

UAF School of Natural Resources & Agricultural Sciences

Agricultural & Forestry  
Experiment Station

# Annual Report 2009



*Fire on Nenana Ridge.*

—UAF PHOTO BY TODD PARIS

This report is published by the Agricultural and Forestry Experiment Station, University of Alaska Fairbanks.

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[www.uaf.edu/snras/afes/pubs/](http://www.uaf.edu/snras/afes/pubs/)

Our blog is kept updated regularly with news, announcements, research highlights, and more. Please see it at:

<http://snras.blogspot.com>

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The University of Alaska Fairbanks is accredited by the Commission on Colleges of the Northwest Association of Schools and Colleges. UAF is an AA/EQ employer and educational institution.



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## Letter from the dean:

June 21, 2011

The Honorable Sean Parnell  
Governor of Alaska  
P.O. Box 110001  
Juneau, Alaska 99811-0001



Dear Sir:

I submit herewith the annual report from the Agricultural and Forestry Experiment Station, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks, for the period ending December 31, 2009. This is done in accordance with an act of Congress, approved March 2, 1887, entitled, "An act to establish agricultural experiment stations, in connection with the agricultural college established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and also of the act of the Alaska Territorial Legislature, approved March 12, 1935, accepting the provisions of the act of Congress.

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

Very respectfully,

Carol E. Lewis  
Dean and Director

# AFES Statement of Purpose:

**T**HE 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.

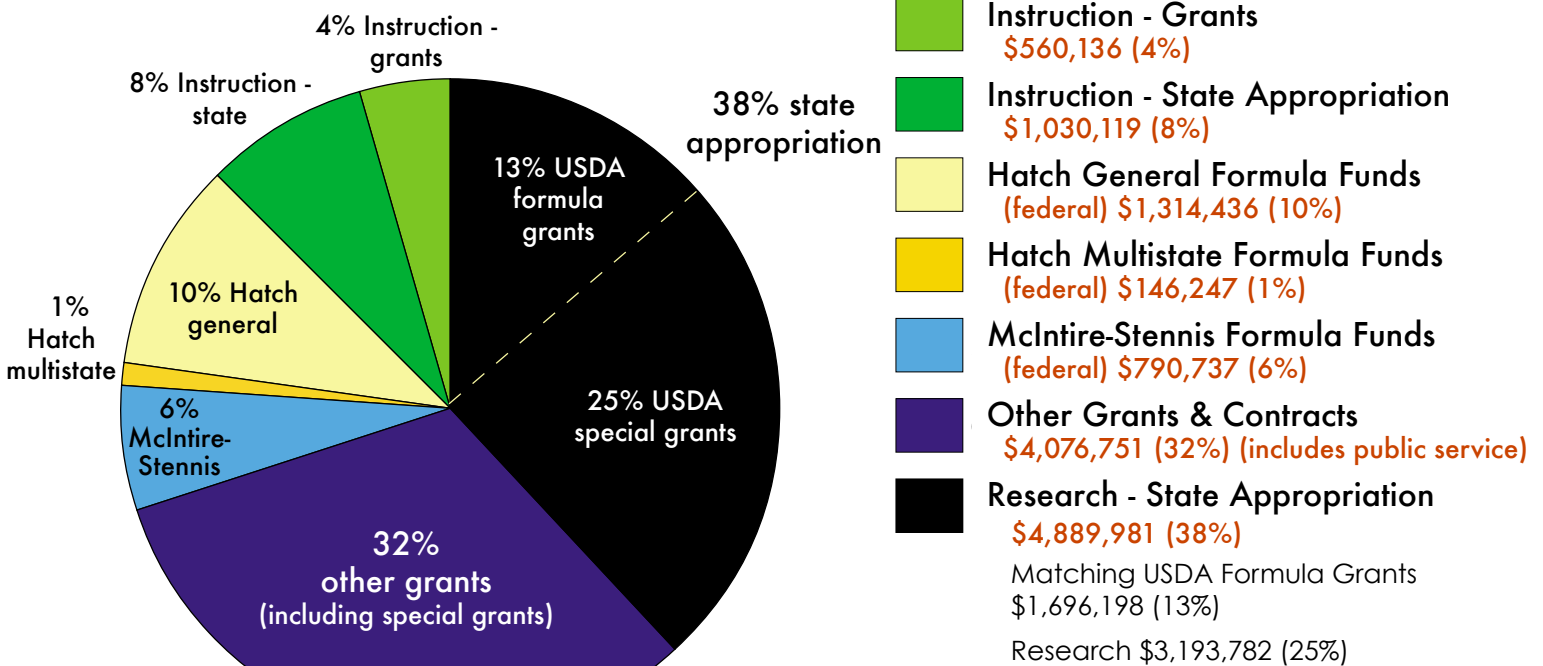


*Kids bobbing for vegetables during Alaska Agriculture Appreciation Day at the Matanuska Experiment Farm.*  
AFES PHOTO BY NANCY TARNAI

# Financial statement

## Expenditures: July 2009 through June 2010

The following statement of expenditures of federal and state funds for the fiscal year beginning July 1, 2009 and ending June 30, 2010 (FY 2010) is not an accounting document.



Total Funds: \$12,808,407

# Grants

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GRANTS & CONTRACTS/SPECIAL FUNDS	PI	AGENCY
Building Alaska Garden Soils	Anderson	Utah State University
Climate Change and Social Vulnerability	Barber	USDA Forest Service (PNWR Oregon)
Forest Products Program - Year 9	Barber	USDA CSREES
Forest Products Program Yr 8	Barber	USDA CSREES
Project Income for FPP YR9, G6072	Barber	Program Income Account
UAF Sitka Forest Products #7	Barber	Cooperative State Research Services CSRS
BLM Range Management FY10	Finstad	Bureau of Land Management
NRCS Cooperative Agreement 2007	Finstad	NRCS - Natural Resources Conservation Service
NRCS Reindeer Cooperative Agreement	Finstad	Natural Resources Conservation Service
ARSP: Analysis & Publication	Fix	USDA Forest Service (JFSL)
CESU AK Resident Statistics Program	Fix	Bureau of Land Management
CESU BLM Visitor Satisfaction	Fix	Bureau of Land Management
CESU, MMS Startup	Fix	USDI Minerals Management Services
Monitoring Indicator in DNP	Fix	National Park Service
New crop for Alaska VII	Fix	Cooperative State Research Services CSRS
Alaska Biome Shifts	Fresco	Fish and Wildlife Service-Anchorage
Canada Biome Shift-Ducks Unlimited	Fresco	Ducks Unlimited, Inc.
Temp Monitoring for AK Streams	Fresco	Cook Inlet Keeper
Yukon Climate Projections	Fresco	Yukon College - Northern Research Institute
Economic Analysis of Feedstock	Geier	Washington State University
Matanuska Sports Turf Field	Harris	UA Foundation
The Atlas of Alaska	Heiser	Alaska Humanities Forum
D. Beistline Memorial Garden	Holloway	UA Foundation
Drew Amphitheater Foundation	Holloway	UA Foundation
GBG Children's Garden	Holloway	UA Foundation
GBG Foundation	Holloway	UA Foundation
GBG Ohlsen Family Garden	Holloway	UA Foundation
2010 Yukon River Basin Study	Juday	USDI Geological Survey
FFA Foundation Support	Karlsson	UA Foundation
Greenhouse Crops III	Karlsson	Cooperative State Research Services CSRS
Sustainable Horticulture Research	Karlsson	UA Foundation
Oil & Gas Development Impacts	Kofinas	USDI Minerals Management Services
ADAP Regional Food Security	Lewis	University Of Hawaii
ADAP Regional Food Security Yr 22	Lewis	University Of Hawaii
Alaska Berries 3	Lewis	USDA CSREES
Alaska Berries: II	Lewis	Cooperative State Research Services CSRS
CESU: FY10 USGS Lab Services	Lewis	USDI Geological Survey
Dean Discretionary Acct II - SNRAS	Lewis	UA Foundation
DNA Sequencing ARS Task Order FY09	Lewis	USDA - Agricultural Research Service
Ethnobotany Project III	Lewis	Cooperative State Research Services CSRS

CONTINUED ON THE NEXT PAGE

FY09 NPS Soil Sample Processing	Lewis	National Park Service
FY10 ARS Maint, IT, and Admin Suppt	Lewis	USDA, ARS
FY10 ARS Palmer Utilities	Lewis	USDA, ARS
New Crops for Alaska VIII	Lewis	USDA CSREES
Program Income for 2011 NERAOC	Lewis	Program Income Account
Program Income for G5918 FY10 Hatch	Lewis	USDA National Institute of Food & Agriculture NIFA
Afognak Island Sample Plots	Liang	Afognak Native Corporation
Projection of Forest Growth & Yield	Liang	USDA Forest Service (ALB)
Potential Efficacy of 6th Grade MCC	Lipka	Department of Education
SNAP: Warm-Season Precipitation	Mann	National Science Foundation
2010 Potato Seed Lot Testing	McBeath	AK Division of Agriculture
Aster Yellow Phytoplasma	McBeath	USDA Foreign Agricultural Service
Cultivation of Pine Wilt Nematode	McBeath	Alaska Department of Natural Resources
Flux and Transform of Carbon	Ping	National Science Foundation
ALFRESCO Grassland Module	Rupp	USDI Fish & Wildlife Service, Anchorage MS-235
CESU Modeling Fire Regimes	Rupp	National Park Service
Climate change scenarios for NW Canada	Rupp	The Nature Conservancy
Climate Change Workshop	Rupp	Yukon College - Northern Research Institute
Connecting Landscapes	Rupp	USDI Fish & Wildlife Service, Anchorage MS-235
Effects - Fuels Reduction Treatment	Rupp	Bureau of Land Management
Forest Climate Change Impacts	Rupp	USDA Forest Service (ALB)
Impacts of Climate Change on Fire	Rupp	National Science Foundation
Integrated Ecosystem Model for AK	Rupp	Fish and Wildlife Service-Anchorage
Joint Fire Science Project	Rupp	USDI Fish & Wildlife Service, Anchorage
PNW Scenarios Network for Alaska Planning	Rupp	USDA Forest Service (PNWRS)
Projected Climate Change in AK	Rupp	Bureau of Land Management
SNAP Climate Model - USGS CESU	Rupp	US Geological Survey
Experimental Turf Putting Course	Scott	Mat-Su Health Foundation
Matanuska Sports Field Complex	Scott	Mat-Su Health Foundation
AGA Geospatial Content	Sfraga	Nat'l Geographic Society
AGA Restructure	Sfraga	Nat'l Geographic Society
CESU Researcher in Residence Program	Sfraga	National Park Service - Denali Nat'l Park
Policy Linkages with Climate Change	Sfraga	USDA Forest Service (PNWR Oregon)
The UA and AT&T Alaska GeoPortal	Sfraga	AT&T Alascom
SNAP FY08/09	Sharpton	UA Foundation
Seed Quality in Northern Latitudes	Smeenck	USDA - Agricultural Research Service
Weather Related Vectors - Potatoes	Smeenck	USDA - Agricultural Research Service
CHN for Biomass/Biofuel Research	Soria	Cooperative State Research
Gasification of Salmon Waste	Soria	USDA - Agricultural Research Service
Low NOx Emitting Biodiesel	Soria	University Of Hawaii
Moisture Content Determination	Soria	USDA Forest Service - Juneau
ANEP MAPTEACH	Stephens	US Department of Education
Dev UAF IPM Plan	Todd	USDA Forest Service
Capacity Building in Climate Change	Trainor	Wilburforce Foundation

Wildland Fire Science in Alaska	Trainor	USDI Geological Survey
CESU Remotely Monitor Ice	Verbyla	National Park Service
Lake Surface Area at KVNP	Verbyla	National Park Service
AFES-ARS Fish Compost 09	Zhang	USDA - Agricultural Research Service
Evaluating AK Whitefish By-Products	Zhang	USDA - Agricultural Research Service

## FORMULA FUNDING, FEDERAL OCT 1 TO SEPT 30 FISCAL YEAR

### Hatch Multistate

Balancing Natural Resource Recreation Mgt, Human Well-Being and Community Resilience, ALK-09-07	Fix	USDA - National Institute of Food and Agriculture
Rangeland Fragmentation W 1192, ALK-07-07	Harris	USDA - National Institute of Food and Agriculture
Commercial greenhouse NE-1035, ALK-09-05	Karlsson	USDA - National Institute of Food and Agriculture
Regional Administration W-106, ALK-99-05	Lewis	USDA - National Institute of Food and Agriculture
Reproductive Performance, W 1112, ALK-06-06	Shipka	USDA - National Institute of Food and Agriculture
Nitrogen Mineralization NC 1032, ALK-07-08	Zhang	USDA - National Institute of Food and Agriculture

### Hatch General

Reindeer Production & Meat Quality, ALK-04-07	Finstad	USDA - National Institute of Food and Agriculture
Balancing Natural Resource Recreation Mgt, Human Well-Being and Community Resilience, ALK-09-07	Fix	USDA - National Institute of Food and Agriculture
Natural Resources & Economics, ALK -08-02	Greenberg	USDA - National Institute of Food and Agriculture
Spatially Modeling Dist of Beef Cattle, ALK-03-03	Harris	USDA - National Institute of Food and Agriculture
Rangeland Fragmentation W 1192, ALK-07-07	Harris	USDA - National Institute of Food and Agriculture
Horticultural Crop Production for AK, ALK-08-01	Holloway	USDA - National Institute of Food and Agriculture
Laws Affecting Environment, ALK -05-01	Joly	USDA - National Institute of Food and Agriculture
Controlled Environment Horticulture for AK, ALK -07-06	Karlsson	USDA - National Institute of Food and Agriculture
Commercial greenhouse NE-1035, ALK-09-05	Karlsson	USDA - National Institute of Food and Agriculture
Potato Phytoplasmas in Alaska, ALK-07-13	McBeath	USDA - National Institute of Food and Agriculture
Hydric Soils Monitoring, ALK -09-02	Ping	USDA - National Institute of Food and Agriculture
Livestock Production, ALK-06-06, W-1112	Shipka	USDA - National Institute of Food and Agriculture
Season Extension for High Lat Garden Prod, ALK-08-04	Smeenk	USDA - National Institute of Food and Agriculture
Lignocellulosic Energy Crops, ALK-08-03	Sparrow	USDA - National Institute of Food and Agriculture
Quality of Life and Landscape, ALK-09-01	Todd	USDA - National Institute of Food and Agriculture
Alternative Agronomic Crops for AK, ALK-08-06	Zhang	USDA - National Institute of Food and Agriculture
Nitrogen Mineralization NC 1032, ALK-07-08	Zhang	USDA - National Institute of Food and Agriculture
Yield & Quality of Barley, ALK-04-03	Zhang	USDA - National Institute of Food and Agriculture

### McIntire-Stennis

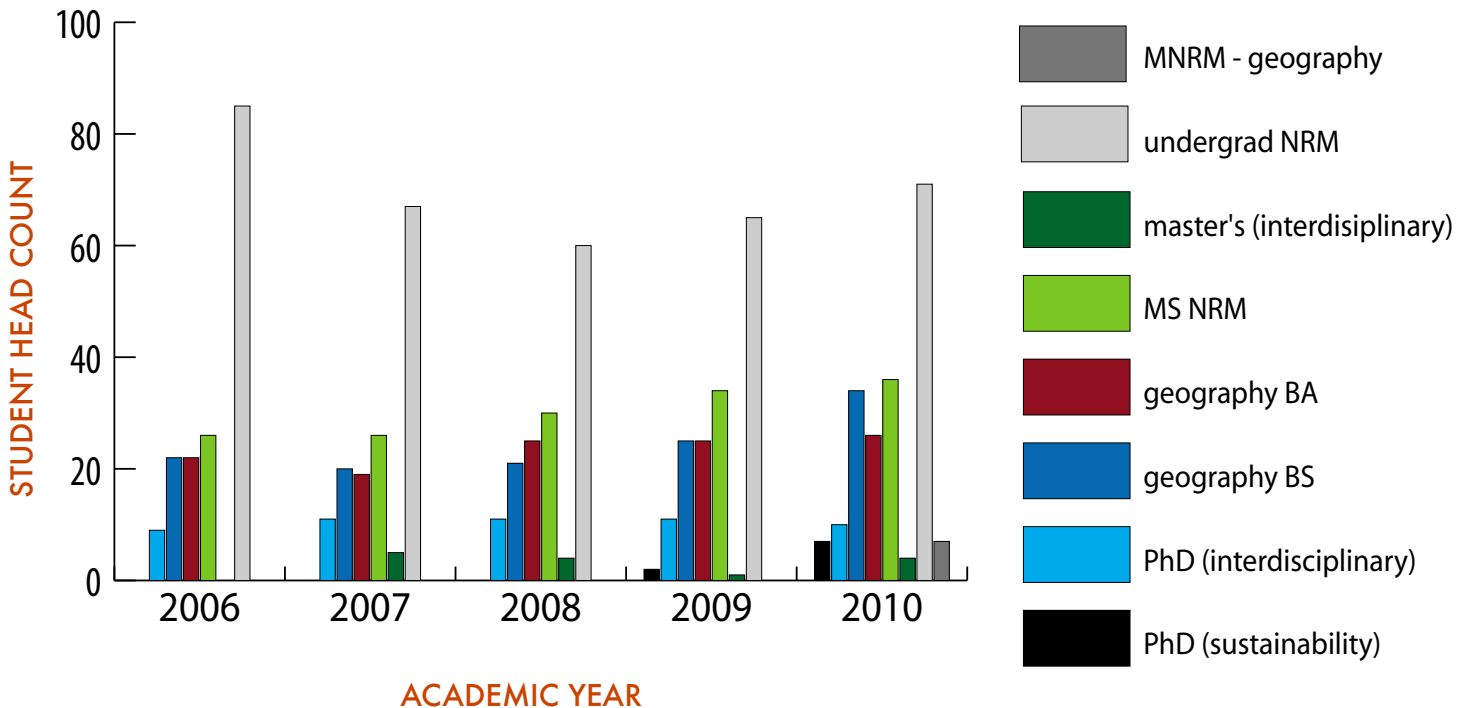
Evapotranspiration from Boreal Forest, ALK-05-04	Fox	USDA - National Institute of Food and Agriculture
Climate Sensitivity of Tree Growth, ALK-07-12	Juday	USDA - National Institute of Food and Agriculture
Measurement & Mgt of Boreal Forest, ALK-09-08	Liang	USDA - National Institute of Food and Agriculture
Sensitivity of Carbon Budgets, ALK-07-11	Valentine	USDA - National Institute of Food and Agriculture
The Dynamics of Forest Growth, ALK-06-04	Yarie	USDA - National Institute of Food and Agriculture

### Animal Health

Mineral Flux in Reindeer, ALK-03-07	Finstad	USDA - National Institute of Food and Agriculture
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# Students

five-year statistics: number of students enrolled, 2006-2010



7

ACADEMIC YEAR	PHD (SUSTAINABILITY)	PHD (INTERDISCIPLINARY)	GEOGRAPHY BS	GEOGRAPHY BA	MS NRM	MASTER'S (INTERDISCIPLINARY)	UNDERGRAD NRM	MNRM GEOGRAPHY
2006	0	9	22	22	26	0	85	
2007	0	11	20	19	26	5	67	
2008	0	11	21	25	30	4	60	
2009	2	11	25	25	34	1	65	
2010	7	10	34	26	36	4	71	7

## degrees offered

### Bachelor's degrees

#### BACHELOR OF SCIENCE:

- Geography, options in environmental studies, landscape analysis and climate change studies, or geographic information science and technology
- Humans and the Environment (formerly Natural Resources Management), options in high-latitude agriculture, forest sciences, or humans and the environment (formerly resources management)

#### BACHELOR OF ARTS:

- Geography

#### Master's degrees:

- Master's of Science in Natural Resources Management
- Master of Natural Resources Management and Geography
- Interdisciplinary Master

#### Doctoral degrees:

- Doctor of Philosophy in Natural Resources and Sustainability
- Interdisciplinary Doctor of Philosophy

# Graduates as of May 2010

\*December 2009 degree recipient

\*\*Summer 2010 recipient

## Baccalaureate Degrees

**Matthew Balazs**, BS, Geography: Geographic Information Science and Technology; Landscape Analysis and Climate Change Studies. *Golden Key Honor Society*; BA, Geography. *Golden Key Honor Society, cum laude*

**Kasey Lynne Brovold**, BS, Geography

8 **David Dunbar**, BA, Geography

**Hannah Harrison**, BS, Natural Resources Management: Resources

**Ellen Hatch**, BS, Natural Resources Management: Plant, Animal and Soil Sciences, *Honors Program, Golden Key Honor Society, magna cum laude*

**Daniel Hazen**, BS, Geography: Landscape Analysis and Climate Change Studies

**Heidi Isernhagen**, BA, Geography

**Joseph Kendall**,\*\* BS, Natural Resources Management: Resources

**Cori Kindred**, BA, Geography

**Tamara Lozano**, BS, Natural Resources Management: Plant, Animal and Soil Sciences

**Christine McLean**, BS, Geography: Environmental Studies

**Robert Mikol**,\*\* BS, Geography: Landscape Analysis and Climate Change Studies

**Anne Miller**, BS, Natural Resources Management: Plant, Animal and Soil Sciences

**Amanda Peacock**,\*\* BS, Natural Resources Management: Plant, Animal and Soil Sciences

**Amy Rath**, BS, Geography: Landscape Analysis and Climate Change Studies

**Katherine Riffey**, BS, Natural Resources Management: Geographic Information Science and Technology; Landscape Analysis and Climate Change Studies

**Matthew Sprau**, BS, Natural Resources Management: Forestry

**Nicole Swensgard**, BS, Natural Resources Management: Plant, Animal and Soil Sciences

**Molly Timm**, BA, Geography. *Golden Key Honor Society, cum laude*

**Vincent Waters**, BS, Natural Resources Management: Resources

*Ellen Trainor, graduate student, participating in the birling event at the Forest Sports Festival.*

AFES PHOTO BY NANCY TARNAI

## Master's Degrees

**Jill Maynard**, MS, Natural Resources Management

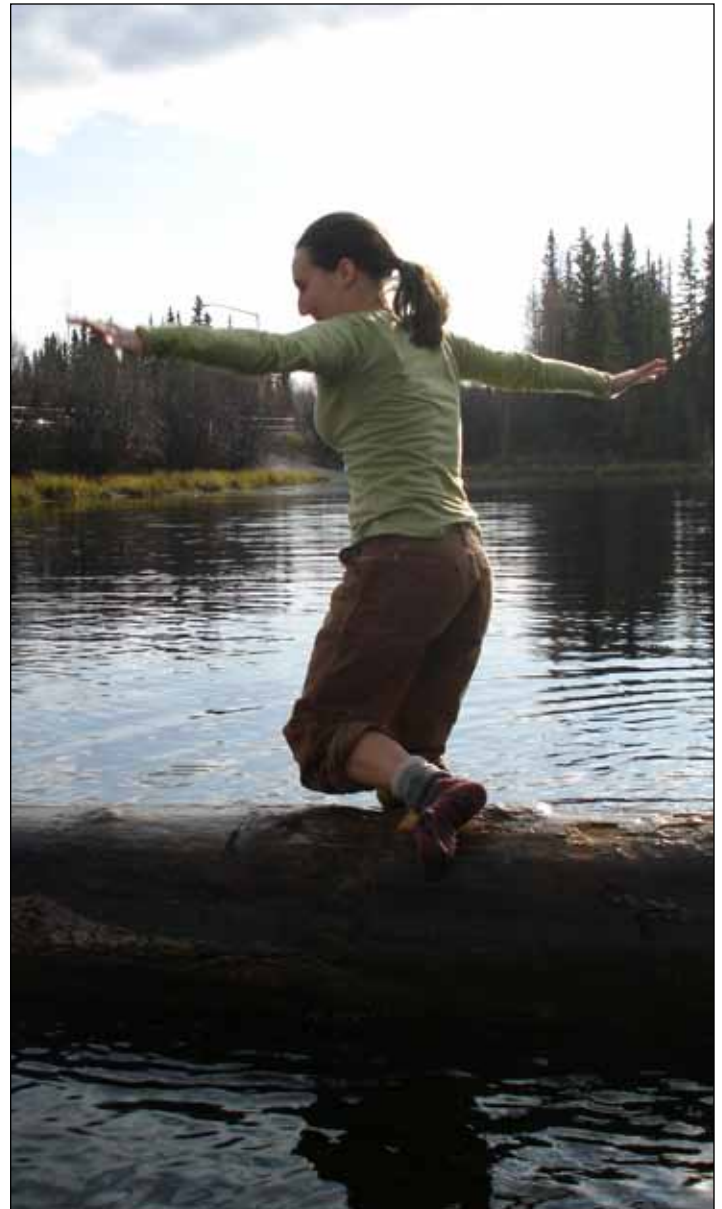
Thesis: Factors Influencing the Development of Wind Power in Rural Alaska Communities  
*BS, Oregon State University, 2001*

**Ellen Trainor**, MS, Natural Resources Management, Golden Key Honor Society

Responses of Soil Nutrients and Soil Respiration to Frass and Cadaver Deposition from Grasshoppers (Orthoptera: acrididae) in Alaska Agricultural Soils  
*BS, University of Prince Edward Island (Canada), 2001*

**Jennifer Jenkins**,\*\* MS, Natural Resources Management

Project title: Status and distribution of wetland habitats in the Greater Fairbanks Area  
*BS, Adams State College (Colorado), 1998*





# Research Reports

**T**HE SCHOOL and experiment station pursue their missions with faculty in four departments: High-Latitude Agriculture; 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 SNRAS faculty author under subject focus. A detailed index with subject links is available at the end of this publication.

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- 10 • Programs
- 13 • Research Sites & Facilities
- 15 • Geography
- 23 • High-Latitude Agriculture
- 43 • High-Latitude Soils
- 49 • Management of Ecosystems
- 63 • Natural Resources Use & Allocation
- 76 • Index to Reports

## Partners and Collaborators

### Agricultural Research Service

The Subarctic Agricultural Research Unit of the US Department of Agriculture (USDA) Agricultural Research Service (ARS) is hosted at the School of Natural Resources and Agricultural Sciences.

[www.ars.usda.gov](http://www.ars.usda.gov)

### Alaska Center for Energy and Power

The Alaska Center for Energy and Power (ACEP), based at the University of Alaska, is dedicated to applied energy research and testing, with programs in wind-diesel, hydrokinetic, and diesel applications. The center is focused on lowering the cost of energy throughout Alaska and developing economic opportunities for the state, its residents, and its industries.

[www.uaf.edu/acep/](http://www.uaf.edu/acep/)

### Alaska Community Agriculture Association

This is a group of Alaska farmers and gardeners who grow and sell produce for direct sale to the public. Its members are committed to promoting, supporting, and working toward healthy, sustainable local food systems.

[www.alaskacommunityag.org/](http://www.alaskacommunityag.org/)

### Alaska Peony Growers Association

This organization is made up of the state's peony growers, who are working to grow high-latitude peonies for the international market.

[www.akpeonygrowers.blogspot.com](http://www.akpeonygrowers.blogspot.com)

### Alaska Center for Climate Assessment & Policy

The Alaska Center for Climate Assessment and Policy assesses the socio-economic and biophysical impacts of climate variability in Alaska, and makes this information available to local and regional decision makers, in an effort to improve the ability of Alaskans to adapt to a changing climate.

[www.uaf.edu/accap/](http://www.uaf.edu/accap/)

### Alaska Climate Change Strategy

Formed in September 2007, the Alaska Climate Change Strategy is a subcabinet that advises the Office of the Governor on preparation and implementation of Alaska climate change strategy. It seeks to be of use to Alaskans by conveying state plans for adaptation to warming as well as presenting realistic approaches to mitigating the root causes of climate change.

[www.climatechange.alaska.gov/](http://www.climatechange.alaska.gov/)

### AT&T

AT&T is the world's largest communications holding company, recognized as a leading worldwide provider of IP-based communications services to businesses and the top US provider of wireless, high-speed internet access, Wi-Fi, local and long distance voice, and directory publishing and advertising services.

[www.att.com](http://www.att.com)

### Boreal Ecology Cooperative Research Unit (BECRU) USDA Forest Service

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. The Alaska Region Forest Service works with the public to manage more than 22 million acres in southcentral and southeast Alaska. The Alaska Region of the Forest Service is a leader in protecting the land's bounty while providing a place for people to work and play.

[www.fs.fed.us/r10/](http://www.fs.fed.us/r10/) • [www.becru.uaf.edu/](http://www.becru.uaf.edu/)

### Chena Hot Springs Renewable Energy Center

The vision at Chena Hot Springs Resort is to become a self-sufficient community in terms of energy, food, heating, and fuel use. The resort is developing renewable energy and sustainable development projects and is forming partnerships

within the community and across the US to promote and implement renewable technologies.

[www.chenahotsprings.com](http://www.chenahotsprings.com)

### **Cold Climate Housing Research Center**

CCHRC is an industry-based, nonprofit corporation created to facilitate the development, use, and testing of energy-efficient, durable, healthy, and cost-effective building technologies for Alaska and the world's cold climate regions. The research center was conceived and developed by members of the Alaska State Home Builders Association.

[www.cchrc.org](http://www.cchrc.org)

## **10 Cooperative Ecosystem Studies Unit Network**

The North and West Alaska Cooperative Ecosystem Studies Unit is a network of federal agencies, universities, and other organizations that have united in order to better facilitate research in local and regional ecosystems. The University of Alaska hosts the NWA-CESU, with the University of New Hampshire and the Alaska SeaLife Center as partners. Research focuses on arctic and subarctic anthropology, landscapes, ecology, archaeology, and physical and biological sciences.

[www.uaf.edu/snrascesu/](http://www.uaf.edu/snrascesu/)

### **Cooperative Extension Service**

The UAF Cooperative Extension Service is the state's gateway to its university system, serving 60,000 Alaskans annually, and providing a link between Alaska's diverse people and communities by interpreting and extending relevant university, research-based knowledge in an understandable and usable form to the public.

[www.alaska.edu/uafces/](http://www.alaska.edu/uafces/)

### **EPSCoR: Alaska Experimental Program to Stimulate Competitive Research**

Alaska EPSCoR is a university-state partnership which builds Alaska-based research and addresses national scientific priorities, training students for the twenty-first century technologically based workforce. EPSCoR aims to strengthen science and technology infrastructure for enhanced research competitiveness in universities, for broader participation of students in science, mathematics, and engineering, and for increased linkages among higher education, government agencies, and the private sector.

[www.alaska.edu/epscor/](http://www.alaska.edu/epscor/)

### **Google Earth**

Millions of people use Google Earth and Google Maps to explore the world. Google Earth Outreach gives nonprofits and public benefit organizations knowledge and resources. Google sent a team of Googlers to Alaska who are passionate about education and whose goal is to make tools like Google Earth more accessible to educators.

[www.earth.google.com](http://www.earth.google.com)

### **Kawerak Reindeer Herders Association**

The Kawerak Reindeer Herders Association provides assistance to its twenty-one members in the development of a viable reindeer industry, by enhancing the economic base for rural Alaska and improving the management of the herds. The program offers administrative, logistical, advocacy, and field support toward the development of a self-sustaining reindeer industry.

[www.kawerak.org](http://www.kawerak.org)

### **National Geographic Society**

The National Geographic Society's Education Foundation funds an alliance in every state. The UAGP is the home of the Alaska Geographic Alliance, and receives teaching materials which are distributed to schools throughout the state. The AGA participates in Geography Action!, Geography Awareness Week, My Wonderful World, the Giant Traveling Map program, NGS Summer Institutes, and the State Geographic Bee.

[www.nationalgeographic.com/education/alliance](http://www.nationalgeographic.com/education/alliance)

### **Pike's Waterfront Lodge**

The lodge turns over its greenhouse during the growing season to FFA students and university researchers who use the facilities to grow vegetables hydroponically. Nightly educational seminars are offered all summer, and produce is served at restaurant facilities at the lodge. FFA members sell extra produce to the public at the greenhouse. All proceeds benefit FFA.

[www.pikeslodge.com](http://www.pikeslodge.com)

## **Programs**

### **Alaska Residents Statistics Program**

This program seeks to identify common recreation management information needs among federal and state agencies, using surveys in an ongoing effort to gather data, with a core set of questions remaining consistent over time and additional questions regarding specific issues asked on a rotating basis. The goals are to decrease redundancy in data gathering efforts and develop a shared database on recreation trends in Alaska. Data sought to date includes information on travel patterns, participation in outdoor recreation activities, and broad measures of benefits received from recreation on public lands in Alaska. Possible future surveys may gather data on detailed use information for specific sites, economic impacts, attitudes toward land management issues, and value orientations held by Alaskans on natural resource issues.

[www.uaf.edu/snrasc/facilities-programs/alaska-resident-statistic/](http://www.uaf.edu/snrasc/facilities-programs/alaska-resident-statistic/)

### **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 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.

[www.lter.uaf.edu](http://www.lter.uaf.edu)

### Controlled Environment Agriculture Laboratory (CEAL) program

Basic to highly technical controlled environment systems—from temporary cold frames and high tunnels to facilities using technology originally developed for space exploration and missions to Mars—can be adapted to Alaska’s regional conditions to improve production of vegetables, berries, and floral crops. Controlled environment and greenhouse research at CEAL investigates plant requirements, varieties, and treatments to maximize productivity and efficiency. The laboratory facility allows for precise control of lighting, temperature, humidity, and nutrients, so that different varieties and various production techniques can be tested. The new West Ridge greenhouse now under construction will allow research in a technologically advanced greenhouse starting spring 2012.

[www.uaf.edu/snras/facilities-programs/controlled-environment-ag/](http://www.uaf.edu/snras/facilities-programs/controlled-environment-ag/)

### Forest Dynamics & Management program

Providing the people of Alaska with scientifically accurate information by monitoring the growth and change of the northern forests is the major purpose of the UAF Program of Forest Dynamics and Management. With a goal of best-practice forest management, UAF researchers in this program seek to provide the best scientific information to help land managers and owners with decision making. By setting up a system of permanent plots for long-term monitoring, foresters are providing data for growth and yield models. Nearly 200 plots are being actively studied in the Tanana Valley, Copper River Valley, Matanuska-Susitna Valley, and Kenai Peninsula. The growth models of major tree species define the density and diversity of the forests, and measure site index, growth equations, volume equations, and levels of growing stock. Research is focused on simulation and optimization, forest health, wildland fires, and climate change. In addition to charting the growth and health of forests, the program identifies forest characteristics and regeneration properties. UAF forestry specialists offer free consultations on forest management to all Alaskans, including Native corporations and the forest industry.

[www.uaf.edu/snras/facilities-programs/forest-dynamics-management/](http://www.uaf.edu/snras/facilities-programs/forest-dynamics-management/)

### 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 program was established in 1996 through the Center for Global Change and Arctic Systems Research at the University of Alaska Fairbanks.

[www.cgf.uaf.edu/Globe/default.html](http://www.cgf.uaf.edu/Globe/default.html)

### 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. In 2006 the GBG was the recipient of the All-America Selections Display Garden Exemplary Education Award. The GBG is one of five botanical gardens in the nation to be a satellite test garden for the International Hardy Fern Foundation. Garden staff test more than 1,000 trees, shrubs, and herbaceous perennials for hardiness each year, including Alaska native plants and those collected from China, Russia, and Iceland. The garden serves as a location for variety trials of annual flowers, vegetables, herbs, and fruits, where researchers conduct experiments on new horticultural crops for Alaska’s conditions, such as peonies.

[www.georgesonbg.org/](http://www.georgesonbg.org/)

### MapTEACH

MapTEACH is developing a culturally responsive geoscience education program for middle- and high-school students in Alaska that emphasizes hands-on experience with the geosciences and spatial technology (GPS, GIS, and remote sensing imagery). The project draws upon the combined expertise of teachers, education researchers, remote sensing specialists, geoscience professionals, Native elders, and others with traditions-based knowledge. Participants work directly with local experts and Alaska Division of Geological & Geophysical Survey scientists to authentically emulate scientific activities at a novice level, using real data in a real-world setting. Students and teachers have access to locally and culturally relevant geospatial IT curriculum facilitated by web-served imagery, geographic information systems data, analysis tools, and field resources.

[www.mapteach.org](http://www.mapteach.org)

### Math in a Cultural Context

Math in a Cultural Context is a supplemental elementary school math series. The math modules that compose MCC are the result of a collaboration of educators, Yup’ik elders and teachers, mathematicians and math educators, and Alaska school districts. This culturally relevant curriculum

also includes traditional stories that accompany the math modules. This collaboration produces culturally relevant materials that connect local knowledge to school knowledge, and includes integrated materials (literacy, geography, and science). The reform-oriented curriculum is designed for Alaska students, has been extensively studied, and meets the highest research standards. Studies of its efficacy repeatedly show that MCC students outperform comparable control group students who use their regular math curriculum. It is one of the very few curricula for Alaska Native and Native American students that show such powerful results.

[www.uaf.edu/mcc/](http://www.uaf.edu/mcc/)

## 12 OneTree Alaska

OneTree, a community outreach and research project coordinated by the UAF Forest Products Program (see below), explores art and science through connections to a single tree. OneTree is based on an earlier project by the same name which got its start in 1998, when a single large oak was felled in the National Trust estate of Tatton Park in Cheshire, England. The OneTree project aims to show the unique value of woodlands and wood products by demonstrating the volume and quality of work that can be made from one tree. By focusing on a common goal—full utilization of a single tree—OneTree unleashes the breadth of creativity in its participants. OneTree creates collaborations among area schools, the university, and community artists and artisans. As a curriculum-building project, OneTree utilizes the Alaska boreal forest as the basis for active learning and inquiry investigations into science, social studies, and the arts.

[www.onetreealaska.org](http://www.onetreealaska.org)

## 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.

<http://reindeer.salrm.uaf.edu>

## 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, policymakers, and managers to address regional sustainability issues in an integrated fashion.

[www.uaf.edu/rap/](http://www.uaf.edu/rap/)

## Scenarios Network for Alaska & Arctic Planning (SNAP)

SNAP is a collaborative network of University of Alaska personnel and stakeholders from state, federal,



*Jan Dawe, OneTree coordinator, during Week in the Woods, a craft workshop focusing on trees and forests.*  
AFES PHOTO BY NANCY TARNAI

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.

[www.snap.uaf.edu](http://www.snap.uaf.edu)

## UAF Forest Products Program (Wood Utilization Research [WUR])

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.

[www.uaf.edu/snras/facilities-programs/forest-products-wood-util/](http://www.uaf.edu/snras/facilities-programs/forest-products-wood-util/)

## Research Sites & Facilities

### 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, 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.

[www.uaf.edu/snras/afes/fairbanks-experiment-farm/](http://www.uaf.edu/snras/afes/fairbanks-experiment-farm/)

### Agricultural Soils Research Laboratory

The Agricultural Soils Research Laboratory (ASRL) is located in the O'Neill Building on West Ridge at the University of Alaska Fairbanks. The laboratory supports research and teaching conducted by Dr. Steve Sparrow and Dr. Mingchu Zhang and other UAF researchers. It is also used for research in partnerships with federal and state agencies. ASRL is used to conduct plant and soil sample analyses for studies that are primarily in the areas of 1) biofuels using oilseed crops such as canola, camelina, sunflowers, and other plants, and biomass research on woody and grass plants; 2) nitrogen and phosphorus cycling in cold soil; 3) evaluating

traditional soil laboratory procedures and developing new and more accurate nutrient analysis better suited for colder high latitude soils; 4) analysis of Alaska sources of organic nutrient amendments for organic food production; and 5) developing new diagnostic tools for peony nutrition. The laboratory has use of an Astoria Pacific rapid flow analyzer, a Shimadzu organic carbon analyzer, spectrophotometers, a Horiba fluorometer, Ankom fiber analyzers, pH meters, incubators, and other laboratory equipment. ASRL has the capacity for soil and plant sample preparation as well as analysis. It supports field research conducted at the Fairbanks Experiment Farm, the Delta Junction Field Research Site, the Matanuska Experiment Farm, and many other field research locations throughout Alaska. Researchers from the Institute of Arctic Biology, Institute of Water Resources, Geophysical Institute, Alaska Center for Energy and Power, State of Alaska Division of Agriculture, Natural Resource Conservation Service, USDA Agricultural Research Service, US Fish and Wildlife, Alaska Department of Fish and Game and internationally Ag Canada have used the equipment in this laboratory.

### Climate and Tree-Ring Laboratory

The CTRL conducts state-of-the-art tree ring studies at UAF. Much of the scientific consensus about climate change is based on tree ring data. With their annual or seasonal resolution, widespread occurrence, and multiple measurable properties, tree rings are one of the best sources of information about past climates and ecosystem conditions. UAF was involved in the early development of tree-ring research. More recently, it was one of the first academic institutions to develop a focus on climate change and has contributed important and widely recognized results in climate and tree-ring research. Many challenging questions remain in the far north in this time of rapid environmental change, such as net boreal forest uptake or release of carbon, reconstruction of past climates, and forest growth. International research groups, federal agencies, and state institutions are increasing their demand for Alaska tree-ring sample preparation, measurement, analysis, and archiving related to climate change issues and to the multiple applications of tree-ring analysis such as the earth sciences and archaeology.

[www.uaf.edu/snras/facilities-programs/climate-tree-ring-laborat/](http://www.uaf.edu/snras/facilities-programs/climate-tree-ring-laborat/)

### Forest Soils Research Laboratory

The Forest Soils Laboratory (FSL), established in 1966, is located in the O'Neill building on West Ridge at the University of Alaska Fairbanks, and includes a laboratory equipped to carry out a wide array of physical, chemical, and biological analyses of soil and plant tissues, a shop, and office space. The FSL also maintains three trucks, two ATVs, a snowmachine, and three boats to access field sites. Research conducted by the FSL provides information that aids understanding tree growth, forest development, and soil processes in the unique environment of subarctic Alaska. Emphasis is placed on physical, chemical, and biological soil properties and processes in relation to tree growth and forest development.

This is done through the study of nutrient cycles (dynamics of chemical elements required by plants) in selected forest types. Much of the research carried out at FSL is conducted on a cooperative basis with other university institutes and departments, including the Boreal Ecology Cooperative Research Unit of the USDA Forest Service, particularly in conjunction with the ongoing Bonanza Creek Long-Term Ecological Research (LTER) program funded by the National Science Foundation. Approximately thirty active field study sites are located in areas broadly representative of the major vegetation types encountered in interior Alaska, ranging from the most highly productive (birch, aspen, balsam poplar and white spruce, all of potential economic importance) to the most widespread (black spruce, which experiences the greatest impact from fire in interior Alaska). Many sites are jointly maintained with the Bonanza Creek LTER program.

### Palmer Center for Sustainable Living

The Palmer Center for Sustainable Living (PCSL) highlights the history of the Alaska Agricultural Experiment Station in the Matanuska Valley. It embraces an expanding urban community while retaining the adventurous and independent spirit of the frontier for self-sufficiency and forging new trails and byways. The definition of agriculture worldwide has changed to include more than traditional agriculture, but also forest products, urban landscaping, sportsturf, agrotourism and recreation, lake and stream management for fish habitat, and nutrition and habitat for wildlife. The 1,000-acre PCSL honors and continues the history of agricultural research, education, and outreach with its controlled environments, field horticulture, hay production, organic production fields, animal pastures, turfgrass demonstration plots, and wildlife nutrition research. It encompasses the Matanuska Experiment Farm, Kerttula Hall, and the future Matanuska Colony History Center and Alaska Environmental Studies & Learning Park. Neighbors of the PCSL are important to its work, and lend themselves to the linkages between urban and suburban Alaska. The PCSL connects Matanuska-Susitna Borough lands, UAA Matanuska-Susitna College lands, and State of Alaska lands in the Kepler-Bradley State Recreation Area. It links the existing, heavily used, trail system in surrounding communities with these lands.

[www.uaf.edu/snras/afes/palmer-research-extension/](http://www.uaf.edu/snras/afes/palmer-research-extension/)

### ENVIRONMENTAL STUDIES AND LEARNING PARK

Lifelong learning is an important part of sustainable living. The Park has learning experiences for all ages that tie to the three other components of the PCSL, and include agriculture, forestry, geography, wildlife biology, parks and recreation, and renewable energy and conservation. Plans to expand the park include a lifelong learning center and a center for mountain science research.

### KERTTULA HALL

Kerttula Hall is the centerpiece of our education programs in southcentral Alaska. It is the center for many outreach,

educational, and research partnerships with educational institutions and state and federal agencies, offering a connection to the largest transportation and communications hub in Alaska, and the headquarters for faculty who are involved in natural resources management, geography, business administration, and related fields. It is our research and laboratory facility, housing scientists whose fields range from soil science to plant science to wood chemistry. It serves as an important center for students who are studying to become leaders in the natural resource management and environmental issues facing Alaska.

### RENEWABLE-BASED HYDROCARBONS LABORATORY

This new facility focuses on the production of renewable hydrocarbons from biomass using thermochemical processing techniques. The efficient and sustainable use of biomass in Alaska is being addressed through gasification and liquefaction research involving agronomic and forest crops. By controlling the reaction conditions, adding or subtracting chemicals, changing pressures and temperatures, biomass is modified into a mixture of gas, solid, and liquid hydrocarbons. Researchers are investigating ways to convert the chemicals into more familiar types of hydrocarbons, analogous to petroleum. Biomass is the only renewable resource that can produce hydrocarbons. These substances, like those in petroleum, have the potential to be refined into fuel, plastics, resins, lubricants, synthetic medicines, and thousands of other hydrocarbon-based products. Obtaining them from biomass will not only provide Alaskans with a sustainable source for these compounds and help decrease dependence on petroleum, it should also provide the state with new industries.

<https://sites.google.com/a/alaska.edu/jasoria/berd-biomass-energy-r-d-lab>

### MATANUSKA COLONY HISTORY CENTER

Historically, the Matanuska Colony emphasized the importance of reliable food supplies in southcentral Alaska. The historical buildings of the PCSL will house a library, conference center, and offices, and currently house a distance delivery facility in structures important to the state's agricultural history.

### 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 700 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.

# Geography

**G**EOGRAPHY PROVIDES a holistic view of the earth, its distinct and varied regions, as well as the types of, and interaction between, human activities and the physical world. Geography is the two-way bridge between the physical and social sciences, as it explores the interrelationships between the earth's physical and biological systems, and investigates how these environmental systems provide a resource base for human societies. Geography also provides the framework for the integration of new and emerging technologies such as GIS and Remote Sensing with studies in a broad range of academic disciplines.

Geographers are interested in patterns and processes of physical and social change including climate change, geographic information science and technologies, human settlement patterns, natural resources distribution and management, environmental studies, and in the inherent "sense of place" among peoples throughout the world. Geographic methodologies include observation, measurement, description, and analysis of places including likenesses, differences, interdependence, and importance.

## GEOGRAPHY REPORTS:

(note: authors listed below are SNRAS researchers)

### 15 • K-12

Determining the potential efficacy of sixth-grade Math in a Cultural Context

Jerry Lipka

Returning the Elders' Gift: Systemic implementation of an effective culturally-based math curriculum and professional development program

Jerry Lipka

MapTEACH: Mapping Technology Experiences with Alaska's Community Heritage

Sidney Stephens, Patricia Heiser

### 17 • cultural geography

Marine policy issues of future arctic marine transportation

Lawson Brigham, Mike Sfraga

Social vulnerability and equity in the context of climate change

Valerie Barber, Ellen Hatch

The study of sharing to assess the vulnerability of coastal communities to oil and gas development in arctic Alaska

Gary Kofinas, Peter Fix, Shauna BurnSilver, Marcy Okada

Stakeholders and climate change

Sidney Stephens

Interviewing for sense of place

Cary de Wit

Perceptual geography of Alaska

Cary de Wit

### 20 • physical geography

Scenarios Network for Alaska & Arctic Planning

T. Scott Rupp, Nancy Fresco, Mark Olson, Tim Glaser, Tom Kurkowski, Anna Springsteen, Ellen Hatch

## K-12

### Determining the potential efficacy of sixth-grade Math in a Cultural Context

15

Jerry Lipka

purpose

The major purpose of this work is to: Determine through testing if five different sixth-grade modules in the Math in a Cultural Context (MCC) series have the potential to be effective; Conduct professional development workshops on these modules; Conduct and analyze the research findings; Improve one module (not yet published—*The Kayak*, on math statistics) and improve the professional development component of each module.

approach

There are five different sixth-grade modules in the MCC curriculum. One module was implemented in fall 2007, two in spring 2008, and two more in fall 2009. Before teaching the module all teacher volunteers are randomly assigned to teach one of two modules. Because teachers are randomly assigned, the project is able to compare results, eliminating teacher factors. There is also a control group which does not receive MCC's professional development training (pedagogy and culture) or MCC's module. These teachers teach their regular school math curriculum. This allows us to compare teachers who receive MCC's full treatment module plus the professional development workshop (culture and pedagogy) to teachers who use their regular math curriculum. This design also identifies the contribution of each component of MCC's intervention. However, to ensure reliable data, the project tests classes to determine if different classes are comparable at the starting point.

progress

By the end of spring 2010 we await the final few data sets from teachers. Once this has been received the project will conduct its final analysis. Preliminary analysis to date shows promising trends: students using these sixth-grade math modules make good gains, and the preliminary data on comparing groups is also trending toward MCC's planned intervention, meaning those teachers who receive both MCC's module and professional development appear to have students who perform better than students of teachers who receive either MCC's professional development or teach their regular math curricula. Further research will take place

toward the end of the granting period when the results will be analyzed in multiple ways; qualitative analysis is underway, including videotape analysis, student and teacher interviews, teacher logs, and workshop evaluations. At this time, these modules appear to have the potential to be effective.

#### impact

MCC is one of the few programs that has systematically tested culturally-based materials (the math curriculum) and has produced positive results in favor of that curriculum. Further, the design of this study enables us to understand the contribution of the MCC curriculum and the MCC pedagogical approach vs. the mainstream pedagogical approach, and vs. the curriculum in place. This work has direct implications for schooling in Alaska especially if the results of the forthcoming studies continue to show statistical significance when comparing MCC's curriculum intervention to the curriculum in place. This work also has implications for the field of culturally-based education, and to the larger field of educational reform in the state, nation, and other countries. The impact of MCC can be also measured by the number of invites the program has received domestically and internationally. This past year has shown multiple requests for MCC staff to be key presenters at conferences as well as to prepare journal articles and chapters in books.

#### grants/funding

US Department of Education

### **Returning the Elders' Gift: Systemic implementation of an effective culturally-based math curriculum and professional development program**

Jerry Lipka

#### purpose

Math in a Cultural Context is a long-term federally funded K-12 outreach and research program. It has been continually funded through competitive grants from the National Science Foundation and the US Department of Education. MCC is currently working under two grants received from the US Department of Education.

The major purposes of Returning the Elders' Gift are to: Improve the academic (math) performance of elementary school students, particularly Alaska Native students; Implement MCC's curriculum and its professional development component to increase teachers' math pedagogical knowledge as a way to improve students' academic performance; Work with at least ten Alaska school districts.

#### approach

Since 2001 MCC has conducted a series of studies on the effectiveness of its curriculum. These studies have repeatedly shown that students using MCC's curriculum outperform students using their regular curriculum. These findings held in urban and rural areas of Alaska and were consistent across Alaska's diverse geographical and cultural regions. Based on approximately fifteen studies showing statistically significant

findings in favor of MCC's curriculum, the major approach is to provide professional development training along with MCC's integrated math curriculum. To accomplish this MCC holds inservice workshops for school districts interested in using MCC; MCC also provides professional development workshops such as its Summer Math Institute and Teacher Leadership workshops; and MCC also offers "E-live" courses.

#### progress

During 2008-2009 Returning the Gift worked with approximately 17 school districts, 113 teachers, and 1,565 students experienced MCC modules. Note that MCC counts students by module use. If a student was taught with more than one MCC module then this student was counted twice.

#### impact

Results from this project's ongoing testing of students in classes that use MCC's supplemental curriculum show repeatedly that MCC's second-grade curriculum series has a statistically significant advantage over the curriculum in place. This is particularly meaningful since repeated studies have more credence than single studies. Each year that we use the second-grade *Berries* module (math content is graphing, measuring, and interpreting data), students have increasingly made higher raw score gains. We interpret this to mean two things: 1) teachers who become experienced users of MCC produce strong results; and 2) MCC has improved its professional development component. Current analysis of this data shows that MCC has improved the performance of low performing students (as indicated by their pretest scores); MCC also performs well with students who come to school with more prior knowledge (again reflected in pretest scores). Interpreting this, all students, particularly rural Alaska Native students on this second-grade module, gain from using MCC.

This work has direct implications for assisting Alaska's schools, particularly rural school districts. Most of the districts using MCC are rural and noted by the state as not achieving the Adequate Yearly Progress target under the No Child Left Behind Act, so improvements such as the MCC curriculum are important.

One measure of impact of the approach taken by MCC is the request for information and requests for presentations. This past year MCC presented to indigenous educators in Sweden (Sami) and in Guam (approximately eight different groups were represented).

#### grants/funding

US Department of Education

### **MapTEACH: Mapping Technology Experiences with Alaska's Community Heritage**

Sidney Stephens, Patricia Heiser; Peter Webley  
(Geophysical Institute Volcano Observatory)

#### purpose

This proposal aims to better prepare Yukon-Koyukuk School District teachers to meet the distinctive educational needs of Alaska Native students by engaging teachers in



long-term professional development opportunities focused on place-based geospatial education, and by providing them with increased access to curricular materials to support such teaching.

#### approach

This project builds on the success of the MapTEACH program, which began as an NSF-funded science education project for middle and high school students that emphasized hands-on experience with geology, geography, and spatial technology in conjunction with traditional activities. Program implementation will require 36 months to complete and will involve up to 24 Yukon-Koyukuk School District science, social studies, Alaska studies, and technology teachers of grades 7-12 and their ~140 students. Activities will be tailored to the needs, schedules, and specialties of the teachers who enroll and will include: Yukon-Koyukuk School District-based professional development coursework delivered both on site and through video conferencing; on-site and distance-delivered support for program implementation and development of community-based explorations; a capstone field experience for teachers, students, and community members; development of community-scale image data sources; and evaluation, revision, and publication of the MapTEACH curriculum.

#### progress

MapTEACH is nearing completion of its first year of professional development efforts including the following activities: (1) creation of a three-credit Geography 595 course enrolling ten teachers; (2) two three-day Fairbanks workshops for teachers; and (3) six 1.5-hour video conferences. During these activities, teachers were introduced to the MapTEACH curriculum and had the opportunity to then practice these activities in their home communities. They subsequently designed a two- to three-week MapTEACH unit which they are currently implementing with students. In addition to these activities, new geology and Google Earth lessons have been written and piloted, new data sources have been acquired and distributed, and recruitment for a GIS technician is underway.

#### impacts

By participating in this project, middle and high school teachers and their students will increase their understanding of landscape concepts, relate those concepts to their local environments, communities and cultural heritage, and gain the skills necessary to complete complex technology tasks. They will also understand the significant role geospatial technology plays in their everyday lives and become aware of existing and emerging geospatial career options. Broader impacts of this work are a blueprint for a region-specific professional development program that can be adapted in other Alaska communities and an enhanced MapTEACH curriculum that will be available free, via the Internet and in limited hard copy.

#### grants/funding

US Department of Education

## cultural geography

### Marine policy issues of future arctic marine transportation

Lawson Brigham, Mike Sfraga

#### purpose

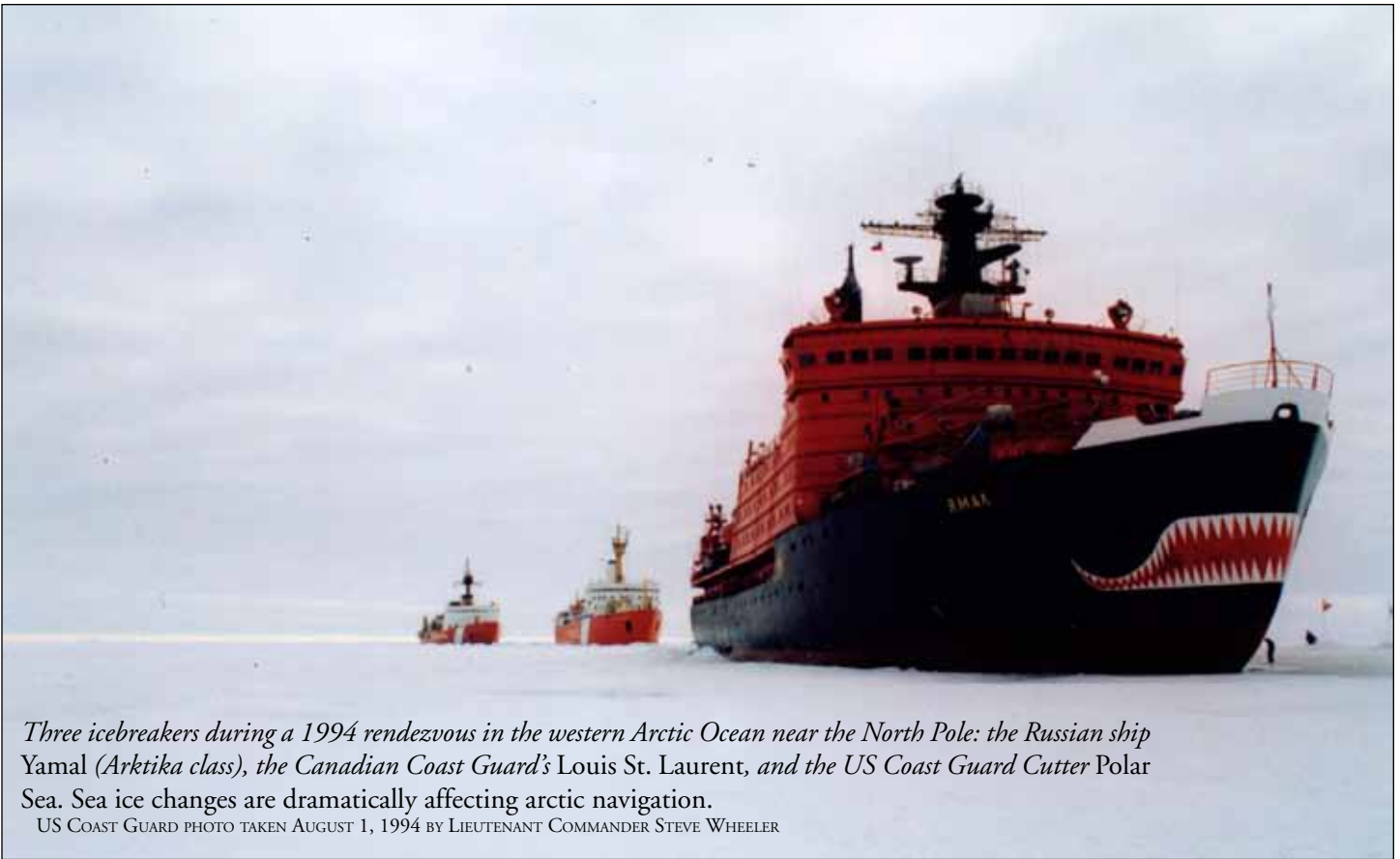
This long-term project extends the work of the Arctic Council's Arctic Marine Shipping Assessment (AMSA) conducted 2005-09. A key objective is to explore a range of future policy issues and possible actions by the Arctic states to protect the people of the Arctic and the marine environment. The potential impacts of expanded arctic marine operations driven by natural resource development and arctic climate change are being identified for Alaska and the circumpolar world. Under the University of Alaska Geography Program (UAGP), this project is closely tied to the work of the Scenarios Network for Alaska Planning (SNAP). It is also the beginning of an academic concentration at UAF on policy (versus political science).

#### approach

An international workshop, Considering a Roadmap Forward: The Arctic Marine Shipping Assessment Workshop, was held 22-24 October 2009 at UAF. Jointly hosted by the University of the Arctic, Dartmouth College, and UAF, this was the second meeting held as part of the University of the Arctic's Institute for Applied Circumpolar Policy. More than sixty-five experts from Canada, China, Denmark, Norway, UK, and the US discussed the seventeen AMSA recommendations, and developed for each a roadmap for action, key issues, funding challenges, and important timing issues. A mix of marine industry, government, indigenous, university research, and nongovernmental organization interests were represented at the workshop. The workshop provided a broad overview of the policy challenges confronting the Arctic states in a new era of increased marine activity throughout the Arctic Ocean. The workshop also provided a number of key outcomes regarding marine use of the coastal waters of the US Arctic, one of the objectives of this UAGP project. A series of Arctic policy workshops such as the October 2009 venue are envisioned. The results of AMSA and policy options from this research were presented in testimony at two US Senate hearings during 2009.

#### progress

AMSA also involves using scenarios, or plausible futures, of arctic marine transportation. These have been presented in several papers and at recent conferences of the World Future Society. The project will use the continuing work of SNAP to understand the retreat of arctic sea ice under anthropogenic warming scenarios. Regional and Arctic Ocean simulations of sea ice will be used to determine the projected, increasing marine access that may result in future extent and thickness changes in the Arctic's sea ice cover. A range of model simulations will be used and key navigation areas, including Alaska's coastal seas, will be studied to estimate the plausible lengths of the navigation seasons based on the projected



*Three icebreakers during a 1994 rendezvous in the western Arctic Ocean near the North Pole: the Russian ship Yamal (Arktika class), the Canadian Coast Guard's Louis St. Laurent, and the US Coast Guard Cutter Polar Sea. Sea ice changes are dramatically affecting arctic navigation.*

US COAST GUARD PHOTO TAKEN AUGUST 1, 1994 BY LIEUTENANT COMMANDER STEVE WHEELER

sea ice cover. Scenarios of future arctic navigation will be developed integrating climate change, natural resource developments, and additional linkages of the Arctic to the global economy. Scenarios of a future Arctic will be used in the UAGP to suggest alternative futures for the region and stimulate discussion and debate about the future of Alaska in a warming world.

#### impact

This research will assist strategic planners, elected representatives, and decision makers with developing policy options for a range of issues related to future arctic marine use. An objective of this long-term project will also be to provide US Arctic policy makers with information on arctic scenarios and policy options for environmental protection and sustainable development of the US Arctic. Results of this research will also be communicated to the seven other Arctic states at the Arctic Council and through UAF's relationship with the University of the Arctic as a key partner in the Institute for Applied Circumpolar Policy.

### Social vulnerability and equity in the context of climate change

Valerie Barber, Ellen Hatch (UAF); Ellen Donoghue (USDA Forest Service, PNW Research Station-PFSL); Kathy Lynn (Resource Innovations, Institute for a Sustainable Environment, University of Oregon)

#### purpose

This is one component of a multi-part project that is charged with synthesizing knowledge about the effects of

climate change on indigenous people and resource-based communities in the United States and Canada. The purpose of this project is to produce a synthesis of knowledge related to social vulnerability and equity in the context of climate change for indigenous populations in Alaska and Canada. Written reports and white papers will inform policymakers and resource managers of the opportunities, challenges, and issues related to social vulnerability and equity in the context of climate change.

#### approach

Information about issues, policy, and programs pertaining to socioeconomic and cultural effects of climate change on indigenous people in Alaska and Canada will be synthesized into a literature review. Sources of information include academic literature, gray literature, popular media, and governmental and nongovernmental websites, which will go into an Endnote file for resources.

#### progress

Over 260 references have been collected and entered into Endnote and a few dozen been annotated. The next step is to finish the annotations and write a paper.

#### impact

Using our references will allow us to not only synthesize what available science says about social vulnerability and climate change in Alaska and Canada, but also document the emergence of issues not currently addressed in academic literature, and in ways that will educate decision makers, inform the policymaking processes, and serve as a basis for future research.

### The study of sharing to assess the vulnerability of coastal communities to oil and gas development in arctic Alaska

Gary Kofinas, Peter Fix, Shauna BurnSilver, Marcy Okada; Craig Gerlach (UAF Center for Cross-Cultural Studies); Jim Magdanz (ADF&G)

#### purpose

The Sharing Project uses multiple methods to assess the resilience and vulnerability of two North Slope coastal communities and one Interior rural community of Alaska to the effects of oil and gas development with climate change. The project is funded by the Bureau of Ocean Energy Management, Regulation, & Enforcement (formerly the Minerals Management Service) of the Department of the Interior through the Cooperative Ecosystem Studies Unit. The study seeks to inform communities and resource management agencies on potential changes in northern Alaska and contribute to theory on social-ecological sustainability.

#### approach

In partnership with three Alaska communities (Kaktovik, Wainwright, and Venetie), we use social network analysis, focus groups, ethnographic analysis, and simulation modeling to study sharing systems of indigenous communities as strategies for coping with change. We focus on the sharing of subsistence foods, information, and money, collecting qualitative data with focus groups and quantitative data through a survey administered to all households. Researchers and leaders of participating communities compare community resilience and vulnerabilities with other communities through the activities of the Community Adaptation and Vulnerability in Arctic Regions, an initiative of the International Polar Year.

#### impact

Local communities have traditionally used informal institutions of sharing subsistence resources as a method of coping with uncertainty. In contemporary Alaska Native communities, subsistence sharing is part of a dynamic and evolving cultural system that contributes to identity, livelihoods, and community wellbeing. Historically, resource management agencies have studied subsistence primarily through the documentation of total harvest and without a careful examination of community social-ecological dynamics. This study explores the application of recent theories on the networks to northern community sustainability and represents a novel approach in assessing the implications of Arctic oil and gas development on indigenous culture. Our project team is collaborating closely with the NSF-funded “IPY: Impact of High-Latitude Climate Change on Ecosystem Services and Society” (Chapin, Hepa, Kofinas, and Rupp) to explore how oil and gas development with climate change will affect rural livelihoods.

### Stakeholders and climate change

Sidney Stephens; William Schneider (UAF Rasmuson Library); Craig Gerlach (UAF Center for Cross Cultural Studies); David Atkinson (International Arctic Research Center, now at the Univ. of Victoria)

#### purpose

The goals of this project are to enhance communication about climate change between IARC and other science researchers, rural community members, and teachers so that the perspectives of each are shared; and to investigate how this approach and how existing or potential climate change resources or activities might further school and community dialog about this complex global and local issue.

#### approach

The project approach has two strands. First, the project is teaming with scientists, social scientists, village councils, and community members in Tanana, Fort Yukon, and Chalkyitsik in order to develop an understanding of local perceptions of climate change observations and impacts in the middle and upper Yukon River watershed. Fieldwork and meetings in these communities and in Fairbanks serve as the venue for these discussions. Interviews with local residents and larger group meetings are video and tape recorded, selectively transcribed, and produced in a web-based format with synchronized searching capabilities and housed on the Alaska Stakeholders and Climate Change Project Jukebox website. Participant guidance on creation of public forums and web products is central to our approach. Second, the project is surveying teachers statewide to gain a broader understanding and to prioritize the approaches, materials and needs of teachers desiring to further pursue integrated climate change education in their classrooms. Focused discussion with teachers in the three communities is also key to the project approach.

#### progress

Fifteen interviews have been conducted, transcribed, and digitized and are being processed into a web-based format and housed on a draft Project Jukebox climate change website. Interviews have been analyzed and sorted according to six emerging themes (weather, rivers and lakes, fire, permafrost, plants and animals, and seasonality). Synchronized searching of interviews by theme, location, or speaker will be possible.

#### impact

This work reveals the complexity of local climate change observations as well as the impacts of these changes on landscape and on subsistence resources and practices at local levels. It also reveals that the exchange of information between community members and scientists can enhance mutual understanding of climate changes issues, and that there are many ways in which science and local observations intersect and ways in which they differ. Local residents were particularly attuned to the impacts of change on their lives and livelihoods and were interested in getting a better scientific understanding of climate change in their area. They also were quite interested in: access to university resources

and data; community employment associated with climate change research; and getting climate change information out to communities and schools. Researchers were interested in how their investigations and knowledge might align more directly with local concerns.

grants/funding

National Science Foundation

## Interviewing for sense of place

Cary de Wit

purpose

Sense of place is an important aspect of place experience, and of personal identity in relation to place. This work will result in a published set of guidelines for fieldworkers who wish to study sense of place in a given locality.

approach

This will be a distillation of techniques I have developed during my sense-of-place field research, a matter-of-fact guide for beginning field workers on what works and what fails, using my field research on the High Plains as a case study.

progress

An article is in final editing stages, and will be included in a special issue of the *Journal of Cultural Geography*. In essence, the techniques are: You have to spend a lot of time talking to people to find out what really matters to them. Start with an open mind about what will be relevant to sense of place in a given place. Allow plenty of time to build trust and accept hospitality when offered. Let people talk about what's important to them (semi-structured interviews). Don't be scared away by the formless chaos of information that piles up. Form will emerge from the chaos as you go through a repeating cycle: Talk to people in the field, write, think, talk to colleagues, read, talk to people in the field, write, think, etc.

impact

The geographic literature is seriously lacking in guidelines for qualitative fieldwork, and contains almost nothing on techniques for studying sense of place. These guidelines will be helpful to beginning fieldworkers who wish to study sense of place.

grants/funding

State of Alaska

## Perceptual geography of Alaska

Cary de Wit

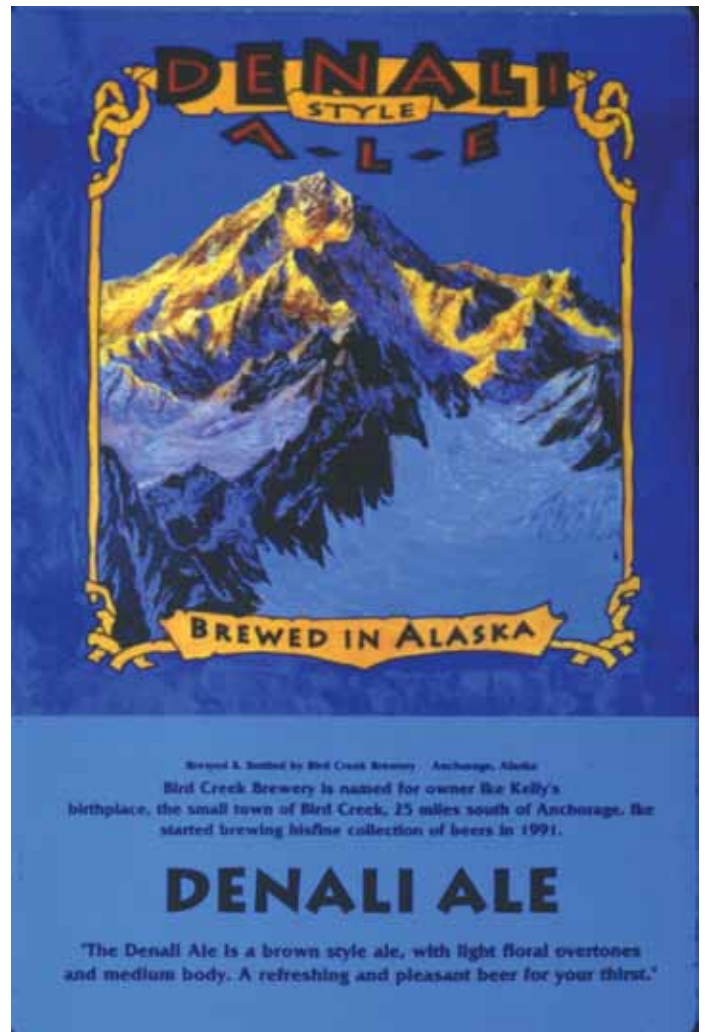
purpose

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

approach

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

.....  
[www.uaf.edu/snras/](http://www.uaf.edu/snras/) • <http://snras.blogspot.com>



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. A few themes are emerging: Wild Frontier, Resource Treasurehouse, Technology in the Wilderness, Land of the Tough.

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.

grants/funding

State of Alaska

## physical geography

### Scenarios Network for Alaska & Arctic Planning

T. Scott Rupp, Nancy Fresco, Mark Olson, Tim Glaser, Tom Kurkowski, Anna Springsteen, Ellen Hatch; Sarah Trainor (SNRAS/Institute of Northern Engineering); Dan White (ACCAP); Serey Marchenko, Vladamir Romanovsky (Geophysical Institute Permafrost Laboratory); Brad

Griffiths, Falk Heuttman (IAB); Jessica Cherry (IARC), Amy Tidwell (Institute of Northern Engineering); Amalie Couvillion, Evie Whitten (The Nature Conservancy)

### purpose and approach

Most climate models predict that high latitudes will experience a much larger rise in temperature than the rest of the globe over the coming century. Indeed, substantial warming has already occurred at high northern latitudes over the last half-century, and arctic summers are now warmer than at any other time in the last 400 years. In addition to changes in climate, Alaska is undergoing rapid changes in human population and demands on natural resources. Environmental conditions are changing so rapidly in Alaska and the Arctic as a whole that it is increasingly difficult to develop well-informed plans for such things as ocean navigation, pipelines, roads, urban expansion, community relocation, and management of fisheries and wildlife.

The Scenarios Network for Alaska & Arctic Planning (SNAP; [www.snap.uaf.edu](http://www.snap.uaf.edu)) is a collaborative network, whose mission is to provide timely access to scenarios of future conditions in Alaska addressing climatic, ecological, and economic change relevant to public decision-makers, communities, and industry. Initiated as part of UA's International Polar Year, and supported by the chancellor and vice chancellor for research at UAF, this UAF-based initiative is producing (1) geographically defined time series (e.g., maps; downscaled projections) of future conditions that are linked to present and past conditions, (2) objective interpretations of scenarios, and (3) detailed metadata and explanations of the models (including assumptions and uncertainties) that describe controls over projected changes.

### progress

#### INTRODUCTION

The mission of SNAP includes not only creating innovative models of climate and land use scenarios in the context of rapid change, but also working closely with those who are most concerned and affected. Interpretation, assessment of uncertainty, and outreach to stakeholders are central to our purpose. Over the past year, we have been pleased to forge strong collaborations with diverse partners whose interests range from economics to ecology and from a single community to the whole state of Alaska. The SNAP team is currently working with a wide range of stakeholders, including nonprofit organizations and state and federal agencies. We also work in close collaboration with other University of Alaska groups, including the Alaska Center for Climate Assessment and Policy (ACCAP), and Cooperative Extension Service (CES). We regularly field questions from potential stakeholders and share our maps, graphs, and interpretive information. Below is a brief summary of these efforts.

#### SNAP PROGRESS REPORTS FOR 2009

Projects completed or in progress

- The Joint Fire Science Program has funded SNAP to take the lead in developing and implementing

a Wildland Fire Science Consortium for Alaska. The pilot phase was funded in July 2009. The main goal of the Consortium is to institute, develop, and foster two-way communication between fire scientists and the fire suppression and management community in Alaska to ensure that research results are widely disseminated and that research projects are designed to meet the needs of practitioners on the ground.

- SNAP is working closely with conservation organizations that are funded by the Wilburforce Foundation and working in the western and transboundary Arctic and the Tongass National Forest in southeast Alaska. We review climate-related materials and organizational missions, convene a series of dialogues to identify climate information needs and discuss how projected changes will likely affect project goals and missions, develop a set of recommended products to fill existing information needs, and produce a subset of products based on priority of needs and available scientific expertise and resources. A major outcome of this project will be improved habitat connectivity via land management regimes that are resilient to climate change.

- In partnership with NMFS Habitat Conservation Division Alaska Region, municipal hydropower utilities managers, and researchers from IARC and WERC, SNAP helped assess whether recent precipitation and reservoir inflow anomalies in southeast Alaska are within the normal range of variability over the observational record, as opposed to providing evidence of a potential regime shift associated with climate change. SNAP's role was to provide long-term climate projections downscaled to the watersheds feeding pertinent reservoirs, help assess natural variability on seasonal-to-decadal scales, and help interpret the results of the study. Results showed about half of the observed climate change in Southeast may be attributable to long-term climate change and about half may be attributable to natural climate variability on decadal and multi-decadal timescales.

- SNAP collaborated with the Northern Climate Exchange (NCE), a project of Yukon College, to create data, maps, and written information relating to climate change projections in the Yukon, Canada, in order to develop shared understanding and improve public education on climate change adaptation strategies in northern Canada. SNAP created a total of approximately fifty climate projection maps for the Whitehorse area and the entire Yukon. These included projected change for temperature and precipitation for each of two emissions scenarios (A1B and B1) and two time periods (2030 and 2050). SNAP also created additional projections for frost-free days, and assisted in the interpretation of the above data.

- The Connecting Alaska Landscapes into the Future project was a collaborative effort co-led by partners at SNAP, IAB, and USFWS, with input from numerous other state and federal agencies and nonprofits. The

project used historical climate data and climate projection data from SNAP coupled with Alaska and Canadian biome categorizations to project potential biome shifts, and to identify areas of Alaska that may become important in maintaining landscape-level connectivity, given climate change. The Connectivity Project also examined potential impacts on four selected species: barren ground caribou (*Rangifer tarandus granti*), Alaska marmots (*Marmota flaviventris*), trumpeter swans (*Cygnus buccinator*), and reed canary grass (*Phalaris arundinacea*). Results showed dramatic shifts in potential biomes and some potential species ranges statewide, and highlighted areas most likely to be resilient to change.

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#### Projects being developed

- Continuation of the Alaska Wildland Fire Science Consortium has been funded until May 2012.
- Due to strong interest in the Connecting Landscapes project, two new projects were developed in 2009, with funding starting in 2010, to refine the scope, reliability, and pertinence of the results. One of these projects is a collaborative effort between USFWS, SNAP, IAB, and participants from multiple state and federal agencies and non-profits. The second involves extending the biome-shift model into northern Canada, specifically the Yukon and Northwest Territories. This project will be co-led by partners from the Nature Conservancy, with input from diverse participants and funding from Ducks Unlimited Canada and Government Canada.

#### Community Connections

- In conjunction with the Wildland Fire Science Consortium for Alaska, we held an Inaugural Consortium Workshop in October 2009. Nearly sixty fire managers, scientists, and land managers participated, representing: UAF, Alaska Department of Forestry, University of Idaho, US Army, NPS, BIA, USFWS, BLM Alaska Fire Service, the Canadian Forest Service and two Native nonprofit organizations: Chugachmiut and Tanana Chiefs Conference. Also in October 2009, we held our first regional fire science webinar, a presentation by Stacy Drury, "Introduction to the Interagency Fuels Treatment Decision Support System," (IFT-DSS; a JFSP-funded project). There were nearly fifty participants, including those in Alaska, Washington, the Yukon Territory, British Columbia, and Ontario. Participants included representatives of BIA, Ontario Ministry of Natural Resources, NPS, Seattle Fire Lab, USFWS, UAF, USFS, British Columbia Coastal Fire Center, Wildland Fire Operation Research Group, Anchorage Fire Department, BLM, and the University of Idaho.
- SNAP products were showcased in the Alaska Center for Climate Assessment and Policy webinar series in fall 2009. Participation ranged from 45-75 people, including representatives from state and federal agencies, industry, the news media, education and nonprofit organizations. (A more specific list of participants is

available on request.) Podcasts and presentations are available at: [www.uaf.edu/accap/telecon\\_archive.htm](http://www.uaf.edu/accap/telecon_archive.htm). The series included: *Connecting Alaska Landscapes into the Future*; *Changes to Permafrost in Alaska: Observations and Modeling*; *Climate Change Impacts on Water Availability in Alaska*; and *Tutorial: Using Web-Based and Google Earth Maps of Projected Climate Change in Alaska*.

#### University connections

- The southeast Alaska hydroelectric assessment was developed in conjunction with Jessica Cherry (assistant professor, IARC) and Amy Tidwell (former IPY post-doc, now research faculty with INE Water and Environmental Research Center).
- SNAP works closely with ACCAP via Sarah Trainor, Dan White, and other ACCAP employees. The two programs collaborate in reaching out to communities and otherwise broadening the scope of outreach efforts, as well as in sharing data and information and creating presentations and brochures.
- On behalf of the SNAP/FWS connectivity project, Falk Huettman (Institute of Arctic Biology [IAB] and Michael Lindgren) have developed an Alaska-specific model of vegetation and biome change over the next century, which is being used in corridor modeling.
- Brad Griffiths (IAB, Dept. of Wildlife and Biology, and USGS) and Dave McGuire (IAB, Dept. of Wildlife and Biology, and USGS) are working with SNAP data—in collaboration with Amalie Couvillion and Evie Whitten of the Nature Conservancy—regarding their modeling of climate change and caribou habitat.
- Ellen Hatch, a NRM student, worked closely with SNAP on her senior thesis, an assessment of the future of growing degree days and agricultural potential in the Fairbanks North Star Borough. SNAP Network Coordinator Nancy Fresco was Ellen's thesis advisor.
- Vladamir Romanovsky and Serey Marchenko of the Geophysical Institute Permafrost Lab have incorporated SNAP data into their models.

#### impact

SNAP is a pragmatic plan to facilitate integration of the University of Alaska's world-class high-latitude research capabilities and deliver timely information and interpretation of climatic, ecological, and economic change to public decision-makers (managers, policy makers, and planners), communities, and industry. The scenarios produced by SNAP and the data used to produce them are openly available to all potential users. Because SNAP is driven by user needs and delivers the products to these users, it serves as an end-to-end prototype for similar efforts in other geographical regions. SNAP is positioning Alaska and the Arctic at the vanguard of climate applications relevant to planning and policy.

# High-Latitude Agriculture

**A**GRICULTURE AND agricultural research have a long history in Alaska: the Russians colonized Alaska in 1725 to exploit the fur trade and brought with them a desire to produce food for their colonists. Early soil surveys extending as far north as the Yukon River indicated that the US Alaska Territory had agricultural potential. Following these historical beginnings and soil survey findings, the first agricultural experiment station was established in 1898 in Sitka by the US Department of the Interior. The Alaska AFES has since become housed administratively at the University of Alaska Fairbanks, the land grant campus of the UA system, and is now within SNRAS as its research arm. Agriculture in the circumpolar world has always faced environmental extremes, not the least of which is the short growing season. There are also challenges based on distance both to world markets and from the great food-growing regions of the world. Alaska has historically imported food from elsewhere, yet has rich soils and bountiful harvests that could sustain its population and even provide export crops and products—were an agricultural industry properly tailored and developed for it. Research in high-latitude agriculture helps circumpolar regions move toward this goal of a sustainable agriculture. UAF and SNRAS/AFES provide insight and knowledge benefitting Alaskans and the circumpolar world. Alaska contributes unique cold-climate information to agriculture that reflect national and international information needs, particularly in light of the rapidly changing weather patterns in the circumpolar regions.

Agricultural research includes exploration and development of new crops and alternative livestock suited to the unique demands and opportunities afforded by high latitudes; controlled environment and greenhouse production systems; production, uses, and adaptive management pertaining to high-latitude crops and landscaping materials; adaptation of livestock production to the rigors of high-latitude conditions; application of technology to northern plant materials and identification of value in new plant products and chemistry; integrated pest management; marketing, quality control, and acceptance of Alaska agricultural products; revegetation of disturbed lands; treatment of waste products in cold climates; and biomass analysis and treatment for biofuels.

(note: authors listed below are SNRAS researchers or ARS partners)

## HIGH-LATITUDE AGRICULTURE REPORTS:

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4-H Reindeer Market Steer Program

George Aguiar, Greg Finstad

### 24 • animal husbandry

Cattle genetics

M.A. Cronin, Milan Shipka

Elk genetics

M.A. Cronin

Timing of breeding and gestation length in muskoxen  
Milan Shipka, Janice Rowell

Reindeer genetics

M.A. Cronin, Milan Shipka, Greg Finstad, Jan Rowell

Habitat use, diet, and herd composition of Seward Peninsula reindeer during the breeding season

Leslie Davis, Greg Finstad

Hematological, immunological, and serum chemistry reference ranges for reindeer

Greg Finstad

Artificial insemination in reindeer using thawed frozen semen

Milan Shipka, Janice Rowell

Effect of progesterone and melatonin on gestation length in reindeer

Janice Rowell, Milan Shipka

High Latitude Range Management curriculum

Greg Finstad, Lee Haugen

### 29 • biofuels

Low NOx biodiesel production from Pacific Island feedstocks

J. Andres Soria

Potential perennial lignocellulosic energy crops for Alaska

Stephen D. Sparrow, Mingchu Zhang

### 30 • controlled environment production

Light emitting diodes (LEDs) for greenhouse crops

Meriam Karlsson, Jeff Werner

Specialty plastic coverings and strawberries

Meriam Karlsson, Jeffrey Werner

Retractable flat-roof high tunnel

Jeffrey Werner, Meriam Karlsson

Apples in high tunnels

Kendra Calhoun, Meriam Karlsson

Arsenic absorption in vegetables

Jeff Bue, Jeffrey Werner, Meriam Karlsson

Flowering primrose

Meriam Karlsson, Jeffrey Werner

Field and high tunnel production of snap beans

Meriam Karlsson, Jeff Werner

Early short day treatment of sunflowers

Meriam Karlsson, Jeff Werner

Working with local greenhouses

Jeffrey Werner, Meriam Karlsson

### 34 • 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

The effect of forage variety and color of plastic wrap on haylage quality and quantity in Alaska

Norman Harris, Beth Hall

Annual flower cultivar trials

Patricia S. Holloway, Grant E.M. Matheke, Katherine DiCristina

Arctic and subarctic plant genetic resources conservation, research, and information management

Alberto Pantoja, Bonnie Furman, Nancy Robertson, Joe Kuhl (ARS)

Peonies as field grown cut flowers—field production

Patricia S. Holloway, Shannon Pearce, Janice Hanscom

Commercial Horticulture Program: potatoes

Jeff Smeenk

Heirloom vegetable trials

Grant E.M. Matheke, Patricia S. Holloway, Katie DiCristina

Vegetable cultivar trials

Grant E.M. Matheke, Katie DiCristina, Patricia S. Holloway

## 40 • food policy, security, & sovereignty

Measuring food security in Alaska

Joshua Greenberg, Charles Caster

## 40 • pests & disease control

Integrated pest management for Alaska Agriculture

Alberto Pantoja, Dennis Fielding, Jeff Conn, Steve Seefeldt (ARS)

Distribution, transmission, and molecular characterization of potato phytoplasmas in Alaska

Jenifer H. McBeath

## 42 • 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

## agricultural markets & products

### 4-H Reindeer Market Steer Program

George Aguiar, Greg Finstad

purpose

Each year, the 4-H Club of the Tanana Valley, Alaska FFA, and the UAF Cooperative Extension Service, organize a livestock show and auction at the Tanana Valley Fair. Reindeer are unique northern livestock and are an ideal option for Alaska market livestock programs. Besides being uniquely adapted to the northern climate, they are good-natured and respond well to the intensive human contact typical of 4-H and FFA livestock projects. They are also the only livestock species being studied in an agricultural production setting at the University of Alaska Fairbanks. Including reindeer in the 4-H livestock show and auction will provide the reindeer

industry with husbandry and economic data to support the marketing of reindeer meat.

approach

The Reindeer Research Program made available five reindeer male calves (approximately four-month-old steers) to select 4-H and FFA members in the state of Alaska. These young producers participated in weekly instructional sessions at the Fairbanks Experiment Farm covering all aspects of reindeer husbandry including health, handling, feeding and nutrition, herd management, and facilities design and maintenance. The producers worked collaboratively with each other and RRP personnel when vaccinating, treating, and handling their animals in order to prepare them for the Tanana Valley Fair.

progress

Under the guidance of RRP personnel, students constructed pens and transported, began feeding, caring for, and socializing their calves to build a close human-animal relationship. The reindeer calves were raised like other 4-H market animals, in a manner consistent with the 4-H livestock program guidelines. They were housed with the other livestock for the complete duration of the Tanana Valley Fair where they competed in the livestock showmanship and market event and were eventually auctioned off for slaughter. Three of the five reindeer steers completed the project. Animals sold for \$7.25/lb., \$5.25/ lb. and \$5.75/lb on the hoof or live weight.

impact

Diversification is critical to regional food production in Alaska. Through the outreach and educational platform provided by the 4-H program we are enhancing the production capabilities of a small industry and delivering a regionally produced red meat to market. This program supports the development and delivery of agricultural education to the public, and provides important insight on marketing for the reindeer industry.

grants/funding

USDA/Hatch

## animal husbandry

### Cattle genetics

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

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. This includes 34 microsatellite loci and DNA sequences for the mitochondrial DNA cytochrome b gene and k-casein gene. Additional samples were collected in 2006 from the university's cattle herd in Palmer and Larry DeVilbiss' Galloway cattle. DNA has been extracted from these samples and will be analyzed during summer 2010 at the ARS lab in Miles City, Montana.

#### 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.

#### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

### Elk genetics

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

#### purpose

We developed 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 paper was published in the *Journal of Animal Science* in 2009.

#### 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.

#### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

### Timing of breeding and gestation length in muskoxen

Milan Shipka, Janice Rowell

#### purpose

Our purpose was twofold. We sought to:

- Compare gestation length between muskoxen bred in late August with muskoxen bred 30 days later (late September); and
- Using a radiotelemetric heat detection system, compare the time from estrous synchronization to mounting between early and late-bred muskoxen.

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#### BACKGROUND

We have documented a negative association between gestation length and the time of breeding in reindeer. A similar relationship has been reported in other cervids and, anecdotally, in a number of different species (bison, moose, alpacas, pronghorn, and bighorn sheep) suggesting that the phenomenon may be common to a wide range of seasonal ungulates [ungulates that breed at a specific season: in reindeer and muskoxen, this happens only in fall]. Although no one has specifically investigated gestation adjustment in muskoxen, we have been aware of a discrepancy in gestation length between muskoxen in a captive research herd in Saskatoon (235 days, 52°N) and the muskoxen at the Robert G. White Large Animal Research Station (LARS) (245 days, 64.8°N). We initially speculated that genetic differences between subspecies of muskoxen (*Ovibos m. wardi* in Fairbanks and *O. m. moschatus* in Saskatoon) were responsible for gestation length variability. However, subsequent genetic studies failed to demonstrate differences between the presumed subspecies. At 52°N, muskoxen normally bred in mid-late September compared to a breeding time of late August/early September in Fairbanks. The different gestation lengths could be reflecting a seasonal gestation adjustment, similar to the phenomenon in reindeer.

A radiotelemetric heat detection system has been used successfully in muskoxen and provided the basis for a description of estrous behavior and mounting in this species. This technology provides a non-invasive, reliable means of identifying the approximate time of conception and also allows us to investigate the effect of season on the timing of ovulation.

#### approach

Female muskoxen (total number was 15) were divided into two groups balanced for weight, age, and reproductive histories. The Early Group (seven members) received CIDRs\* modified according to manufacturer's directions for the smaller muskox size, on Aug. 20. The CIDRs were removed one week later and the animals received 15 mg i.m. (intramuscular) injection of prostaglandin.



*First reindeer calf of 2009 with its mother at the Fairbanks Experiment Farm.*

AFES PHOTO BY NANCY TARNAI

Radiotelemetric estrous detection transponders were attached using hip tag cement to a small shaved patch on the female's rump. The females were placed in harem the following day for one week (Aug. 28 – Sept. 4). The Late Bred Group (eight members) underwent an identical synchronization protocol beginning Sept. 21 and were put into harem from Sept. 29 - Oct 6. Calf birth date, weight, and sex information will be collected following calving in May.

\* CIDR = Controlled Internal Drug Releasing device, Eazi-Breed CIDR, Pfizer Animal Health, [www.pfizerah.com](http://www.pfizerah.com)

#### progress

In the Early Bred Group, radiotelemetry recorded mounts in six of seven females on Aug. 30–31. Of these, one aborted in March and one died from unrelated causes. The remaining four are due to calve during the first week of May.

In the Late Bred Group, two females lost their CIDRs and, therefore, were not synchronized with the others and one died from unrelated causes. Radiotelemetry only recorded mounts on two females. Calving is expected in mid May.

#### impact

The impact of the timing of breeding on gestation length, pregnancy rate, calf sex, calf birth weight, and calf survival all have important implications on the successful management of muskoxen in captivity.

#### grants/funding

USDA Hatch

#### Reindeer genetics

M.A. Cronin, Milan Shipka, Greg Finstad, Jan Rowell; M.D. MacNeil (USDA); J.C. Patton (Purdue Univ.)

#### purpose

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

#### approach

We are emulating 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. In 2008 DNA was extracted by J.C. Patton at Purdue University and sent to the ARS lab in Miles City, Montana. Initial analysis at Purdue has shown three k-casein alleles that occur in two homozygotes and two

heterozygotes in four of the university reindeer. These will be compared with other Alaska herds.

#### 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.

#### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

### Habitat use, diet, and herd composition of Seward Peninsula reindeer during the breeding season

Leslie Davis, Greg Finstad

#### purpose

Reindeer producers on the Seward Peninsula need additional information on where free-ranging reindeer go and what forages they consume during fall to identify key seasonal grazing areas. Reindeer undergo rut during this time when females are attempting to replenish fat and tissue to support winter gestation and spring lactation. The goal of this project was to integrate high resolution animal location data with vegetation mapping capabilities to examine movement patterns, habitat choice, diet, and herd composition during the breeding season.

#### approach

Ten experimental satellite collars employing the Iridium satellite constellation were deployed onto female reindeer during the June 2009 handling of the Lee herd. Fourteen traditional VHF-radio collars outfitted with “store-on-board” GPS units were deployed to increase sample size for range utilization study. Field observations were made July 19–22, July 30, August 25–28, Sept 3–6, and Oct. 10–12. Data included herd demographics and antler category (harvested or not). Fecal samples were collected for diet composition analysis.

#### progress

A presentation on the project was given to the Reindeer Herders Association during the annual meeting, March 2010. Twenty-four composite fecal samples (eight from each temporal period) were sent to the Wildlife Habitat Laboratory, Washington State University, for a diet composition analysis. I am currently working on demographic and positional data analysis.

#### impact

This project will promote more intensive management of reindeer during a critical period in their reproductive cycle. Outputs from this project will be used to model the animal/landscape interface to identify preferred seasonal habitats and diet in an effort to set baseline requirements for rotational grazing strategies needed by Natural Resource Conservation Service land managers and reindeer producers.

#### grants/funding

USDA Hatch

### Hematological, immunological, and serum chemistry reference ranges for reindeer

Zoe Purtzer, Antony C. Bakke (Oregon Health & Science Univ.); Greg Finstad

#### purpose

The purpose of this project was to develop gender, age related, and seasonal hematological, immunological, and serum chemistry reference ranges. The reference ranges will be used to establish herd health standards and provide a baseline for future studies of disease in reindeer.

#### approach

Blood and serum samples were collected seasonally from healthy reindeer in the Reindeer Research Program of various ages and reproductive status. Blood and serum samples were also collected opportunistically from any sick or injured reindeer. Samples were shipped to Oregon Health and Science University. Complete blood counts were performed on an automated hematology analyzer and manual differentials were performed by microscopy. The automated measurements included total white blood cell count, platelet count, and red blood cell enumeration. Manual counts were performed on fixed blood smears, stained with a Wright-Giemsa stain. Red blood cells and platelets were graded for morphology using standard pathology descriptors. On each slide, 200 white blood cells (WBCs) were counted to determine the manual cell differential. The manual count included WBCs categorized as lymphocytes, monocytes, neutrophils, bands, eosinophils, and nucleated red blood cells.

Serum samples were frozen and archived for later analysis. In collaboration with Abaxis, Inc., serum chemistries were performed with Vetscan comprehensive diagnostic profiles. The Vetscan profile includes thirteen analytes, which evaluate multiple organ function. Serum proteins were analyzed by serum protein electrophoresis (SPEP) to establish age related changes in protein content.

#### progress

Hematological measurements revealed several age related trends. Hemoglobin increases with age. Nucleated RBCs and total WBCs decrease with age. The fraction of neutrophils, eosinophils, and monocytes increase with age, while the lymphocytes decrease.

Serum chemistries were performed on ill animals and revealed increases in both glucose and aspartate transaminase (AST) compared to normal healthy controls. Samples from 30 animals were compared to other studies on reindeer (UAF range study and Bronx Zoo database) and revealed both age related and seasonal differences.

Serum protein analysis was conducted on 30 samples. This analysis also revealed several age related trends. Newborn calves have very low levels of gamma globulin (antibodies) and do not reach adult levels for several months (three to six months of age). Some calves with illness have

significant increase in gamma globulins, indicating a robust immune response. Gamma globulins also increased with age, due to immune system maturation and exposure to antigens (bacteria, fungi, virus, parasites) in the environment. Other systemic changes were noted, such as decreases in albumin and increases in clotting proteins during illness.

Hematological and serum chemistry ranges for the entire captive herd are near completion.

#### impact

Reference ranges are basic health parameters, critical for the health management of any animal production system. Establishing reference ranges will enhance the ability of Alaska's reindeer industry to identify and control disease. In turn, this will lead to enhanced local food production, food security, and commercial enterprise.

#### grants/funding

USDA Hatch

## Artificial insemination in reindeer using thawed frozen semen

Milan Shipka, Janice Rowell

#### purpose

Our objective is to customize established artificial insemination (AI) techniques using frozen thawed semen for use in farmed Alaska reindeer.

#### approach

Semen was collected from a 15-month-old reindeer bull in Saskatchewan, Canada, processed to a final dilution of  $3.5 \times 10^7$  sperm per 0.5cc straw, frozen and shipped to Alaska. Sperm motility was 70 percent (fresh) and 45 percent (thawed) with 68 percent normal sperm. We applied a white-tailed deer AI protocol to 8 nulliparous, 2.5-year-old captive reindeer at the UAF Agricultural and Forestry Experiment Station. The females were synchronized with CIDR-b,\* modified to fit the smaller reindeer vagina, using a two CIDR, 14-day schedule. At removal of the second CIDR, the females received 200 IU PMSG i.m. [intramuscular] (four each received PG 600 or PMSG, Sigma Chemicals). At the time of breeding, one female's vagina was too small to accommodate the speculum and she was dropped from the study. The remaining seven females exhibited signs of estrus (copious, clear mucus) at insemination. Intra-cervical insemination took place 55 hours after CIDR removal on Sept, 24, 2009. Serum collected 11 weeks post-insemination and assayed for PSPB indicated one pregnant, one possibly undergoing pregnancy loss and five non-pregnant females.

#### progress

On April 22, 2010 a 5.5 kg male calf was born. Gestation length was 212 days, a relatively short gestation consistent with the late breeding. To our knowledge this is the first confirmed report of a live calf born from artificial insemination technology using frozen semen.

#### impact

This is the first important step in customizing AI technology for the Alaska reindeer industry. Future efforts

will be directed toward improving pregnancy rates and simplifying the estrous synchronization protocol.

\* CIDR = Controlled Internal Drug Releasing device, Eazi-Breed CIDR, Pfizer Animal Health, [www.pfizerah.com](http://www.pfizerah.com)

#### grants/funding

USDA Hatch

## Effect of progesterone and melatonin on gestation length in reindeer

Janice Rowell, Milan Shipka

#### purpose

We investigated the potential of a) progesterone and b) melatonin to accelerate early embryonic growth as evidenced by a shortened gestation length without compromising calf birth weight.

#### BACKGROUND:

Reindeer bred early in the breeding season (Aug. 27) have a longer mean gestation length ( $224.7 \pm 0.73$  days) compared to reindeer bred later in the breeding season (Sept. 25:  $216.2 \pm 1.02$  days). The underlying mechanisms for this phenomenon are unknown, although there is some evidence in domestic ruminants that elevated progesterone in the first 4-10 days of gestation may enhance trophoblast growth and embryonic development. We have found higher ( $P < 0.001$ ) progesterone concentrations in reindeer bred late compared to progesterone concentrations when these same reindeer were bred early in the season. We hypothesize this could be an event driven by the seasonal hormone melatonin.

This study addresses the following hypotheses:

- Hypothesis 1: Elevated progesterone during the first 5-12 days post-conception will improve pregnancy rate and shorten gestation length in reindeer bred early in the season (Aug. 27/28).
- Hypothesis 2: Exposure to subcutaneous melatonin implants (24 mg) for 21 days before estrus synchronization will improve pregnancy rate and shorten gestation length in reindeer bred early in the season (Aug. 27/28).

#### approach and progress

### Hypothesis 1: Elevated progesterone during the first 5-12 days post-conception - Agricultural and Forestry Experiment Station

Twenty reindeer had estrus synchronized using modified CIDR (Controlled Internal Drug Releasing device, Eazi-Breed CIDR, Pfizer Animal Health, [www.pfizerah.com](http://www.pfizerah.com)) on Aug. 17, 2009. At CIDR removal seven days later the reindeer were given 15 mg of  $\text{PGF}_{2\alpha}$  and were divided equally between two harems where they remained with the bulls for seven days. At harem break-up, five females from each harem (Group 1, total females 10) received a second CIDR for a further seven days (estimated 5-12 days post-breeding) while the remaining reindeer (Group 2, also 10 members) acted as an early-bred control. On Sept. 15 the reindeer were placed in pens with a genetically different bull from their harem bull. Calving dates and calf birth weights will be collected

during spring 2010 and hair samples from cow/calf pairs will be analyzed at the UC Davis genetics lab to confirm sire and, hence, time of breeding.

### **Hypothesis 2: Exposure to melatonin – Robert G. White Large Animal Research Station**

Twenty reindeer were divided into two groups balanced for age and weight. Gr. 1 received a subcutaneous implant at the base of the left ear containing 24 mg melatonin (manufactured by Melatek, LLC and sold through MWI Veterinary Supply, www.melatek.net) on July 28, 2009 (three weeks before estrus synchronization). Both groups had estrus synchronized with modified CIDRs on Aug. 18, 2009. CIDRs were removed seven days later and the reindeer given 15 mg PGF<sub>2α</sub> i.m. and placed in one of two harems. Females treated with melatonin were divided between the two harems. They remained in harem for seven days after which the bulls were removed and the females remained together and were managed identically until calving.

#### **impact**

Understanding these mechanisms and ultimately their potential impact on blastocyst survival, fetal development and calf growth are important to breeding management of reindeer, especially if techniques like artificial insemination are to be applied.

#### **grants/funding**

USDA Hatch and Western Sungrant Center

### **High Latitude Range Management curriculum**

**Greg Finstad, Lee Haugen**

#### **purpose**

The HLRM curriculum was amended to include coursework and training in the meat sciences with delivery of a Mobile Slaughter Unit to Nome, Alaska.

#### **approach**

A Mobile Slaughter Unit was designed with increased floor space to accommodate on-site observation and hands-on training of students in the slaughtering and processing of reindeer carcasses. The HLRM curriculum provides coursework for local people to commercially develop available natural resources in a sustainable manner.

#### **progress**

Two HLRM courses were taught this year while one student will have completed certificate requirements and will be graduating in May 2010. Work began on the operational plans and meat science instructional manual and materials to be used in conjunction with the MSU.

#### **impact**

This curriculum provides a critical link to integrate an educational platform with local animal production research, and to provide the regional economy with a highly marketable product.

#### **grants/funding**

USDA Hatch

### **Effects of sodium bicarbonate supplementation on feed intake and weight gain of reindeer**

**Greg Finstad, George Aguiar**

#### **purpose**

A barley-based ration has been developed by the Reindeer Research Program which is readily consumed by reindeer and results in rapid weight gain. However, the feeding of a predominately grain diet to a ruminant can lead to metabolic disturbances such as acidosis. The conventional livestock industry uses dietary buffers (e.g. bicarbonates, hydroxides, and silicates) to neutralize ruminal acidity, which promotes animal performance. The purpose of this project was to evaluate the effect on feed intake and performance of reindeer fed a cereal grain-based diet supplemented with sodium bicarbonate.

#### **approach**

The project was conducted at the Agricultural and Forestry Experiment Station with reindeer from the Reindeer Research Program. In May of 2009 twelve cow/calf pairs were randomly allocated into treatment and control groups. All twelve cow/calf pairs were fed a 60 percent barley-based, milled ration ad lib for five weeks. The treatment group was fed a ration supplemented with 1.5 percent sodium bicarbonate of the total feed fed. Daily dry matter intake of feed was monitored and recorded and cow/calf pairs weighed weekly.

#### **progress**

Animals fed the sodium bicarbonate supplemented diet ate significantly less and gained less than control animals during the five-week trial.

#### **impact**

Feeding high energy diets supplemented with 1.5 percent sodium bicarbonate is a common practice to reduce economic loss due to acidosis in feedlot beef production. Results from our study suggest that commonly used techniques in the beef industry may not be applicable to reindeer operations. Preliminary results confirm that a barley-based diet supplemented with sodium bicarbonate at 1.5 percent causes a decrease in DMI along with a decrease in weight gain. Reducing the percentage of sodium bicarbonate supplement within a barley-based ration may prove to be effective in reindeer.

#### **grants/funding**

USDA Hatch

### **biofuels**

#### **Low NOx biodiesel production from Pacific Island feedstocks**

**J. Andres Soria**; Richard Ogoshi (Univ. of Hawaii); Ian Gurry (American Samoa Community College); Mari Marutani (Univ. of Guam); Dilip Nandwani (Northern Marianas College); James Currie (College of Micronesia); Darrin Marshall (UAA)

### purpose

This multistate, collaborative project is designed to produce low NO<sub>x</sub>-emission biodiesel from tropical plants that grow in the Pacific Islands and Hawaii, as a means of developing a sustainable and environmentally friendly fuel source that can help offset petroleum-based fuel and emissions. Selected plants include jathropa and coconut.

### approach

The collaborating teams from the Pacific Islands and Hawaii will collect the fruits from the selected tree species and extract the raw oil. The oil will be shipped to the UAF AFES Palmer Research & Extension Center for characterization and transformation into biodiesel. The biodiesel will be run in a vehicle and its behavior measured using a dynamometer and emissions analyzer. A correlation between the emissions and biodiesel characteristics along with the original harvesting site will help determine the environmental factors that influence the final product behavior in the vehicle use.

### progress

Collaborators from the Pacific Islands have shipped coconut, kamani, and jathropa oils from the Commonwealth of the Northern Marianas Islands. Other partners have not yet shipped any samples to UAF for conversion and analysis.

### impact

The development of a renewable fuel source from locally available species is a major benefit of the research, especially for the small isolated communities in the Pacific Rim, which, just like in Alaska, rely on imported fuels. The development of a cleaner biodiesel that can be used to offset their diesel use, such as in outdoor motors, is a benefit of consideration. Furthermore, the research may be a catalyst for promoting a secondary industry, in the planting, growing, managing, harvesting, and processing of the oil species studied.

### grants/funding

Western Sungrant Center

## Potential perennial lignocellulosic energy crops for Alaska

Stephen D. Sparrow, Mingchu Zhang

### purpose

The high cost of petroleum-based fuels in Alaska, particularly in remote areas of rural Alaska, has resulted in high interest in local, renewable energy sources, including growing crops for bioenergy. The purpose of this research is to screen various trees/shrubs, perennial grasses, and perennial forbs as potential bioenergy crops for Alaska and to determine best management practices for efficiently producing bio-energy crops.

### approach

Field research plots were established at Fairbanks and Palmer in 2008. In 2009, three willow species, felt-leaf willow (*Salix alaxensis*), Pacific willow (*S. lasiandra*), and balsam poplar (*Populus balsamifera*) were established on poorly drained soil at Fairbanks. The same species plus two alder species were planted in unreplicated plots at Delta Junction

in 2009. Grass plots previously established for other purposes were used for biomass energy trials in 2008 at Fairbanks and again harvested in 2009. In addition, grass plots from a previous study at Delta Junction were used for biomass trials in 2009 and included Carlton smooth brome grass (*Bromus inermis*), Nortran tufted hairgrass (*Dechampsia caespitosa*), and Wainwright slender wheatgrass (*Elymus trachycaulus*) managed under three nitrogen fertilizer rates (0, 50, 100 kg N/ha) and three harvest timing regimes (two cuts per season, single harvest in the fall, single harvest in spring of succeeding year).

### progress

At Fairbanks, for fall harvest at the high nitrogen rate, yields averaged over two years were 7,950 kg dry matter per ha for smooth brome grass, 6,470 kg/ha for hairgrass and 5,650 kg/ha for wheatgrass. Smooth brome grass had much higher water content than the native grasses; this would reduce its gross energy value. Spring harvest yields were 3,775 kg/ha for smooth brome grass, 5,650 kg/ha for tufted hairgrass, and 4,430 kg/ha for slender wheatgrass, indicating significant yield losses over winter, especially for smooth brome grass. At Delta Junction in 2009 for the fall harvest under the high N rate, smooth brome grass produced 6,710 kg/ha dry matter, tufted hairgrass produced 7,100 kg/ha and slender wheatgrass produced 5,190 kg/ha. We do not yet have spring harvest yields at Delta Junction. At both locations, harvesting twice (mid-season and at end of season) produced similar yields to a single harvest at the end of the growing season, indicating no advantage to a two-harvest management regime. Dry matter yields for all species were increased by addition of N fertilizer up to the highest N rate. A preliminary study at Fairbanks showed yields of 5,530 kg/ha for fireweed (*Chamerion angustifolium*) and 6,490 kg/ha for bluejoint reedgrass (*Calamagrostis canadensis*), both species native to the area. We intend to add additional species and study sites in 2010.

### impact

Since the study is in its infancy, it is too early to provide impacts. Expected impacts include provision of management information for farmers and communities wishing to grow biomass crops for energy use in Alaska.

### grants/funding

USDA-NIFA, Hatch

## controlled environment production

### Light emitting diodes (LEDs) for greenhouse crops

Meriam Karlsson, Jeff Werner

### purpose

Light emitting diodes show promise to complement and replace the high intensity discharge (HID) lamps now commonly used for lighting crops in greenhouses. This study was initiated to evaluate plant growth and development under light from LEDs.

### approach

LEDs were used to grow the black-eyed Susan cultivar Toto. Three panels of LEDs were evaluated. One panel

was assembled of red LEDs (peak emission at 665 nm) supplemented with 10 percent blue LEDs (peak emission at 456 nm). The tri-band panel had a combination of 40 percent red (660 nm), 40 percent orange-red (630 nm), and 20 percent blue (460 nm) LEDs. The third panel consisted of all white LEDs. The frequently used high-pressure sodium (HPS) and metal halide (MH) lamps for greenhouse lighting were also included. The air temperature was a constant 68°F and the light intensity for all lamp types was approximately 750 foot-candles. Net photosynthetic rates were measured when the plants had fully developed buds but no open flowers.

#### progress/result

Plant growth and flowering were slightly faster under the HPS and MH lamps. Still the rates of photosynthesis were similar, suggesting the intensity of light to be more important for driving photosynthesis and growth than the type of spectrum the LEDs or HID lamps provided.

#### impact/implications

To make greenhouse production feasible under the short days and low light conditions of the north, energy effective lighting technologies are required. The characterization of less electrical energy use, extended lamp life and opportunities for customizing the type of light has brought attention to the technology of LEDs for greenhouse lighting. Results from this study suggest the potential for using LEDs to light future greenhouses, although additional research on crop responses is needed.

#### grants/funding

USDA Hatch

## Specialty plastic coverings and strawberries

Meriam Karlsson, Jeffrey Werner

#### purpose

High tunnels offer opportunities to increase yield, improve quality, and extend the field season for high value crops. Under northern conditions with naturally extreme day lengths and short seasons, high tunnels covered with non-traditional plastic materials may more effectively support crop productivity.

#### approach

The strawberries Tribute and Fern were evaluated in the field and in high tunnels covered with the materials K50 Clear, K50 IR/AC, and KoolLite380 from Klerk's Plastic Product Manufacturing (Richburg, South Carolina) and a Visqueen material called Solatrol. Tribute is a day-neutral strawberry and Fern is an everbearing selection.

#### progress/result

Harvest started at the end of July and continued until end of season frost on September 20. All four high tunnel environments resulted in higher yields than the field despite an exceptionally warm 2009 season. Fern in the high tunnel with a KoolLite380 covering had the highest yield at 12.6 oz per plant. The harvest was reduced to about 8 oz per plant for the K50 Clear, K50 IR/AC, and Solatrol environments. In comparison, the outside production was 4.7 oz. The

KoolLite380 covering was also most favorable for Tribute (8.9 oz), followed by K50 Clear and K50 IR at 8.2 oz per plant. Outside the high tunnels, yield was 3.8 oz per plant for Tribute. The KoolLite380 material was comparable to the commonly used K50 Clear, which moderates the environment during high temperature peaks. During the warm summer of 2009, the improved temperature control in KoolLite380 high tunnels was beneficial for growing strawberries.

#### impact/implications

The results suggest high tunnels are suitable for growing strawberries. The KoolLite380 material is a good covering material for strawberries during exceptionally warm seasons. We have shown earlier that the K50 IR/AC covering keeps the environment slightly warmer as night temperature drops in the fall. Since weather conditions are unpredictable, using several high tunnels and covering materials is recommended to ensure ongoing production throughout the season.

#### grants/funding

USDA Hatch

## Retractable flat-roof high tunnel

Jeffrey Werner, Meriam Karlsson

#### purpose

In this project, the use and application of a retractable flat-roof high tunnel are tested to improve crop performance under field season conditions.

#### approach

A retractable double-layer flat-roof high tunnel was erected on the Fairbanks Experiment Farm during the 2009 field season.

#### progress/result

The flat roof high tunnel covers a field area of 36 by 60 feet with 12 feet tall posts. The structure is equipped with one layer of translucent material and one layer of blackout covering for photoperiodic control. The coverings are retracted using gear motors (RW4-2, Ridder Drive Systems) and controlled independently with an integrated climate controller (iGrow 1400, Link4 Corporation). The material for the roof is a knitted aluminized PLS 40 ABRI fabric (45 percent shade, AB Ludvig Svensson) suitable to retain warmer temperatures during colder periods and reflect heat during hot days. To allow roll up, the transparent wall material is a polyethylene curtain (LS Solar Woven Ultra Poly, AB Ludvig Svensson). The blackout material for the roof and walls is XLS Obscura Firebreak (AB Ludvig Svensson).

#### impact/implications

Opportunity to protect crops from inclement weather along with the ability to pull back the covering for natural ventilation, direct sunlight, and field exposure present optimal conditions for crop productivity. Comparing growth under twilight-extended continuous light to conditions with traditional daily cycles of light and dark will provide insights on plant responses for crop establishment, early season development, flowering and fruit set, plant growth habits, frost protection, yield, and crop quality.

## grants/funding

USDA Hatch and

## Apples in high tunnels

Kendra Calhoun, Meriam Karlsson

### purpose

This research project is investigating the potential to domestically grow apple trees on cold (zone 2) sites in interior Alaska.

### approach

We have constructed two high tunnels (42 by 96 feet) and planted more than 39 apple varieties inside and in the field adjacent to the structures. We have been monitoring climate and tree development such as flowering and fruiting since 2007. Our site is located on the Fairbanks Experiment Farm at the University of Alaska in Fairbanks, Alaska.

### progress/result

A total of 12 trees in 2008 and 27 trees in 2009 flowered although we did not expect flowering and fruit set until the third full growing season. The first open flowers were observed on May 26 and flowering continued through the first week of June. Fifteen of the 27 flowering trees produced apples. All fruit-yielding trees were inside the high tunnels while the two flowering trees outside did not produce apples.

The harvest was small but more than exceeded expectations. The soluble solid content (SSC) was determined in samples from each harvested variety. The SSC level is an indication of the fruit sugar content expressed in °Brix. The apples varied in size from 20 to 200 g with sugar contents between 6 and 20 °Brix. The varieties Advance, Arctic Red, Heyer 12, Norland, Nova Sibirski, Parkland, PF-12, Prairie Sun, Red Heart, Rescue, Ukalskoje, and 18-8-11 produced apples in 2009. Heyer 12 had the largest and Red Heat and Rescue the smallest-sized apples. The sweetest apples were Ukalskoje, and Red Heart had the lowest SSC values.

### impact/implications

We expect to identify specific apple varieties that survive and produce fruit in zone 2, and explore the use of high tunnels for apple production in the Interior and other areas of Alaska. We are hoping for more complete flowering, fruit set, and yield during the 2010 field season with an expectation of 80 to 90 percent of the trees producing apples.

## grants/funding

USDA Hatch, CES, SARE

## Arsenic absorption in vegetables

Jeff Bue, Jeffrey Werner, Meriam Karlsson

### purpose

This study was initiated to evaluate if lettuce absorbs arsenic in water used for irrigation.

### approach

Two groups of lettuce were grown in greenhouse conditions. The control group was irrigated with water uncontaminated with arsenic. The treatment group was irrigated with water spiked with arsenic to a level of 1 ppm

(1 mg/liter). The samples were digested using a microwave digester and analyzed for arsenic content.

### progress/result

We found that the arsenic concentration in the lettuce grown using arsenic-contaminated water was 1.125 ppm compared to a concentration of 0.024 ppm in the control group.

### impact/implications

High levels of arsenic in groundwater and wells are not uncommon around Fairbanks due to the geological minerals of the bedrock. Questions frequently arise concerning uptake in vegetable gardens when watered with arsenic-contaminated well water. The results suggest lettuce takes up significant amounts of arsenic when irrigated with arsenic-containing water. More research is needed to establish absorption abilities of other garden vegetables besides lettuce, as well as the relation between the concentration in the irrigation water and the arsenic concentration in vegetables.

## grants/funding

USDA Hatch

## Flowering primrose

Meriam Karlsson, Jeffrey Werner

### purpose

Long days or a cooling period have been used to prompt flowering in primrose (primula). Flowering in the recently released primroses Orion and Primera is not well understood or known. This study was initiated to evaluate the effect of cooling and day length on the development of flowers in these selections.

### approach

Seven-week-old seedlings of Orion and Primera were placed at 40°F for two, four, or six weeks and then transferred to a greenhouse kept at approximately 68°F. In comparison, one set of primroses remained in the greenhouse without a cool treatment. Plants were also grown at short and long days at 60 or 68°F. Time to flowering was recorded as the first flowers were fully developed and open.

### progress/result

The response to day length was limited for both selections with just a few days faster flowering at long days. Flowering at 60°F and long days was recorded after 52 days for Primera and after 62 days for Orion. A 36-day greenhouse period was sufficient for flowering in Primera after two weeks of cooling. The quickest flowering for Orion was at 47 days in the greenhouse following four weeks of cooling. Six weeks of cold resulted in delayed flowering for both varieties.

### impact

Understanding patterns of crop development in response to climatic conditions is useful for efficient greenhouse production, particularly as energy costs are high and efficient use of heated greenhouse space is essential.

## grants/funding

USDA Hatch



## Field and high tunnel production of snap beans

Meriam Karlsson, Jeff Werner

### purpose

We compared the yield of snap beans grown in a high tunnel environment with the productivity of beans grown in an unprotected open field.

### approach

The selected cultivars were Concesa, Provider, Stayton, and Gold Rush. Provider is a well-established green bean for northern conditions, Concesa and Stayton produce tender bean pods of smaller diameter, and Gold Rush is a yellow wax-type snap bean. The beans were seeded in a greenhouse and transplanted nine days later, on June 4, 2009, in high tunnel and field locations.

### progress/result

Harvest was initiated on July 25 and continued through September 1. The high tunnel environment was beneficial for the included cultivars despite the warm summer conditions of 2009. Provider had the highest yield for a three-foot-long double row of beans, at 14 lbs. The high tunnel yield for Gold Rush and Stayton was 12 lbs. Under field conditions, the harvest was similar (11.5 lbs) for Provider, Gold Rush, and Stayton. Concesa produced the smallest amounts of beans at 8.5 lbs in the high tunnel and 7.8 lbs in the field. The average weight of individual pods was 0.28 ounces for Provider, 0.23 ounces for Gold Rush, 0.17 ounces for Concesa, and 0.15 ounces for Stayton.

### impact/implications

High tunnels are advantageous even during seasons of favorable weather conditions for producing snap beans. In addition to promoting yields, a high tunnel environment often results in exceptional quality beans for capturing premium price on high-end specialty markets.

### grants/funding

USDA Hatch

## Early short day treatment of sunflowers

Meriam Karlsson, Jeff Werner

### purpose

The sunflower selections Red/Lemon Bicolor in the ProCut series and Sunbright Supreme were evaluated for flowering under field conditions.

### approach

The sunflowers were seeded in a greenhouse and transplanted into the field fourteen days later. Groups of plants were grown in a controlled environment using high-pressure sodium lamps or light emitting diodes (LEDs) and in a greenhouse with natural light. The seedlings were grown from germination to transplanting under 16-hour long days or with dark from 6 PM to 8 AM for short days.

### progress/result

Sunbright Supreme flowered forty-five days from planting after short days during the seedling stage. In comparison, long days resulted in a month-later flowering.

The only exception was under LEDs where short and long day conditions resulted in slower flowering independent of the day length. Early flowering came with shorter plants at 42 inches compared to 76 inches for the later flowering plants. We have shown earlier that R/L Bicolor has limited response to early day length conditions. The results here confirm those findings with flowering approximately fifty days from transplanting independent of early day length conditions.

### impact/implications

Providing short days prior to transplanting will shorten time to flower for some types of sunflower. More research is needed to determine the potential for using LEDs to administer a short day treatment to hasten flowering.

### grants/funding

USDA Hatch

## Working with local greenhouses

Jeffrey Werner, Meriam Karlsson

### purpose

We have developed partnerships with local greenhouses to field test research findings and develop best management procedures for high-latitude greenhouse operations. These partnerships also offer opportunities for high school and college students to participate in apprentice work training.

### approach

At the greenhouse operated by the Pike's Waterfront Lodge, techniques suitable for northern conditions are used and demonstrated throughout the summer season. The production greenhouse heated and powered from geothermal resources at the Chena Hot Springs Resort uses growing techniques modified for year-round crop production. Educational tours and programs on production techniques and UAF research results are given daily throughout the year at Chena Hot Springs Resort and during the summer at Pike's greenhouse.

### progress/result

The geothermal greenhouse produces sufficient amounts of lettuce and tomatoes to support the restaurant at the Chena Hot Springs Resort. The large seasonal variations in light, day length, and temperature necessitate continuous adjustments in production approach and management. These challenging conditions stimulate research on the fundamental understanding of plants for continuous development of most effective crop production methods. In Pike's greenhouse, plants are grown for landscaping of the property as well as tomatoes for the restaurant during the summer months.

The sustainable energy approach at Chena Hot Springs Resort draws constant interest and the well-attended educational programs on operation and production methods at the geothermal greenhouse are conducted several times a day. At Pike's, crop production techniques and information about UAF research and Alaska agriculture are presented at daily formal and self-guided educational tours. These instructional programs at Chena Hot Springs and Pike's attract participants from the local population, visitors from

various parts of Alaska, and tourists from all over the world. The socio-economic backgrounds and educational levels vary extensively among the attending individuals.

The Chena Hot Springs and Pike's greenhouses, in collaboration with UAF and SNRAS, also offer training and summer job opportunities for high school FFA and college students. At Pike's, in addition to taking care of the greenhouse and the grounds, the students provide the daily educational programs and answer questions related to greenhouse and local crop production, and their summer employment experience.

#### impact

34 Opportunity to view practical applications stimulates interest and encourages Alaskans to develop greenhouse projects for production and education. Practical hands-on training prepares students for successful careers following high school and college. These partnerships also offer effective information dissemination on UAF research to commercial producers and the public.

#### grants/funding

USDA Hatch; Chena Hot Springs Resort, Pike's Waterfront Lodge (in-kind donations)

## 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 a yearly update of information on new and better adapted agronomic crop varieties (small grains and oilseeds) and their response to dryland farming conditions and harvest methods at Fairbanks, Delta Junction, and Palmer. It also provides a data base for local producers to determine the economic viability for those crops.

#### approach

We use variety trials for continued evaluation of spring 6-row feed barley, 6-row hullless barley selections, hard red spring wheat, and oilseeds including Polish canola, Argentine canola, hybrid canola, oriental and brown mustards, yellow mustard, camelina, and dwarf, open-pollinated Sunwheat selected from northern Canadian and US sources for testing against the standard Alaska varieties (Otal spring feed barley, Thual hullless barley, Ingal hard red spring wheat, and Reward Polish canola) for early maturity and high yields. Replicated trials of all varieties were planted at all three test locations, with the exception of oilseed varieties which were tested only at Fairbanks and Delta Junction.

#### progress

Summer growing conditions at all three locations were slightly warmer and drier compared with the long-term

averages. Small grain and oilseed yields were about equal to the long term average. Average test weights (an indicator of ripeness) were lower than the long term average due to the drier conditions. Plant height characteristics and lodging were about equal to the long-term average values. Average yields for the feed barley at all locations were about equal to the standard test variety, Otal. The final selection from a hullless, 6-row, barley cross that was made in 2008 was officially released in 2009 as 'Sunshine'. Sunshine had higher yields, one to two days earlier maturity and 15 percent better lodging resistance compared to the standard hullless barley, Thual, at all locations. Average yields for hard red spring wheat were about equal to the standard test variety, Ingal at all three locations. Winter rye was tested only at the Fairbanks location with yields slightly higher than wheat but maturity was significantly later. Argentine canola, hybrid canola, oriental, brown and yellow mustard yields were significantly lower than standard test variety, Reward Polish canola. They are later maturing which resulted in green, unripe, and high moisture seed at harvest. The Polish canola and camelina varieties had average yields similar to the standard test variety, Reward, at the Fairbanks and Delta Junction locations. The dwarf, open-pollinated Sunwheat variety, Midnight Sunflower, resulted in yields that were slightly higher than the long-term average. There were no oilseed trials planted at the Palmer location. For 2010, testing of spring and fall planted small grains and oilseed varieties will continue.

Three harvest methods for Polish canola were tested again in 2009 in an attempt to increase seed uniformity at harvest with an increase in yields and a decrease in high moisture, green seed. The three methods included direct combining, spraying with a glyphosphate herbicide (Roundup) to kill the weeds two weeks prior to combining, and pushing with a tool bar six to eight inches off the ground to crimp the main stem and halt translocation of moisture up the plant three weeks before combining. The best method at both locations was spraying, with higher than average yields and a corresponding 1 percent green seed. The next best method was pushing, with lower than average yields and 3 percent green seed. The worst method was direct combining, with below-average yields and 4 percent green seed.

Results from phosphorus rate and application methods for barley fertilization indicate that a medium rate of phosphorus applied as a band with the seed produced the highest yields. Continued research into fertilizer carry-over will be conducted in 2010 at all locations.

The use of a urea volatilization inhibitor to reduce nitrogen loss on fall and spring fertilizer applications on brome grass hay was continued in 2009. Preliminary results showed significant ammonia volatilization occurring without application of the inhibitor. The highest loss occurred with the fall application. This will be continued into 2010 with an additional treatment of a spring/summer split application.

#### impact

The release of the new hullless barley Sunshine stimulated an increased interest in growing adapted small grains

for human consumption in both large and small scale production. The harvest method of spraying Polish canola with glyphosphate resulted in 2 percent green seed or less for the third straight year. The oil from this seed is suitable for use as human consumption or as a biofuel. This makes Polish canola a viable crop for Alaska. Results from both the phosphorus and nitrogen (urea) studies show an increased nutrient plant use efficiency and prevention of loss to the environment.

#### grant/funding

Hatch General Project Grant—Alternative Agronomic Crops for Alaska (ALK 08-06, CRIS 0215263)

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

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 production of quality haylage in Alaska and develops remote sensing techniques for estimation of biomass production.

#### approach

Different types of forage were harvested at two times during the summer for haylage production. This year we baled the haylage using three different colors of plastic wrap; black, white, and green. Self-recording thermistors were inserted into the bales to record temperatures at the plastic's surface and at the center of the bale. At the end of a three-month storage period, samples were collected for fiber analysis and high performance liquid chromatography. Thermistors were removed at this time.

#### progress

The color of the plastic wrap had an effect on the surface temperature of the plastic. The white plastic wrap reached a maximum temperature of 52°C while both the black and green plastic almost reached 60°C. However, the internal temperatures for all bales were not statistically different, around 23°C. Black-wrapped bales showed a darkening of outer layers indicative of heat damage while green-wrapped bales produced bales which were visually greener when fed out to the animals.

#### 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's consumers. Remote sensing technology will provide farmers with a way to better estimate production allowing them to make informed decisions concerning their operations.

#### grants/funding

USDA Hatch

## Annual flower cultivar trials

Patricia S. Holloway, Grant E.M. Matheke, Katherine DiCristina; Etta Gardiner, Judy Weber (GBG volunteers)

#### 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 forty-six 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

Seventy-seven of the 307 cultivars tested showed excellent performance with an overall rating of '4' (outstanding quality, best of its kind) for 2009. Plants that rated highest in flower quantity, quality and foliage quality included: African daisy Buff Beauty; aster Starlight Mix; bidens Golden Star; butterfly flower Angel Wings; California poppy Jelly Beans; chrysanthemum Dunnetti Choice Mix; coleus Chocolate Splash, Versa Burgundy to Green, and Versa Watermelon; dahlias Big Wow, Emory Paul, Grand Prix, Jayleen G, Kelvin Floodlight, Maggie C, Myrtle's Folly, Redskin, Summer Breeze; dianthus Bouquet Rose; flowering flax Charmer Mix; Gaillardia Mesa Yellow; feather grass Capriccio; great quaking grass; Laurentia Avante Garde Blue; marigolds Taishan Orange, Petite Harmony; milk thistle Variegated; morning glory Grandpa Ott's; mosquito flower Pretty Rose; nemesia Danish Flag; nicotiana Aztec Sweet Scent; osteospermum Ballade Mix; oxypeyllum Heaven Born; and pansies Matrix Yellow Clear, Promise Pure Silver Azure, and XXL Golden.

#### impact

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

#### grants/funding

USDA Hatch

## Arctic and subarctic plant genetic resources conservation, research, and information management

Alberto Pantoja, Bonnie Furman, Nancy Robertson, Joe Kuhl (ARS)

Note: please see information about the Agricultural Research Service under Partners & Collaborators, p. 9.

#### purpose

Agricultural development in circumpolar regions depends upon the availability of a broad genetic base of plant cultivars

adapted to long day, short season, and cool climate conditions. The biological properties of most high-latitude native plant and crop species are poorly understood, especially in plant hardiness zones not found in the conterminous US. Characterizations of germplasm and subsequent documentation of data are critical for germplasm management and utilization, and the development of new crops for northern latitudes. There is a need for increased research to improve management of arctic/subarctic germplasm and to understand disease etiologies, host-pathogen interactions, and disease vector relationships. The goals of this project are to conserve, evaluate, and distribute a broad spectrum of genetic resources of plants adapted to short cool seasons and a long photoperiod, to generate and manage associated information, and to provide a scientific base for its use in research and crop improvement.

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#### approach

The USDA/ARS/National Plant Germplasm System (NPGS) is responsible for maintaining a diverse collection of plant genetic material in the US. The Subarctic Agricultural Research Unit is the primary US location for preservation of plant germplasm important as food, feed, medicine, land reclamation, and site remediation in arctic/subarctic zones. This project is the only ARS plant genetic resource conservation unit in the circumpolar region. The germplasm collection in Palmer maintains approximately 400 accessions. Research projects on targeted plant species include, but are not limited to, *Rheum*, *Carex*, *Juncus*, *Calamagrostis*, *Deschampsia*, and *Angelica* spp. Other species such as potato, lupine, clover, black medic, barley, currant, strawberry, and other fruits are being studied or will be studied on the Palmer site to help other NPGS units.

To achieve our objectives, we:

- Conserve and regenerate priority crops, crop varieties, native species, and other NPGS genetic resources adapted to circumpolar and other high latitude regions efficiently and effectively and distribute samples and associated information worldwide.
- Strategically expand the genetic diversity in genebank collections and improve associated information for priority genetic resources of crops, crop varieties, and native plant genetic resources adapted to circumpolar and other high latitude regions.
- Strategically characterize (“genotype”) and evaluate (“phenotype”) priority *Rheum*, *Deschampsia*, and other selected genetic resources for molecular markers, morphological descriptors, and key agronomic or horticultural traits.
- Elucidate the effects of key associated insects and pathogens on selected crops, crop varieties, and native plant genetic resources adapted to circumpolar and other high latitude regions.

#### progress and impact

Considerable progress has been made in the evaluation of the Palmer germplasm collection. A complete inventory of seed holdings, including updating taxonomic identification, germination status, seed weight and number of seed has been

completed. Information has been updated on the Genetic Resources Information Network database (GRIN) as well as on seed containers. Historical information of rhubarb has been corrected and updated on GRIN.

#### GERMINATION TESTING

Completed germination testing for SARU germplasm collection. The seed of species such as *Carex*, *Juncus*, and *Calamagrostis* has been in storage for many years subsequent to their transfer to Alaska and seed health was known to be compromised. Germination testing was carried out. Knowledge of the status of the collection is imperative for future conservation, regeneration, and utilization of the collection.

#### HAIRGRASS

Fifty-five morphological characters and sequenced nuclear and chloroplast regions from arctic *Deschampsia* were evaluated. *Deschampsia* species have been widely utilized for their ability to stabilize disturbed areas, including metal contaminated sites. It also represents a genus with circumpolar distribution at both poles. To access the completeness of the NPGS collection it is first necessary to determine the phylogenetic relationship of naturally occurring populations. Molecular data were collected and evaluated to carry out phylogenetic inferences.

#### RHUBARB

Amplified fragment length polymorphisms previously applied to rhubarb cultivars in the Palmer germplasm collection were added to GRIN. A total of 1,400 AFLP markers had been previously generated for 46 accessions of the SARU *Rheum* collection and the results published. These data were added to GRIN for access by other NPGR scientists.

Phenotypic descriptors for *Rheum* were incorporated into GRIN. A total of 26 morphological descriptors were completed for accessions of the SARU rhubarb collection. Characterization of existing collections is important for their utilization and future expansion. Existing relationships can also be elucidated and gaps identified. These data are now on GRIN for utilization by the public.

Digital images to document each of the *Rheum* accessions were uploaded into the GRIN system. Digital imagery of collection accessions provides a means to document phenotypes as well as horticulturally important traits. Farmers and scientists can now access these images to assist their utilization.

#### BLUEBERRY STUDY

A blueberry study was initiated in collaboration with growers in the Kenai region of Alaska and the national Clonal Germplasm repository in Corvallis, Oregon. Nine varieties of cultivated blueberry are being grown in two locations.

#### LEGUMES

Legumes are being grown in collaboration with the Plant Germplasm Introduction and Testing Research Unit

in Pullman, Washington. Two hundred eighty-five accessions from the lentil core collection, 17 varieties of peas and 10 accessions of *Scorpiurus* are being grown to test survival and productivity under Alaska growing conditions.

#### VIRUS DETECTION

Sampled rhubarb from germplasm collection for potyvirus detection, and more precisely for species identification such as Turnip mosaic virus. Initiated potato and carrot sampling for Angelica virus Y (AnVY) detection. Initiated large scale purification for AnVY antiserum production. Continued sampling barley/grasses/oats plant species for Barley/Cereal yellow dwarf virus strains. Confirmed three plant viruses from potato survey by their partial genomic sequences. Continued collections and characterizations of pathogens from diseased small fruits (blueberry, raspberry, lingonberry, gooseberry, and currant).

Several native larkspur plants in an ornamental garden were severely stunted with discolored leaves. The pathogen responsible for the disease was determined to be a new plant virus, classified with the potyviruses, and tentatively named Delphinium vein-clearing virus. New viruses detected in native plants may pose as emerging pathogens that may act as potential threats to crops and home gardens.

#### INSECT PESTS

Initiated sampling *Agropyron* species to identify possible insects affecting seed set.

#### RHUBARB APHIDS

The insect fauna associated to *Rheum* species is little known and there is no consensus on the aphid species associated with this plant. This work was initiated to identify the aphids associated with rhubarb in the USDA rhubarb collection in Alaska and to identify potential vectors of virus. Based on their disease transmission, potential, and abundance in rhubarb fields, four aphid species were identified as potential vectors. Information (species composition, phenology, and abundance) needed to develop integrated pest managements programs is now available to growers and researchers working on rhubarb.

### Peonies as field grown cut flowers—field production

Patricia S. Holloway, Shannon Pearce, Janice Hanscom

#### purpose

We have conducted research since 2001 to assist growers in identifying all components of peony field cut flower production and distribution, from field selection and planting to post-harvest handling and packaging for export. This experiment addressed three components of the production cycle: field planting dates, root quality and plant productivity, and post-harvest handling of cut stems.

#### approach

Fifteen roots of four peony cultivars were purchased in late summer 2007 from one commercial source. Five roots of each cultivar were planted immediately into prepared Fairbanks



Shannon Pearce at the Fairbanks Experiment Farm summer 2009 in a peony trial patch.

AFES PHOTO BY NANCY TARNAI

silt loam soil. The remaining roots were stored in plastic bags containing a slightly moistened wood chip/sawdust mixture following treatment with elemental dusting sulfur and maintained at 34°F (1°C) + 2°F in a cold room. Five roots of each cultivar were removed from cold storage on 4 April 2008 and potted into a peat-lite greenhouse mix and grown in 3 gal (11 liter) containers in the greenhouse until 1 June. Plants were watered, fertilized, and hardened off in late May, and field planted 16 July. The third set of roots was removed from the cooler on 14 May and planted immediately into the same field as the fall-sown and containerized roots. Data collection commenced in June 2009, one full season after planting and consisted of non-destructive counts of vegetative and reproductive stems and stem height. Counts were repeated in July after new growth was observed on some plants. Data were analyzed by two-way analysis of variance for cultivar and planting date effects and interaction. Sarah Bernhardt roots and crown buds were weighed, counted and measured prior to planting in order to learn if a correlation exists between root quality and subsequent growth and flowering. Roots were planted in the same field as above in autumn, 2008. Data on plant growth were collected beginning in mid summer, 2009. In June and July 2009, flowering stems were harvested at the proper stage for cut flower production and handled in a variety of treatments: directly into a vase, placed

directly into buckets of water, held for one or three hours dry or placed directly into a cold room with or without trimming the stems, at (34°F). Once in the cold room, stems were held for one week dry or in water, then were placed in containers of water at room temperature (68°F) to record vase life.

#### progress

In a comparison of planting times (autumn, spring, or as containerized plants in midsummer), Sarah Bernhardt and Felix Crouse showed no difference in shoot number and growth one full year after planting. Duchess de Nemours and Alexander Fleming showed significant reductions in growth compared to the other cultivars, and we suspect disease rather than planting time as the problem. In all treatments where bud break had occurred in storage with Duchess de Nemours and Alexander Fleming, new shoots rotted, and recovery was slow. A treatment of elemental sulfur was not sufficient to protect roots from storage rot. Three root attributes were correlated with the total number of stems produced: total number of eyes per plant, total number of roots per plant and root fresh weight. Characteristics such as root length and maximum diameter were not correlated with subsequent growth. We found no relationship between any root characteristics and number of flowering stems and foliage height in the first year. Best methods of handling peony cut flowers for greatest vase life include cutting peonies dry and storing them dry in a cooler (34°F) at 80+% relative humidity until shipping. Use of water in buckets in the field or pulsing flowers with water in the cooler does not improve vase life of peonies. Under optimum conditions, Sarah Bernhardt peonies lasted up to 15 days in a vase, 8-9 days from bud break to full bloom, and an additional 5-6 days in full bloom. Chilling in a cooler is the most important attribute to long vase life.

#### impact

There are 33 Alaska peony growers statewide, 15 of whom have at least 500 peonies in the ground. The baseline information collected in these studies is critical to the identification of best management practices for Alaska both in identifying potential pest problems and elucidating best methods of shipping a quality product to the Lower 48 and potentially world markets.

#### grants/funding

USDA Hatch

## Commercial Horticulture Program: potatoes

Jeff Smeenk

#### purpose

Our goals for the potato projects are to determine the marketable yields of established yellow-fleshed potato varieties that are new to Alaska tablestock potato growers; and to develop new varieties of potatoes for Alaska niche markets. The purpose of both the survey and the evaluation of the non-commercial potato producers is to evaluate the risk to Alaska's commercial seed industry posed by non-commercial growers that do not follow the industry sanitation protocols.

#### approach and results:

**YELLOW-FLESHED POTATO TRIALS:** Eleven yellow-skinned varieties, four dark red-skinned varieties and two light red-skinned varieties of yellow-fleshed potatoes were evaluated for marketable yields at the Matanuska Experiment Farm at Palmer. Of the yellow-skinned varieties, Satina, Yellow Finn, and Nicola had the highest yields (0.68, 0.59, and 0.56 lbs per sq ft respectively). Of the dark red-skinned varieties Desiree had the highest marketable yield (0.44 lb/sq ft), and Red Gold led the light red-skinned varieties (0.49 lb/sq ft). Nine of the varieties were duplicated in the 2009 trial with seed grown in Alaska (in 2008) compared to seed grown in Maine (in 2008). The 2009 yield data was inconclusive, with the Alaska-grown seed out-producing the Maine-grown seed in five of the varieties and the Maine seed out-producing the local seed the other four times. This trial will be repeated in 2010 to see if the trend is consistent over multiple years.

**NOVELTY POTATO EVALUATION PROJECT:** Eight advanced breeding lines were evaluated for marketable yields in a replicated trial. The outstanding 2009 growing season resulted in larger than expected tubers for five of the varieties. While these lines were selected for the trait of producing many small uniform tubers the longer growing season, along with adequate irrigation, caused several of the lines to bulk up and produce significant numbers of US#1 marketable tubers. To screen new material approximately 2,500 accessions were planted and about 100 lines were selected for further evaluation in 2010.

**POTATO VIRUS SURVEY OF NON-COMMERCIAL POTATO PRODUCERS:** 171 test potatoes from 49 separate plots representing 29 communities were sprouted in the greenhouse and foliage was sent to a commercial laboratory (Agdia, Inc.) to be screened for Potato Virus X, Potato Latent Virus, Potato Leaf Roll Virus, and a suite of Potyviruses. Only 3 percent of the plants were positive for insect-transmitted viruses (four plants had Potato Leaf Roll Virus and 1 plant had Potato Virus A). No Potato Latent Virus was observed and 9 percent of the samples (15 plants) were positive for the mechanically transmitted Potato Virus X.

**POTATO EVALUATION BY NON-COMMERCIAL PRODUCERS:** Certified seed of five varieties was sent to six non-commercial growers for yield and virus pressure evaluation. Samples of the trials were returned and stored over the winter. The material is currently growing in the greenhouse and the first 100 samples have been sent to the commercial laboratory for virus screening. The results are expected in mid-May 2010.

#### impact

The impact of the yellow-fleshed potato trial is to provide actual yield data for the growers to make varietal selection decisions on. Several growers have ordered seed of some of the varieties to evaluate them under their production system. The novelty evaluation program is too new to have impact on the potato market. Top selections are being evaluated by selected non-commercial growers to determine market potential. The major impact of the virus survey project is to document the presence of low levels of potato viruses in rural Alaska. Awareness of locations with potato viruses will help seed



*Potatoes in Galena.*

PHOTO BY JODIE ANDERSON

producers better manage their disease-free seed potato crops. These potato field trials are a result of a successful UAF-ARS collaboration.

#### grants/funding

Funding from USDA-ARS – Integrated Pest Management Program

### Heirloom vegetable trials

Grant E.M. Matheke, Patricia S. Holloway, Katie DiCristina

#### purpose

Twenty-six modern and heirloom vegetables were grown at the Georgeson Botanical Garden in the Ohlsen Family Food Garden to compare yield and quality of older, open

pollinated cultivars with modern hybrids.

#### approach

Cabbage, cucumber, and winter squash cultivars were grown from greenhouse transplants; bush beans, beets, and kohlrabi were direct seeded into replicated plots on prepared, fertilized (500 lb/acre 20-10-10s) Tanana silt loam soils. Cucumber and squash transplants were grown through infrared-transmitting plastic mulch. Plots were trickle irrigated and hand weeded all summer, then harvested as vegetables matured. The harvest was weighed and yield recorded along with a visual inspection for diseases and insect damage.

#### progress

Bush beans yielded 0.44- 1.12 kg/m for all cultivars (modern: Provider, Oregon 54; heirloom: Bush Blue Lake, Black Valentine), and there were no differences among cultivars, either modern or heirloom. There was also no difference among modern or heirloom cultivars of beet (1.16–1.86 kg/m; modern: Red Ace; heirloom: Chioggia, Early Blood Turnip, Egyptian), cabbage (2.12–4.31 kg/m; modern: Arrowhead, Tobia, Deacon; heirloom: Early Jersey Wakefield, Glory of Enkhuizen, January King), cucumber (5.25 - 8.3 kg/m; modern: Genuine; heirloom: Straight Eight, Long Green Improved, Marketmore 76) and kohlrabi (1.90–3.46 kg/m; modern: Kolibri, Winner; heirloom: Early Purple Vienna, Early White Vienna) cultivars. Only Blue Hubbard heirloom squash out-yielded all other cultivars by more than two times (7.62–1.7 kg/m; modern: Heavenly Hubbard, Red October; heirloom: Boston Marrow, Blue Hubbard).

#### impact

Nationwide, there is great interest in growing open-pollinated, heirloom cultivars. This comparative study will assist gardeners and growers in determining how well heirloom vegetables yield compared to newer, more expensive hybrids.

#### grants/funding

USDA Hatch

### Vegetable cultivar trials

Grant E.M. Matheke, Katie DiCristina, Patricia S.

Holloway; Alfreda Gardiner

#### purpose

Vegetables were 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 (4 lb per 100 sq ft, 195 g per sq meter). Plots were irrigated as needed, and harvest began the third week of June with spinach

and 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; bean Carson Yellow Wax; beets Chiogga, Cylindra, Scarlet Supreme; Brussels sprouts Jade Cross E; cabbages Deadon, Earliana, January King, Glory of Enkhuizen, Tobia, Arrowhead II, Early Jersey Wakefield; carrots Adelaide, Bolero, Sweetness, Tendersweet, Thumbelina; cauliflowers Amazing, Apex, Fremont, Minuteman, Snow Crown; celery Florida 683; cucumbers Genuine, Sweet Success, Sweeter Yet, H-19 little leaf; eggplant Tango; kales Red Russian, Winterbor; kohlrabis Kolibri, Early Purple Vienna, Early White Vienna; leeks Arena, King Richard, Giant Musselburg; lettuces Revolution, Oscarde; peppers Ace Fajita Bell, Gypsy, Blushing Beauty; pumpkins Connecticut Field, Lumina, New England Pie, Racer, Rock Star; radish Rudi; spinach Melody, Spaulding; summer squash Magda, Papaya Pear, Superpik, Eight Ball Jade Bar, One Ball, Raven; winter squash Blue Hubbard, BonBon, Heavenly Hubbard; Swiss chard Bright Yellow; and turnip Tokyo Cross.

#### impact

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

#### grants/funding

USDA Hatch

## food policy, security, & sovereignty

### Measuring food security in Alaska

Joshua Greenberg, Charles Caster

#### purpose

The access of Alaskans to healthy and affordable foods is of primary concern to the state. This study begins a process toward assessing Alaska's capacity to provide food for Alaskans. It is also intended to assist citizens, communities, and the state in expanding this capacity with the end goal of making Alaska more food secure.

#### approach

A survey is being developed of community food producers in the Interior region of Alaska. The intent is to develop an effective survey instrument that can be extended to other regions of the state.

#### progress

Background research on Alaska food production systems and available food production data has been completed. Initial contact with key informants has been made.

#### impact

Increased reliance on imported food has weakened Alaska's food security. Effective planning to address this vulnerability requires understanding Alaska's current food production and its ability to meet state needs.

#### grants/funding

ADAP and USDA Hatch

## pests & disease control

### Integrated pest management for Alaska Agriculture

Alberto Pantoja, Dennis Fielding, Jeff Conn, Steve Seefeldt (ARS)

#### purpose

Since 1973, the winter temperatures in Alaska have increased by 2-3°C resulting in increased concentrations of insects and diseases and renewed attention to the development of the potential of agricultural expansion in the circumpolar region. However, 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 arctic/subarctic regions is lacking, poorly documented, or not well developed. There is a need for increased research to improve management and to understand the biology of invasive plants, diseases, and insect pests in sub-arctic regions. The Subarctic Agricultural Research Unit is the only unit of the United States Department of Agriculture, Agricultural Research Service that addresses arctic and subarctic Integrated Pest Management (IPM) research strategies. Primary goals are to develop effective, economical pest management strategies with a minimum of adverse environmental impacts. Objectives include identification of insect pests of agricultural importance, prediction of pest damage, development of cultural practices for the integrated management of weeds and grasshoppers; evaluation of the ecological impact of weeds, and preventing the establishment of new invasive pests in Alaska. The work on IPM will contribute to enhanced productivity, profitability, and environmental quality of Alaska's farming industry and natural resource areas by reducing threats posed by insect pests, weeds, and pathogens through research and technology transfer resulting in new and innovative IPM strategies.

The over-arching goal of this project is to develop new knowledge to increase the understanding and management of the biology and ecology of non-indigenous invasive plants and insect pests in sub-arctic agricultural systems, especially in plant hardiness zones not found in the conterminous United States. The proposed research program is designed to provide integrated pest management technologies for weed and insect control in subarctic environments to support the expansion of state, national, and international agriculture. Our research and development programs provide user-friendly, economical, and environmentally acceptable technologies for pest management in subarctic environments. The technologies developed in Alaska will be relevant to other countries in subarctic environments. The research agenda is derived from discussions with collaborating scientists, Alaska producers, and state and federal agencies. This will be achieved by accomplishing the following objectives: 1) Monitor and map



the distribution and spread of weeds and invasive plants in high-latitude agricultural systems and immediately adjoining natural land for patterns of diversity, origin, and spread to provide strategies for integrated weed management programs in a changing climate; 2) Determine expanding habitats of select insect pests and insect vectors, including grasshoppers as a model, to elucidate the impact of landscape and climate variables on IPM strategies for sustainable, high-latitude agricultural systems.

#### approach, progress, and impact

Herbicide selection is not only based on controlling the weed. Orange hawkweed is a troublesome invasive weed in pastures and open fields in Alaska. ARS Researchers in Fairbanks, Alaska, determined that two herbicides, Aminopyralid and Clopyralid, were very effective at controlling orange hawkweed. Aminopyralid is best used where grasses are the desirable vegetation, whereas Clopyralid, which does not control as many broadleaf plant species, would be best in areas where maintaining species diversity is desired. Selection of the most appropriate herbicide should not be based solely on its impact on the intended weed species.

Weed seeds can survive for years in the cold soils of Alaska. Weed seeds that can survive for years in soils can cause problems in the future. ARS researchers in Fairbanks, Alaska, determined that 12 of 17 weed species still had viable seed after being buried for 25 years in soils. Variability was high between replicates showing that some seed burial sites are safer than others for continuing seed viability. The results of this research highlight the importance of developing long-term strategies for the control of weeds in cold climates.

Grasshoppers may become an annual occurrence in northern regions with changing climate. Currently, grasshopper eggs in this region require two years to hatch. Cohorts in odd-numbered years are sparse, whereas cohorts of even-numbered years are abundant. ARS researchers from Fairbanks developed prediction models indicating that an increase of 3 to 4°C in summer temperatures will result in a significant proportion of the grasshopper population switching to a one-year life cycle, causing a breakdown of the alternate-year population dynamics.

Wireworms from interior Alaska are different than Palmer. Wireworms are becoming more of a problem in potato producing areas, especially where potatoes are seasonally rotated with grasses, like in interior Alaska. ARS entomologists from Fairbanks determined the species composition and seasonal biology of adult elaterids associated with potato production at two localities in interior Alaska: Fairbanks and Delta Junction. The species composition was different between localities; in spite of the highest insect trap catch recorded, insect counts in Fairbanks remained low during most of the season, indicating the pest low economic importance under the study area. This represents the first long term report on species diversity of elaterids in potatoes from interior Alaska and the first time elaterids have been shown associated with potatoes in Delta Junction.

#### POTATO SEED

This is part of a collaborative research project with Jeff Smeenk of SNRAS. Seven non-commercial producers collaborated with UAF and ARS researchers in a sentinel potato study to grow five varieties of certified seed potatoes in communities around Alaska. During 2009 research sites were inspected for virus symptoms. None of the plants at any site exhibited virus symptoms. While no potatoes had aphids, 60 aphids were collected from nearby plants. The ARS entomology team identified the aphids as members of the *Euceraphis* (18 percent), *Myzus* (63 percent), and *Macrosiphum* (18 percent) genera.

A colored-flesh potato study was initiated in 2010. Replicated trials were established at six sites and demonstration plots were established at twelve additional sites to determine both the adaptability of the material and the consumer acceptance of the new material. All sites received the same four novel colored-flesh varieties which were developed and selected through the ongoing collaborative effort between ARS and UAF.

A potato biomass study has been established at the MEF and the statewide network of potato collaborators will send the two largest potatoes from each variety. Analytic protocols are being developed to evaluate the biomass potentials of the varieties and to determine impacts of harvest dates and production locations on the extractable compounds.

#### grants/funding

USDA Hatch

#### Distribution, transmission, and molecular characterization of potato phytoplasmas in Alaska

Jenifer H. McBeath

#### purpose

I am investigating the distribution, host range, mode of transmission, and molecular characterization of potato witches' broom and other phytoplasma diseases found in Alaska. A thorough understanding of these diseases will aid effective management and eradication of these quarantined diseases.

#### approach

To investigate the presence of phytoplasma in potatoes, including potential latent infection, I collected samples from potato plants in seed lots on farms in the Delta, Eielson, Nenana, Palmer, and Wasilla areas. Because of the extremely low phytoplasma disease incidence, I conducted a systematic visual survey of the potato fields for phytoplasma diseases. When I found plants displaying symptoms resembling phytoplasma, I harvested and tested the entire plant for the presence of phytoplasma disease. Clover and other potential wild hosts such as leafhoppers in the potato fields and adjacent areas are also examined and identified, harvested, and tested. Purified nucleic acids of aster yellow phytoplasma (phytoplasma group 16Sr I) and clover proliferation and vinca rosette phytoplasma (both members of group 16Sr VI)



*Cattle at the Matanuska Experiment Farm, 2009.*

AFES PHOTO

will be obtained as controls. The sequences of 16S rDNA obtained from plants and leafhoppers will be analyzed and the phylogenetic distance tree of phytoplasmas found in Alaska will be constructed by comparing their 16SrDNA sequence with those of other phytoplasmas.

#### progress

From June through August 2009, potato plants displaying symptoms of phytoplasma diseases were collected from three farms in Delta and Point MacKenzie, Alaska. (One aster yellow-diseased plant was found.) The numbers of witches' broom and other phytoplasma diseased plants found in the potato fields were low. Tubers collected from these diseased plants were maintained in growth chambers and cold rooms for long-term observations and analysis, respectively. Leaves and stems harvested from diseased and healthy potato plants were then stored in a deep freezer to await further analysis.

#### impact

In 2003 Alaska became the first US state able to export seed potatoes to China. Two of the four pathogens quarantined by China are phytoplasmas. A clearer understanding of these diseases in Alaska will aid the development of tools for effective management of them.

#### grants/funding

USDA Hatch

## 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

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[www.uaf.edu/snras/](http://www.uaf.edu/snras/) • <http://snras.blogspot.com>

of animal interactions with their environment will allow producers to optimize feed rations and minimize adverse impacts to the landscape.

#### approach

Observational and tracking collar data of domestic beef cattle, and semidomestic livestock, reindeer, are analyzed using spatial/temporal techniques to develop parameters specific to high-latitude areas for use with the KRESS predictive modeling program.

#### progress

Data collection for a project studying the relationship between thermal patterns and reindeer calving sites on the Seward Peninsula has been completed. A predictive model was developed by analyzing thermal data and correlating environmental data with landscape features. The model was tested against a verification dataset of known animal positions to assess model performance. A master's thesis is currently being written. We are still converting the last of our positional data for cattle into digital format. Cattle in Alaska show similar activity patterns to animals in other regions indicating that these activities are unaffected by day length. Low-cost GPS tracking collars were tested and will collect two-second data for five and a half days using four D-cell batteries. Five collars are now being assembled using this design.

#### impact

These modeling efforts will give Alaska meat producers more tools for developing cost-effective animal management strategies by incorporating normal animal behavioral patterns and environmental factors. The resulting strategies will benefit local consumers by fostering further development of an Alaska-based meat industry.

#### grants/funding

USDA Hatch

# High-Latitude Soils

**S**OILS ARE the fundamental natural resource. They are the base for production of crops, range for animals, and forest growth and yield. Soils must be considered in transportation and building construction, and play a primary role in oil, gas, coal, and mineral extraction. Knowledge about cold-climate soils is crucial for sustainable Alaska resource management. Climate variability affects our soil base. Cold soils are experiencing significant changes that are in turn causing changes in natural and managed ecosystems.

Research on high-latitude soils at SNRAS/AFES is focused on soil properties as they relate to soil quality, ability to resist and recover from disturbance, and soil productivity; plant nutrition and soil fertility; and soil management, land reclamation, and remediation of contaminated soils. SNRAS/AFES researchers study the origin, formation, and classification of soils; permafrost soil characteristics, limitations, and potential uses; soil responses to and influences on climate change; soil biology and processes of boreal ecosystems in a management context; and long-term soil data.

## HIGH-LATITUDE SOILS REPORTS:

(note: authors listed below are SNRAS researchers)

### 43 • carbon in soils

Carbon cycle science in the Alaska coastal temperate rainforest

David D'Amore, David Valentine

Impacts of experimentally induced drought on soil respiration in interior Alaska

David Valentine, John Yarie

Log decomposition in interior Alaska

J. Yarie

### 45 • soil fertility

Characterizing active soil organic matter pools contributing to soil nitrogen availability

M. Zhang, Alan Zhao

Characterizing active soil organic matter pools contributing to soil nitrogen availability

M. Zhang, Alan Zhao

Evaluation of phosphorus fractionation and determination methods

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

### 46 • soil properties

Assembly, verification, standardization, and analysis of soil pedon data for Alaska with special regard to carbon storage assessment

Chien-Lu Ping, Gary Michaelson

Soils of the arctic tundra in northern Alaska

C.L. Ping, et al.

Key soil properties affecting thermokarst formation in North Slope, Alaska

Chien-Lu Ping, Gary Michaelson

Hydric soils study in Alaska

C.L. Ping, Gary Michaelson, Cindy Stiles, Mark Clark

## carbon in soils

### Carbon cycle science in the Alaska coastal temperate rainforest

David D'Amore (US Department of Agriculture Forest Service, UAF); David Valentine

#### purpose

Forests are major areas of carbon capture worldwide and carbon accounting is a priority for land management agencies as a means to mitigate gaseous emissions. Forested ecosystems play an important role in mitigating excess carbon emissions in the balance of carbon on earth. Worldwide estimates of carbon fluxes are important in understanding gross and net fluxes of carbon between the atmosphere and terrestrial ecosystems, such as forests. Several important biomes lack detailed carbon flux estimates that are used to validate and calibrate global models. One of these areas is the North Pacific coastal margin, including the coastal fringe of southeast Alaska. This project was designed to provide a means to measure forest carbon fluxes across a range of ecosystem types and scale these fluxes up to the coastal temperate rainforest region for use in carbon flux models.

#### approach/methods

Measurements of carbon fluxes from terrestrial and aquatic ecosystems have been taken across a suite of replicated, nested study sites within major ecosystem types in forested watersheds. These measurements are being combined with associated characteristics of forest stands to quantify carbon sequestration rates in coastal temperate rainforests.

#### progress

Measurements of soil respiration rates and associated temperature have been combined to establish temperature-driven models of soil respiration rates across the hydrologic gradient of ecosystems for southeast Alaska soils. These models can be applied to similar ecosystems through GIS coverages to upscale estimates of respiration at catchment, watershed, or regional scales of measurement. Soil respiration fluxes have been compared to dissolved organic carbon fluxes from the replicated catchments to establish ratios for these two important carbon export pathways in the coastal temperate rainforest. These data provide measured values for calibrating ecosystem models of carbon flux from the catchments that will be finalized during the next phase of the project.

#### impact

This research has provided the foundation for models of carbon fluxes across ecosystem types in the coastal temperate rainforest. These measurements are closely associated with variations in temperature and soil moisture. This association is being coupled with predicted changes in

regional temperature and precipitation to provide predictions of carbon flux changes due to climate shifts in the coastal temperate rainforest. This information will also provide information on the magnitude of the carbon sink or source of the coastal temperate rainforest that can be applied to regional and national carbon accounting goals.

#### grants/funding

US Forest Service

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

David Valentine, John Yarie

### 44 purpose

This study examines how the timing of experimentally induced drought affects decomposition and soil respiration. We hypothesized that:

- snowmelt exclusion would result in an early-season drought that would slow tree growth (most ringwidth growth occurs relatively early in the growing season) without significantly slowing soil carbon mineralization, and
- throughfall exclusion would result in late-season drought that would slow soil carbon mineralization without significantly affecting tree growth.

#### approach/methods

This study uses existing summer moisture exclusion sites (three replicate 10x15 m plots in both upland and floodplain landscape positions) that have been maintained by the Forest Soils Research Laboratory since 1989, and adds an additional set of three replicate 15x15 m snowmelt exclusion plots in both landscape positions. All respiration and decomposition measurements began in 2006 in the throughfall exclusion sites, and began the summer following the snowmelt exclusion treatment i.e., 2009 in upland sites, 2010 in floodplain sites). Following establishment of soil respiration collars, soil respiration rates have been monitored at biweekly intervals during each growing season using a LiCor 6262 infrared gas analyzer. Surface soil and air temperatures were monitored concurrently with the respiration measurements.

#### progress

Soil respiration rates in 2009 continued to be 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 (Ra, root respiration) and heterotrophic (Rh, mostly microbial respiration) contributed to the overall difference in respiration. A new master of science student, Emily Schwing, will use three approaches to address this question during summer 2010. Snowmelt exclusion shelters were completed in floodplain sites in summer 2009.

#### impact

We already know that the timing of moisture stress has important impacts on fire behavior and severity in Alaska's boreal forests: late season drought tends to allow more complete combustion of surface organic fuels, which in turn

makes it more likely for broadleaf deciduous trees to dominate the post-fire burned area. This study will enable us also to examine how the timing of moisture stress also affects carbon capture and loss in mid-successional, broadleaf deciduous stands. If the results support our hypotheses, then ecosystem modelers will have a basis for projecting how boreal forest carbon balance might be altered by a drying climate.

#### grants/funding

McIntire-Stennis, LTER, US Forest Service

## Log decomposition in interior Alaska

J. Yarie

### purpose

Logs are a significant carbon and organic matter input into the forest floor in natural forest ecosystems. This input will have implications on the carbon, organic matter, and nutrient dynamics of forest soils. The purpose of this study is to document the decomposition dynamics of logs within interior Alaska.

#### approach

Fifteen logs were placed on the forest floor in forest stands for each major upland and floodplain vegetation type. The species sampled were aspen (*Populus tremuloides* Michx.), birch (*Betula neoalaskana* Sarg.), white spruce (*Picea glauca* (Moench) Voss) and black spruce (*Picea mariana* (Mill) B.S.P.) in upland locations and alder (*Alnus tenuifolia* Nutt.), balsam poplar (*Populus balsamifera* L.), white spruce, and black spruce in floodplain locations. Each vegetation type was replicated six times. The logs were 4 meters in length and had a minimum diameter on the small end of 10 cm. Also, sample locations were established in recently burned ecosystems of upland and floodplain white and black spruce. Individual logs will be sampled to monitor changes in log carbon, nutrient, cellulose, and lignin concentrations over the next century. Due to the timing of initial establishment of all sites, field sampling of decomposed logs will occur on a yearly basis. The sequence for sampling will follow a consistent time frame of 0, 2, 5, 10, 15, 20, 25, 30, and at 10-year intervals till year 100.

#### progress

Currently all time zero, two, five, and ten-year samples have been collected for the unburned alder, aspen, birch, balsam poplar, floodplain white spruce, and upland white spruce sites. Two of the three sets of the 15-year samples from the unburned sites have been completed. 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 initial results indicate that alder displayed the highest decomposition rates with only 34 percent of its original wood weight remaining after 10 years while floodplain white spruce and birch showed the slowest rates of decomposition with 72 percent and 70 percent, respectively, remaining after 10 years. Aspen, balsam poplar, and upland white spruce had 53 percent, 60 percent, and 69 percent of their wood weight remaining after 10 years



*Log decomposition, soil respiration, revegetation, and forest health studies are among the many research topics at SNRAS.*

PHOTO BY GLENN P. JUDAY

of decomposition. Loss of the mass of carbon from the logs ranged from 48 to 50 percent.

#### impact

At this time it is not clear what effect coarse woody debris has on the carbon dynamics of the taiga forest in interior Alaska. However, it appears to take only a single decade for the logs to lose half of their carbon. 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.

#### grants/funding

McIntire-Stennis, LTER

## soil fertility

### Characterizing active soil organic matter pools contributing to soil nitrogen availability

M. Zhang, Alan Zhao

#### purpose

The goal for the project is to provide ways to manage nitrogen fertilizers. We laid out a field experiment with smooth bromegrass (*Bromus inermis* Leyss.) at the Fairbanks Experiment Farm of the University of Alaska in May 2004. There were three fertilizer treatments: 1) Check (0-30-30); 2) Low nitrogen (50-30-30); and 3) High nitrogen (150-30-30), and two cutting frequencies: one cutting per year and two cuttings per year. In the spring 2006, isotope  $^{15}\text{N}$  enriched urea (10 percent) was applied in the fertilizer treated plots in 1 m x 1 m microplots. Plant samples from the microplots were taken in June, July, and August in 2006, 2007, and 2008. The microplots were subdivided into quarters; soil samples were taken from a successive quarter in August 2006, 2007, and 2008. Soil samples from the Delta Junction area for three land uses were also collected and used for incubation

#### progress

Soil samples with  $^{15}\text{N}$  treatment were incubated at 90 percent field capacity and at  $15^\circ\text{C}$  for 200 days. Destructive soil samples were taken at different time intervals to determine  $^{15}\text{N}$  release of applied fertilizer nitrogen in soils. The samples were extracted by distilled water, and  $^{15}\text{N}$  in soil samples before and after extraction was determined. To further understand water extractable labile organic nitrogen and carbon in high latitude soils, another incubation experiment has been conducted with soil samples from three land uses (Conservation Reserve Program, forest, and agriculture). Water extractable nitrogen and carbon, mineral nitrogen, fluorescence emission and excitation matrix of water-extractable carbon and nitrogen in incubated samples taken at different times are to be determined. Characterization of water-extractable carbon and nitrogen from the three land uses prior to incubation was completed.

#### impact

The results showed that residual  $^{15}\text{N}$  fertilizer in soil was released four weeks after incubation, indicating residual fertilizer nitrogen was still in the labile nitrogen pool. Soluble organic nitrogen in soils before incubation was higher in agricultural soils than in forest and CRP soils. Air-drying and sieving processes can increase soil-soluble organic carbon, but these increases mostly occurred in soluble carbon fractions of less than 1 kD [kiloDalton] fraction. Fluorescence EEM [Excitation Emission Matrix] contour curves and PARAFAC analysis indicated three components in soluble organic carbon: humic-, fulvic-, and tyrosin-like materials. The determination of a labile nitrogen pool from different nitrogen application rates and soils under different land uses further illustrates the uniqueness of soil labile nitrogen fractions under Alaska climatic conditions.

### Evaluation of phosphorus fractionation and determination methods

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

purpose

In previous phosphorus (P) studies, we fractionated P following a sequential P fractionation method described in the literature. In that study, we found some problems with respect to the P determination method. As such we compared three different P determination methods (Alpkem Continuous Flow Analyzer, Bausch & Lomb spectrophotometer, and ICP). The principle for Alpkem Continuous Flow Analyzer and the spectrophotometer methods are all based on the Murphy-Riley method for determination of orthophosphate in solution, but one is continuous flow, the other is manual. When ammonium persulphate digested solution samples were used for total P determination in Alpkem, precipitants formed and the continuous flow was plugged. As such, a traditional spectrophotometer has to be used for P determination, and it is therefore necessary to compare if these two instruments can result in a similar P determination from the same solution sample. The ICP method, on the other hand, determines the total P in solution samples. To accurately assess soil P status under different management, a thorough evaluation of these three methods in combination with sequential P fractionation is needed.

approach

We used a 0-5 cm depth soil sample from a long-term tillage and straw management experiment started in 1983 near Delta Junction (64.8o N, 147.7o W). Sequential P fractionation of the soil sample was based on the modified Hedley method. The solution samples for each fractionation were divided into three subsamples, and P in the samples was determined respectively by ICP, Alpkem Continuous Flow Analyzer, and a spectrophotometer (Spectronic 70, Bausch & Lomb). There were ten replicates for each fractionation.

progress

The results showed P in solution was below diction limits of all three instruments in fractionation #6 (1 M HCl extraction), #7 (concentrated HCl extraction), and #8 (digested concentrated HCl extraction). Among the three determination methods, there were differences for P concentration. Theoretically, P measured from ICP should be higher than the P measured from the colorimetric method of Alpkem and spectrophotometer. However, in our results, P from ICP determination was lower for the #3 fraction (digested NaHCO3), #4 fraction (0.1 M NaOH), and #5 fraction (digested 0.1 M NaOH). Also, for the #2 and #4 fractions, the measured P was higher for the spectrophotometer than the Alpkem.

impact

The research was to evaluate P determination methods, and such evaluation will help researchers to use appropriate

means for understanding P status in soil under different management regimes, so that the results can help to improve P fertilizer use efficiency by crops.

### soil properties

#### Assembly, verification, standardization, and analysis of soil pedon data for Alaska with special regard to carbon storage assessment

Chien-Lu Ping, Gary Michaelson

purpose

We are assembling and summarizing into a more useful form existing soils data. The data has been collected over the last sixty-plus years across the state of Alaska by multiple sources including NRCS, the University of Alaska's soils laboratories, and others.

approach

Data is being collected from various sources and entered into a standardized digital format. Then it is explored record by record to identify missing and incorrect points and to assess methodologies used in obtaining data. Missing data and disparate methodologies are identified and the course of action is determined if possible to correlate existing data and provide estimates for missing data where correlates are reasonably possible. Finally, data will be assembled with detailed metadata and explanations and analysis of data will be performed along with calculations of soil carbon stocks. Data will be summarized for the regions of the state and the new data set published for general use.

progress

Data has been collected for over 500 Alaska soil pedons. Initial correlations of organic carbon and bulk density data have been made for pedons with disparate methodologies. Initial calculations for carbon stocks have been made for nearly 250 pedons.

impact

Subsets of this new data set were available earlier and used in multiple modeling and assessment projects for estimating carbon stocks of Arctic and permafrost affected soils. Initial data was summarized for soils under black spruce stands across Alaska and published in *Soil Science Society of America Journal*. When the complete data set becomes available it will be an invaluable tool that will be used far into the future in global systems modeling studies.

#### Soils of the arctic tundra in northern Alaska

C.L. Ping, M.T. Jorgenson, G.J. Michaelson, M. Kanevskiy, Y. Shur

purpose

Our intent was to determine the distribution of soil types in arctic tundra of Alaska.

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## approach

Soil landscape and microtopography relationships were formulated and the distribution of soil types was delineated based on such relationships using soils data from previous NSF and USDA projects.

## progress

### SOIL DISTRIBUTION:

There are two major physiographic regions in Arctic Alaska: the Arctic Foothills and the Arctic Coastal Plain. In the northern part of the Arctic Foothills, most soils form in carbonate-rich loess of Holocene age, the drainage is somewhat poor and the landcover type is nonacidic tundra (MNT) dominated by the genus *Dryas*, herbs, and low shrubs. Dominant soil types in the northern Foothills are Aquic Molliturbels and Ruptic-Histic Aquiturbels. Southward, there is a decreased loess influence with increased dominance of glacial moraine as parent material accompanied with an increase in precipitation and temperature. The landcover type changes to moist acidic tundra (MAT) and soil drainage is poor. The dominant soil types on the southern foothills are Ruptic Histoturbels. Most of the organic soils are Histels, formed along the narrow stream banks and in limited depressions. Soils under both the MNT and MAT are highly cryoturbated, mainly due to the activity of nonsorted circles (frost boils) which have churned the surface organic layers down to the lower active layers with some encasement in the upper permafrost. Except on exposed hilltops, the depth of cryoturbation judged by the presence of concentrated organic matter is usually within 1.3 m. The landscape of the Arctic Coastal Plain is characterized by ice wedge polygons, generally low-center polygons on the western part and high-centered polygons on the eastern part. Most of the soils on the coastal plain are ice-rich averaging 80% ice by volume. However, for the western part of the coastal plain nearly 60% is dominated by thaw lake sequence landforms with land cover type dominated by wet nonacid tundra (WNT). The parent materials include alluvium, glaciomarine, and eolian deposits. On the average the volume of ice-wedge and ground ice reaches 20%, and field evidence showing frost churning of organics commonly reaches two to three meters. Thus the cryoturbation process in the thaw lake landscape is due to the combination of ice wedge formation, mixing through thaw lake cycles and frost boil activity. The dominant soil types are Ruptic-Histic Aquiturbels, Ruptic Histoturbels, Glacistels, and Glacic Historthels. In the eastern part of the coastal plain, the parent material is dominantly moraine followed by eolian and alluvium. The average volume of ice wedge and ground ice is about 10%. The dominant soil types in the east include Ruptic-Histic Aquiturbels and Ruptic Histoturbels. Delta landforms constitute nearly 25% of the Arctic coastline of northern Alaska. Soils formed in newly deposited deltaic sediments lack cryoturbation and permafrost within one meter and are classified as Geleaquents, those with permafrost within one meter are Typic Aqorthels and Sulfuric Aqorthels.

### EROSION:

The Arctic Coast Plain of Alaska is not only threatened with an increased rate of permafrost degradation but also

coastal erosion due to global warming. Based on observation over the past fifty years there is accelerated erosion along the coast. Because of the high ice content and accelerated ice wedge deterioration, the erosion rate in the area with the highest ice wedge contents (>20%) has reached 13 m per year. Along with land loss, the eroded coastline also exported nearly one half million tons of carbon into the Arctic Ocean annually. In summary, cryopedogenesis on the Arctic Foothills is manifested mainly through nonsorted circle formation whereas on the Arctic Coastal Plain, especially the wet western part, cryopedogenesis is manifested through a combination of ice wedge formation, thaw lake cycles, and nonsorted circle formation.

## impact

The results of this work have been incorporated into the *Circumpolar Atlas* published by the European Union Joint Research Committee as part of the global change assessment. Detailed soils and ground ice descriptions and data from across the extensive regions of northern Alaska are for the first time available in the national database.

## grants/funding

National Science Foundation

## Key soil properties affecting thermokarst formation in North Slope, Alaska

Chien-Lu Ping, Gary Michaelson

## purpose

We are characterizing soil properties important to soil thermo-insulation, stability, and strength that affect the susceptibility of tundra to thermokarst damage on the north slope of Alaska.

## approach

Data collected for soils of 64 sites across the arctic North Slope of Alaska were analyzed, including updated data from collection sites investigated in the 2009 field season.

## progress

Soil BD, water content, and texture are important to soil thermo-insulation, stability, and strength that each affect the susceptibility of tundra to thermokarst damage. These properties are important in three components of the soil profile 1) the organic surface layer that insulates the permafrost, 2) the mineral active layer that provides weight-bearing strength and 3) the upper permafrost that is often ice-rich and must be maintained in the frozen state. We examined data available for soils of 64 sites from across the arctic north slope of Alaska. Site soil profile data were averaged within the three profile components for the major landscape units: Coastal Lowlands and Upland/Foothills, and for terrain units within the landscapes.

For the organic surface layer: thickness, bulk density, and water content are variable both on a micro and landscape scale. Bulk density of this layer tends to be higher on the Coastal Lowlands (average 0.38 g cm<sup>-3</sup>) than on the Upland Foothills (average 0.21 g cm<sup>-3</sup>) contributing to regional differences in heat transfer and the potential for surface

compaction. Organic layers of the Upland/Foothills terrain tend to be more insulating but could be more susceptible to compaction than those of the Coastal Lowlands.

The mineral active layers of the Upland Foothills have higher soil BD and soil textures are heavier than those of the Coastal lowlands (average 1.22 g cm<sup>-3</sup> /loamy in the Upland/Foothills and average 1.03 g cm<sup>-3</sup> /sandy loam for the Coastal Lowlands). Differences result from disparate regional factors such as landscape evolution and the higher average soil organic matter contents in the Coastal Lowland soils compared to the Upland Foothills, average 9.0% and 5.5% C respectively.

The upper permafrost (to 1 meter) is generally high in volumetric water and segregated ice content (52-81%), but the Polygenic and Lake terrain units of the Coastal Lowlands along with the Upland areas tend to be higher in volumetric water/ice (average 72-76%) than the Foothills tussock tundra area (average 52%) to one meter's depth.

#### impact

Project data were presented at the first annual Tundra Travel Conference held in Anchorage March 30, 2010. For the first time on the north slope all available soil pedon data for the north slope was summarized for the regions impacted by tundra travel and ice road construction. These data are now available to support tundra travel regulation decisions and for the evaluation of potential thermokarst consequences based on measured regional soil properties.

#### grants/funding

Hatch, State of Alaska

## Hydric soils study in Alaska

C.L. Ping, Gary Michaelson, Cindy Stiles, Mark Clark

#### purpose

We are comparing the effectiveness of MRIS (Manganese Reduction Indicators in Soils) and IRIS (Iron Reduction Indicators in Soils) tubes as indicators for reducing conditions in volcanic ash-derived soils, soils with seasonal frost, and soils with high pH.

#### approach

The study is in cooperation with the USDA-NRCS National Soil Survey Center and the NRCS Alaska State Office. Five test sites were selected; one is a calcareous fen at Sukakpak Mountain (Dalton Highway Milepost 203) in the Brooks Range of Alaska. This installation location was selected because of previously observed high pH/Eh conditions and the presence of hydric soils and a supporting hydrophytic vegetation community. Here ten MRIS and five IRIS tubes were installed on July 12, 2009.

A second location with somewhat poorly drained soils was chosen to install MRIS tubes to determine if oxide removal could occur in problematic soils. This location was on the University of Alaska Fairbanks arboretum near Smith Lake and the soils belong to the Chatanika series. Five MRIS tubes were installed on the location from August 18–25, 2009.

A third location was chosen to install IRIS tubes in a volcanic ash-derived soil with a long saturation period in the Upper Susitna Valley.

The fourth location is on Adak Island of the Aleutian Islands where soil drainage is restricted by a cemented tephra layer at about 60 cm, thus wetlands develop in microlow positions in an hummocky landscape. Three IRIS tubes were installed in August 2009.

The fifth site is at the UAF Matanuska Experiment Farm where four locations were identified to represent each landform position along a toposequence. At each site five IRIS and MRIS tubes were installed in late spring 2010 to test if the reduction/oxidation features in the soils are caused by seasonal frost rather than prolonged saturation.

#### progress

At the first site, the MRIS tubes were removed from the soils because of the high percentage (>50%) of oxide removal indicating strong reduction. The IRIS tubes were pulled to examine both when the MRIS tubes were removed (four days) and after a six week installation period. The six-week period is the usual recommendation for IRIS installation to detect reducing conditions in soils. At four days, only small spots had begun to be removed from the surfaces of the IRIS tubes. When the tubes were taken out after six weeks, the oxide removal in the upper 15 cm (6 inches) of four of the five tubes was <30% and four of the five tubes had 10–20% of black deposit within the upper 15 cm of the tube lengths that was later determined to be pyrite (FeS<sub>2</sub>).

At the second site, there was less than 30% oxide removal from the MRIS tubes after 6 weeks. At the third site (Upper Susitna Valley) there was no detectable oxides removal after a year, thus MRIS tubes will be installed to determine if this soil is wet but not reduced. Three IRIS tubes that were installed in August 2009 at the fourth location (Adak) were pulled out after six weeks and more than 30% iron oxides were removed. The fifth site at Palmer is installed and removal of tube will begin near the end of April.

The MRIS tubes proved effective as hydric soils indicators in soils with high pH/Eh which would facilitate the wetland delineation process. In the second site, the imperfect drained Chatanika series does not meet the criteria of hydric soils and thus not wetland criteria.

The Upper Susitna site may experience oxyhydric condition. More tests will be done on this site. On Adak Island, since the IRIS tubes reacted well under over a relatively long period, MRIS tubes will be tested to see if reduction occurs within few days.

#### impact

Although validation work continues, both the MRIS and IRIS tube have proven effective in identifying reduced conditions in agreement with soil observations indicating they will be likely candidates to be certified for use by environmental consultants in the field to aid in the wetland delineation process.

#### grants/funding

Hatch, State of Alaska



# Management of Ecosystems

**S**ITUATED AT high latitudes, Alaska is a bellwether for the effects of climate change. Its climate varies strongly with its broad variety in landscape, from the extreme northern tundra to the Tongass National Forest to the Aleutian Islands. The large land area and coastline of Alaska combined with its significant proportion of public lands make management of natural landscapes an important and challenging feature of policy and planning in the state. SNRAS and AFES research and analysis examine the sensitivity of northern resources to climate variability and change; biodiversity and wildland crop opportunities, conservation biology, and revegetation; resource management systems; forest measurement systems, forest growth and yield, boreal forest silviculture and forest health; wildland fire and fire effects and management; wilderness ecosystem management, and the wildland-urban interface.

## MANAGEMENT OF ECOSYSTEMS REPORTS:

(note: authors listed below are SNRAS researchers)

### 49 • climate research & global change

Alaska climate change: 2009 update

Glenn Juday

International collaboration in anthropology and archeology of wood use and climate change research

Glenn Juday, Claire Alix

Evapotranspiration from boreal forest landscapes

John D. Fox, Jr.

### 52 • education & outreach

Monitoring seasons through global learning communities

Elena B. Sparrow, David Verbyla, et al.

Resilience and Adaptation Program / Integrative Graduate Education Research Traineeship

Gary Kofinas, et al.

### 53 • fire-related studies

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

T. Scott Rupp, Mark Olson, et al.

### 55 • forest health & growth

The browning of the boreal forest: Evidence from historic satellite imagery

Dave Verbyla, Becky Baird

Dynamics and management of Alaska boreal forests

Jingjing Liang

Resilience and Adaptation Program / Integrative Graduate Education Research Traineeship

Gary Kofina

Photo monitoring forest development and health

Glenn Juday

Influence of precipitation timing on tree growth in upland and floodplain forest ecosystems in interior Alaska

J. Yarie

Relationship of tree growth to environmental and soil fertility factors for 40 years in interior Alaska

J. Yarie, K. Van Cleave

The Yukon River Basin project—the Densmore Tree Regeneration Installation

Glenn Juday

Natural regeneration of white spruce 2009

Glenn Juday

Remotely sensed evidence of shrub expansion in the arctic tundra

Dave Verbyla, Ken Tape

The Yukon River Basin project—2010 Yukon Flats studies

Glenn Juday

Comparing forest growth from tree rings and satellite NDVI measurements

Glenn Juday, Valerie Barber, Claire Alix, Patricia Heiser

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Invasive Plant Management Plan for UAF

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Remote sensing techniques for the study of white sweet clover on the Matanuska River floodplain

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Can Kenai River chinook salmon survive watershed land use changes? Historical land use effects on salmon in Alaska's Kenai River Watershed

Susan "Shana" Loshbaugh, Susan Todd

## climate research & global change

### Alaska climate change: 2009 update

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. We are identifying the history, risks, and opportunities of climate change and climate variability as they affect natural and managed forests.

#### approach

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

#### progress

In interior Alaska the summer of 2009 represented the second warmest July with the highest mean daily maximum temperature for any month in the 104-year Fairbanks record. The summer as a whole (May:August) ranked fifteenth in mean temperature at Fairbanks, and it would have ranked higher except for the occurrence of cool weather in the second half of August (monthly rank 69). However, the first half of September was the warmest on record. The number of days with maximum daily temperature equal to or greater than 70°F in 2009 (75 days) was tied for fifth greatest with 2004 the record warm summer overall. The number of consecutive frost-free days (growing season length) in 2009 totaled 131, also ranked fifth highest at Fairbanks. The snow-free season began early at most low elevation locations in 2009, with nearly continuous above-freezing temperatures at Fairbanks from mid-April onward. Daily record warm temperatures occurred in late April. The Fairbanks April through July precipitation total was the sixth lowest in the record, and July was the driest summer month in the record. In 2009, Barrow experienced the eighth warmest mean annual temperature in the 89 years of continuous records and tied for the third warmest summer (May:August). In the 92 years of record at Anchorage, 2009 was the nineteenth warmest summer but the thirty-second in mean annual temperature. Warm weather at Anchorage was concentrated in July, which experienced the eleventh highest monthly mean temperature of the record. At the Juneau airport station, the July 2009 mean temperature was third highest and very close to the highest in the 66-year record.

#### impact/implications

The result of the hot, dry conditions of 2009 was another extreme fire year, with the seventh largest area burned in Alaska since 1950 at 1.19 mill. ha (2.95 mill. ac). The combination of warmth and dryness was severe. In the late stages of the fire season in early August 2009, extreme fire behavior began, including rapid spread through normally low-combustibility fuel types such as broadleaf tree (aspen and birch) stands. In interior Alaska, early and extended warm seasons with extreme warmth rapidly deplete snow pack (the principal contributor to annual soil moisture supply), causing reduced tree growth on most low elevation forest sites the following year. July temperature is the best single temperature predictor of white spruce growth on low elevation sites in the Interior, with warm years causing reduced growth primarily in the following year. As a result, it is highly likely that 2010

white spruce growth on low-elevation sites in the Interior will be extremely low, and stress-related forest health vulnerability will be high. Favorable spring weather (early warmth) in 2010 would very likely result in a severe 2011 spruce budworm outbreak. Although sea ice can strongly affect local temperatures at Barrow, if a temperature regime similar to 2009 continues, major negative anomalies of sea ice duration and thickness, compared to the long-term record, are almost certain to result. Warm season temperatures in the treeless North Slope tundra region inland of Barrow were very near the minimum requirements for white spruce tree survival in 2009 and several preceding years. Weather conditions in 2009 in southcentral Alaska were favorable for a buildup of spruce bark beetle populations in 2010 and 2011.

Alaska weather in 2009 received a moderately strong warming influence from El Niño, the periodic short-term temperature anomaly in the equatorial Pacific Ocean. However, solar activity was at the lowest levels of the last century during 2009, constituting a cooling influence. From the longer-term perspective, while Alaska continues to experience short- and medium-term climate variability from solar and ocean/atmosphere influences, there is consistent evidence of directional change in most weather parameters relevant to forestry and agriculture. In 2008 Alaska experienced temperatures in the middle range of the last 100 years of record, although it was not the start of a cooling trend. Instead, in 2009 elevated temperatures, typical of the last few decades, returned as anticipated and predicted.

#### grants/funding

Support was provided by the MacIntire Stennis Cooperative Forestry Program and the US Geological Survey, Yukon River Basin cooperative project with UAF.

## International collaboration in anthropology and archeology of wood use and climate change research

Glenn Juday, Claire Alix

#### purpose

This is a new project to exchange information with French research groups to convey new findings in Alaska climate and tree ring research, new discoveries in the archaeology of wood use in the Alaska Arctic, and results of anthropological studies of today's use of wood in rural Alaska. The project also involves comparing stable isotope and other properties of wood and ice cores to explore possible new applications.

#### approach

The width of tree rings can be affected by many factors other than weather and climate, and when confirmation is needed of an interpretation of environmental change or events that is based on ring width alone, stable isotopes have been found to be very useful in a number of cases. Several isotopes in tree rings can be referenced to isotope content of Greenland and Antarctic ice cores, and even short Alaska ice cores. Advanced processing and careful technique are required in measuring isotopic content of wood samples



*Sample from the Climate and Tree Ring Laboratory.*

PHOTO BY GLENN P. JUDAY

or else measurement uncertainty will be nearly equal to isotope differences in samples caused by actual change in the environment.

Results of the latest Alaska field studies in the archeology of wood use and of the latest dendrochronology studies of floodplain white spruce are being presented to French research teams for use in collaborative efforts, technical publications, and a planned synthesis publication. The capabilities of a major European-wide laboratory in comparing stable isotopes in wood and ice cores are being explored for application to Alaska studies. Results of reconstructions of past environments from wood samples are being applied to archaeological studies. Studies of contemporary uses of wood in western and northern Alaska are being used to interpret archaeological material objects.

#### progress

Seminars Claire Alix was invited to present were given to the public and to anthropology and archaeology research groups working on the use of wood in the Arctic at the (1) Laboratoire des Musées de France (Louvre), (2) Maison de l'Archéologie et de l'Ethnologie, Université Paris X Nanterre, and (3) Centre d'Etudes Préhistoire Antiquité et Moyen Age (Antibes). A seminar and information exchange took place at the Laboratoire des Sciences du Climat et de l'Environnement for groups working on carbon cycling, tree ring studies, climate modeling, and climate reconstruction. Collaborations are planned.

#### impact

Results of studies of the current availability of wood in north and west Alaska and the selection of types of wood by people have helped improve the interpretation of ancient environments and ancient ways of life of native Alaskans. An improved understanding of the different responses of boreal trees to temperature increases is leading to improved models

of carbon cycling. Alaska data on the climate sensitivity of boreal trees are being compared with satellite remote sensing reconstructed data on gross photosynthesis. The collaboration will continue as a member of this team takes up a faculty Chair of Excellence in Archaeology of the Americas at the Sorbonne in Paris.

#### grants/funding

USDA McIntire-Stennis

## 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 affect 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 (PET) and actual evapotranspiration reported for Alaska in the literature. From 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

After confirming no significant trend in fifty-eight years of pan evaporation data for Fairbanks, concentration has been on utilizing physically based methods of estimating pan evaporation from readily available weather data. Another season of continuous pan-evaporation measurements was collected along with air and water temperature, wind speed and global irradiation. While original formulations of the Penman method seem to track pan evaporation in general, the modified PenPan method better accounts for the long days and low sun angles found in the boreal regions. Much of the success of estimating evaporation is a function of the success in estimating global and net radiation. The biggest factor of uncertainty affecting these variables is often portrayed as cloud cover. This study has looked at 112 weather stations across the US and has found that the amount of explained variance ( $R^2$ ) between monthly mean daily ratio of global radiation to extraterrestrial radiation and monthly mean daily

sky cover to be increased by an average of 40.6 percent by including the predictable factor of optical path length for the sun's rays through the atmosphere at different latitudes. The average R2 for the linear relation with sky cover was 52 percent, while the average R2 with the enhanced model was 92 percent. I am in the process of expanding this analysis to non-US sites around the world.

An influence on vegetation water use in the boreal forest is the number of days in which the average temperature is above freezing. This has been used as an index of the growing season length or the frost-free period. While recent reports have claimed 45–50 percent increases in growing season length in Fairbanks, our analysis found a significant trend of increased number of days between last and first frosts in the range of 22–39 percent, depending upon how location changes and missing data are handled. This was over the period of 1906–2006.

Water balance calculations in boreal settings do not fully support claims of increasing evapotranspiration with increasing temperature. While there may be increases in potential evapotranspiration, we found this does not translate directly into increased actual evapotranspiration.

#### impact

Progress in 2009 yielded practical insights as issues of climate change, wildfire management, and landscape hydrology loom large in the north. With increased applications of remote sensing, GIS, and techniques to downscale climate projections from global climate models, it becomes even more important to have good ground-based measurements and physically based model outputs available to validate spatial and temporal extrapolations. An undergraduate senior thesis was completed based on this project and another one initiated.

#### grants/funding

USDA McIntire-Stennis

## education & outreach

### Monitoring seasons through global learning communities

**Elena B. Sparrow, David Verbyla;** Elissa Levine (NASA Goddard); Rebecca Boger (Brooklyn College); Leslie S. Gordon (Gordon Consulting); Kim Morris (UAF Geophysical Institute); Martha R. Kopplin (IARC)

#### 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 Earth system science and the nature of science, inquiry, and science process skills.

#### approach

Rural and urban Alaska K-12 teachers, as well as teachers from other parts of the United States and the world, are

being 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 are learning 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 learn to use standardized scientific measurements and protocols developed by this project that is also called Seasons and Biomes, the Global Learning and Observations to Benefit the Environment (GLOBE) program, other Earth System Science research programs, and best teaching practices in inquiry- and project-based learning. New protocols are being developed and/or adapted as needed to help teachers and students monitor seasons (internannual variability) in their biomes. Teachers and students have also been connected to scientists from the International Arctic Research Center and the School of Natural Resources and Agricultural Sciences at the University of Alaska Fairbanks, as well as from other universities and federal agencies.

#### progress

In addition to new measurement protocols, we developed new learning activities (such as the Leaf Inquiry, Getting to Know Your Terrestrial Biomes, How to Make a Climograph, Setting Up a Study Site) to support student understanding of science concepts in the protocols and in the project. Professional development workshops for K-12 teachers, GLOBE Partner Coordinators, and teacher trainings were conducted in Alaska in February and October, in Australia in June, Nigeria in August, and in Tanzania in September for 121 teachers, teacher trainers, and scientists.

#### impact

Seventeen presentations as well as eight publications have resulted from this project this year. Not only have teachers been implementing the protocols and activities in their classrooms—teaching their students what they learned at the PD workshops—but some teachers and teacher trainer participants of this project have also conducted ten PD workshops for 220 teachers and ten pre-service teachers. Analysis of both the project-provided content assessments and the teacher-designed assessments indicated that students made significant gains in their understandings about biomes, seasons, Earth as a system, changes in ice in their local environment, and the inquiry process.

#### grants/funding

National Science Foundation

### Resilience and Adaptation Program / Integrative Graduate Education Research Traineeship

**Gary Kofinas;** Terry Chapin, Bernice Joseph (CRCD); Craig Gerlach (Anthropology); **Julie Lurman Joly, Joshua Greenberg, David Valentine;** Mark Herrmann (School of Management); and other UAF faculty

### purpose

The Resilience and Adaptation Program (RAP) is a UAF graduate program that trains scholars, policy makers, community leaders, and managers to address issues of 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. The RAP is sponsored by the National Science Foundation (NSF) through its Integrative Graduate Education and Research Traineeship (IGERT) program.

As directed by NSF, IGERT programs are intended to change the culture of graduate education 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

RAP is open to master's- and PhD-level students of participating departments, including SNRAS. PhD students are supported with an IGERT Fellowship for two years. All students integrate social and natural science as a part of their dissertation research and take the RAP core classes—Regional Sustainability, Integrated Assessment & Adaptive Management, and the Resilience Seminar. These courses are taught by a 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 2009-10 thirty-five graduate students were enrolled in RAP, with twenty-five 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 past research topics of graduate students working with SNRAS faculty include: climate change and its effects on subsistence systems, alternative energy options for villages of Alaska, the effect of agency culture on marine mammal co-management, and the use and implementation of community sustainability indicators in public decision making.

### impact

RAP has developed into an internationally recognized graduate program. Faculty and students are contributing to understanding of resilience, adaptability, and transformation of social-ecological systems of the North, and developing new models for partnering with local communities in research. The program has also strengthened inter-departmental cooperation across campus and created an interdisciplinary community of young scholars. In 2007 RAP hosted a meeting of seventy-five PhD students from twenty-seven other IGERTs with a sustainability theme from across the

country. The event demonstrated RAP's leadership among these programs and the common interest, benefits, and special challenges facing students seeking to do integrated research.

### grants/funding

National Science Foundation Integrated Graduate Education Research Traineeship program

## fire-related studies

### **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

### purpose and approach

This project confronts the current poor understanding of fire responses to climatic change in Alaska by integrating paleorecords and computer modeling. The centerpiece of the project is its innovative and rigorous approach to understand 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) from sediment charcoal data 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. Finally, 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 is year four of a four-year paleo-modeling project. Due to complications in processing and analyzing the paleodata a no-cost one-year extension was granted by NSF to complete the modeling objectives. We have focused primarily on modeling fire-climate relationships and the influence of vegetation including feedbacks. We have a fully implemented model that is available to state and federal land managers in Alaska (and to the general public; see [www.snap.uaf.edu/downloads/boreal-alfresco](http://www.snap.uaf.edu/downloads/boreal-alfresco)).

### 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.

#### grants/funding

National Science Foundation

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

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

### 54 purpose and approach

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

#### progress

In collaboration with the UAF Scenarios Network for Alaska & Arctic Planning initiative statewide simulations of future fire regimes based on IPCC climate projections have been completed. Statewide and regional reports have been created for use by federal land management agencies—primarily US Fish and Wildlife Service and National Park Service (see [www.snap.uaf.edu/downloads/reports-boreal-alfresco](http://www.snap.uaf.edu/downloads/reports-boreal-alfresco)). A manuscript presenting projected fire activity through this century was submitted (still in review process) and a final report to the funding agency (Joint Fire Science Program) has been submitted.

#### 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.

#### grants/funding

Joint Fire Science Program

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

T. Scott Rupp; Roger Ottmar, Bret Butler (USFS); Robert Schmoll (Alaska Division of Forestry) Randi Jandt, Kato

.....  
[www.uaf.edu/snras/](http://www.uaf.edu/snras/) • <http://snras.blogspot.com>

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., thinnings) 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. To address this need, 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 thirty 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 fuel treatment plots (5 acres) were established. In each unit two shearblade treatments and two 8 x 8 ft thinnings pruned to four feet were established. 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. Following wet 2007 and 2008 fire seasons we were successful in burning one of the units on June 17, 2009. We documented fire behavior from the time of ignition until steady-state behavior ceased using a combination of cameras, video, direct observations, and thermal dataloggers. Consumption plots were located in both treatment units (thinnings and shearbladings) and the control vegetation. The second unit will be burned in summer 2010 if weather and resources permit. Following completion of the second burn several peer-reviewed journal articles will be produced.

#### 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 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.

#### grants/funding

Bureau of Land Management

## forest health & growth

(see also forests & forest products, under Natural Resources Use & Allocation, p. 68)

### The browning of the boreal forest: Evidence from historic satellite imagery

Dave Verbyla, Becky Baird

#### purpose

The purpose of this study was to document trends in a remotely sensed vegetation index at several spatial scales at the Bonanza Creek Experimental Forest.

#### approach

A time series of Landsat imagery from the mid 1980s to 2009 was used in this study. The Normalized Difference Vegetation Index (NDVI) from Landsat sensor data was used as an index of forest productivity during the peak growing season period of each year. Spectral reflectance was normalized so that unvegetated dark and bright surfaces (water and dry soil) had similar reflectance values throughout the twenty-three-year time series. We then computed mean NDVI from a hierarchy of spatial scales including landscape units (uplands, active floodplain, lowlands), north versus south-facing slopes in upland landscapes, and within stands of different vegetation types.

#### progress

There was a significant decrease in NDVI values at all spatial scales studied. The only units that had increasing NDVI were within re-vegetating areas that burned in 1983 and 2001. Most vegetation types had similar decreasing trends, except aspen which was infested with a defoliating insect (large aspen tortrix) in the mid 1980s. In general the strongest decreasing trend was from the Tanana River floodplain forests. The interannual trend varied among landscape units. For example, in 2006 the mean NDVI from wetlands was above the trend line, while the mean NDVI from upland and floodplain regions was below their respective trend lines.

#### impact

We confirmed at landscape scale a declining NDVI trend that has been established using regional remote sensing. The observed trend may be related to increased insect infestation and drought stress associated with a warming climate.

#### grants/funding

USDA McIntire-Stennis

### Dynamics and management of Alaska boreal forests

Jingjing Liang

#### purpose

I sought to develop a detailed and accurate forest growth model for the Alaska boreal forests and to apply this model to study forest management in interior Alaska.

#### approach

An empirical matrix model was calibrated with plot and tree data from over 400 Cooperative Alaska Forest Inventory plots. The model was tested on over 200 validation plots and was found to be accurate and reliable. The present model was applied on a typical commercial stand in interior Alaska to study a forest management regime that is commonly used in the region.

#### progress

Despite the comparatively low financial returns, current management regimes may generally benefit wildlife species by maintaining continuous forest cover and decent stand diversity, and properly managed forests have potential for timber production and wood-based energy.

#### impact

A useful forest growth model is finally developed for the Alaska boreal forests. The model could substantially improve our understanding of the dynamics and management of Alaska's vast forest resources, and hence will encourage better forest management and local economic development.

#### grants/funding

USDA McIntire-Stennis

### Photo monitoring forest development and health

Glenn Juday

#### purpose

This project uses repeat photography to document patterns and events in forest development and forest health on a long-term basis following forest fire, and the background of natural forest change in forest types of commercial management value. The study began in 1989 in Bonanza Creek Experimental Forest (BCEF), and is being expanded to Research Natural Areas in the Tanana Valley State Forest on sites typical of managed boreal forests.

#### approach

This project monitors post-1983 fire succession in the BCEF Long Term Ecological Research (LTER) site. Long-term monitoring photos are taken in six stand types made up of three forest types (white spruce, aspen, Alaska birch) in the mature forest condition and the same three in young post-fire regenerating forest. Five photo points are established in reference stand hectares, consisting of the center of each quarter-hectare plus the center of the hectare. Two of the stand types (burned aspen and unburned white spruce) have two different hectares photographed, for a total of eight locations. In each location photos taken to parallel to the axes of the plot perimeter which are roughly north, south, east, west, and up. The entire set of photos for all locations and all directions is taken (A) in spring between the time of snowpack disappearance and budburst, (B) in midsummer, and (C) in the fall between the time of leaf fall and start of snowpack. A special air photo series of the six BCEF stands was also taken in May 2009.

## progress/result

The 2009 ground photo data set included 17 photo dates. The entire project photo set from 1989 onward, totaling 7,175 photos from eight locations, was renamed with standard syntax for ease of search. Every photo was quality checked for proper correspondence between name and scene. The entire set of 7,175 digital pictures totals 38.5 GB of data. A metadata file was developed as a guide to the project. The entire database was archived on CDs, and distributed to the Bonanza Creek LTER data manager and to the USGS Yukon River Basin project. Target flasher panels were placed on the ground at the center and each corner of the reference stand hectares for the aerial photo project so that high-quality position control could be obtained in the photos. Patterns of change were identified from the earliest photo dates.

## impact/implications

For over a century, foresters and forest scientists have understood and applied the concept of ecological succession, which is the gradual, stepwise, and ordered replacement of one ecological community with another through time following an initial disturbance and culminating in a final stage of forest development. Because of the long periods that are required for the completion of successional processes, ideas about how succession proceeds have largely come from comparing a series of different sites that have experienced the same amount of time since disturbance, supplemented by a few long-term studies based on some key measurements. A comprehensive, annual visual record of both the developing new forest and the course of change in the original forest that was not disturbed has not been available before. This project is now organized and archived so that future users can easily and quickly access such a record.

## grants/funding

USDA McIntire-Stennis

## Influence of precipitation timing on tree growth in upland and floodplain forest ecosystems in interior Alaska

J. Yarie

### purpose

Seasonal precipitation quantities are predicted to change as part of the climate change dynamics that are predicted to occur in the boreal forest. In an attempt to document changes in forest growth that might occur as a result of precipitation changes a set of drought experiments was established in hardwood ecosystems in both upland and floodplain locations in interior Alaska. The overall objective of the study is to determine the influence of summer rainfall or spring snowmelt on the growth of trees in both upland and floodplain locations. 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 and (3) forest growth in both upland and floodplain locations is strongly tied to soil moisture recharge resulting from spring snowmelt.

### approach

PVC greenhouse panels were used to construct a cover under the overstory canopy in each replicate upland and floodplain summer drought site. The covers were designed to prevent summer rainfall from entering the soil and recharging soil water during the growing season. The covers, designed to drain rainfall off the plot, were placed on wooden framing. On the floodplain sites the high end of the cover was at approximately two meters and the low end at one meter above the ground. On the upland sites the covers were parallel to the sloping surface of the plot. A hole was placed in the cover at the location of each tree and a dam was placed up-slope from each tree to force drainage of water around the tree and off of the treatment area. The snowmelt removal covers were constructed using plywood, placed on 2x4 framing that was set directly on the forest floor. To prevent snowmelt drainage into the holes around trees, the snow pack was removed from the plywood surface in the spring prior to the start of the snowmelt period (early April). The rainfall covers were assembled in late May of 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 percent with a range from 22.7 to 72.1 percent. The snowmelt covers are assembled and removed within one day of the placement or removal of the throughfall covers.

### progress

Summer rainfall exclusion from the upland sites significantly decreased growth for birch in 1992 and 1993 and balsam poplar in 1992. In all other years birch, balsam poplar, and white spruce displayed a nonsignificant decrease in growth. Aspen showed no treatment effect. Tree basal area growth was significantly decreased on the floodplain sites due to summer rainfall exclusion for balsam poplar in 1992 and white spruce from 1990 through 2009. This was the first year of treatment in upland sites for the snowmelt removal. However the early soil moisture estimates using TDR equipment (currently installed in one replicate site) indicated a significant difference in soil moisture immediately after soil thaw. After a single year of treatment tree growth in the upland sites was lower in the treated sites than in the control. Basal area growth for the treated trees by species was 0.6, 0.6, 0.08 and -0.1 sq. cm for aspen, birch, poplar, and spruce compared to the control plot with 2.9, 1.1, 3.0 and 2.0 sq cm, respectively.

### impact

In upland sites soil moisture recharge from melting snow pack is a major moisture supply for tree growth although it is not clear if a significant moisture limitation occurs during the summer even in the control plots. However in the floodplain stands tree growth was highly dependent on seasonal rainfall even though the ground water table was within the rooting





*The crosscut sawing event at the ever-popular Forest Sports Festival, on the Fairbanks Experiment Farm.*

UAF MARKETING PHOTO BY MEGAN OTTS

zone and the soils were supplied with a spring recharge due to snowmelt. A number of factors are probably causing this strong relationship. These include rooting distribution, soil texture, and the electrical conductivity of the ground water which is sufficiently high to limit moisture uptake.

#### grants/funding

USDA McIntire-Stennis

## Relationship of tree growth to environmental and soil fertility factors for 40 years in interior Alaska

J. Yarie, K. Van Cleave

#### purpose

Fertilization and thinning studies were developed in birch, aspen, and white spruce forest types, representing young, middle, and old age classes in the common forest types in interior Alaska. The studies were started in the late 1960s. Both climatic and tree growth monitoring has continued through 2009. These measurements represent a long-term record of tree growth and climate data for an age sequence of forest stands.

#### approach

Tree growth and the effects of fertilization and thinning are being monitored on a yearly basis. The result is the development of a long-term data set.

#### progress

The comparative analysis of this large data set 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. These locations are usually dominated by black spruce vegetation types. A seasonal progression of growth controlling factors occurs and it is strongly tied to the state factor structure 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, vegetation type present on the site, and age structure of the vegetation.

#### grants/funding

USDA McIntire-Stennis

## The Yukon River Basin project—the Densmore Tree Regeneration Installation

Glenn Juday; Roseann Densmore (USGS); David Spencer

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#### purpose

The Densmore Tree Regeneration Installation (DTRI) was established in 1985–86 in the portion of the Bonanza Creek Experimental Forest affected by the Rosie Creek Fire of 1983 as a cooperative UAF and USGS study. The early goals of DTRI were to determine the interacting effects of different site preparation treatments versus tree regeneration techniques on white spruce establishment and early growth. The purpose of the current study is to document the rate of growth and survival of all tree species and to measure carbon accumulation in artificially regenerated stands in middle life, especially in the context of changing climate. The current study is being conducted through the Yukon River Basin (YRB) project, a cooperative effort of the US Geological Survey with the University of Alaska as a local partner. The YRB project is part of a planned national Climate Effects Network, designed to assess major climate-related changes to ecosystem function.

#### approach

The DTRI covers 29.4 ha (72.7 ac) and is one of the largest and most comprehensive tree regeneration installations in Alaska. The study was designed by Dr. John Zasada, USDA Forest Service Research silviculturalist, and Rosanne Densmore, USGS revegetation scientist. Site preparation work at DTRI was conducted in 1985 and seeding and planting of white spruce took place in 1986. At this stage of the YRB work, the goals are to geo-reference all treatments and plots, rehabilitate plot markers, transfer original data to modern digital formats, and survey overall conditions as preparation for the first cycle of remeasurement since 1997.

#### progress/result

We relocated and rehabilitated 306 plot marker posts in dense, shrubby vegetation last visited twelve years ago. We obtained 165 precision (sub-meter) GPS readings of key locations, and 207 key distance measurements. We produced the first precise maps of the installation and adjacent area, and geo-registered specific sub-parts of DTRI on close-scale aerial photography taken in May 2009. We transferred nearly all of the original field data from paper forms to digital files.

#### impact/implications

The DTRI is the principal managed forest environment available for detecting and quantifying climate change effects

in boreal Alaska. The installation has many characteristics that make it a particularly valuable research site. The DTRI area is currently a vigorous, young (twenty-three years old in 2009) forest with numerous treatments adjacent to controls (untreated areas), providing opportunities to evaluate the basic parameters of short-rotation biomass energy production. The installation is adjacent to on-site weather stations maintained by the Bonanza Creek LTER and large natural forest reference stands that have been monitored since the mid-1980s, so that most LTER experimental results are directly applicable to DTRI. Finally, because of the large-scale replication of treatments in DTRI, sites with known histories of treatments and early forest characteristics are available for destructive analysis in measuring biomass and wood product yield. A pilot program of tree remeasurement is planned, and cost estimates for full measurement are being developed. A users committee of scientists and managers is planned.

#### grants/funding

Support was provided by the McIntire Stennis Cooperative Forestry Program and the US Geological Survey, Yukon River Basin cooperative project with UAF.

## Natural regeneration of white spruce 2009

Glenn Juday

#### purpose

This is a long-term study of white spruce that regenerated naturally following the 1983 Rosie Creek Fire. The 2009 growing season represents the twenty-first year of data collection in the study and the twenty-seventh 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

Every white spruce tree that occurs in the Reserve West reference hectare (2.47 acres) at Bonanza Creek Experimental Forest LTER has been mapped and measured annually since 1988. During the 2009 annual survey, the measurements made included (a) white spruce survival, (b) 2009 height growth, and 2009 base and breast height diameter, (c) total height, and (d) budworm damage level. A close-scale aerial photo was taken in early May, 2009 at the time of budburst/leaf expansion in order to be able to identify individual tree crowns within the hectare.

#### progress

In 2009, 2,265 white spruce trees were measured and entered into the long-term database. Average 2009 height growth of all trees was 12.2 cm (max = 95 cm), which is 0.6 cm less than 2008 growth. Average total height was 153 cm (max 867 cm). Slightly less than 79 percent of the white spruce trees were taller than 50 cm and about 40 percent were taller than 137 cm, or breast height (the conventional measurement point for diameter). At the end of 2009 about a half percent fewer trees (7 percent) were free of all shade from competing trees than in 2008, and about a half percent

fewer trees (18.5 percent) were partially shaded by neighbor trees than in 2008. The great majority of white spruce (74.5 percent) were under shade of other trees. At the end of 2009 the average stem diameter was 3.2 cm at ground level and 2.8 cm at breast height. In 2009 spruce budworm damage was practically absent, with only 15 percent of trees having any damage, and nearly all of that only at the threshold level for detection. The pattern of the location of dominant crowns seen in 2009 aerial photography shows that aspen are losing competitive position to neighboring white spruce and Alaska birch because of low foliage mass and cover, even in aspen trees with superior height advantage, presumably because of a succession of years with heavy to very heavy leaf damage from aspen leaf miner.

#### impact/implications

Twenty-six years after a moderate- to severe-intensity wildfire, the process of forming a new forest at this site has gone through some rapid but distinct changes. The new generation of white spruce all came from seed, with the major seed crop years in 1983, 1987, and 1990, and almost no other years represented. A few dozen 1998 and 2003 seed crop seedlings were alive in the plot in 2009, but they have almost no potential to become dominant trees without major disruption of the canopy to allow them to escape their profoundly suppressed condition. Broadleaf trees regenerated both from seed and from stem sprouts of trees alive at the time of the 1983 fire. Even though the diameter and height distributions of all white spruce in 2009 suggest a steady recruitment of new trees into the population took place, the new spruce forest essentially developed from three seed crop years. The timing and abundance of those seed crops were decisive influences on the composition of the new forest. Other notable events occurred in the early years of the life of this stand, including rapid elimination of suitable spruce seedbed conditions, moose browsing and insect damage on broadleaf trees, stem breakage from extreme snow loads, crushing of new trees snagfall, two spruce budworm outbreaks, repeated and extensive clipping of spruce shoots by squirrels, and record droughts. The new forest may now be entering a period of consolidation and slower change, but at other points in the life of this project when such projections seemed reasonable, subsequent events proved them to be wrong. Continued monitoring represents the best way to address this important issue.

#### grants/funding

Support was provided by the McIntire Stennis Cooperative Forestry Program and the US Geological Survey, Yukon River Basin cooperative project with UAF.

## Remotely sensed evidence of shrub expansion in the arctic tundra

Dave Verbyla, Ken Tape

#### purpose

The purpose of this study was to map shrub expansion using historic satellite imagery in arctic Alaska.

## approach

A time series of Landsat imagery from the mid 1980s to present was used in this study. The Normalized Difference Vegetation Index (NDVI) from Landsat TM data was used as an index of shrub areas. Tall shrub areas, because of relatively high leaf area have the highest NDVI among tundra vegetation types.

## progress

We assessed the expansion of NDVI across four regional frames in the arctic foothills in northeast Alaska. We used an NDVI threshold of  $>0.6$  as a proxy for shrub pixels. Within each regional frame, the distribution of high NDVI pixels in 1986 mostly followed channels in the landscape. In 2009, adjacent areas also had high NDVI, likely as a result from shrub expansion, which is consistent with field-based historic photography. Also the mean NDVI within high 1986 NDVI areas did not significantly increase in 2009, while the areas mapped as shrub expansion did significantly increase in NDVI value since the mid-1980s, consistent with shrub expansion.

## impact

Based on this study and field-based repeat photography, much of the shrub expansion has occurred in drainages and is likely to continue due to a warming arctic climate. The expansion of shrubs in arctic Alaska can promote a positive feedback where shrubs trap wind-blown snow, thus insulating the ground in the winter and accelerating soil warming, leading to increased shrub growth and expansion.

## grants/funding

USDA McIntire-Stennis

## The Yukon River Basin project—2010 Yukon Flats studies

Glenn Juday

## purpose

The Yukon River Basin (YRB) Project is a cooperative effort of the US Geological Survey with the University of Alaska as a local partner. The YRB is designed to understand and predict climate-induced changes to the air, water, land, and biota within the YRB, particularly as they affect ecosystem functions of carbon and water cycling. An overall YRB goal is develop predictive capabilities before potential adaptation strategies are lost and more costly responses become necessary. A 2009 prototype field campaign was carried out on an intensive study area on the Yukon Flats by a USGS team at Boot Lake and Canvasback Lake, and a UAF team working along the Yukon River in the Yukon Flats. The goals of this 2009 project were to determine the climate sensitivity of white and black spruce tree growth in the flats.

## approach

A river-based expedition traveled from the Dalton Highway Bridge to the Yukon Flats, covering about 300 miles. The expedition collected sawn disks of wood or drilled cores from a total of 92 trees at 10 locations along the transect. Many were dead trees (recently fallen), or trees about to fall

into the river from bank erosion, or that were killed by a 2004 forest fire. The sampled sites were evenly spaced along the route. Of the 55 cores and 125 disk sections, 95 were white spruce, 84 were black spruce, and one was aspen. Multiple sections were cut along the length of some of the fallen dead trees.

## progress/result

We sanded and marked the tree rings on about 100 of the 125 disk sections. We measured about 60 ring-width series and began analysis of the climate sensitivity of tree growth at the Yukon River Bridge, Boot Lake, and Canvasback Lake field study sites.

## impact/implications

Preliminary results suggest similar climate factors control black spruce growth as previously discovered for white spruce, and that recent warm temperatures are the least favorable period of growth for the past two centuries. Nearly all trees were negative responders, meaning that they grew less as summer (especially July) temperatures increased and grew more as summer temperatures decreased. Spruce budworm reproduction, a major cause of tree death in Canada, was discovered in the tops of felled black spruce. Willow leafblotch miner damage was extensive across the Yukon Flats. These findings are consistent with effects of climate warming documented elsewhere in boreal Alaska.

## grants/funding

Support was provided by the MacIntire Stennis Cooperative Forestry Program and the US Geological Survey, Yukon River Basin cooperative project with UAF.

## Comparing forest growth from tree rings and satellite NDVI measurements

Glenn Juday; Pieter Beck (Woods Hole Research Institute); Valerie Barber, Claire Alix, Patricia Heiser

## purpose

The purpose of this project is to compare ground-based tree growth measurements from productive, low-elevation sites across the boreal forest portion of Alaska with long-term satellite-based measurements that estimate total photosynthesis on the Earth's surface.

## approach

This project is a collaboration with Pieter Beck and Scott Goetz of Woods Hole Research Institute, who are assembling satellite data series. The UAF participants assembled tree-ring measurements of the growth of white spruce and black spruce samples from 856 trees collected from 1987 to 2009 in 46 white spruce stands and 42 black spruce stands. The sampled stands were distributed from the Alaska Range in the south to the Brooks Range in the north, near the Alaska-Yukon Territory border in the east to the limit of tree growth in western Alaska. Tree growth was compared with the record of satellite-sensed Normalized Difference of Vegetation Index (NDVI), indexed to reflect gross photosynthesis of the Earth's surface. Growing season photosynthesis was calculated at 8 km spatial resolution using the Global Inventory Mapping &

Monitoring System (GIMMS) NDVI data set, and growing season length from the Moderate Resolution Imaging Spectroradiometer (MODIS) data set.

#### progress/result

Analysis is still underway. To demonstrate reliable results, tree growth should both increase each year NDVI does within a given pixel, and decrease in the same years as NDVI. Also, in a given year where NDVI increased in some pixels and decreased in others tree growth should demonstrate the same spatial pattern of increases and decreases.

#### impact/implications

Alaska tree ring series are represented in publicly accessible tree ring data bases. However, until recently most samples of tree growth in Alaska were collected from trees growing at cold treeline sites for research projects designed primarily to reconstruct past climates. In such climate reconstruction studies, sampled tree populations increased in growth during warm years and decreased in growth in cold years. However, treeline trees occur on sites marginal of productivity, and tree cover is not dominant over the 8km by 8km satellite pixel of the Earth's surface where they occur, so that the tree growth generally does not dominate the total amount of photosynthesis in the pixel. As a result, only weak relationships between NDVI and ring width series have been established to date. By contrast, our tree samples have been focused on low elevation sites that are the most productive and have the greatest potential for commercial timber management. If successful, this project would establish a rapid and reliable way to obtain an approximate index of forest growth across the entire boreal region.

#### grants/funding

Funding was provided by UAF (MacIntire Stennis Cooperative Forestry program), USGS Yukon River Basin project, NASA, Centre National de la Recherche Scientifique, Bureau of Land Management, and UAF Geist Fund.

## invasive plant management

(see also range management, under High-Latitude Agriculture, p. 42)

### Invasive Plant Management Plan for UAF

Marie Heidemann, Susan Todd

#### purpose

The purpose of this master's degree project is to prevent the spread of invasive plants from the UAF campus to the surrounding natural ecosystems of interior Alaska by developing an Invasive Plants Management Plan for the campus. The plan will spell out management actions for managing existing invasive plants on campus and preventing their establishment and spread in the future.

#### approach

Throughout the US and Canada, communities, states, and provinces have found the best way to deal with invasive species is to develop a comprehensive plan that tackles the

problem from a number of angles and that considers the underlying causes of the weed infestation. The most successful plans are developed in collaborative processes by a team of stakeholders. We will follow this model at UAF.

#### progress

A map of the current distribution of invasive plants on campus was produced in summer 2008. In the fall of 2009, a UAF Invasive Plant Task Force was established which included invasive plant experts, campus landscaping staff, faculty, and students. These two steps provided the groundwork for this project to develop a plan. A draft of the plan will be produced by July 2010 and finalized by December 2010.

#### impact

The plan will have an impact on invasive plants on campus and also elevate UAF's status as a model of good environmental stewardship. We are ahead of many other campuses and communities and our work on the plan will help others develop their invasive plant plans.

#### grants/funding

USDA Hatch and United States Forest Service

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

Norman Harris, Beth Hall; 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 122m using a small, tethered, helium-filled blimp carrying two digital cameras, one collecting color and the other collecting infrared imagery. Images from both cameras are processed to create four-band spectral imagery which 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

This study is in its sixth year. Earlier analysis of spectral data indicated that white sweet clover was easiest to detect using the visible-light spectral bands taken late in the growing season, September or October, when phenological differences between the white sweet clover and other vegetation were at their greatest. At the end of their biennial cycle, white sweet clover dies and turns pink-brown in color. Plants in their first year of growth remain green while the other flood plain vegetation exhibits a color change to shades of red or yellow. These phenological differences are not strongly linked to calendar dates but are dependent on environmental

conditions. Infrared imagery did not improve detection rates. In 2009 we acquired imagery late in the growing season, August 27 and again on September 29. We are continuing to study plant population dynamics to better model susceptibility to weed establishment. We have acquired our fifth, and last, high-resolution LIDAR (laser imaging detection and ranging) data set. Time-change modeling with LIDAR data generated erosion/deposition maps which were useful for modeling the spread of white sweet clover.

#### impact

Land managers can effectively and cost-efficiently use remote sensing data to detect and monitor major sweet clover infestations if the data is supported with ground-based observations to detect proper phenological stages for imaging. Remote sensing is unlikely to detect initial infestations of scattered small plants. A probability model will allow land managers to better use scarce resources to combat the establishment of invasive species in critical habitats.

#### grants/funding

United States Forest Service and USDA Hatch

## 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 when potential adverse impacts from human disturbance are of concern.

#### approach

To assess herd interactions, genetic variation will be determined among the arctic Alaska herds. Comparison of demography and genetics is integral to our approach.

#### progress

Papers from our study were previously published. New molecular markers from cattle will be applied to Alaska caribou in 2010.

#### 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.

#### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

### Grizzly bear genetics

M.A. Cronin; R. Shideler (Alaska Department of Fish and Game); J.C. Patton (Purdue University); 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, Mc1r, and major histocompatibility complex). Review of the 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.

#### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

### Polar bear genetics

M.A. Cronin; S.A. Amstrup, S. Talbot (US Geological Survey)

#### 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 and Chukchi seas in northern Alaska and compare it with that in other worldwide subpopulations. Genetics is also being used to understand the timing and nature of evolution of polar bears from ancestral brown bears.

#### progress

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, Mc1r, Mc4r). Papers were published in 2006 and 2009.

#### impact

This study is helping quantify genetic variation and subpopulation differentiation as well as clarify the evolutionary relationships of polar bears and brown bears. Such information is potentially useful in population management and policy formulation at the national and international levels. This is particularly important because of the May 2008 Endangered Species Act listing of polar bears as a threatened species.



*Kenai River, June 2008.*

PHOTO BY FRANK KOVALCHEK, WIKIMEDIA COMMONS, CREATIVE COMMONS ATTRIBUTION 2.0 GENERIC LICENSE

### grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

## Can Kenai River chinook salmon survive watershed land use changes? Historical land use effects on salmon in Alaska's Kenai River Watershed

Susan "Shana" Loshbaugh, Susan Todd

### purpose

The purpose of this master's degree project is to see whether there is a link between land development and salmon productivity in the Kenai River Watershed (KRW). Land use changes that reduced the quality of freshwater habitat are considered a primary reason for the decline and extinction of salmon stocks in the Pacific Northwest. Could the same thing happen to the Kenai River? I am examining the land use changes in the watershed over the past century to consider whether the river's famous chinook salmon runs are sustainable if these land-use trends continue.

### approach

Approaches from historical research, interdisciplinary landscape science, and geographic information systems (GIS)

will be used to describe the watershed's land-use history to see if there is a link between land use changes and the productivity of salmon runs. The study will also compare the KRW with land-use histories of other salmon-producing watersheds and suggest ways to maintain or enhance the resilience of the KRW social-ecological system.

### progress

Historic maps, census data, aerial photographs, and documents have been collected and analyzed. GIS maps of the historic changes to the watershed have been compiled. Interviews with long-term residents are complete and the project should be finished by October 2010.

### impact

Although the KRW appears undisturbed compared to many salmon-producing watersheds in other states, over the past sixty years urban sprawl and development close to the river have dramatically altered the riparian vegetation. However, there are still extensive forested areas along the river, so it may not be too late to avoid the fate of so many salmon rivers in the Lower 48.

### grants/funding

USDA Hatch

# Natural Resources Use & Allocation

**R**ESOURCE MANAGEMENT in Alaska is constrained by needs to fulfill public expectations, follow processes that are legally required, and meet the substantive requirements of state and federal laws and policies. To be implemented properly, resource management programs must be solidly based on reliable information that can successfully meet legal review and gain public acceptance. The costs of harvesting Alaska resources can be high, and most Alaska products face strong competition in global markets. To remain competitive, Alaska resources must be harvested or extracted efficiently and marketed effectively. They must also be developed and used with cognizance of non-extractive users. Outdoor and wildland recreation and nature-based tourism have become a relatively large part of the Alaska economy and social fabric. This sector is highly dependent on the user-relevant management of public land resources.

Sound natural resource economics requires developing and sharing information to establish more effective market mechanisms, identifying new resource use opportunities, and developing non-market valuation systems. Research in natural resources at SNRAS and AFES focuses on integrated studies of economic, managerial, and ecological aspects of natural resource use and allocation: multi-resource planning and the process of determining public resource policy; non-market resource economics; outdoor recreation resource management; resource economics and policy impact assessment; rural community culture and economic development analysis; nature-based tourism; environmental law and policy; new product opportunities in forests and wildlands; and subsistence resource systems.

## NATURAL RESOURCES REPORTS:

(note: authors listed below are SNRAS researchers)

### 64 • biomass

Establishment and evaluation of native willows, alder and cottonwoods for biomass production

Norman Harris, Stephen Sparrow, J. Andres Soria

Pyrolysis of Alaska biomass

J. Andres Soria, Magdalena King

Gasification of Alaska biomass

J. Andres Soria, Magdalena King

Salmon waste gasification

J. Andres Soria, Shawn Freitas

### 66 • fisheries & fishery products

Analysis of minimum size limit for Eastern Bering Sea tanner crab fisheries

Joshua Greenberg, Gordon Kruse, William Bechtol

Converting Alaska fish byproducts into value-added ingredients and products

Alberto Pantoja, Peter Bechtel, Cynthia K. Bower (ARS)

The effects of changing fishery regulations to local participation in the Bristol Bay salmon fishery

Joshua Greenberg

### 68 • forests & forest products

A bark thickness model for white spruce in Alaska northern forests

Thomas Malone, Jingjing Liang

Lumber grade and yield for Alaska birch

Kevin Curtis, Valerie Barber

Chemical characterization of Alaska trees

J. Andres Soria, Magdalena King

Moisture content determination of fire-killed trees in interior Alaska

J. Andres Soria, Magdalena King, Norman Harris, Beth Hall, Valerie Barber

Sitka Tribe Harvesting Survey

Valerie Barber

Non-destructive testing of Alaska tree species

Valerie Barber, Larsen Hess

Anatomical and mechanical properties of woods used to manufacture bassoons

Katy Levings, Valerie Barber

### 71 • policy & planning

International Polar Year: Impacts of high-latitude climate change on ecosystem services and society

T. Scott Rupp, Gary Kofinas

Endangered Species Act science and management

M.A. Cronin

When laws affecting the environment conflict: Focus on public lands

Julie Lurman Joly

### 72 • recreation

Monitoring indicators in Denali National Park

Peter J. Fix

Squirrel River sport hunter study

Peter J. Fix, Andrew M. Harrington

### 73 • revegetation

Revegetation of a gravel-extraction operation

Norman Harris, Beth Hall, Dot Helm

### 73 • water & wetlands

Lake level changes at Harding Lake

John D. Fox, Jr.

Feasibility study for development of a storm water utility in the City of Fairbanks

Jackson Fox, Susan Todd

Impacts of water and sanitation projects on communities in Ghana

Josie Osafo-Adu Sam, Susan Todd

## biomass

(see also biofuels under High-Latitude Agriculture, p. 29)

### Establishment and evaluation of native willows, alder and cottonwoods for biomass production

Norman Harris, Stephen Sparrow, J. Andres Soria; Peggy  
Hunt (Alaska DNR)

#### 64 purpose

This project is designed to determine the feasibility of growing endemic Alaska woody species as sustainable agricultural crops for bioenergy and bioproduct applications. High-resolution remotely sensed images will be used to evaluate plant growth and estimate biomass accumulation.

#### approach

Plots of selected woody species will be established at the Plant Materials Center (PMC), located in Palmer, and at the UAF Fairbanks Experiment Farm. Growth and mortality data will be collected to determine the best species for biomass production. Imagery, using our small, tethered, helium-filled blimp carrying two digital cameras, will be acquired of existing plots containing 30-year old trees at the PMC to develop models for accurately estimating biomass. Models will be calibrated and assessed using destructive sampling of selected trees.

#### progress

Imagery was obtained of established willow test plots at the Plant Materials Center on September 28, 2009. Our imagery was acquired with a resolution of 2 cm on a side. Preliminary analysis indicated that using imagery for biomass estimates may be difficult because of the raster format of digital terrain models. We have accuracy limitations that are inherent in the mapping grade global positioning unit (less than one meter) we use to collect ground control points and the resolution of our imagery. Terrain models using a resolution of 2.5 cm had inherent noise while models using a 25 cm resolution were not fine-grained enough to detect small trees. Our initial modeling runs indicate that a model with a resolution of 5 cm on a side worked best. Estimates of biomass would be limited to multiples of 25 cm<sup>2</sup>. Future work will use a vector-based software program to model tree biomass.

#### impact

The production of biomass will allow Alaskans to develop a renewable source of biomass for energy production and bioproduct applications. This will allow people to wean themselves from expensive, nonrenewable energy sources and allow them to have greater control of some necessities required for life in Alaska.

#### grants/funding

USDA Hatch

## Pyrolysis of Alaska biomass

J. Andres Soria, Magdalena King; Armando G. McDonald  
(Univ. of Idaho)

#### purpose

The production of bio-oil as a stable liquid substrate to hold the chemicals produced by the heating of wood in the absence of oxygen (pyrolysis) is a major goal for finding alternatives to petroleum. This multistate collaborative research project is geared toward building a custom pyrolysis unit and performing the initial investigations of Alaska woody species as reacted in this apparatus.

#### approach

A pyrolysis reactor was designed by J.A. Soria at UAF and fabricated at the University of Idaho in 2009. The reactor, housed at the Palmer Research & Extension Center's Renewable-Based Hydrocarbons (RBH) Laboratory, is able to process 1 kg/hr of Alaska biomass to conduct fundamental research in the production of bio-oil and its characterization. The bio-oil is analogous to petroleum oil, where a series of compounds can be extracted and refined into various products. Being a liquid, bio-oil can be stored and transported in similar fashion to petroleum, but processing varies, and fundamental research in this area continues to be an active arena at the national and international level. Alaska biomass is being pyrolyzed in differing conditions and the reactions and products characterized for degree of completion, chemical composition, and analysis of bio-char, bio-oil, and syn-gas by chromatography and spectroscopy techniques.

#### progress

The pyrolysis reactor is installed at the RBH facility in Palmer. Controllers and peripheral equipment continue to be designed to automate the equipment operations as well as data gathering techniques. Work related with this phase is expected to be completed by the end of the summer of 2010. Alder and black spruce samples have been collected and processed/prepared for pyrolysis treatment. These species will yield bio-oil and bio-char which will be characterized in summer/fall 2010.

#### impact

The production of bio-oil from pyrolysis of Alaska species has not been fully investigated. Facilities in Alaska did not exist until now, and as such this research provides a first in understanding the fundamental principles of pyrolysis for Alaska biomass, as well as establishing the basic research equipment and infrastructure with which to continue and expand this work. Future phases of research will involve catalytic upgrading of the bio-oil into diesel boiling range fuels, and assessing its potential applications as transportation and heating fuel alternatives.

#### grants/funding

USDA Wood Utilization Research Grant 09—Biofuels  
Module



## Gasification of Alaska biomass

J. Andres Soria, Magdalena King

### purpose

Gasification is a thermochemical technique that, under controlled conditions, can produce a gaseous combustible mixture that can operate small internal combustion engines and displace natural gas for some applications such as cooking and heating. Alaska biomass has not been studied from a fundamental perspective under gasification regimes. Factors such as chemical composition, moisture, and reactor conditions all play a significant role in the quality of the gas produced. This is the first fundamental study of Alaska lignocellulosic biomass under gasification.

### approach

Alaska lignocellulosic biomass will be processed into compressed logs and various particle sizes which will be introduced in a small fixed bed downdraft gasifier. The reaction conditions will be analyzed using probes, and response surface optimization procedures employed to improve the gasification process. Analysis of the produced gases will occur using chromatography and mass spectrometry. Elemental analysis, caloric value determination, and chemical composition of the raw feedstock as well as of the products after reaction will be conducted. The combination of data from the reaction parameters, results, and baseline information will allow the response surface method used to optimize the system to be tailored to the specific species of biomass and yield the highest production of combustible gas. The methods used will enable an understanding of what the output may be if parameters such as moisture are changed, leading to practical range of biomass attributes that could still produce usable gas, outside of ideal conditions.

### progress

We have conducted gasification runs on small diameter alder wood, yielding promising results in the production of syn-gas from this fast growing, low value species. The elemental analysis, basic chromatography, and caloric content have been completed, and two publications detailing the alder runs in contrast to salmon/alder mixtures are being prepared. Other species of lignocellulosic Alaska biomass have not been studied yet, and this is part of the ongoing work at the Palmer Research & Extension Center.

### impact

The production of a gas fuel that can be used directly in generating mechanical power using internal combustion engines can play a significant role in remote locations in the state, where current fragmented energy infrastructure makes it too expensive to pipe natural gas. The utilization of local biomass resources for the production of such a fuel may prove important in diversifying the energy portfolio of the state and enable the growth of a secondary industry outside of dimensional lumber products that can capitalize on the utilization of Alaska biomass resources.

### grant/funding

USDA Wood Utilization Research 10

## Salmon waste gasification

J. Andres Soria, Shawn Freitas; Cindy Bower, Peter Bechtel (USDA ARS)

### purpose

Alaska produces 100,000 metric tons of salmon waste yearly. These waste streams include heads and viscera which have no commercial value. By combining these wastes with another low-value biomass stream in the way of small-diameter black spruce and alder, the mixture may be used in gasification, leading to the production of a combustible gas that can run small combustion engines. This is the first study to investigate these waste streams for the production and characterization of energy-specific uses.

### approach

Small-diameter alder and black spruce were harvested at the Palmer Research & Extension Center and the materials processed into sawdust. Salmon wastes from commercial fishing processors in Kodiak Island were mixed with the sawdust in a variety of ratios, not surpassing 25 percent fish due to high moisture content. The mixture of salmon and wood sawdust was compressed into “firelogs” three inches in diameter and placed inside a fixed bed downdraft gasifier.

In parallel, fundamental research into the characterization of the individual raw feedstocks, different mixtures, and related products is being conducted to qualify and quantify the best conditions under which gasification technology can be used to produce a combustible gas mixture. The long-term goal is to design reactor and reaction conditions that will optimize the production of combustible gas from these Alaska-specific waste streams, and be able to run a small generator to power a modest load of 2kW.

### progress

We have completed the pilot scale gasification runs, and found the optimal range of fish and alder wood to use to produce a high quality combustible gas. The work has resulted in one master's thesis and three publications (in process).

### impact

This is the first fundamental and applied research study to focus on gasifying Alaska wood and salmon, and one of the first studies anywhere to optimize salmon and wood biomass for syn-gas production. This information provides the basis for design and operation of new reactor systems that can serve as the building blocks to direct heating systems, combined heat and power systems, or process heat for fishery operations. The fundamental work generated by this research is now being used by the principle investigator to design feedstocks for upgrading via catalysis of the syngas into high grade hydrocarbon liquid fuels.

### grants/funding

Joint Venture Agreement with USDA ARS Alaska.

## fisheries & fishery products

### Analysis of minimum size limit for Eastern Bering Sea tanner crab fisheries

Joshua Greenberg, Gordon Kruse, William Bechtol

#### purpose

Our purpose is to assist fishery managers and regulators in the determination of whether a reduction in the minimum size limit for the tanner crab fishery in the Eastern Bering Sea may be appropriate to better attain fishery management objectives to optimize sustained yields while maintaining spawning biomass.

#### 66 approach

Simulated tanner crab catches at various size limits are extrapolated from historic catch and observer data. Effects of size limits to the fleet performance are estimated from the extrapolated data. Historic ex-vessel prices, wholesale prices, and fishery quota prices and lease rates are examined to explore how changes in fishery harvests and size of crab will affect the economic performance of the crab fishing industry.

#### progress

The initial analyses were completed and preliminary findings reported. The study will be completed next year and findings provided to industry, fishery managers, and the Alaska Board of Fisheries.

#### impact

The Bering Sea tanner crab fishery has historically been a major component of the Alaska crab fishing industry. Declines to the size at maturity for male tanner crabs in the Bering Sea have compromised the economic profitability of this commercial fishery and had important consequences to the underlying stock dynamics. A reduced size limit may enhance the contribution this fishery makes to the crab fishing industry in the state and the nation.

#### grants/funding

USDA Hatch

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

Alberto Pantoja, Peter Bechtel, Cynthia K. Bower (ARS)

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

#### purpose

The Alaska seafood industry harvests more than 50 percent of the total US catch; however, much of the processing byproduct is underutilized or discarded. The total Alaska seafood harvest in 2008 was over 2 million metric tons (MT) per year, resulting in over 1.1 million MT of byproducts. These byproducts could be processed into more than 200,000 MT of fish meals and oils and other value-added byproducts with an annual value in excess of \$200,000,000. Further, these byproducts contain fractions that could be recovered and utilized as high-value feed and food ingredients such as

increasing the content of omega-3 fatty acids in feeds and foods, increasing feed intake and increasing performance of farmed fish. In addition, specialty protein and oil supplements can potentially reduce current levels of fish meal and oil used in feeds.

This research project focuses on increasing the value of Alaska seafood processing byproducts through the development of scientific information and methods required to use these materials as food and feed ingredients. The overarching goal of this project is to develop new knowledge to increase the value of underutilized byproducts as food and feed ingredients in a sustainable manner. Development of effective means of dealing with these byproducts will reduce potential deleterious environmental impacts and increase the economic viability of the seafood industry and the communities that depend on them. The aquaculture industry will benefit from a greater supply and greater choice of feed ingredients, and the prospect of switching from dependence on ocean harvests of industrial fish used to produce fish meal and oil to sustainable produced grains and oil seeds.

#### approach, progress, and impact

#### ALASKA FISH PROTEIN MEAL AND OIL QUALITY

The chemical and nutritive quality of Alaska byproduct fish meals was evaluated. The quality of these meals was indistinguishable from commercial meals for shrimp and, with one exception, in formulations for Pacific threadfin and rainbow trout. A large study found Alaska seafood byproducts were well suited for inclusion into trout diets to enhance fillet omega-3 fatty acid levels. Studies were complete using Alaska "organic" meals and oils as aquaculture feeds.

#### PERSISTENT ORGANIC CONTAMINANTS IN BYPRODUCTS

The presence of persistent organic pollutants in Alaska byproducts needs to be determined. Scientists with the USDA/ARS Subarctic Research Unit in Fairbanks, Alaska collaborated with scientists from the Institute of Environmental and Human Health, Texas Tech University, to screen a number of fish oils and meals made from Alaska byproducts. Results indicated the persistent organic contaminants (organochlorine pesticides and polychlorinated biphenyl) were not detected in any of the samples analyzed with a detection limit of 0.8 parts per billion for DDE and 0.4 parts per billion for a selected PCB. These results suggested byproducts from coldwater marine fish caught in Alaska are very low in persistent organic pollutants.

#### SNACK FOODS FROM SALMON BYPRODUCT POWDERS

Many Alaska products are at a disadvantage in competing in international markets due in part to high transportation costs. One way to reduce transportation costs and avoid refrigeration is to develop new products made from dried fish byproduct powders. Scientists from USDA/ARS laboratories in Albany, California, and Fairbanks used an infrared dryer to make dried salmon flakes that were subsequently milled to powder. The powders were formulated with starch, water, and seasonings and extrusion molded for deep frying and

infrared drying. These shelf-stable fish snacks produced from salmon byproduct powders can be incorporated into shelf-stable ethnic fish snacks as well as pet foods.

#### CHONDROITIN SULFATE FROM FISH HEADS AND SKATE SKELETONS

There is potential to utilize fish processing byproducts for the production of chondroitin sulfate; however, there is the need to determine the concentration and chemical characteristics of chondroitin sulfate found in the connective tissues of byproducts such as fish heads and skate bodies. Two separate analytical techniques, HPLC and dimethylmethylene blue staining, were adapted to determine chondroitin sulfate content in the heads of different salmon species and the cartilaginous material in skate bodies. Results using HPLC analysis showed salmon heads had on average 15-23 mg/g total chondroitin sulfate (dry weight basis), while Skate samples had on average 19-29 mg/g. The results of this study imply that extraction of chondroitin sulfate from fisheries byproducts is possible and may lead to the development of valuable new products.

#### PHYSICAL AND CHEMICAL PROPERTIES OF COMMERCIAL SALMON OIL

There is interest in utilizing Alaska pollock and salmon oils as food and feed ingredients. However, changes in composition of the commercial oils during the harvesting season must be evaluated in terms of oil quality, concentrations of fat soluble vitamins, composition of long chain 3-omega fatty acids, and quantity of free fatty acids. A study was conducted by USDA/ARS scientists in Fairbanks and industry collaborators to examine the physical and chemical properties of commercial fish oil collected from two different salmon oil and meal processing plants over one entire salmon fishing season. Results indicated the oils were good sources of vitamins A, D, and E and there were no large changes seen in the fatty acid profiles or vitamin levels over the course of the fishing season, although steps may be needed to protect the oils collected early in the season. Over the course of a fishing season, these salmon oils are of high and generally consistent quality.

#### UV-B LIGHT AND FISH SKIN GELATIN PROPERTIES

Cold-water fish skin gelatins have characteristic physical properties significantly different from either warm-water fish skin or mammalian gelatins; however, some applications require improvement of physical properties to resemble those of other types of gelatins.

Collaborating scientists at the USDA/ARS laboratories in Albany, California, and Fairbanks embarked on studies to alter the physical properties of dried cold water fish skin gelatins using UV-B light. Results indicated that UV-B light can induce protein chain modifications to the dried and milled cold water fish skin gelatins. The modifications can increase gel strength, gel set temperature, and aqueous viscosity as well as affect the mechanical properties of gelatin films. UV-B modified cold-water fish skin gelatins can be used for specific

applications as food thickeners and emulsifiers at different temperature ranges.

#### DEHYDRATING POLLOCK SKINS PRIOR TO SHIPMENT

Pollock skins destined for gelatin production currently must be transported to processing facilities outside of Alaska. Untreated, the skins contain roughly 80 percent water, making transport expensive. ARS researchers have determined that dehydrating fish skins using chemical desiccants prior to transport can stabilize the material and reduce shipping weight. Results show that dehydration does not harm the functional properties of gelatin, including gel strength, gelling temperature, and viscosity. This research suggests that fish skins can be economically stabilized for transport through the use of reusable desiccants commonly employed in the food industry.

#### SHRIMP-FEEDING STIMULANTS FOR USE WITH PLANT-BASED DIETS

Pacific white shrimp (*Litopenaeus vannamei*) show reduced growth when fed diets where soy protein is substituted for fish meal. Additionally, there is little information on the feeding stimulant properties of Alaska fish processing byproducts reported for Pacific white shrimp. Scientists from the Oceanic Institute in collaboration with the University of Alaska and USDA/ARS scientists conducted three trials to evaluate effects of nine Alaska fisheries byproducts (byproduct meals from different species, bone, liver, and other meals) and feeding stimulants in plant-based diets for the Pacific white shrimp. Results found that Alaska byproducts can be effective supplements in stimulating shrimp fed soy protein based diets to increase consumption and the effect depended on inclusion levels. Shrimp aquaculturists can remedy reduced growth due to plant based diets by stimulating increased consumption rates with selected byproducts of Alaska fish processing.

#### FISH BONE MEALS AS A SOURCE OF DIETARY PHOSPHORUS

Alaska fish bones can be made into a meal that may become a useful dietary phosphorus source for rainbow trout. Scientists at the University of Idaho in collaboration with University of Alaska and USDA/ARS scientists evaluated the physical and chemical properties of bone meals derived from Alaska pollock. Performance characteristics were determined for rainbow trout (*Oncorhynchus mykiss*) fed a balanced dietary mix of plant proteins supplemented with either fish bone meal (FBM) derived from Alaskan seafood processing byproducts or dicalcium phosphate. Seven experimental diets were formulated to contain two levels of dicalcium phosphate or two levels of two different kinds of FBM. Results indicated that these meals were inferior to dicalcium phosphate as dietary phosphorus sources. These results suggest that the phosphorus in bone meals produced from Alaska seafood processing waste may require additional processing to increase phosphorus availability.

#### ENERGY FROM PYROLYSIS OF SALMON BYPRODUCTS

One potential use for unused fish processing byproduct is as an energy source for heating dwellings, water etc. This

research project conducted by a collaboration of University of Alaska and USDA/ARS Fairbanks researchers optimized conditions of pyrolysis for using salmon processing wastes to generate energy. Alaska salmon waste products and alder wood were pelletized and gasified to produce a combustible gas. Results indicated that up to 21 percent salmon waste enhanced the gasification of alder. This research can potentially be applied to heat greenhouses in remote Alaska fishing villages, thereby increasing access of garden-fresh foods and extending their growing season. (See "Pyrolysis of Alaska biomass," p. 64, and "Gasification of Alaska biomass," p. 65.)

#### NANOFIBERS FROM FISH GELATIN

68 This study tested the potential of using gelatin from fish skin to make nanofibers. Gelatin was prepared from Alaska pollock skins and used to spin nanofibers. Pollock Gelatin/Poly (Vinyl Pyrrolidone) and other combinations were evaluated for their ability to be electrospun into nanofiber. Characteristics of the nanofibers parameters affecting the spinning process were evaluated. Pollock gelatin/poly nanofibers have the potential to be made into many products including controlled release of drugs since the nanofibers have very high surface areas.

#### grants/funding

USDA/ARS Subarctic Research Unit

### The effects of changing fishery regulations to local participation in the Bristol Bay salmon fishery

Joshua Greenberg

#### purpose

The economic performance of the Bristol Bay salmon fishery has been hampered by competition from farmed salmon. The state has dual objectives of improving the fishery's economic viability while maintaining its contribution to the regional and state economy. This study will examine the effect of a regulatory change in the fishery to local participation in the fishery and fishery performance.

#### approach

The study will rely on qualitative and quantitative methods to examine the double stacking issue. A survey approach will be used to examine the original intent of the Alaska Board of Fisheries in passing the double stacking regulation. Time series analysis will be used to examine the relationship between the double stacking regulation and local and regional participation in the fishery.

#### progress

The study is in the beginning stage. Fishery permit information has been examined to provide insight into recent changes that have occurred in the fishery. A draft survey has been constructed. Initial investigation of applying time series analysis to address this policy question has been completed.

#### impact

This study is expected to contribute to improved assessment of policy tradeoffs in Alaska state salmon policy,

and to improve the ability of state fishery regulations to achieve policy goals.

#### grants/funding

USDA Hatch

## forests & forest products

(see also forest health & growth, under Management of Ecosystems, p. 55)

### A bark thickness model for white spruce in Alaska northern forests

Thomas Malone, Jingjing Liang

#### purpose

We developed a model to predict bark thickness of white spruce in Alaska northern forests.

#### approach

An empirical regression model was calibrated with a large sample collected through interior and southcentral Alaska. Geographic difference has been tested to show that the model could be applied statewide.

#### progress/impact

This study is finished. An article was published in the *International Journal of Forestry Research*. The bark thickness model may contribute to the study of tree volume and biomass of Alaska's northern forest species, and hence will support potential studies on forest biomass and management. The model is also supportive of Alaska's ecological and economic improvement.

#### grants/funding

USDA McIntire-Stennis

### Lumber grade and yield for Alaska birch

Kevin Curtis, Valerie Barber

#### purpose

Alaska birch from Fairbanks and Matanuska-Susitna Valley will be used for product recovery (yield studies) and to evaluate lumber drying characteristics. Specific goals are:

- Evaluate whether lumber grade (of recovered lumber) is commensurate with log grade (determined before sawing);
- Evaluate the minimum diameter of birch sawlog that can be profitably sawn by operators in southeast Alaska;
- Evaluate the potential for producing value-added wood products from lower grade birch.

#### approach

Sixteen trees from Fairbanks and sixteen from the Matanuska-Susitna Valley will be cut for the project and delivered to Palmer where they will be milled into lumber, dried, planed, and then scaled and graded. They will be evaluated according to the National Hardwood Lumber Association lumber standards and board foot volume of lumber recovered will be measured. Lumber value will be determined based on current hardwood market values.

Lumber value will be determined in two ways: dollars per hundred cubic feet of log scale (\$/CCF); and dollars per thousand board feet lumber tally (\$/MLT). Lumber value will be correlated with log diameter.

#### progress

Trees were cut in the Nenana State Forest and delivered to Palmer. Trees were also collected from the Palmer Trunk Road Extension Project in October 2009.

#### impact

Birch is an underutilized tree in Alaska and currently is used primarily for firewood. Some is milled and dried, and used for cabinets and other products. Alaska birch species (*Betula neolaskana* and *B. kenaica*) are different from birch found in the lower 48 states (*Betula papyrifera* or paper birch). Research is still being conducted to determine if they are a subspecies of paper birch or if they are a specific species. Yield and grading studies of Alaska birch have not yet been done but are needed to manage the species and put a value on the wood.

#### grants/funding

USDA-Wood Utilization Research-09

### Chemical characterization of Alaska trees

J. Andres Soria, Magdalena King

#### purpose

Alaska trees are understood from an ecological perspective, but little fundamental research exists on the chemical composition of the lignocellulosic stock of the state. This ongoing research project is designed to provide fundamental compositional data of the lignocellulosic biomass in the state by conducting chemical characterization of the available biomass.

#### approach

Characterization of wood involves the determination of carbohydrate, lignin, extractives, and inorganics. Based on this information, further breakdown of these fractions is possible, leading to the determination of specific sugars, propyl-phenolic compounds, and aromatics which can play a significant role in discovering secondary value-added products, particularly in the fields of pharmaceutical and nutraceutical applications. Chemical characterization involves liquid and gas chromatographic tools and mass spectra to determine the chemical species found. Caloric analysis and inorganic compounds (ash) is also performed as a means of collecting fundamental information and producing a baseline database to complement the existing body of knowledge in physical attributes of dimensional lumber and the ecological role of trees in the local ecosystems across the state.

#### progress

We have done analysis on a variety of additional species, with some of the data being included in a new updated publication from the Forest Service titled *Fuelwood Characteristics of Northwestern Conifers and Hardwoods*, published by the Pacific Northwest Research Station. The work on extractives is continuing with the help of the Plant Materials Center in Palmer.

#### impact

The chemical characterization of wood fills the void in knowledge in the fundamental understanding of the local biomass resource. It provides new information that can lead to the development of secondary value-added industries, including pharmaceutical, nutraceutical, fuels, additives, resins, and many other specialized products.

#### grants/funding

USDA Wood Utilization Research 09

### Moisture content determination of fire-killed trees in interior Alaska

J. Andres Soria, Magdalena King, Norman Harris, Beth Hall, Valerie Barber

#### purpose

Alaska's interior forests are under a natural fire disturbance regime that results in large areas being burned yearly. Very little information exists on the quality, from a chemical and physical perspective, of the standing deadwood. This project is designed to fill this gap by focusing on the areas affected by the fires of 2000 and 2006 in the Interior. The research project will also develop remote sensing algorithms to estimate the biomass available within the affected areas by using optical imagery taken by a blimp.

#### approach

The team traveled to the locations along the road system that were affected by fires between 2000 and 2006 in the Interior. At each location, plots and trees were selected based on BAF10 prism methodology, noting the landscape characteristics and forest structure. Representative samples of fire-killed trees were harvested and taken to the laboratory for further analysis. Determination of moisture was done by gravimetric and electrical resistance methods, while chemical and physical characterization was done based on ASTM standards for wood. Additional determination of heat content for potential recovery of biomass for heating fuel was performed based on ASTM standards. Spatial analysis incorporating field data with laboratory results is being used to create GIS maps that can serve as management tools for the utilization and restoration of this vast biomass resource.

#### progress

The final report was prepared for delivery in summer 2010. We expect two publications to come out of this study.

#### impact

The state of Alaska has a very small forest products industry, which has traditionally been focused on large diameter trees for producing dimensional lumber products. The study will offer insight into the properties and characteristics of fire-killed trees that can potentially be used in a variety of applications including heating fuel, composite materials, and other specialized value-added products.

#### grants/funding

Joint Venture Agreement, USDA Forest Service—Pacific Northwest Sitka Forest Products and Utilization Group

## Sitka Tribe Harvesting Survey

Valerie Barber; Polly Bass (Sitka Tribe of Alaska)

### purpose

Our purpose was to survey and better understand the use and importance of native plants in southeast Alaska. Sitka Tribe has 17 different tribal groups under its jurisdiction. We are surveying these groups' annual harvesting practices (past and present) of non-timber forest products. Sitka Tribe is also conducting interviews with elders to record and preserve harvesting practices information. The UAF Forest Products/Wood Utilization Research program is using the survey to assess interest and resources in potential non-timber forest product businesses.

### approach

Surveyors were hired in each community to gather information from the local inhabitants with a readymade survey. Many of these communities are primarily Native Alaskan but the survey is not limited to only Native Alaskans.

### progress

Over the course of three years, elders and staff conducted 432 surveys and interviews in 15 southeast Alaska communities. Plant harvester respondents included elders, tribal citizens, and community members.

The project employed tribal citizens and provided education on non-forest timber product businesses and marketing, while evaluating the interest in and resources available to initiate such enterprises. Surveyed communities included Sitka, Craig, Kake, Yakutat, Hoonah, Kasaan, Hydaburg, Klawok, Ketchikan, Saxman, Skagway, Haines, Klukwaan, Douglas, and Angoon.

### impact

Hiring surveyors from each community provided some much-needed cash; several communities are excited about potential non-timber forest product businesses.

Traditional plants are an important food and nutrition source for over 90 percent of those surveyed. Individuals desire more instruction on the safe preparation of traditional plant-based foods, other traditional uses of plants, ethical gathering guidelines, subsistence, and small business enterprises and marketing.

Most harvesters are open to the marketing of traditional species by locals at a sustainable level. The project identified the need for a Southeast Alaska Kayaani Commission or similar organization. Commissioners and survey respondents suggested a resolution go before the Alaska Native Sisterhood/Alaska Native Brotherhood Grand Camp and the Alaska Federation of Natives to draw awareness to the need for native species subsistence rights, knowledge preservation, research, and resource protection. A resolution would encourage statewide and nationwide recognition for the protection of native plant species and knowledge.

### grants/funding

USDA Wood Utilization Research-09

## Non-destructive testing of Alaska tree species

Valerie Barber, Larsen Hess

### purpose

Our intent is to use portable acoustical testing equipment to determine wood quality on standing trees and cut logs by developing standard curves of speed of sound vs. soundness of tree. We seek to determine the relationship between standing trees and cut logs.

### approach

We used FibreGen's Director ST300 to test for soundness and rot in standing birch. The Director ST300 is a portable device used to measure the speed of sound waves through standing trees. We cut down a number of trees and cut them into discreet lengths, and then used FibreGen's HM200 on discreet size logs to determine the relationship between the two. The HM200 is a portable device used to measure the speed of sound through cut logs. With these tools we can determine the amount of rot in each tree and evaluate the relationship between soundness and acoustic measurements. All tree species in Alaska will be evaluated and standard curves developed.

### progress

Thirty-eight birch trees ranging from very rotten to very sound and high quality wood were sampled (using the ST300 for standing trees and HM200 for logs) as a senior thesis project; the results were presented in a written thesis and a presentation. Another sixteen birch were measured and sound trees collected for a mill study. Another senior thesis will evaluate aspen. Preliminary data has been collected.

### impact

By applying this method, property owners can make better forestry decisions regarding safety, profit maximization, wildlife habitat, and aesthetics.

### grants/funding

USDA Wood Utilization Research-09

## Anatomical and mechanical properties of woods used to manufacture bassoons

Katy Levings, Valerie Barber

### purpose

We sought to examine Alaska hardwoods for their resonance potential for use in bassoon bells.

### approach

We are first determining anatomical and mechanical features that characterize a good bassoon resonance wood by comparing known resonance woods (*Acer* spp. and *Dalbergia melanoxylon*) to a known non-resonant wood (*Juglans nigra*). Using the features found, we are then examining Alaska hardwoods.

Microscopic analyses will be used to explore cell characteristics; these include transmitted light microscopy (LM), confocal scanning laser microscopy (CLSM), transmission electron microscopy (TEM), and atomic force microscopy (AFM). Vibration and sound tests will be conducted on the woods used as wall material for the bassoon.

All analyses will be used as a basis of comparison for the Alaska woods to be evaluated for bassoon manufacture. The final test will be on a concert stage with bells constructed from the Alaska woods and played on a polypropylene bassoon.

#### progress

We photographed and measured fresh samples and herbarium slides for the analyses. Preliminary LM results indicate that the amount and positioning of parenchyma are important. CLSM micrographs showed that parenchyma overall had more lignin content than the other two major cell types. Attempts at embedding wood for TEM were unsuccessful, and micrographs could not be generated. During vibration testing, it was found that one of the data acquisition components was not sensitive enough to get accurate readings.

#### impact

Information from this study will be made available to musicians and bassoon manufacturers so informed wood choices can be made without the waste normally associated with wood testing in instrument manufacturing.

#### grants/funding

USDA Wood Utilization Research-09

## policy & planning

(see also food policy, under High-Latitude Agriculture, p. 40)

### **International Polar Year: Impacts of high-latitude climate change on ecosystem services and society**

F.S. Chapin, III (UAF Institute of Arctic Biology); T. Scott Rupp, Gary Kofinas; T. Heppa (North Slope Borough Wildlife Department)

#### purpose and approach

Arctic environmental and ecological changes have had profound social impacts on indigenous and non-indigenous people because of both the large magnitude of changes and the generally strong dependence on renewable resources that characterizes northern societies. Ecosystem services, the benefits that society derives from ecosystems, are the critical link between environmental and ecological changes and their impacts on society. Although we know in a general sense that northern ecosystem services are changing, the overall patterns, causes, interactions, and consequences of these changes are too poorly known (or are considered only in isolation from other changes) to provide policymakers and the public with a firm foundation for policy formulation and change. The goals of this research are to (1) document the current status and trends in ecosystem services in the arctic and boreal forest, (2) project future trends in these services; and (3) assess the societal consequences of altered ecosystem services and contribute to adaptive capacity.

#### progress

In year three of this project modeling efforts have focused on (1) the development of downscaled historic and projected

datasets of climate, (2) preliminary simulations of statewide vegetation and fire dynamics component. Objectives 1 and 2 are now complete. We also developed methodologies to assess past and future response of ecosystem services to climate change through the integration of local knowledge and science. Kofinas has worked with Dr. Todd Brinkman, the postdoctoral fellow of the project, to implement this objective. Focus group interviews in four subsistence-based villages were completed, documenting local knowledge of “availability” of important harvested resources. A modeling framework was developed by Brinkman that draws on local knowledge and best available science to project future conditions. Engagement with stakeholders will in the future use these integrated projections to discuss community adaptation strategies. These activities leveraged strongly on the resources and expertise of the University of Alaska SNRAS’s statewide Scenarios Network for Alaska Planning (SNAP) initiative.

#### impact

Ecosystem services are the single most critical link between climate change and societal consequences. By focusing on this critical link, we are, by definition, addressing those ecological changes that are most important to society. By working with communities and other stakeholders to identify the ecosystem services of greatest concern and learning from those communities about the consequences of changes in these services, we are integrating ecological and social dimensions of that linkage, with the explicit goal of helping communities decide which policy options they wish to consider.

#### grants/funding

National Science Foundation

### **Endangered Species Act science and management**

M.A. Cronin

#### 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 for ESA listing, assessment of threatened or endangered status, and possible management actions to achieve specific objectives. Information is translated for dissemination to policymakers and managers. Collaboration with state and federal agency biologists is part of this effort.

#### progress

Since August 2004, information has been provided to the Alaska governor’s office, the Attorney General, state legislators, and the natural resource industries on several Alaska ESA issues, including polar bears, beluga whales, Steller sea lions, sea otters, eiders, loons, goshawks, wolves, and species in the other forty-nine states. Review and assessment of scientific and management documents have been done for several of these species.

## impact

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

## grants/funding

The project is funded with a natural resources grant from the Alaska Legislature to SNRAS.

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

Julie Lurman Joly

### 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 am examining the issue of Assisted Migration, a method of dealing with increasingly endangered flora and fauna in a time of climate change, which is currently being debated by conservation biologists.

2. I am examining how the courts have failed to properly apply the “Best Scientific Data Available” standard and what statistics have to say about what “scientific” really means.

3. I am following up on earlier work examining the potential for direct conflict between the state’s Intensive Management statute and the enabling legislation for certain federal land management agencies. The initial work looked at the issue from the perspective of the National Park Service. This followup work examines the same issues from the perspective of the US Fish and Wildlife Service and the National Wildlife Refuge system.

### progress

1. Our analysis of the existing legal support and legal obstacles to Assisted Migration has been completed. The manuscript describing this work can now be found at: Julie Lurman Joly and Nell Fuller, “Advising Noah: A Legal Analysis of Assisted Migration,” 39 *Environmental Law Reporter* 10413, 2009.

2. This work analyzes why the courts have not given meaning to the term “scientific” and attempts to define what “scientific” ought to mean within the context of the statutes in which the “Best Scientific Data Available” criteria appears. A manuscript has been accepted by the *Stanford Environmental Law Journal* and will be published in the summer of 2010.

3. After an analysis of the applicable statutes and case law was completed it was clear that the conflict in question is impairing the Fish and Wildlife Service’s ability to meet its statutory goals regarding refuge management should preempt these rules on refuge lands. This manuscript has been accepted for publication and will appear in the June 2010 issue of the *Alaska Law Review*.

## impact

1. As the concept of Assisted Migration becomes a hot topic in conservation biology circles it will be useful for

scientists, conservationists, and advocates to understand the legal regime in which such a program would have to operate.

2. This work will be of interest to all federal land and resource managers who operate under a statute that contains “best scientific data available” language. Failure to consider whether data is “scientific” can have significant management repercussions.

3. This project’s findings 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.

## grants/funding

USDA, Hatch. When Laws Affecting the Environment Conflict: Focus on Public Lands

## recreation

### Monitoring indicators in Denali National Park

Peter J. Fix

### purpose

In 2006 Denali National Park and Preserve (DNPP) finalized its Backcountry Management Plan (BCMP). That plan set forth the management direction of the backcountry, and seeks to preserve the unique character of backpacking in Denali. A key component of the plan is indicators and standards. Indicators are conditions important to the backcountry experience in Denali and standards are the maximum acceptable level of the indicators. The BCMP identified five indicators for resource conditions and five indicators for social conditions.

The indicators of resource conditions are:

- Trail and campsite disturbance;
- Evidence of modern human use;
- Landscape modifications;
- Litter and human waste;
- Natural sound disturbance.

The indicators of social conditions are:

- Encounters with people;
- Encounters with large groups;
- Camping density;
- Accessibility;
- Administrative presence.

As specified in the BCMP, several of these indicators are to be measured by visitor survey once every five years. This study will serve as the first measure of the indicators after the BCMP has been adopted.

### approach and progress

Visitors hiking in the backcountry (both day hikers and overnight backpackers) will be sampled and asked to fill out a survey. The survey will ask what level of the indicators they encountered while in the backcountry. The survey was developed and approved by the Office of Management and



Budget in 2009; the survey will be administered in summer 2010.

#### impact

The results of this survey will help DNPP determine if current conditions in the backcountry are within standards specified in the BCMP. Adaptive management will be applied as needed.

#### grants/funding

This project was funded by the National Park Service.

### Squirrel River sport hunter study

Peter J. Fix, Andrew M. Harrington

#### purpose

This project was designed to assist the Bureau of Land Management in developing a management plan for the Squirrel River area. A study was designed to provide managers information regarding the extent and causes of conflict between residents and non-residents and to gather information to assist in implementing Benefits Based Management. This phase of the study focused on sport hunters.

#### approach and progress

A mail survey was sent to hunters who returned a Squirrel River area harvest tag to the Alaska Department of Fish and Game during 2006–2008. One hundred eighty-four surveys were completed (55 percent response rate). For the analysis, these 184 surveys were combined with 17 surveys completed on site in fall 2008 at the Kotzebue airport.

#### impact

This study will assist the Bureau of Land Management in understanding the nature and extent of conflict on lands the BLM manages as well as provide guidance in developing appropriate management plans. Results showed that most sport hunters were from the Lower 48 (73 percent), and many had hunted in the area before. Caribou was the primary focus of the hunt for 77 percent of the respondents. In addition to harvesting game, important reasons for visiting the area included escaping crowds, experiencing nature, and exploring the area. Of particular interest to this study, the mean level of crowding was very low (1.3 on a 9-point scale where 1 = not at all crowded) and, of twelve statements regarding potential sources of conflict, only two were rated above “slight problem:” lack of meat processing facilities in Kotzebue and lack of meat shipping facilities in Kotzebue.

#### grants/funding

This project was funded by the Bureau of Land Management to study recreation issues in the state.

### revegetation

#### 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 eighth year of a long-term study. Imagery was taken on September 16, 2009. Ground-based plot photography was also obtained at this time for high-resolution cover estimates to calibrate and test vegetation indices. While chickweed initially infested the site during the first couple of years, it has since decreased in abundance and is only a minor component now. Other problem species (white sweet clover, hawksbeard, bird vetch, and pepperweed) have increased slightly over last year. Annual ryegrass persists in the area; however, native bluejoint is increasing. Shrubs, wild rose and cranberry, and birch are becoming more visible above the herbaceous layer and easily detected in remote sensing imagery.

#### 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 the monitoring of revegetation efforts.

#### grants/funding

USDA Hatch

### water & wetlands

#### 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 by locating 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.



*Boat launch at Harding Lake, about 40 miles south of Fairbanks, Alaska. John Fox has been studying change in the lake's water levels.*  
 PHOTO BY BEEBLEBROX, WIKIMEDIA COMMONS, CREATIVE COMMONS ATTRIBUTION-SHARE ALIKE 3.0 UNPORTED

### progress

Review of maps, aerial photographs, ground photographs, and land survey notes rendered valuable evidence on the history of lake level changes from the early 1920s to the present. It facilitated the hypothesis that the regimen of Harding Lake changed after a flood in 1967 that resulted in the capture of Rogge Creek by a new channel flowing toward the Salcha River. Monthly water balance simulations of Harding Lake were calibrated with measured water level data from 2004–2008. The model was then used to estimate unknown historic contributions from Rogge Creek from 1950–2003 and to speculate on the future lake levels. Winter lake level measurements revealed an initial decline followed by a period of little change. One reasonable explanation of these perplexing winter changes, that still needs to be tested, is that the water level drops in early winter as ice thickens around the periphery of the lake and becomes grounded. This effectively reduces the volume of liquid water (and floating ice) in the lake. Once ice formation proceeds from the lake perimeter to where the water is deeper than the maximum ice thickness, the lake level holds steady until breakup. The summer of 2009 was marked by the lake holding steady the

increased levels from 2008. It appears that the input to the lake from Rogge Creek was just enough to counterbalance the net losses from evaporation and seepage. Future lake levels will be largely dictated by precipitation, since during rainy days evaporative loss is reduced, water is added directly to the lake, and runoff from Rogge Creek is increased. Adjustments to the control structure on Rogge Creek may be needed to ensure that significant contributions to the lake occur. Some concern exists that the new channel flowing to the Salcha at the diversion structure may experience accelerated erosional down-cutting due to the lowered base level of the Salcha river relative to Harding Lake.

### impact

The information collected for this project has contributed to the design and operation of the Rogge Creek diversion structure and provided projections of its impact on lake levels. Information continues to be shared with the State of Alaska Dept. of Natural Resources, and Dept. of Fish & Game. I presented a poster and extended abstract at the American Water Resources Specialty Conference summarizing this study. From a scientific perspective this project underscores

the importance of site-specific data for precipitation and stream flow measurements, and the difficulty of assessing net groundwater flow for the lake. Observations also support the hypothesis that lake evaporation may be higher than previously expected, particularly in the fall.

#### grants/funding

USDA McIntire-Stennis

### Feasibility study for development of a storm water utility in the City of Fairbanks

Jackson Fox, Susan Todd

#### purpose

The purpose of this master's degree project is to determine if the City of Fairbanks would save money on legally-mandated storm water management services by creating a storm water utility.

#### approach

This project will assess the following:

- The cost of existing city storm water management services;
- The expected future cost of required storm water management services, including capital improvements and large deferred maintenance projects;
- The cost of establishing a storm water utility;
- Alternative utility fee structures.

#### progress

Work began in September 2009 and is expected to be completed by fall 2010.

#### impact

In June 2005, the US Environmental Protection Agency required the city to institute new storm water management programs, including illicit discharge detection/elimination, construction site storm water management, and other activities. Complying with these requirements has placed a substantial burden on the city's general fund, including the creation of a new environmental manager position to direct the development and implementation of the city's storm water management services. The city is therefore considering developing a storm water utility to represent an equitable way for the community to share the cost of this public service. This feasibility study will benefit not only Fairbanks but many other communities in the far north to decide how to pay for storm water management.

### Impacts of water and sanitation projects on communities in Ghana

Josie Osafo-Adu Sam, Susan Todd

#### purpose

This PhD project considers the impacts of water wells on community life in two villages in Ghana, with emphasis on its effects on women and children.

#### approach

A combination of interviews, surveys, local school and clinic records, and participant observation will be used to assess the impacts.

#### progress

Initial fieldwork was completed in August 2009; final fieldwork will be completed in the summer of 2010.

#### impact

Water, sanitation, and hygiene education projects are vital in Ghana, where inadequate water and sanitation contribute to over 70 percent of diseases. Women and girls spend an average of four hours each day obtaining the family's water. This time commitment limits women's ability to take part in decision-making and food production and it is common for girls to be pulled out of school to help with this task. Anticipated types of impacts include improved health, improved farming output due to reliable access to water, increased school attendance by girls, more time for women to be involved in decision-making roles and economically productive work, and greater gender equity.

#### grants/funding

The project is funded by the Nyarkoa Foundation.

### Status and distribution of wetland habitats in the Greater Fairbanks Area

Jennifer Jenkins, Susan Todd

#### purpose

The purpose of this master's degree project was to delineate wetland habitats in the Fairbanks area.

#### approach

Using 2007 and 2002 imagery, wetlands within the Greater Fairbanks Area were delineated using an on-screen (head-up) method and classified using an image interpretation guide developed by the US Fish and Wildlife Service Fairbanks Field Office. Once delineation and classification were complete, data were field checked.

#### progress

The project was completed in the fall of 2009.

#### impact

It is not possible to protect wetland habitats if you don't know where they are and that is essentially what the situation has been in the Fairbanks area. The images provided by this effort are at a higher resolution than anything previously available in Fairbanks; the database was created using a locally developed classification system. Fairbanks has seen considerable development in areas that are predominantly wetland habitats. As these habitats are lost and/or degraded, there is a growing need to assess the acreage, locations, and types of wetlands in the Fairbanks area. This project will facilitate such an assessment.

#### grants/funding

The work is supported by the US Fish and Wildlife Service.

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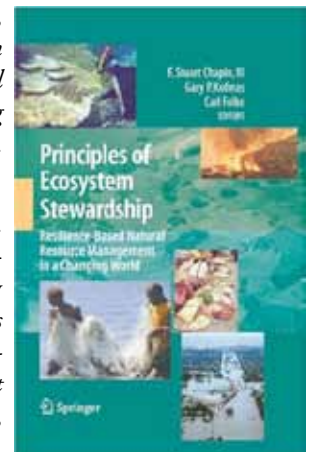
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*Alice Orlich, SNRAS graduate, at approximately 78°N 145°W in the Canada Basin of the Arctic Ocean, just north of the Beaufort Sea. Orlich describes her work there: "We were at a buoy deployment floe of multi-year ice...all the necessary work had been completed and we were awaiting a helo flight back to the ship." Orlich is the recipient of a Space Grant fellowship, and has been taking ice observations and samples in a satellite validation project, comparing in-situ sea ice data with AMSR-E and SSM/I imagery and tracking the movement and deformation of the ice pack in the Arctic.*

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