consultant was hired in spring of 2006 to go over the original survey to optimize information collected and organize it in a more efficient way. As a result, the survey was modified, but kept in line with the original so all information could be used from the previous year. Many of these communities are primarily Native American but the survey is not limited to only Native Americans.

### progress

To date, no surveys have been collected in Ketchikan because there were problems with the surveyor hired. Ten surveys have been collected from Hydaburg and more are expected. In Kasaan, 8 surveys were collected from the small population of around 40 and no more are expected due to 'survey burn-out'. Twenty surveys were collected in Klawock, 11 from Saxman (more may come from Saxman if another surveyor can be found).

### impact

Hiring surveyors from each community has provided some much-needed cash; some communities are excited about potential nontimber forest product businesses. Marketing workshops are planned for some of the communities for 2007.

## International markets study China

**Valerie Barber**; Daisuke Sasatani (Univ. of Washington CINTRAFOR); Margaret Ma



### purpose

We explored the potential Chinese markets for Alaska softwood and softwood products.

### approach

We took part in China International Wood Products Summit 2006 in Shanghai (October 27–29) to promote Alaska's softwood. We also met and interviewed seven managers in seven wood products factories in cities in China (Shanghai, Guangzhou, Dalian, and Beijing) to determine what kind of wood they were interested in for their products, where they obtained wood, how much wood they purchased, what they were willing to pay for it, and how much product they were exporting annually and to which countries.

### progress

UAF set up a promotion booth for Alaska wood products, provided informational brochures at the Softwood Export Council booth, and answered questions mainly from Chinese manufacturers. We distributed surveys for participants of the conference on their perception and knowledge of Alaska wood. We learned much useful information about Chinese markets from the presenters.

After the conference, we embarked upon our trip to the four main Chinese cities of Shanghai, Guangzhou, Dalian, and Beijing. We wanted to understand two different markets in China: manufacturers' demand for Alaska's softwood as raw material, and consumers' demand for Alaska's softwood products. We visited seven factories to understand manufacturers' needs and two project sites to understand consumers' demands. We observed people's lifestyles in each city, especially in both traditional and modern residential areas.

The sites visited included Canada Wood in Pudong, Shanghai. Canada Wood promotes wood frame single-family and multi-family residential housing, and wood frame reroofing projects. In Zhujajiao, Shanghai, we visited the city hall and a nearby bridge, which were made with engineered wood using US species such as southern yellow pine. The factories visited made doors, flooring, and furniture.

### impact

In China, consumers are still not aware of the economy, safety, and aesthetics of wood construction, so it will be

difficult for US exporters to sell directly to Chinese consumers. However, government contractors will be using huge amounts of wood soon, so it should be a great opportunity for Alaska's softwood exporters.

There is a large demand in China for some Alaska tree species, but others have little demand. There are abundant opportunities for Alaska yellow cedar but the supply of this species is constrained and prices are high. Alaska should solve the supply problem in advance. There is some demand for Sitka spruce, but it is not easy for Alaska Sitka spruce to compete against European spruce in terms of price. Alaska needs to find some high-end niche markets for Sitka spruce. One of the challenges for Alaska wood products engineers is to find markets for Alaska hemlock, which is currently underutilized. One potential market is door manufacturers.



Transportation costs from Alaska are also prohibitive at the moment, but this problem should be alleviated some when the Prince Rupert container port in southeast Alaska is finished, estimated to be within the next five years.

China still has different rules (written and unwritten) than the US when it comes to business practices, so it is not easy to break into Chinese markets by using simple marketing tools. Future studies should focus on objective quantitative analyses of the Chinese market while being cognizant of the cultural ramifications.

## Lamstock and glulam beam study

Joseph A Roos (Univ. of Washington CINTRAFOR); **Valerie Barber**

### purpose

Our purposes were to determine trends in Japan's lamstock and glulam beam markets; and to participate in the Japan Home & Building Show 2006 and interview attendees regarding trends in Japan's lamstock and glulam beam market.

### approach

In Phase 1 of this project we traveled to Japan to visit lamstock and glulam beam factories and conduct interviews with their owners and managers. During these interviews, we asked questions on: the source of the wood used for these beams, the demands for wood needed for these products, current market for these beams, and the emerging trends in these markets. Further interviews were conducted at the Japan Home & Building Show 2006 in Tokyo.

The second phase will be to display Alaska forest products at the Japan Home Show at Tokyo in November 2007 in collaboration with the Softwood Export Council, the Foreign Agriculture Service, and the Alaska Office of International Trade.

### progress

In Tokyo, we visited the Hosoda Wood Industrial Co., LTD. and spoke with the senior managing director and the president. We went on to the Japan Laminated Wood Products Association and met with the president. From these individuals we learned that raw material supply for glulam beams is getting tighter and glulam manufacturers are looking for new suppliers. We also attended a reception held for US and Japanese wood industry people at the Tokyo American Club.

We visited five glulam plants around the greater Tokyo area (Meiken Glulam Plant, Torisumi Glulam Plant, Marudai Pre-Cut Lumber Mill & Innosho Glulam Mill, Mokuzi Glulam Plant, and the Emachu Lam Tec Glulam Plant) and conducted interviews.

Roos also participated in the Japan Home & Building Show 2006, where he handed out Alaska Forest Products Manufacturers directories and interviewed industry experts regarding trends in Japan's lamstock and glulam beam market.

### impact

Japan lumber imports from North America were up approximately 4% in 2006 from 2005 (Japan Lumber Journal 2007). Our main conclusion is that Japanese glulam beam manufacturers are searching to diversify their raw material supplies due to the increasing cost of European whitewood. (This fact was stated numerous times by various manufacturers). As the European supply is being constrained, Japanese lumber importers are looking for new suppliers. This provides opportunity for Alaska lumber producers to increase their Japanese market share by supplying the glulam beam market. A marketing strategy for Japan will be needed.

## Strength ratios in Alaska softwoods

John Bannister (Ketchikan Wood Technology Center); Kevin Curtis, **Valerie Barber**

### purpose

The effect of knots on the failure strength of full-size lumber pieces is integral to the calculation of design strengths in in-grade lumber testing programs. Each type and size of knot is assigned a "strength ratio" intended to indicate degrade in failure strength from clear wood failure values. Currently, these knot strength ratios are calculated using formulas developed during the North American in-grade testing program and based on data that did not include test results from any lumber harvested in Alaska. Alaska softwood in-grade testing indicated that some timber species grown in Alaska exhibit failure behaviors that differ from similar species grown in the contiguous United States. One possibility for this difference may be the effect of knots on lumber strength, so we are investigating this in two Alaska-grown species, yellow cedar and Sitka spruce.

### approach

To investigate the effects of various types and sizes of knots, lumber specimens were tested using both in-grade and small clear test methods. A comparison of small clear and in-grade failure stresses will provide an empirical strength ratio for the knot which causes the in-grade failure of the piece. These empirical strength ratios can then be compared to the strength ratios currently in use for in-grade design strength

analysis. Full-size lumber pieces were tested according to the in-grade testing procedures outlined in ASTM 1990 (American Society for Testing and Materials). A corresponding small clear specimen harvested from a non-stressed portion of each in-grade specimen was tested according to ASTM 143 procedures. This produced a data set of in-grade test results (including failure defect type and size) and matched small clear results.

### progress

All in-grade and small clear testing has been completed. A statistical analysis is being performed on the results data. A rough draft of the project report with preliminary conclusions will be ready by late fall 2007, with a reviewed final report ready for publication in spring 2008.

### impact

This project will provide good indications as to whether defect strength ratios formulas currently in use are accurate for Alaska-grown yellow cedar and Sitka spruce. These results, we hope, will contribute to the ongoing discussion regarding the accuracy of the currently accepted strength ratios used for in-grade lumber design strength analysis. We plan to incorporate these results into a future project that further analyzes the methods of softwood lumber design strength analysis for Alaska-grown softwood species.

## Wood plastic composites

J. Leroy Hulsey, Allen Brackley, **Valerie Barber**

### purpose

We sought to evaluate the use of Alaska white spruce in a wood plastic composite for use in landscaping projects.

### approach

The first step was to produce a product to be tested. Alaska white spruce boards were shipped to Strandex Corporation in Madison, Wisconsin, where they were ground into sawdust and mixed with polyethylene, the same plastic found in recycled pop bottles commonly found in municipal recycling programs. The wood composite was designed to simulate a product that could be made from bark-beetle-killed white spruce and recycled plastics from a municipal recycling plant. On a weight basis, the composite boards consisted of 56% white spruce ground to wood dust, 31% polyethylene plastic, and 13% phenolic resin binding agent. Half of the manufactured composites had, 2% by weight of the fungicide zinc borate. These were then shipped back to Alaska where they were distributed to three different climatic zones (Fairbanks as a cold climate region, and Sitka and Kenai as wet climate regions.

A portion of these boards where constructed into raised planting beds. Raised planting beds were chosen as the method to test the product outside because soil would be located directly against the surface of the material. Up to six raised beds were constructed at each test site. Half of the beds were constructed with the fungicide-treated boards, and half with untreated boards. The raised beds where then left outside to the elements for two years in Fairbanks and Sitka and one year in Soldotna (Kenai). The remaining boards not used were placed in a dry protected environment and used as a control. After the prescribed exposure, samples of these boards were taken to the University of Alaska Fairbanks for testing.

### progress

Tests were conducted in accordance with ASTM standards on both controlled (no exposure to weather) and weather-exposed boards, and conducted two different ways, as a wood and as a plastic, and the results were compared. Samples were tested for tensile strength, compressive strength, bending, and shear. Samples were labeled for location, exposure, and with or without zinc. This enabled the researchers to evaluate the influence of zinc (fungicide) and exposure on strength. For each type of test, 80 samples were tested: 10 from Fairbanks with zinc, 10 from Fairbanks without zinc, 10 from Sitka with zinc, 10 from Sitka without zinc, 10 from Kenai with zinc, 10 from Kenai without zinc, 10 control samples with zinc and 10 control samples without zinc. Samples were tested in tension, compression, three-point bending, and for shear as a wood.



Tensile strength parallel to surface were tested in accordance with ASTM D1037–06a (section 10) for wood and ASTM 638-03 as a plastic. Compression strength parallel to the surface was tested in accordance with ASTM D1037-06a (section 12) as a wood and ASTM D6108-03 as a plastic. Three-point bending was tested in accordance with ASTM D1037-06a (section 9) as a wood and ASTM D790-03 as a plastic. Shear tests were only tests as wood since shear test standards were unavailable as a plastic. The specimen size for the shear tests were smaller than the standard size specified by ASTM 1037, because the manufactured planks were only one inch thick. Standards suggest a sample size of 2” x 2” x 2.5”.

We also conducted moisture tests to evaluate changes in density when exposed to moisture over time. Three samples from each test group were submerged in water for two weeks. After 14 days the samples were weighed and measured for mass and volume. This occurred every other day for a week and then every few days for another. After the mass change became close to zero samples were put into an oven at 40°C for ten days. After ten days it was assumed that all free water in the samples was evaporated. The samples were then weighed and measured again. This was the basis for percent mass and volume change calculations.

Test samples were cut to 1.5" x 2" x .375" chips. The volume of each chip was calculated based on measured dimensions. Each sample was weighed three times to find an average. Water retention, average density, percent volume change, and percent mass change for each of the sample groups were evaluated and trends were observed.

Although there was a small rise in volume after sitting in water for two weeks, it was only about 0.06 percent, indicating that there is very little expansion of the composite when it is saturated with water. The density of the samples stayed

relatively constant with a small increase after being soaked in water. The percent mass increased while in water and slowly decreased when removed from the water.

### impact

Preliminary studies for the use of wood plastic composites in Alaska made from Alaska wood are positive, and indicate that this process would be good for using marginal wood and wood cleared for fire breaks, under power lines, etc. Future studies will examine using beetle and fire-killed trees of different species, and municipal wood waste.

## Western hemlock knot study: Development of software to provide yield estimates from simulated rough mill processing of western hemlock from Alaska



Craig Boden, Phillip Steele (Mississippi Sate Univ.); Kevin Curtis (KWTC); **Valerie Barber**

### purpose

We intend to produce software to allow yield estimates from simulation of the cutup of a developed database of western hemlock lumber.

### approach

Simulation has been used to determine the yield of cuttings from hard maple, black walnut, alder, red oak, and ponderosa pine lumber, and to determine how processing parameters such as salvage sawing and edging severity affect cutting yields. We are using the same approach to create simulations for western hemlock. Approximately 1,500 board feet of rough western hemlock lumber was collected, dried, and transported to the Ketchikan Wood Technology Center (KWTC) in Ketchikan, Alaska, planed, and digitized. A lumber database will be created from these digital images, and software for estimating yields created.

### progress

The lumber was transported to the KWTC. The dried rough lumber was planed to 1.5-inch thickness and digital images of both wide faces were acquired by a color digital camera. The MatLab and DigiStruct software packages were employed to delineate the periphery of each defect on the lumber surfaces. The digitized images were converted to a Cartesian coordinate system in a format compatible with the ROMI-3 software package. The digital lumber database will be attached to the ROMI-3 program and a user's manual will be written for distribution to Alaska manufactures.

### impact

With the descriptive board data developed in this research, both yields and operational parameters for western hemlock lumber can be investigated. This will facilitate the development of niche markets for underutilized Alaska western hemlock, one of the more abundant species in southeast Alaska.

## Alaska yellow cedar New Crop Opportunities

Colin Beier, Scott Sink, **Glenn Juday**, Paul Hennon, Dave D'Amore

### 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 more than 200,000 hectares. The cause of yellow cedar decline was a mystery for several decades until recent research results, including this project, identified the probable cause.

### approach

Tree-ring growth of Alaska yellow cedar populations in southeast Alaska were compared with daily minimum and maximum temperature, total precipitation, and snowfall for six weather stations in southeast Alaska, and with late winter thaw/freeze events. Specific periods of decreased growth were compared with weather data that reflect conditions that previous studies suggested might be associated with potential injury to the species, especially freezing injury.

### progress

A large database of ring-width growth from 17 declining and two healthy stands totaling 254 trees was measured back to 1700, and compared with the climate predictors. A clear and strong association was present between major episodes of reduced growth, very likely from sublethal freeze injury, followed by accelerated growth, almost certainly from surviving trees benefiting from the death of neighboring trees. Growth reductions were synchronized in time. Some strong growth reductions occurred across the region in a specific year (e.g. 1987), and some years that mark growth reductions were specific to a subregion. Growth reductions began in years with a particular pattern of sustained above-freezing weather in late winter that likely caused trees to lose winter hardiness, followed by weather cold enough to freeze the ground where the insulating snowpack had thawed.

### impact

This project is a background study for forest managers to help decide the risk of yellow cedar decline. During the last two centuries, a time in which yellow cedar decline appeared, the overall increasing temperatures were favorable for growth during normal years, not unfavorable. But strong winter warming increases the chances that trees will prematurely lose seasonal resistance to freezing in a "false spring." If the snow has melted, a subsequent strong freeze event injures or kills yellow cedar roots. The areas most likely to lose snowpack entirely during a warm late winter episode are generally at lower elevations and in the southern and outer coastal portions of southeast Alaska. Yellow cedar is generally thriving at higher elevations and in the northern part of its distribution, where it has the best prospects to be grown and sustained as a renewable crop.

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

**T. Scott Rupp** (SNRAS); Tom Paragi (ADF&G)

### 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. Senior thesis student Jason Mercer spent the 2006 summer field season documenting the effects of mechanical disturbance of black spruce stands. Information from Mercer's thesis will be incorporated into model simulations in fall 2007 to identify areas within the Fairbanks North Star Borough that would most benefit from fuel reduction treatments.

### 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.

## Levels-of-Growing-Stock (LOGS) studies

Thomas Malone

### purpose

Levels-of-Growing-Stock plantations are designed to determine the effect of initial espacement (distance between planted seedlings) or spacing (pre-commercial thinning) on crop tree growth (diameter, height, branch size, natural pruning, and wood quality). Initial emphasis has been on espacement because it affects plantation establishment costs and can provide spacing targets.

### approach

LOGS plantations were established at Bonanza Creek near Fairbanks in May 1986 (white spruce and tamarack) and at Red Fox (Tok) in August 1992 (white spruce, black spruce, tamarack, lodgepole pine). Espacements are 4x4, 6x6, 8x8, 10x10, and 12x12 feet. Plots (0.1 acre) are remeasured annually for the first twenty years.

### progress

The Bonanza Creek white spruce and the Red Fox LOGS plantations were cleaned and remeasured for height (20-yr and 14-yr, respectively); diameter was remeasured at Bonanza Creek. Tamarack mortality occurs in groups and appears to be related to soil characteristics.

### impact

Information from LOGS plantations will help resource managers optimize operational planting costs and reduce stand maintenance costs, and will provide early growth information essential to stand management and ecological studies.

## Site index of birch in Alaska

Tom Malone, Edmond C. Packee, Sr., John D. Shaw

### purpose

Site index is the major tool for quantifying forest stand productivity and provides access to other mensurational stand tables. Published site index curves for birch in Alaska are anamorphic and not well-suited for modeling. Polymorphic site index equations and curves for birch were developed by Mike Hoyt as a master's of science degree project in 1992. These curves have a standard breast height index age of fifty years. (We aim to develop new polymorphic site index equations and curves for birch with a standard breast height index age of fifty years.)

### approach

Standardized stem analysis procedures are used: age at stump and then at 4-foot intervals to top 4-foot section and then the top section; age, total diameter, and annual incremental radius were measured for each cross-section. Regression is used to develop equations and curves. Fifty-four stands from throughout interior and southcentral Alaska were previously sampled for a total of approximately 266 trees.

### progress

Equations are distinctly polymorphic. During 2004, work on a draft paper for publication continued; initial curves from the MS thesis of co-author Mike Hoyt (deceased) are being reworked; and a final paper for submission is expected in 2007.

### impact

New curves will better define birch productivity on various sites. The index will improve stand treatment prescriptions,

financial decisions, stand structure and growth predictions over time, and productivity correlations with environmental factors such as soils.

## Site index of black spruce in Alaska

Tom Malone, Carolyn Rosner, Edmond C. Packee, Sr., John D. Shaw

### purpose

Site index is the major tool for quantifying forest stand productivity and provides access to other mensurational stand tables. No site index curves existed for black spruce in Alaska; white spruce curves are used as a surrogate. We aim to develop polymorphic site index equations and curves for black spruce with a standard breast height index age of fifty years.



### approach

Standardized stem analysis procedures are used: age at stump and then at four-foot intervals to top four-foot section and then the top section; age, total diameter, and annual incremental radius were measured for each cross-section. Regression is used to develop equations and curves. Fifty-eight stands (33 interior and 25 southcentral) from Alaska were previously sampled for a total of 229 usable trees. Soil description and sampling are conducted to USDA Natural Resources Conservation Service standards.

### progress

Carolyn Rosner completed her MS thesis in August 2004. Final equations are distinctly polymorphic. Submission of a paper for publication is expected in early 2008. Soil description analyses are the basis for Noreen Zaman's MS thesis in fall 2006.

### impact

Black spruce curves for Alaska are a vast improvement over the use of surrogate white spruce curves and will better define black spruce productivity at various sites in Alaska. Curves will improve stand treatment prescriptions, financial decisions, stand structure and growth predictions over time, and productivity correlations with environmental factors such as soils. Efforts to date show that black spruce in Alaska is not always a wetland species, and occurs on all landforms or site types, from poorly drained to well-drained and with or without permafrost.

## Site index of trembling aspen in Alaska

Tom Malone, Edmond C. Packee, Sr., John D. Shaw

### purpose

Site index is the major tool for quantifying forest stand productivity and provides access to other mensurational stand tables. Published site index curves for aspen in Alaska are anamorphic and not well suited for modeling. We aim to develop new polymorphic site index equations and curves for aspen with a standard breast height index age of fifty years.

### approach

Standardized stem analysis procedures are used: age at stump and then at 4-foot intervals to top 4-foot section and then the top section; age, total diameter, and annual incremental radius were measured for each cross-section. Regression is used to develop equations and curves. Sixty stands (39 interior and 21 southcentral) were previously sampled for a total of 244 trees.

### progress

Equations are distinctly polymorphic. A paper drafted in 2003 is being revised for regional journal submission in 2007. Soil description and sampling to USDA Natural Resources Conservation Service standards was initiated in 2003 and continue.

### impact

New curves will better define aspen productivity on various sites. It will improve stand treatment prescriptions, financial decisions, stand structure and growth predictions over time, and productivity correlations with environmental factors such as soils.

## Individual tree volume equations

Thomas Malone

### purpose

Accurate individual tree volume equations are essential for marketing forest fiber; the importance of accurate equations for ecological uses is often overlooked. Tree volume equations can be used for determining biomass, carbon sequestration, and biodiversity functions and processes. For Northern Forest species, some existing equations are questionable; no equations exist for black spruce, tamarack, or balsam poplar. Our goal is to develop new, single-stem, cubic-foot volume equations to replace existing equations for the major commercial species (white spruce, paper birch, aspen).

### approach

We measure felled-tree diameters at four-foot intervals, calculate volumes for individual sections and then the tree, and use regression to develop single-stem individual tree volume, bark thickness, taper, and cambial area equations. For their MS theses, Tom Malone is using the white spruce data and Carolyn Rosner used black spruce volume data to develop an equation. After the white spruce equations are published, we'll work on aspen and birch.

### progress

A literature review continues. Datasets to date include: approximately 2,016 white spruce, 1,050 black spruce, 136 aspen, 274 birch, and >250 balsam poplar/black cottonwood. Draft white spruce and black spruce equations have been developed. Further testing of white spruce volume and bark equations for accuracy and regional differences are being conducted. Additional bark thickness data was collected in 2006, and a statistically accurate white spruce bark thickness equation was developed. This bark equation is currently being included in cubic foot volume equation development.

### impact

Improved equations will contribute to improved management practices, including growth and yield forecasts, forest

fiber product sales, ecological modeling, and wildlife habitat manipulation.

## White spruce stocking guide

**John D. Fox, Jr.**

### purpose

We intend to estimate how many white spruce trees per acre are needed to fully utilize the available growing space without overcrowding. A fixed area can accommodate a large number of small trees, but only a progressively fewer number can occupy the same space as the trees grow larger. How many trees of specified sizes are needed so that all growing space is utilized (i.e., the stand is not understocked)? How many trees of specified sizes represent an excessively crowded condition (overstocked)? If these limits can be established, then foresters can assess existing stands and prescribe such treatments as thinning or planting to improve yield or other management objectives.

### approach

The maximum space a tree of a given size needs can be approximated by establishing a relationship between crown-width (CW) and diameter at breast height (dbh) from a sample of white spruce trees grown in the open, without competition from neighboring trees. Once the CW vs. dbh relationship is established, a relative measure of competition, the crown competition factor (CCF) can be calculated. A CCF of 100 represents the stocking level below which a stand is considered understocked. The upper limit to full stocking, i.e., the threshold between full stocking and overstocking, will be estimated by using the yield table stands for white spruce for interior Alaska. The information on the lower and upper stocking limits will be presented in a format, called the Gingrich stocking diagram, that can easily be used by the field forester.

### progress

A senior thesis student collected data on crown width and dbh from a sample of 49 open grown trees located throughout the Tanana Valley. A linear relationship was established between CW and dbh and found to be statistically different than the relationship established by Vezina in southern Quebec. Crown competition factors were derived for Farr's yield table stands and were found to vary systematically with average stand diameter, stabilizing at around 150 as average tree size increased above 6 inches. Considerable variation in CCF values was found when nonlocal CW-dbh relationships were used. A followup analysis of the data indicated a better fit with a nonlinear regression. Work is continuing to explore the effect of this nonlinear equation on CCF values. A preliminary Gingrich stocking diagram for white spruce has been constructed. The lower limit to full site occupancy was determined from the linear CCF equation, while the upper limit was calculated using equations fitted to yield table stands. The assumption that the maximum ground area needed by a tree of a given stem diameter is equal to the maximum crown area was examined for boreal spruce stands in Alaska and a conceptual modification to CCF was suggested. Uncertainties and limitations of data are recognized.

### impact

These results provide a basis for a preliminary stocking guide for white spruce in the Tanana watershed of interior Alaska. The establishment of a regional CW-dbh relationship allows the crown competition factor to be calculated for white spruce stands in the Tanana Valley. A locally based crown competition factor can be a useful indicator of stand density and contribute towards creating a boreal forest growth model. The Alaska Northern Forest Cooperative is spearheading this effort. These preliminary relationships can be updated as additional data become available but do provide an interim guide for managers. Two manuscripts have been prepared reporting this information.



# policy & planning

## Alaska Northern Forest Cooperative

Tom Malone

### purpose

Members of the cooperative exchange information among forest scientists, managers, and landowners in the Northern Forest of Alaska. The term "Northern Forest" includes the boreal forest or taiga extending across much of mainland Alaska but excludes the Coastal Spruce-Hemlock Forest.

### approach

The cooperative has a technical focus; it is neither a political nor an advocacy organization. It recognizes that nontechnical or traditional knowledge has value in forest management and that learning occurs by collaboration among scientists, landowners, and forest managers. The cooperative meets twice a year (spring and autumn) for business and sponsors at least one workshop or field trip each year that is separate from the business meetings.

### progress

In 2006, two business meetings and one three-day meeting/field trip were held. The 'Hardwood/Deciduous Tree Management' fall symposium was held in the Matanuska-Susitna Valley. Tom Malone made a presentation at this conference, "Response of Alaska Birch to Thinning and Other Hardwood Research."

A cooperative effort produced the second edition of a CD-ROM disk compendium of research projects, although it only scratched the surface of ongoing programs in the state. Through collaboration and the dissemination of information, the quality of forest management in the boreal forest of Alaska should improve on both public and private lands.

## Forest Vegetation Simulator (FVS) model

Tom Malone, Edmond C. Packee, Sr.

### purpose

Forest managers use stand or individual tree models to forecast probable results of alternative silvicultural prescriptions. No such models are currently used on public and private lands in Alaska's Northern Forest. For this project we select model(s) suitable for Alaska forests, determine data requirements, and begin using them for modeling stand response to potential treatments.

### approach

We are developing an FVS model that includes the Stand Visualization Simulator, with these selection criteria: quantitative and visual outputs, ability to handle wide range of silvicultural treatments, minimal data inputs, and user friendliness.



### progress

An FVS workshop was held in Fairbanks in May 2006. This meeting brought together the landowners, managers, and forest researchers with the FVS model developers from the USFS Forest Management Service Center in Fort Collins, Colorado. We worked to develop a timeline for model development and determine what information is available for model development. Our UAF forest growth and yield program has a large portion of the necessary data, but it needs extensive reformatting to fit in the model.

### impact

FVS provides current and post-prescription quantitative and visual results of treatment prescriptions. These can provide the public with a clearer picture of silvicultural treatment outcomes and improve and support State of Alaska Forest Land Use Plan harvest options.

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

**Kenneth A. Barrick**

### purpose

I sought to describe the environmental management of geysers and hot springs in New Zealand, including the management implications of the extinction of more than 100 geysers from various energy development projects.

### approach

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

### 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 these New Zealand geysers 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 geothermal power plant in New Zealand.*
—National Park Service photo by David Shafer, courtesy Yellowstone Digital Slide File, www.nps.gov/archive/yell/slidefile/index.htm; taken December 1997.

### impact

This research on the potential effects on hydrothermal features from nearby energy development can be used to help protect the remaining geysers in New Zealand, and at other geyser basins around the world.

## 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/imagery and ground photographs of the lake and lakeshore, and 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 dynamics of the lake. An interactive model has been created that captures the general dynamics of the lake water balance.

### progress

For the third summer, lake level data was recorded at 15-minute intervals. The lake continued its downward trend, losing another 6 inches from the fall 2005 level. Readings taken through the winter ice cover indicated continued lake decline from November through April. The planned re-channeling of Rogge Creek back into Harding Lake was postponed and construction of the control structure is now scheduled for next winter; inflow to Harding Lake was projected to start during spring 2007. Both a STELLA and an EXCEL model of the lake level have been created to help understand lake dynamics. Simulations and analysis of historical data suggest the lake may have started to decline in the late 1960s. This is consistent with the extreme flood events in interior Alaska in 1967. It is thus possible that a 1967 flood event on Rogge Creek caused the initial divergence of flow into a "new" channel that eventually "captured" the main flow. Another hypothesis is that beaver dams on Rogge Creek caused ponding that initiated the "new" channel diverting water away from the lake.

### impact

This project has provided documentation of lake decline and information for the planning of the re-channeling project. The project is providing a context for an additional senior thesis project this year. Focus now will shift on documenting the recovery of the lake to the target level and on estimating how long it will take the lake to reach that level under different inflow scenarios. 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.

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

**Julie Lurman**

### purpose

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



### approach

1. I examined the potential for direct conflict between the state's Intensive Management statute and the enabling legislation for certain federal land management agencies.

2. I examined several inconsistencies in the implementation of the Marine Mammal Protection Act regarding the Native Alaskan hunting exemption and the meaning of the term "waste."

### progress

1. An analysis of the applicable statutes and case law, as well as the current methods of implementation of the statutes in question, has been conducted and a manuscript was submitted for publication March 2007.

2. An analysis of the relevant case law and statutes has been conducted and a manuscript will be submitted for publication in spring 2007.

### impact

1. This study 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.

2. The work related to the Marine Mammal Protection Act will be of interest to those agencies that manage marine wildlife under the statute, as well as to the Native communities and organizations that depend on marine mammals for subsistence, and economic and cultural purposes.

## The Study of Sharing to Assess the Vulnerability of Coastal Communities to Oil and Gas Development in Arctic Alaska

**Gary Kofinas** (SNRAS/IAB); **Peter Fix** (SNRAS); Craig Gerlach (Anthropology); Jim Magdanz (ADFG)

### purpose

The Sharing Project, funded by the Mineral Management Services of the Department of Interior through the Cooperative Ecological Studies Unit, uses multiple methods to assess the vulnerabilities of two North Slope Alaska coastal communities

and one interior rural Alaska community to the effects of oil and gas development. The study is undertaken with a focus on the resilience of social networks of sharing that are part of Alaska Native subsistence-cash economies.

### approach

The study uses survey research methods, ethnographic analysis, simulation modeling, and a participatory research approach involving the tribal organizations of each community. The information gathered is intended to inform agencies and participating communities of the resilience of social systems of the North Slope villages to potential changes that could result from future oil and gas development. The data will also serve as important baseline for future studies. Researchers and leaders of participating communities will compare community resilience and vulnerabilities with other communities through the activities of the Community Adaptation and Vulnerability in Arctic Regions (CAVIAR), an initiative of the International Polar Year. A postdoctoral fellow and natural resource management masters student will serve as a full members of the research team.



### progress

The project is undertaking the research in close collaboration with local communities. The early work of the project has, therefore, been spent inviting communities to join the project, beginning the literature review, hiring the post doc, and exploring the options of undertaking the survey research.

### impact

The project's use of social network analysis represents a novel approach in the assessment of potential Arctic oil and gas development impacts on indigenous communities and thus, offers a new model for impact assessment. The project's collaboration provides the basis for future research collaboration between SNRAS and Alaska Native villages.

## recreation & 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 (USDI BLM, NPS, and FWS; USDAFS; Alaska DOT, State Parks, F&G), and the resulting information will be incorporated into their planning processes.

### approach

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

### progress

During 2006, we obtained Office of Management and Budget approval for the survey and began gathering data. The first and second waves of the mail survey were completed in 2006.

### 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.

### White Mountains National Recreation Area and Steese National Conservation Area Recreation Experience study

**Peter J. Fix**

### purpose

This project applies the concepts of Benefits Based Management to a study of recreation experiences in the White Mountains National Recreation Area (WMNRA) and Steese National Conservation Area (SNCA). The study will measure the four levels of demand specified by Benefits Based Management: activities, settings, desired experience, and off-site benefits.

### approach

Visitors, selected by a random sample, are asked to participate in a short onsite survey and followup mail or internet survey. Questions in the survey measure the four levels of demand.

### progress

During summer 2006, 166 onsite surveys and 69 followup surveys were completed. Data entry was completed and analysis started.

### impact

This study will assist the Bureau of Land Management in understanding the users of the WMNRA and SNCA and provide guidance in developing appropriate management plans.

*Scene from the Steese National Conservation Area.*
—PHOTO COURTESY BUREAU OF LAND MANAGEMENT

# Publications 2006

## Abstracts

Brinkman TJ, **Kofinas GP,** Chapin FS III, Person DK. 2006. Resilience of a subsistence hunter system in a rapidly changing social and ecological environment. Paper presented at the 12th International Symposium on Society and Natural Resources, Vancouver, British Columbia, Canada. June 6, 2005; p. 36.

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**Juday GP.** 2006. Evidence and Effects of Climate Warming in the Boreal Forest of Alaska (Abstract). Thirtieth Annual National Indian Timber Symposium, June 5–8, 2006. Fairbanks, Alaska. www.tananachiefs.org/natural/forestry/ITC/ITC_symposium_agenda.pdf.

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## Posters, presentations, and workshops

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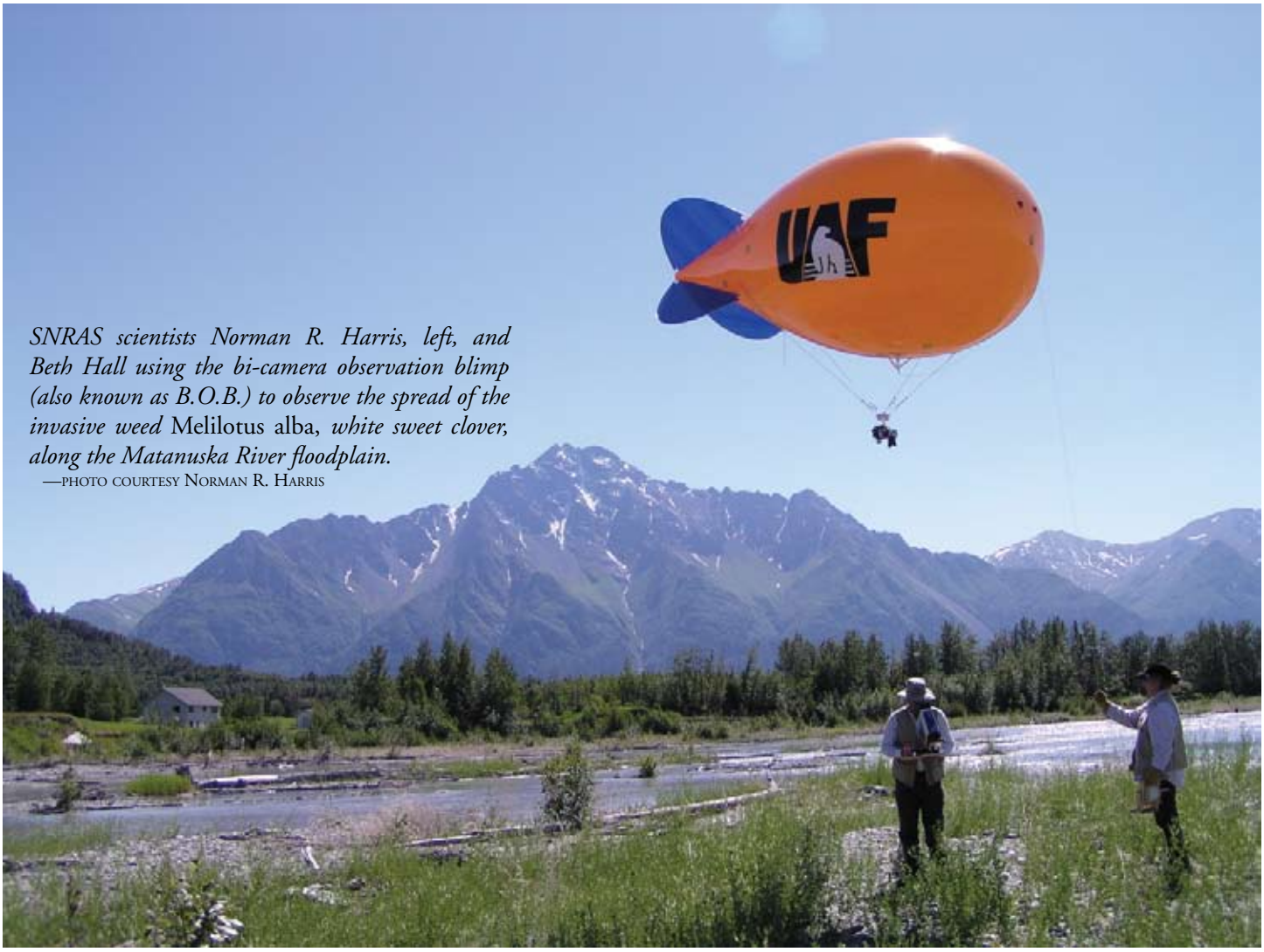


*SNRAS scientists Norman R. Harris, left, and Beth Hall using the bi-camera observation blimp (also known as B.O.B.) to observe the spread of the invasive weed* Melilotus alba, *white sweet clover, along the Matanuska River floodplain.*
—PHOTO COURTESY NORMAN R. HARRIS



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## Proceedings

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