

School of Natural Resources & Agricultural Sciences

Agricultural & Forestry  
Experiment Station

# Annual Report 2003



This photo shows a fire in a spruce forest in the Innoko National Wildlife Refuge. Scientists at SNRAS are studying the effects of fire on carbon bioavailability in soils, boreal forest soil respiration, climate change, and the ecology of morel mushrooms. Other fire-related projects study the vulnerability of human populations to wildfire, fuel loads in forests, and management methods that benefit both humans and the forest ecosystem. For reports on fire-related projects, see pages 8 and 27.

—U.S. FISH AND WILDLIFE SERVICE

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

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## Contents:

3.....Financial statement

4.....Grants

6.....Students

7.....Research reports

7 • Geographic Information

10 • High-Latitude Agriculture

21 • High-Latitude Soils

23 • Management of Ecosystems

34 • Natural Resources Use and Allocation

42.....Publications

45.....Faculty

## Letter from the dean:

September 10, 2004

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



Dear Sir:

I submit herewith the annual report from the Agricultural and Forestry Experiment Station, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks, for the period ending December 31, 2003. 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.

Very respectfully,

Carol E. Lewis  
Dean and Director

# AFES Statement of Purpose:

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

3 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.



The Palmer Research & Extension Center, part of the Agricultural and Forestry Experiment Station.

—PHOTOS BY CONNIE HARRIS

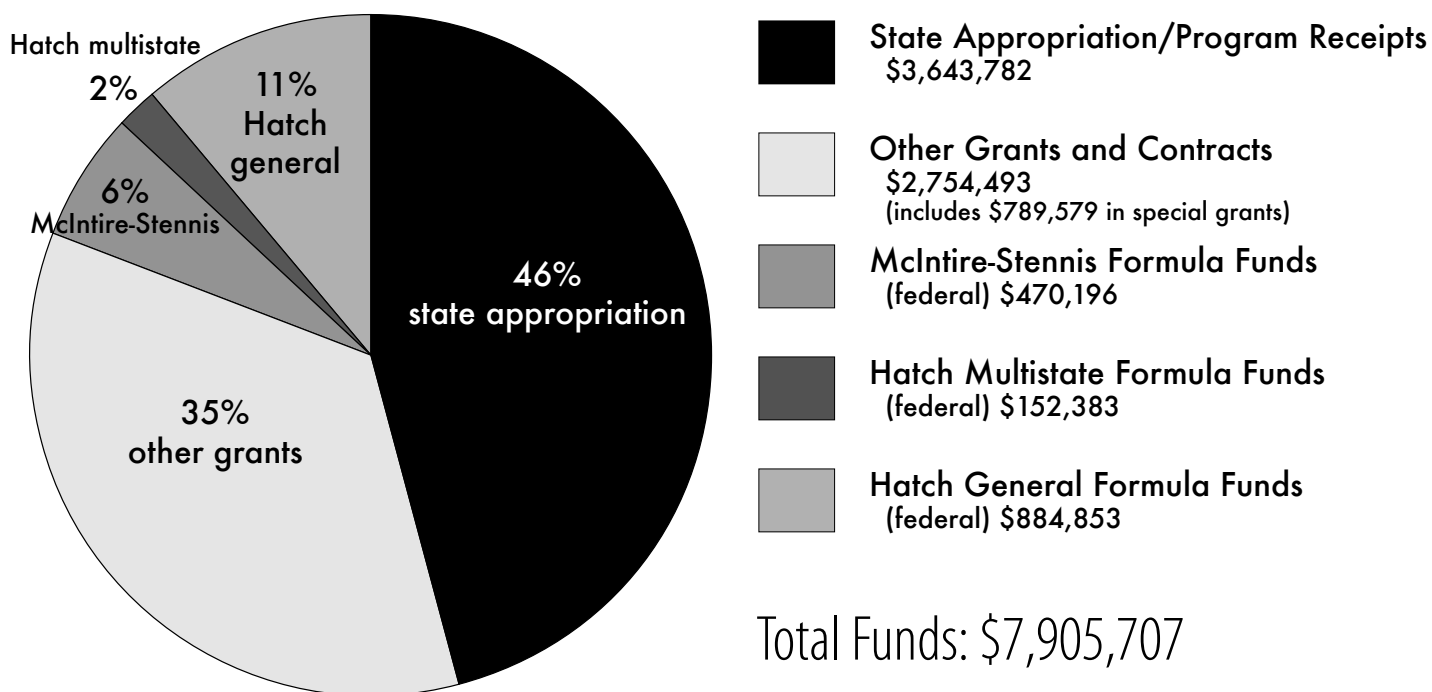


The Matanuska Experiment Farm, adjacent to the Palmer research center.

# Financial statement

## Expenditures: July 2003 through June 2004

The following statement of expenditures of federal and state funds for the fiscal year beginning July 1, 2003 and ending June 30, 2004 (FY 04) is not an accounting document.



# Grants

4

## GRANTS & CONTRACTS/SPECIAL FUNDS

Forest Products II	Brackley	USDA
Forest Products III	Brackley	CSREES
Forest Wood Products IV	Brackley	USDA
Long Term Ecological Research	Chapin	NSF
LTFR Forest Research II	Chapin	USDA / PNW
Extended University	Finstad	UAF / CRA
Virus Vaccination	Finstad	BIA
Satellite Telemetry	Finstad	BIA
Reindeer Herding	Finstad / Greenberg	NSF
CESU, USGS	Fix	USGS
CESU, BLM	Fix	BLM
Alaska Resident Statistics Program	Fix	USDA Forest Service
CESU - NPS	Fix	NPS
International Model King / Snow Crab	Greenberg	NRPB
Near-Earth Remote Sensing	Harris	USDA Forest Service
Foundation Botanical Garden	Holloway	UAF Foundation
GBG Children's Garden	Holloway	UA Foundation
Rotary Garden Pavilion	Holloway	UA Foundation
Environmental Changes 2	Juday	Columbia University
Alaska GAP	Karlsson	Cornell University
Berry Research	Karlsson	USDA
Rural Development / AK Native Berry	Leiner	USDA
New Crops II	Lewis	USDA
New Crops III	Lewis	USDA
New Crops IV	Lewis	USDA
AK Seed Grower Assistance	Lewis	USDA
Pontoja Task Order 04	Lewis	ARS
Geospatial Science Learning	Lewis / Fenno	NSF
Capital Virus Free Seed Potato	McBeath	Department of Commerce
Maintain Alaska Potato Export Status	McBeath	DNR
Robertson Task Order FY04	Mitchell	USDA
Biocomplexity	Ping	NSF
Wet Soils Monitoring	Ping	USDA SCS
High Latitude Terrestrial	Rupp	NSF
Assessing Vulnerability	Rupp	USDA
Computer Model	Rupp	USDI
Fire-Mediated Changes — Rupp	Rupp	NSF (IAB)
Forest / Climate change	Rupp / Yarie	NSF
Global Change Education	E. Sparrow	NSF
Global Climate Variability	E. Sparrow	DNR / NASA
Integrated Phenology	E. Sparrow	Utah State University

High Latitude Terrestrial	Verbyla	NSF
EOS Training Workshop	Verbyla	University of Montana

Natural Resources Fund		
Model Restatement for Boreal Forest Mngmt Regulations	Bader	NRF
Circumpolar Regional Database	de Wit	NRF
Management plan for UA experimental forest	Fox	NRF
UA/MIT Agreement / NRF	Lewis / Trent	NRF
AFES Plant Research	Mitchell / Sparrow / Zhang	NRF

5

USDA FORMULA FUNDING, FEDERAL Oct 1 to Sept 30 Fiscal Year		
Hatch Multistate		
Regional Administration (W-106)	Lewis	USDA
Soilborne Plant Pathogens (W-1147)	McBeath	USDA
Shipka (W-112)	Shipka	USDA

Hatch General		
Reindeer Production & Meat Quality	Finstad	USDA
AK Natural Resources	Greenberg	USDA
Spatially Modeling Dist of Beef Cattle	Harris	USDA
AFES Horticulture Crop	Holloway	USDA
Natural & Supplemental Light	Karlsson	USDA
Cultivar Selection	Leiner	USDA
Production Practices	Leiner / Smeenk	USDA
Plant Microbe Interactions	McBeath	USDA
Forage & Turfgrass	Mitchell	USDA
Palmer Administration	Mitchell	USDA
Black Spruce Forest Soils	Ping	USDA
Domestic Ruminants	Shipka	USDA
Potential Forage Crops	Sparrow	USDA
Enviromental Decisions	Todd	USDA
Yield & Quality of Barley	Zhang	USDA
Variety Testing	Zhang / Sparrow	USDA

McIntire-Stennis		
Forest Timber Harvest	Fox	USDA
Ectomycorrhizae	Helm	USDA
Foresty Ecology	Juday	USDA
Forest Stand	Packee	USDA
Soil Carbon Balance	Valentine	USDA
Satellite Change Detection	Verbyla	USDA
Forest Ecosystem Monitoring	Yarie	USDA

Animal Health		
Mineral Flux in Reindeer	Finstad	USDA

# Students

## Graduates as of May 2004

### Baccalaureate Degrees

Tia Callison, BS, Natural Resources Management (PASS)  
 Matthew Dusenbury, BS, Natural Resources Management (PASS); *magna cum laude*  
 Andrea Facio, BS, Natural Resources Management (PASS); *magna cum laude*  
 Christopher Fay, BA, Geography  
 Michael Gibson, BS, Natural Resources Management (Resources); *magna cum laude*  
 Jason Hoffman, BS, Geography; *cum laude*  
 Paul Kephart, BS, Natural Resources Management (PASS)  
 Francesca May, BS, Geography  
 Cody Peterson, BS, Natural Resources Management (PASS)  
 Margaret Rogers, BS, Natural Resources Management (Forestry); *magna cum laude*  
 Clint Talley, BA, Geography  
 Karen Tilton, BA, Geography  
 Kathleen Tschida, BS, Geography  
 Catherine Webb, BS, Geography; *Golden Key Honor Society*

### Masters Degree

Robin Andrews, MS, Natural Resources Management

### Doctors of Philosophy

Dorte Dissing  
 Climatology: Interdisciplinary Program  
 Thesis title: Landscape Control of Thunderstorm Development in Interior Alaska  
 Jason Gene Vogel  
 Forest Sciences: Interdisciplinary Program  
 Thesis title: Carbon Cycling in Three Mature Black Spruce (*Picea mariana* [Mill.] B.S.P.) Forest in Interior Alaska  
 Martin Wilmking  
 Landscape Ecology/Earth System Science: Interdisciplinary Program  
 Thesis title: The Treeline Ecotome in Interior Alaska—From Theory to Planning and the Ecology in Between

### Statistics

#### Degree conferred summer 2003

1 baccalaureate

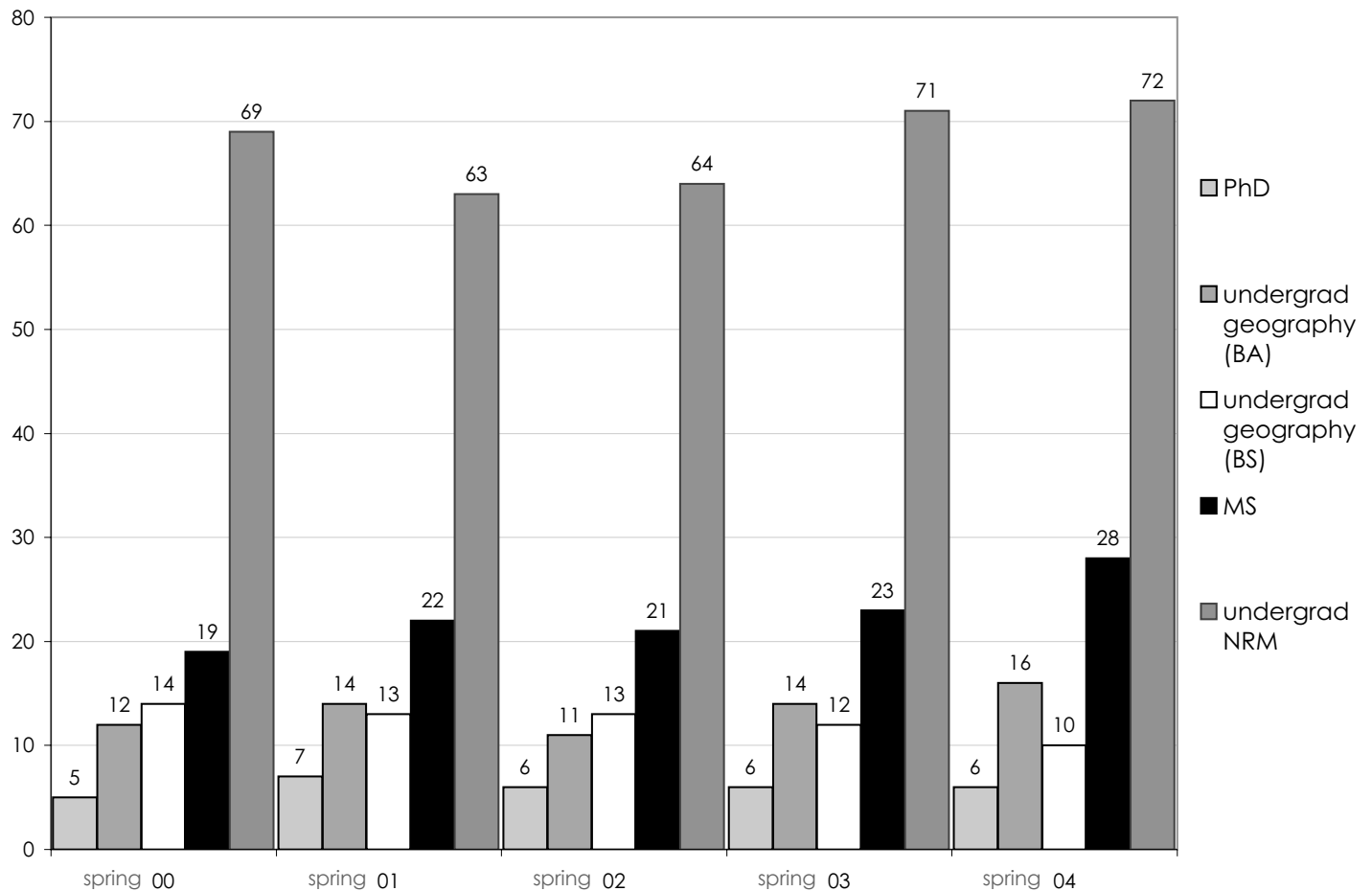
#### Degrees conferred fall 2003

2 doctors of philosophy, 4 baccalaureates (1 bachelor of arts, 3 bachelor of science degrees)

#### Degrees conferred Spring Commencement 2004

1 doctor of philosophy, 1 master of science, 9 baccalaureates (2 bachelor of arts, 7 bachelor of science degrees)

## Five-year enrollment history



# Research Reports

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

## ***Agricultural Research Service***

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

## ***Boreal Ecosystem Cooperative Research Unit***

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

## Report Subject Index

- 7 **geographic information**
  - 7 • climate research
  - 8 • fire
  - 9 • invasive plants
  - 9 • livestock and range management
- 10 **high-latitude agriculture**
  - 10 • animal husbandry
  - 13 • controlled environments
  - 14 • field crop production
  - 18 • forage, tillage, and turf experiments
  - 19 • pest and disease control
- 21 **high-latitude soils**
  - 21 • carbon in soils
  - 23 • wet soils
- 24 **management of ecosystems**
  - 24 • climate research and global change
  - 27 • forests and fire
  - 32 • succession and revegetation
- 34 **natural resources use and allocation**
  - 34 • fisheries management
  - 35 • forests and trees
  - 39 • policy, use, and planning

## Geographic Information

### **Perceptual geography of Alaska**

Cary de Wit

purpose

This study explores how popular perceptions of Alaska affect national opinions on Alaska political and environmental issues. Alaska is one of the most recognized states in the Union, and yet one of the most inaccurately perceived. A remarkably consistent montage of Alaska imagery appears today on a national scale through advertising, post cards, placemats, greeting cards, product labels, magazines, television shows, and films.

approach/method

Collection of imagery from advertising, postcards, films, television programs, and other sources of widely disseminated images of Alaska. Categorization and analysis of images according to source, intended purpose, location of production, and type of Alaska image portrayed.

progress

Progress continues on collecting images and formulating an analysis structure while soliciting feedback on the project through paper presentations at professional meetings.

impact

The strength and persistence of these images in the American psyche, however inaccurate, can significantly influence national sentiments toward many salient political and environmental issues. Debates over pipeline development, snowmobile use, and oil exploration on federal lands in Alaska can be highly subject to American public perceptions, though most Americans have never visited, and never will visit, Alaska. The battles over these issues are largely battles to establish the prevailing national perception of Alaska. 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, both Alaska citizens and residents of other states.

## climate research

### **Decrease in surface water across the landscape of subarctic Alaska**

Brian Riordan, David Verbyla

purpose

This study investigates the change in surface water areas from closed-basin lakes and ponds from 1950 to present across nine regions in Alaska.

approach

Aerial photography and satellite imagery from 1950 to 2002 were used to assess the change in surface water area of over 15,000 closed-basin water bodies in nine regions that range from the Kenai Peninsula to the Arctic Coastal Plain. The area of each water body polygon was computed and stored as an attribute in the GIS. Regional changes in surface water were estimated by summing the area change from each water body between sequential time periods.

progress

The Arctic Coastal Plain region, which is underlain by deep continuous permafrost, had negligible change in surface water area from 1950 to 2000. The eight regions in subarctic Alaska lost surface water during the same period. Many of the regions did not show a significant decline in surface water area until after the mid 1970s. Changes in precipitation regime since the 1950s may have influenced the observed pattern of regional surface water reduction. However, for the nine regions studied, there was a weak relationship between August to July precipitation and surface water area. Two mechanisms that may be responsible for surface water reduction are 1) increased evaporation and plant transpiration associated with climate warming, and 2) increased drainage associated with permafrost melting in regions of discontinuous permafrost.

impact

This study documented that for many subarctic landscapes in Alaska, there has been a significant reduction in surface water areas of closed basin lakes and ponds. A drying landscape could affect waterfowl production, wildfire risk, and insect infestations at the landscape scale.

fire

### Assessing the vulnerability of human populations to wildfire in the Lake States

T. Scott Rupp (SNRAS); Rich Howard (Assisi Software Corp.); Robert Haight (USFS)

purpose

Wildfire risk within the Lake States (Minnesota, Wisconsin, and Michigan) is high. This region has large numbers of fire ignitions and areas of fire-prone forest types. Moreover, fire suppression and forest management has led to uncharacteristically expansive tracts of fire-susceptible ecosystems with altered age-class distributions of short-lived species (e.g., jack pine and balsam fir). These changes produced serious forest health concerns, including insect infestations and natural senescence resulting in increased fuel loadings, and hence fire risk.

approach

This research will develop new approaches to regional fire risk assessment that couple ecological and social factors into a fire risk and consequence model, with an emphasis on reducing the potential for loss of life and property. The overall goal is to provide managers with a scientifically based decision support

tool for prioritizing fire risk reduction activities in a regional, landscape, and local context.

progress

This project has been extended. A spatial model has been developed for evaluating fuel treatment plans using genetic algorithms as a novel optimization strategy. A peer-reviewed journal article is being prepared for submission to the journal *Forest Science* in fall 2004.

impact

Analysis of community vulnerability to wildfire will produce spatial data sets of current vulnerability based on biophysical-based fire risk, human settlement patterns, and suppression resources. Spatial data sets of community vulnerability to wildfire will provide critical current fire risk information to fire management personnel, as well as long-term information to both fire managers and planners.

### Influence of vegetation type and topography on burn severity in interior Alaska

Justin Epting, David Verbyla

purpose

Wildfire burn severity is important in controlling soil carbon loss, immediate carbon emissions, and subsequent post-fire vegetation succession and carbon sequestration. Pre-fire vegetation and topographic conditions may influence wildfire burn severity. This study uses remote sensing methods to investigate the effect of pre-fire vegetation and topographic variables on burn severity.

approach

The study site was the 1986 Eureka Creek burn within the Yukon-Charley Rivers National Preserve. Acquired for the analysis were six Landsat TM and ETM+ satellite images for a time series just before the burn to 2002. Field data from 1986 and high-resolution aerial photography from 1986 and 2002 were used to map vegetation types within the study area. A burn severity map was created using the Normalized Burn Ratio and an elevation grid was used to estimate slope direction and gradient for 25-meter cells in the study area.

progress

Burn severity was strongly controlled by vegetation, with spruce forests experiencing much higher burn severity than broadleaf forests, shrubs, and woodlands. Elevation also influenced burn severity, presumably due to its control on vegetation composition. Areas vegetated with spruce forest had higher burn severity than broadleaf forests and nonforested areas. Higher density spruce, with its greater fuel load, had the highest burn severity values.

impact

This study confirmed at a landscape scale the general hypothesis that a broadleaf shrub or broadleaf forest stand can act as an effective fire break, while black spruce stands typically have higher burn severity values. Vegetation type influenced burn severity more strongly than slope gradient, elevation, or slope direction in a statistical model.



## invasive plants

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

Tricia Wurtz, Norman Harris (SNRAS); R. Ikeya (State Univ. of New York)

#### purpose

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

#### approach

At various times in the summer, spectral data is acquired using a small, tethered, helium-filled blimp carrying a digital camera and a 35mm-camera loaded with color infrared film. Shots were obtained of study plots at four different altitudes.

#### progress

Shots were obtained during the middle of June over a five-day period as the river approached flood stage. Six out of our ten plots were covered by high water and the structure of the flood plain has changed considerably. The imagery is currently being analyzed.

#### impact

Land managers can effectively and cost efficiently use remote sensing data to detect and monitor weed infestations, if the data has sufficient resolution for the project.

## livestock and range management

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

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

#### purpose

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

#### approach

The study started in October 1, 2000 and will continue until September 30, 2005. Researchers in each state use global positioning system (GPS) collars and visual observations to track animal movements and quantify animal activities on the landscape. Data will be spatially and temporally analyzed to develop a model.

#### progress

The analysis of data from previous years has allowed development of a software modeling program called Kinetic Resource and Environmental Spatial System, or KRESS. The software develops model scenarios using a multi-criteria evaluation (MCE) technique. KRESS has gone through several beta

tests and a new module was developed this year to test model performance against GPS collar data using a relative operating characteristic (ROC) analysis.

#### impact

The KRESS model will allow land managers and livestock producers to predict the effects caused by landscape factors and management actions to determine best management practices for effective and efficient use of public and private lands.

### Reindeer Research Program and NRCS satellite telemetry and range monitoring

Darrell Blodgett, Greg Finstad

#### purpose

The Reindeer Research Program collects, processes, and archives satellite telemetry locations of satellite-collared reindeer in a joint project with the Natural Resources Conservation Service (NRCS). Initially this location data is used to generate maps used by reindeer herders to locate and track their reindeer. NRCS and the reindeer herders can also use this information collected over time to better assess and manage reindeer ranges based on grazing history. We needed an interface to our satellite location data that would provide for mapping location information over periods of time.

#### approach

The satellite collar telemetry data is collected, processed, and archived automatically on the Reindeer Research Programs server. We have been using Generic Mapping Tools (GMT) to create the maps used by herders to locate and monitor their reindeer. By allowing the user to interactively select the data, time periods, map overlay information, and map boundaries through a web form, a custom map can be created for the user.

#### progress

A web form has been created which allows the user to select satellite collar IDs, time periods, ranges and other overlay information. When the user clicks on "Make Map," the information that has been selected is sent to a script that processes the selections into GMT commands. The resulting postscript map is converted to a JPEG file and displayed in the web browser.

#### impact

Reindeer herders, land managers, and researchers will have quick and easy access to both current and historical grazing location maps. This assists in range management by both assessing range utilization and monitoring grazing over time.

### Satellite radiotelemetry and reindeer management

Greg Finstad, Darrell Blodgett

#### purpose

Many reindeer herders are unable to locate all groups of free-ranging reindeer roaming over large, remote, and inaccessible grazing ranges. Proper range management requires that locations and grazing patterns of animals be known. Proper location of reindeer herds is crucial for avoidance of migratory

caribou herds. The Reindeer Research Program (RRP), collaborating with the Reindeer Herders Association, continued to improve a system for animal location, automated mapping, and Internet management. This system will help reindeer herders locate and manage their animals over large landscapes.

approach

Locations of reindeer fitted with satellite collars are obtained by the NOAA satellite system and mapped with an automated mapping developed by the RRP and placed on a special website. The herder views current locations of reindeer and caribou on the Internet just prior to herding activities. Animal location records are examined to evaluate range utilization and seasonal grazing patterns of reindeer.

progress

Reindeer in twelve herds were equipped with thirty-six satellite collars and their movements monitored and mapped during 2003. Herders accessed locations of collared reindeer through the Internet and based management decisions on this information. Maps were modified to provide more user-friendly data to the herder.

impact

A more efficient reindeer management system is possible by integrating satellite radiotelemetry locations with range management. Herders can quickly locate scattered reindeer, monitor seasonal habitat usage, react to unexpected movements, and quickly make adjustments in herd location to avoid migratory caribou.

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

Norman Harris, Beth Hall

purpose

The promotion of meat animal production is culturally and economically important in Alaska. A better understanding of animal interactions with their environment will allow producers to optimize feed rations and minimize adverse impacts to the landscape.

approach

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

progress

In this ongoing study, observational data was collected using the UAF beef cattle herd at the Matanuska Experiment Farm. An array of self-recording thermistors was placed on cattle pastures to determine thermal patterns in winter and early spring. Principal components analysis was used to determine the relationship of thermal patterns to landscape features and habitat type.

impact

This modeling effort will give Alaska meat producers another tool for developing cost-effective management strategies.

Consumers will benefit from the further development of an Alaska-based meat industry.

## High-Latitude Agriculture

### animal husbandry

### Aquaculture and livestock feed supplements from fish processing wastes

Peter Bechtel (ARS/USDA)

purpose

The Alaska fishing industry produces over one million metric tons of byproduct and waste annually. Currently almost all of the fishery waste from large processors is converted to low-value, high-ash meal for sale abroad. Meal production is considered a cost of doing business and has not yet become recognized as a significant source of revenue. Much of the waste from smaller processors is disposed using the grind and dump method. Recent regulatory changes requiring 100 percent utilization of cod and pollock make the development of best-use end products urgent. This study seeks to document and characterize the various sources and existing secondary products and to develop new and higher value materials for feed ingredients for animal (agriculture and aquatic) feed.

approach/progress

**Fish testes:** The pilot-level production of fish testes meals and their characterization has been accomplished. Steroids, both anabolic and reproductive, are present in significant quantities in these meals. This suggests that testes meal could be used as a component in fish feed formulations that are based on plant protein, because recent analyses have shown the presence of these steroids in fish meals made from whole fish or seafood processing byproducts. The promise of testes meal to stimulate the immune system in cultured salmonids is an intriguing possibility, although this hypothesis cannot be confirmed without further research.

**Hydrolysis:** The degree of hydrolysis (DH) is an important characteristic of fish protein hydrolysates because it influences peptide length, nutritional properties, and other peptide characteristics. Hydrolysis of ground red salmon heads by different enzymes was evaluated and their effect on percent of oil recovery was determined. The oil layer was removed and DH determined for the protein fractions. The DH of red salmon heads after 75 minutes of hydrolysis ranged from 16.1 to 6.4 percent. Recovery of oil ranged from 5.5 to 10.6 percent and was affected by both incubation time and enzyme type. This study showed that different enzymes, as well as the length of incubation, influenced both the DH values and oil yield from red salmon heads.

**Longfin amberjack growth:** In two growth trials, the nutritional quality of Alaska fish meal for Longfin amberjack was found to be high. In a six-month preliminary trial, one group of fish was fed a diet made with Alaska fish meal, while a second group was fed a commercial feed; both diets were similar in

protein and oil content. Fish growth and survival were similar in both groups. Fish fed the Alaska fish meal had lower liver lipid level than those fed the commercial feed. This is important because elevated liver lipid levels in cultured fish have been identified as a potential indicator of reduced nutritional quality. The information generated from this work could be instrumental in persuading aquatic feed manufacturers to replace traditional fish meals (which are often imported) with fish meals made from byproducts of the Alaska fish processing industry. This work is being followed up in more far-reaching trials.

**Longfin amberjack quality:** A preliminary trial was conducted to establish baseline information on flavor and texture attributes of market size (4–6 kg) amberjack reared on two diets, a commercial feed (50 percent protein and 14 percent lipid) and an experimental feed of similar composition prepared at Oceanic Institute using Alaska fishery byproducts as the principal ingredient. For evaluation of appearance, texture, and flavor qualities, cooked amberjack fillet cubes (two samples for each diet) were presented to a trained sensory panel at the University of Hawaii, Manoa. Overall, the amberjack fillets had an attractive appearance and were moderate in all textural and flavor attributes, and no significant differences ( $P > 0.05\%$ ) were found in fish texture and flavor between the fish reared on the two diets.

**Shrimp diets:** To optimize the use of Alaska fishery byproduct meal in shrimp diets, we examined the functional and contributory roles of the bacterial and phytoplankton components in shrimp culture systems. By contrasting the incorporation pattern from the feeds with and without the microbial components, it will be possible to better define the relative roles of the feed and the microflora; this should improve the use of fishery byproducts in an environmentally and economically sound manner.

**Piglet trials:** Feeding trials with early-weaned piglets in which fish hydrolysate meals replaced porcine plasma protein were completed. The studies demonstrated that partially hydrolyzed fish protein from Alaska seafood waste could partially replace porcine plasma protein, worth between \$1500 and \$2500 per ton. Further research is necessary to develop this product for this specific use, but the potential economic return to Alaska seafood processors is substantial if such a product can be developed and successfully marketed.

**Fish hydrolysates:** Hydrolysates produced using Alaska fish byproducts were shown to enhance the palatability of diets for rainbow trout that contain soybean meal. Soybean meal is likely to be a major dietary constituent of farmed fish diets in the future, but problems with palatability limit its use. Using a small amount of fish hydrolysate protein in the diet could at least partially overcome this problem.

#### impact

This research should lead to development of high-value products from Alaska fish processing waste for future use in plant protein-based diets for many carnivorous species of farmed fish, and increase economic returns to seafood processors in Alaska.

## Estrus synchronization in reindeer

Milan P. Shipka, Jan E. Rowell, M.C. Sousa, A.M. Hirth

#### purpose

Although estrus synchronization as a reproductive management tool has been tried sporadically in reindeer since the early 1970s, studies did not provide detailed methodology, timing of events, and effects of season. This study aimed to investigate the use and effectiveness of two estrus synchronization tools in reindeer cows: (i) controlled internal drug releasing device (CIDR) containing progesterone initiated prior to the onset of the breeding season and (ii) a two PGF2 $\alpha$  injection protocol initiated after the onset of breeding season.

#### approach

The study was conducted from 21 August until 30 October, using 21 reindeer females ranging from two to five years of age. Group one cows received progesterone containing CIDR (Eazi Breed, Pharmacia & Upjohn, Kalamazoo, MI), inserted on 21 August, in combination with a 15 mg intramuscular injection of prostaglandin (PGF2 $\alpha$ ; Lutalyse, Pharmacia & Upjohn, Kalamazoo, MI) at the time of CIDR withdrawal 11 days later. Group two cows received two intramuscular 15 mg injections of PGF2 $\alpha$ , 11 days apart, with the first injection occurring on 11 September. Following completion of each estrus synchronization protocol, the females were penned with mature reindeer bull for 7 days. Blood progesterone was used to determine estrous cyclicity and pregnancy.

#### progress

Estrus synchronization was achieved with 100 percent effectiveness in reindeer cows receiving the progesterone containing CIDR. Ten of eleven of these females conceived during the one week harem period (fertility rate = 91 percent). Estrus synchronization was achieved with 80 percent effectiveness receiving two injections of PGF2 $\alpha$  eleven days apart. Seven of ten of these females conceived during the one week harem period (fertility rate = 70 percent). There were no differences in synchrony rate (Fisher's Exact;  $df = 1$ ;  $p = 0.214$ ) or in fertility rate (Fisher's Exact;  $df = 1$ ;  $p = 0.256$ ) detected in a comparison of the CIDR vs. LSPGF group.

#### impact

Determination of the efficacy of estrus synchronization methods among reindeer cows enhances breeding management and allows shorter harem periods that translate into shorter calving periods. This increases producer efficiency and potentially enhances calf survivability.

## Online reindeer herd record-keeping system

Darrell Blodgett, Greg Finstad

#### purpose

The Reindeer Research Program has collected years of animal production and health records on Seward Peninsula reindeer herds that are used by the reindeer herders to make management decisions. Herders did not have immediate access to this database because it was stored in proprietary software on non-networked computers.

approach

The reindeer records were ported from the proprietary database to a more Internet-friendly MYSQL database on the Reindeer Research Program's server. Data entry, query, browsing, and report generation of each reindeer herder's records will be provided through a collection of password-protected webpages.

progress

All active herd records have been moved into the new MYSQL databases on the server. A draft data entry system has been developed and used to enter all of the records collected at the summer 2003 reindeer handlings. A basic report generation system to create reports summarizing reindeer handling statistics was also developed.

impact

Reindeer herders will now be able to query and browse herd records year round, via the Internet. Seward Peninsula reindeer herders can browse individual animal records on line and select animals for culling or breeding based on production history.

**Radiotelemetric estrus detection in reindeer cows**

Milan P. Shipka, Jan E. Rowell, M.C. Sousa, A.M. Hirth

purpose

The objective of this experiment was to determine the efficacy of the radiotelemetric estrus detection system in reindeer cows and describe breeding behavior of reindeer. We have previously demonstrated the effectiveness of a radiotelemetric estrous detection system in muskox cows.

approach

Radiotelemetry transmitters were applied at the termination of each estrus synchronization protocols described above (CIDR removal + PGF2 $\alpha$  or second injection of PGF2 $\alpha$ ), glued to a 10x10 cm<sup>2</sup> area on the animals' rump approximately 5 cm above the tail head. Mounting data were continuously collected via the system buffer and downloaded daily to a computer.

progress

Mounting activity was detected by radiotelemetry in eight cows at the estrus following synchronization protocols. Breeding occurred in 19 cows, determined by systemic progesterone concentrations. Four cows exhibited one mount, three cows exhibited two mounts and one cow exhibited three mounts. Mean length of mounting activity was 1.5 seconds, with no mount lasting more than 3 seconds. Conception occurred in seven of eight cows for which mounting activity was detected.

impact

Information on reindeer cow breeding behavior, previously nonexistent, is required for accurate estrus detection, which is important in reproductive management and essential for artificial insemination and embryo transfer. Producers of many cervidae species indicate that observing breeding in deer is difficult; this study demonstrates that observing mounting activity in reindeer is unlikely given that the majority of cows exhibit one or two mounts of one or two seconds at the time

of estrus and resultant conception. Further studies are required to determine the mean time from estrus synchronization to ovulation in order to develop these reproductive procedures in reindeer cows.

**Seroconversion of reindeer vaccinated with equine West Nile Virus vaccine**

Greg Finstad, SNRAS; Cheryl Rosa, John Blake, IAB

purpose

The West Nile Virus that first appeared in North America in 1999 has quickly spread across the U.S., infecting both livestock and humans. Reindeer in lower-latitude states have contracted the disease and some have died. The disease is not found presently in Alaska, but there is concern it may spread and infect resident reindeer herds. A vaccine is available for use in horses, but its effectiveness in reindeer is unknown.

approach

Baseline blood samples were collected prior to vaccinating forty-five reindeer of different sex and age classes with a commercially available equine vaccine. A booster was given six weeks later. Serial blood samples were collected post-vaccination to determine West Nile Virus titers.

progress

Seroconversion occurred in 82% of vaccinated animals two weeks post-boost, but dropped to 75% at four weeks and to 38% at fifteen weeks post-boost. Moderate seroconversion does occur after vaccination, but the booster has poor duration.

impact

Vaccination with equine West Nile Virus appears moderately effective in reindeer, but several boosters are recommended during the mosquito season to ensure protection. A program using this product may work in intensively managed herds, but is unlikely to be adopted by producers with free-ranging herds because it requires handling and vaccinating animals multiple times during the mosquito season.

**Steroid endocrinology during pregnancy in reindeer**

Milan P. Shipka, Jan E. Rowell, M.C. Sousa, A.M. Hirth

purpose

Relatively little is known about reindeer reproductive physiology. Gestation lengths reported in scientific literature range from 205 to 240 days, but breeding dates are not definitive in most reports. This study was undertaken to characterize the endocrine profiles of bred female reindeer from the breeding season until calving and begin data collection to establish definitive information on gestation length.

approach

Radiotelemetric heat detection transmitters were attached to ten yearling reindeer on September 9, 2002. They were placed in a breeding harem from September 9 until October 22. Blood samples were drawn three times weekly beginning on September 3, 2003. Sampling was reduced to weekly on October 22 and continued throughout the winter. Sampling

rate increased to three times weekly on March 22, 2003, and continued until calving. Plasma assays for progesterone, estradiol 17β, and estrone by radioimmunoassay (RIA for estradiol 17β, and estrone) were accomplished in the Center for Reproductive Biology core laboratory, Dr. J.J. Reeves, at WSU).

progress

Seven of ten yearlings had elevated progesterone (> 0.5 ng/ml) at study initiation. Seven females had an initial short cycle (range 8-11 d); all 10 females conceived at the first estrus after bull introduction. Progesterone remained elevated until shortly before April calving, averaging 5.89 ± 0.29 (range 2.43 to 11.84 ng/ml). Estradiol 17β levels were at nadir concentrations during the first 24 weeks of pregnancy, after which estradiol 17β rose sharply until parturition at 30.33 ± 1.85 wk. Radiotelemetry correctly identified mounting activity in seven of 10 reindeer. Calving began on 8 April and continued until May 2, 2003.

Impact

Understanding of endocrine physiology during pregnancy enhances the knowledge base about reindeer and allows more definitive determination of gestation length for enhanced management of pregnant animals and better calf survival.

### Time and pattern of onset of anestrus in nonbred reindeer

Milan P. Shipka, Jan E. Rowell, M.C. Sousa

purpose

Examples abound of surprise, late-season reindeer calves resulting from a lack of understanding of the extent to which estrous cycles continue past the winter solstice. Survivability in late-born calves is difficult and the likelihood of rebreeding late-calving reindeer cows during the next season is greatly diminished. This study investigated the extent of estrous cyclicity and the timing and progesterone pattern entering anestrus, ending the breeding season of this fall breeding species. Understanding the length of the breeding season and the time of onset of anestrus is required for proper management, including housing of yearling males and females and adult females that producers wish not to breed.

approach

Systemic progesterone concentrations in five two-year-old female reindeer were used to determine estrous cyclicity throughout the fall, winter, and spring. The time of the cyclic rise and fall of progesterone determined the onset of anestrus.

progress

Reproductive cycles continued throughout the winter with a mean length of 24.12 ± 0.7 d (range: 18–29 d). There was no difference in cycle length for the 6-8 cycles each female had between September and February (n = 5) or March (n = 4) (p > 0.05; ANOVA). Onset of anestrus, indicated by loss of cyclic rise and fall of progesterone, occurred between mid February and mid April.

impact

Reindeer appear far less constrained by season as far as potential breeding capabilities than are most other fall seasonal

breeders. Indeed, out-of-season calves have been reported in farm settings where sexual separation after the normal harem period is not practiced. Based on this study, if producers desire to constrain calving to the spring, sexually segregating non-breeding females from males until late May is recommended.

### Weight gain of reindeer females and steers fed a soybean meal or fishmeal-based ration

Greg Finstad, Carrie Bucki, SNRAS; Peter Bechtel, School of Fisheries and Ocean Sciences

purpose

Developing a low-cost, high-quality reindeer diet from locally produced components is crucial for the development of reindeer farming in Alaska. Typically, soybean meal is used as a protein supplement in ruminant diets, but shipping costs to Alaska are high. Alaska's fishing industry creates byproducts such as fish meal that could be used in formulating a reindeer diet, but its effects on animal performance are unknown.

approach

Starting in June, thirteen two-year-old reindeer females and steers were divided into two groups and fed a 16 percent crude protein diet with either soybean or fish meal as the protein source.

progress

Daily intake rates and weight gain were determined over eight weeks. Mean weight gain of reindeer eating the fish meal diet after eight weeks was 22.5kg ± 1.7kg with a feed efficiency of 6.28kg feed / kg weight gain. Mean weight gain for animals on the soybean diet was 17.6 ± 1.8kg with a feed efficiency of 8.2kg feed / kg weight gain.

impact

A reindeer ration using fishmeal as the protein source produced higher weight gain and feed efficiency than a ration using soybean meal. Fishmeal is produced in Alaska and can be purchased locally at a lower cost per unit protein than soybean meal. Fishmeal demonstrates promise as a cost-effective feed component for intensively managed reindeer operations in Alaska.

### controlled environments

#### Black-eyed Susan responds to the length of the day

Meriam Karlsson, Jeffrey Werner

purpose

Day length affects plant form, growth and flowering of Black-eyed Susan (*Rudbeckia hirta* 'Toto Gold'). Varying the day length offers opportunities to manage growth for essential and desired plant features.

approach

Black-eyed Susan was grown at 8 or 16 daily hours of light. To study the effects of alternating short and long day conditions, some plants were shifted to the opposite day length after three weeks.

progress/result

Long days resulted in flowering 12 weeks from seeding while initiated visible buds at continuous short days failed to develop into flowers. Plants grew 7 inches tall with long days, but less than 3 inches in short days. Although three initial weeks of short days compared to continuous long days slightly slowed flower development, height was reduced, resulting in high-quality flowering plants.

impact

Combining short and long day conditions offers opportunities to manage crop production for exact marketing specifications and dates.

## 14 Germination of Forget-me-not

Meriam Karlsson, Jeffrey Werner

purpose

Since some commercially available selections of Forget-me-not germinate sporadically at recommended settings of 68°F and lighted conditions, more appropriate guidelines are needed. Appropriate procedures for reliable, quick, and consistent germination are essential to predictably and cost-effectively grow available Forget-me-not selections like 'Blue Tower'.

approach

Seeds of Forget-me-not 'Blue Tower' were germinated at 68°F while exposed to light or several experimental durations of complete darkness.

progress/result

Three days of darkness was sufficient to allow fast, uniform, and complete germination of Forget-me-not 'Blue Tower'.

impact

Fast, consistent germination results in quick plant growth and abundant flowering of Forget-me-not selections like 'Blue Tower.' This information will help growers predictably and cost-effectively produce Forget-me-not crops.

## Leaf lettuce produced in a high tunnel greenhouse

Jeffrey Werner, Meriam Karlsson

purpose

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

approach

Leaf lettuce was planted inside and in the field immediately outside a high-tunnel greenhouse.

progress/result

The leaf lettuce grown inside the high tunnel matured for harvest earlier than lettuce outside. Trimming bruised or spoiled portions was virtually eliminated as the tunnel-grown lettuce remained clean and of exceptionally high quality.

impact/implications

These results suggest high-tunnel greenhouses positively alter the local growing environment to support increased yield,

quality, and season for high-value field crops.

## Production temperatures for Forget-me-not

Meriam Karlsson, Jeffrey Werner

purpose

Temperature recommendations are needed to efficiently produce potted flowering Forget-me-not.

approach/method

Forget-me-not 'Blue Tower' was grown at 60°F using five day and night temperature combinations.

progress/result

Different day and night temperatures compared to a steady temperature promoted growth and flowering. Even a large negative difference between day (54°F) and night (68°F) temperatures resulted in fast growth, uniform flowering, and excellent plant features.

impact

Varying the temperature during the day is recommended to most accurately time and meet defined market demands for flowering Forget-me-not.

## field crop production

### Antioxidants in Alaska wild berries

Roseann Leiner, Patricia Holloway, Abe Smyth, Rudy Candler

purpose

This study surveys Alaska wild berries to identify levels of antioxidants in frozen fruit.

approach

Samples of wild berries were collected primarily from the railbelt area of Alaska by university employees, berry pickers, and commercial harvesters. They were analyzed for water soluble antioxidant capacity and to identify specific biochemical activity. We analyzed levels of nine phytochemicals. Samples of wild berries and cultivated baby greens were frozen, stored, and extracted before HPLC analysis. The HPLC records peaks on a chromatogram. Peaks from plant samples are compared to peaks recorded for purified phytochemicals.

progress

The water-soluble antioxidant capacity for five samples of bog blueberry (*Vaccinium uliginosum*) was 93 micromole Trolox equivalents per gram (uM TE/g) and for five samples of lingonberry (*Vaccinium vitis-idaea*) was 206 uM TE/g. As a comparison, an average antioxidant level reported in commercial blueberries grown in the lower 48 states is 24 uM TE/g. Samples of rosehips (*Rosa acicularis*) showed the highest levels of ascorbic acid (vitamin C), while highbush cranberry (*Viburnum edule*) showed high levels of the antioxidant, caffeic acid.

impact

This research will provide basic information on the quality and health benefits of Alaska's wild berries. It will be useful for

anyone harvesting wild berries for personal use as well as small businesses that harvest and process wild berries in Alaska.

### Flower trials for Fairbanks

Patricia Holloway, Janice Hanscom, Grant Matheke, Alfreda Gardiner

purpose

The objective is to identify the best annual flowers for Alaska's commercial landscapes and home gardens.

approach

We plant at least 300 annual flowers in unreplicated beds each season and evaluate them for bloom time, plant height and spread, disease susceptibility, fragrance, frost hardiness, and flower quality. Cultivars are grown for three years.

progress/results to date

Nearly all cultivars grew well and bloomed for most of the short growing season. Some exceptions were *Asclepias* 'Ice Ballet', Cardinal flower, and Branched coneflower 'Ace of Spades'. An unusually severe mid-fall frost provided an opportunity to evaluate plants that would survive a temperature of 12 degrees below freezing (20°F) and add late-season color to Alaska landscapes. They included: *Agastache* Golden Jubilee; *Sweet alyssum*: Snow Crystals, Wonderland Lavender; *Calendula*: Flaskback, Geisha Girl; *Chrysanthemum*: Snowland; *Bellis*: Lipstick; *Gazania*, three cultivars; *Geranium*, three cultivars; *Godetia*: Flamingo Mix; *Linaria*: Fantasy Mix; *Lupine*: Band of Nobles; *Pansy*: 11 cultivars; *Petunia*, three cultivars; *Rudbeckia*: Cherokee Sunset; *Salvia*: Marble Arch; *Snapdragon*: six cultivars; *Statice*: Pastel Shades; *Strawflower*: Perfect Jewels Mix, Three Birds Flying, Tidy Tips; *Verbena*: five cultivars; *Viola*: six cultivars.

impact

The flower trials are designed for homeowners, commercial landscapers, and greenhouse businesses to increase the diversity of hardy, adapted annuals for gardens. Performance information is also shared with five national seed companies who provide seeds for the trials; Johnny's Selected Seeds (ME), Territorial Seed Co. (OR), Pan American and Ball Seeds (IL) and Goldsmith Seeds (CA).

### Green storage cabbage variety trials

Roseann Leiner

purpose

In Palmer, twelve varieties of green storage cabbages were compared to observe differences in size at harvest and differences in quality after several months of storage.

approach

Cabbage seedlings were transplanted into field plots in May and cabbage was harvested in September 2003. Cabbages were stored in refrigerated rooms through the winter and observed for changes in quality.

progress

Storage cabbage varieties form heads more slowly than fresh market types, and low soil fertility late in the growing season may limit yield. Varieties that mature in 85 days (Survivor, Gideon) stored well to December, and varieties that mature

after 100 days (Arena, Safekeeper II, Saratoga) looked fresh and green in March.

impact

The study demonstrated that cabbage varieties adapted to storage can maintain quality for months after harvest. By choosing varieties and production practices that promote storage quality, cabbage sales can be extended through the winter.

### Growing baby greens for salads

Roseann Leiner

purpose

Many types of greens in the cabbage family can be harvested as young leaves for salads. The 2003 trials evaluated arugula, Asian greens, and kales in field experiments at Palmer.

approach

Seeds of ten varieties of baby greens were planted to compare three rates of fertilizer (10-20-20): 0, 600, and 1200 lb/Ac. Three to five weeks after planting, individual leaves were cut to measure fresh weight and dry weight.

progress

Kale grew thick leaves slowly, with yields up to 2 oz/ft and 10-16 percent dry matter. Arugula and Asian greens were ready to harvest sooner, with yields up to 10 oz/ft and 7-9 percent dry matter. Kale and Asian greens showed a growth response to high rates of fertilizer, while arugula did not.

impact

Home and market gardens can produce a variety of baby greens throughout the summer for beautiful, fresh salad mixes. Different types of baby greens should be sown separately and mixed after harvest because the leaves grow at different rates and respond differently to fertilization.

### Head lettuce variety trials

Roseann Leiner

purpose

New selections of lettuce are evaluated for their performance in the long days and cool soils of Alaska because seed companies constantly change the varieties that are available.

approach

Nineteen varieties of crisphead lettuce were transplanted at two times and two locations in the Matanuska Valley. Head weight and diameter were measured and marketability at harvest was evaluated.

progress

Sixteen varieties were included in field trials for the first time, with three varieties from previous years for standard comparison. There were larger differences due to planting date and location than differences between varieties. Some plots had over 90 percent marketable heads, while others were as low as 13 percent. Varieties showing overall quality will be included in further trials.

impact

Performance of lettuce varieties in field conditions is important information for growers. Some varieties show good po-

tential for crop production in Alaska, while other varieties are not adapted to local growing conditions.

### Lettuce transplant production in limited rooting volume

Cody Peterson, Meriam Karlsson, Jeffrey Werner

purpose

Containerized transplants are used extensively in vegetable field production. Flats with many small individual cells are used to quickly and efficiently produce large quantities of transplants. A cell size and shape allowing adequate root and shoot development is necessary to avoid hampering transplant development, field establishment and crop yields.

approach

The head lettuce Alpha was grown in flats with 10 or 50 mL (0.3 or 1.7 oz) individual round cells or square cells of 9.5 or 48 mL (0.3 or 1.6 oz).

progress/result

A high-quality transplant has increased dry weight, good root development, and is compact with a short stem between the soil and the lowest leaf. Three weeks from seeding, transplants in larger cells had more leaves, root and shoot dry weights. Although the overall seedling size was larger in cells with more rooting volume, the below-leaf stem segment remained shorter than in transplants from smaller cells. We were not able to document or record any differences between the two cell shapes in this study.

impact

These results assist in selecting the most appropriate container volume for enhanced transplant quality, field establishment and cropping capacity.

### Peonies as field-grown cut flowers

Patricia Holloway, Janice Hanscom, Grant Matheke

purpose

The study will identify the best varieties of peonies for field-grown cut flower production in Alaska.

approach

Thirty cultivars of peonies were planted during the summer of 2001 in replicated trials. Data have been collected for three seasons on survival, bloom time, bloom quality, and productivity.

progress

The cultivars Sarah Bernhardt, Duchess de Nemours, and Felix Crouse are highly productive, yielding more than ten cut stems per plant. Flower height ranged from 21 inches to 24 inches, too short for U.S. No. 1 grading standards, assuming the stems are cut 12 inches above the ground. Bud blast affected nearly all cultivars but not as severely as the previous year. Removal of all stems and debris from the field at the end of the season minimized the damage.

impact

This information will assist growers interested in devel-

oping a field-grown cut flower business for local and export markets.

### Potato field experiments in Palmer

Roseann Leiner, Don Carling, Gregg Terry, Jeff Smeenk

purpose

We compared some cultural practices, disease control, and yield evaluations for potato varieties with potential for crop production in Alaska.

approach

In 2003, potatoes were planted and harvested in eight field experiments at AFES in Palmer. Dr. Don Carling planned the experimental designs, and Gregg Terry maintained the plots. The data was analyzed by Dr. Jeff Smeenk.

progress

Dark Red Norland and Red Pontiac had high total yield in a trial of 24 red-skinned potato varieties. Cal-White and BakeKing had high total yield in a trial of 23 white and russet potato varieties. Seed size and seed cutting was evaluated on the yield of Russet Norkotah and Shepody, and the effect was small. Another experiment compared seed treatments on Russet Norkotah, in the presence and absence of *Rhizoctonia*, a fungus that can damage potato sprouts. The yield of plants inoculated with *Rhizoctonia* was markedly reduced, despite the presence of fungicide seed treatments.

impact

Fresh market potatoes are produced in Alaska and sold every month of the year. Information on production practices can be used to make good management decisions for variety selection and seed treatments.

### RUSLE plant data

Stephen D. Sparrow, darleen t. masiak (SNRAS); Ann Rippey (USDA-NRCS)

purpose

The Revised Universal Soil Loss Equation (RUSLE) is used by USDA Natural Resources Conservation Service (NRCS) and other agencies to aid farmers and other land managers in developing management practices to minimize soil erosion. Data required for RUSLE include various soil properties, climate data, crop growth and cover, and crop residue cover. Little such data exists for crops in Alaska. The purpose of the project was to obtain this data for various crops in interior Alaska.

approach and progress

We measured various plant growth and cover parameters on barley, broccoli, potatoes, and Alaska wheatgrass (a potential revegetation crop for interior Alaska) during the 2002 and 2003 growing seasons. These data are currently being incorporated into RUSLE by NRCS for use in Alaska.

impact

This information will allow development of a better tool



for use by agencies to advise land managers on practices that minimize soil erosion in interior Alaska.

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

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

purpose

This ongoing research provides information for yearly updates on new and better adapted agronomic crop varieties (barley, wheat, oats, and sunflowers), and on the response of these crops to dryland farming conditions.

approach

Variety trials: Four 2-row and three 6-row hulless barley varieties (*Hordeum* sp.), four hulless oat varieties (*Avena* sp.), and three hard red spring wheat varieties (*Triticum* sp.) were selected from northern Canadian sources for evaluation against standard Alaskan varieties (Thual hulless barley, Toral oat, and Ingal hard red spring wheat). Replicated trials were harvested in the fall of 2003 and planted again in the spring of 2004 at Fairbanks, Delta Junction, and Palmer. Two forage barley varieties (*Hordeum* sp.) were selected for evaluation of forage yield and quality and for seed yield and quality. These were planted at Fairbanks and will be compared with the standard Alaskan variety, Weal hooded barley.

Agronomic crop breeding selections: Six selections from a hulled feed barley cross (*Hordeum* sp.) were planted in replicated trials at all three test sites for comparison with three adapted varieties (Otal, Albright, and Finaska feed barley). One selection with the best plant growth characteristics was made after harvest for planting with the same three adapted varieties 2004. This will result in an eventual release as a named variety in winter of 2004–2005.

Fifty selections from a hulless barley cross (*Hordeum* sp.) were made from 200 single-row plots in fall 2002. These were planted out at the Fairbanks site for 2003 evaluation. After harvest, twelve selections were made that showed the best characteristics for standability, yield, early maturity, and hulless seed for spring 2004 planting in replicated trials at all three test sites for continued evaluation compared with an adapted hulless variety (Thual hulless barley).

From the dwarf, open pollinated Sunwheat (*Helianthus* sp.), 150 single head selections were made, primarily for early maturity. The seed was hand harvested in the fall of 2003 and bagged for distribution to local gardeners and farmers for testing and evaluation in 2004. Eventual release as a named variety is expected in the winter of 2004–2005.

progress

Spring weather of 2004 at all three locations was cooler and wetter than the long-term average. This resulted in excel-

lent germination and emergence at all three locations for all crops. An increase in overall crop yields is expected with an increase in soil moisture levels during this growth stage.

impact

This ongoing study provides a yearly update of information on new and better adapted crop varieties on the response of agronomic crops to dryland farming conditions.

## Soil surface color alters lettuce transplant growth

Jeffrey Werner, Meriam Karlsson

purpose

Compact vegetable transplants with a well-developed root system and a short stem segment below the lowest leaf are best suited for mechanical transplant, field establishment, and crop productivity. A reflective mulch or soil cover may support desired early transplant growth.

approach/method

Lettuce of the cultivar Alpha was seeded and covered with a thin layer of perlite or growing medium. Perlite is a white expanded volcanic rock material commonly used in propagation and in commercial container media. As a comparison, seed was also covered with a single layer of white or black plastic film cut to allow seedling emergence.

progress/result

The below-leaf stem segment was shortest using perlite and longest with black plastic or growing medium. White plastic resulted in slightly longer seedlings than perlite but considerably shorter than the black plastic.

impact/implications

These results suggest that perlite or white plastic covering is effective as a nonchemical method for producing compact, high-quality transplants of lettuce or other vegetables.

## Vegetable trials in Fairbanks

Grant Matheke, Janice Hanscom, Patricia Holloway, Alfreda Gardiner

purpose

The objective is to identify high-yielding, high-quality vegetables for home and market gardeners in interior Alaska.

approach

We identify new cultivars of vegetables from commercial seed sources, and from recommendations by local gardeners and commercial growers. Plants are grown for three seasons and compared to standard, reliable varieties. Data are collected on harvest season, yield, and harvestable quality for nearly all vegetables grown in interior Alaska.

progress/results to date

Two new cultivars were added to the list of recommended vegetables for the Interior. 'Small Wonder' spaghetti squash had an impressive yield for a small, single-serving squash. 'Papaya Pear' squash yielded well and had a sweet, mild flavor.

Both All-America Selections winners are recommended for home or market gardens. Based upon three years of trials, the following outdoor-grown tomato cultivars are recommended for home gardens: Sub-arctic 25, Prairie Fire, Northern Delight, and Oregon 11. All produce medium-sized salad tomatoes for fresh use or processing.

#### impact

The vegetable research is designed for small market gardeners and homeowners. It provides comparative trial information that is useful in developing regional truck farms and expanding produce choices at farmers' markets. The field tomato trials were conducted at the request of Territorial Seed Co., Oregon, to compare varieties they sell as seeds to Alaska gardeners.

18

## forage, tillage, and turf experiments

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

Stephen D. Sparrow, darleen t. masiak

#### purpose

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

#### approach

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

#### progress

These crops are typically slow to establish, thus plant growth was too meager to obtain harvests at any locations in the establishment year. At Fairbanks, dry matter yields in 2003 were 1.34 tons/acre for Gale forage galega and ranged from 0.93 to 1.44 tons/acre for the cicer milkvetch varieties. Stands were so poor at Nenana that we abandoned the plots. At Delta Junction, none of the crops survived the 2002/2003 winter; we do not know if this is because the crops are not adapted to the area or if conditions during that winter were especially adverse to their survival. We reseeded all varieties at Delta Junction in 2003. We do not yet have forage quality data for any of the crops.

#### impact

Results are currently too preliminary to determine if these crops have potential as forage crops for interior Alaska.

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

C. Lussier, Norman Harris, Beth Hall

#### purpose

Some years hay producers do not have sufficient dry weather to produce good quality hay. The production of haylage, fermented hay, is a viable solution that has never before been studied in Alaska.

#### approach

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

#### progress

This was the first year of a two-year study. Bales have been cored at two weeks and one month after baling. Samples are currently under going analysis.

#### impact

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

## Forage and turfgrass research

G. Allen Mitchell, Tim A. Evers

#### purpose

This project is designed to evaluate cultivars and management practices that will reduce winter damage to greens and fairways on golf courses, sports fields, and lawns.

#### approach

Turfgrass variety trials were established on a sand-based green and a soil-based fairway at the Matanuska Experiment Farm. Another trial was established in 2003 at the public Settlers Bay Golf Course to provide a different environment for evaluating variety winterhardiness, disease resistance, and aesthetic qualities; it allows observation of selected varieties under playing conditions. The irrigated fairway turfgrass variety trials established at Palmer in June 2002 involve 24 varieties of indigenous and introduced turfgrass species. Trial selections were based on cultivars that perform well elsewhere in the northern United States, including Kentucky bluegrasses (*Poa pratensis*), fescues (*Festuca* spp.), perennial ryegrass (*Lolium* spp.), and bentgrasses (*Agrostis* spp.).

#### progress

Creeping bentgrass, Kentucky bluegrass, and roughstock bluegrasses (*Poa trivialis*) have been subjected to three overwintering evaluations under close-cut putting green conditions. In the first two years, the bluegrasses had higher survival and earlier spring greenup than the bentgrasses. Alaska variety 'Nugget' Kentucky bluegrass has shown consistent early greenup and excellent playability from early May through September. All cultivars were evaluated for winter survival beginning in April 2003. Fescues demonstrated earliest greenup, followed by the Kentucky bluegrass cultivars, with bentgrasses and perennial ryegrass last to show full live cover. By late May and through the summer, all cultivars survived the winter and demonstrated

turf quality comparable to the indigenous cultivars.  
impact

This project has resulted in inquiries from Alaska sports field managers, municipal landscaping personnel, and golf course superintendents. The latter include the requests from two golf courses for on-site demonstration plots. The Settler's Bay Golf Course superintendent will establish one green using Penn G-6 bentgrass and intends to adopt other suggested cultivars and management practices in the future.

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

Stephen D. Sparrow, darleen t. masiak

purpose

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

approach

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

progress/results to date

In the first year, as the season progressed, yields generally increased and forage quality decreased; increased cutting height resulted in decreased yields and increased forage quality. To date, data on residual effects of past cutting treatments exists for only one year at one location. A consistent trend in the effects of cutting date on the subsequent year's forage yields has not been observed; low-cut treatments generally produced lower subsequent year yields than the other cutting height regimes.

impact

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

### Long-term tillage study

Mingchu Zhang, Stephen Sparrow, Carol E. Lewis

purpose

This study examines the effects of tillage and residue management practices on soil properties (soil carbon content, nutrient status, soil aggregate distribution, etc.), and on grain yield in interior Alaska.

approach

The research began twenty ago at the AFES research site

near Delta Junction. Barley has been a continuous crop for the plots, except a few years when the field was kept fallow for weed control. Research plot soil samples were collected (0–5, 5–10, 10–25, 25–45 and >45 cm depth) in fall 2003, from which nutrient status, organic matter content, bulk density, and pH were determined. Barley yield and protein content of grain from 1990 to 1999 were also statistically analyzed.

progress

Residue management had no impact on soil organic matter content and soil nitrogen and phosphorus status. However, the no-tillage treatment has increased soil organic carbon content significantly in comparison with conventional tillage and disk-once treatments. Most of the organic carbon increase was in the top 0–5 cm depth. Nitrate nitrogen concentration did not differ among the three tillage treatments, but the no-tillage resulted in higher extractable phosphorus than conventional and disk-once treatments. The no-tillage treatment resulted in higher barley yield than the conventional and disk-once treatments.

impact

This research has yielded crucial information on nutrient dynamics and soil organic carbon accumulation in the arable land in interior Alaska under different tillage and residue management practices. In the light of climate change, the amount of carbon sequestered under no-tillage practice can be a tradable commodity.

### pest and disease control

#### Integrated pest management (IPM) strategies for Alaska agriculture

Dennis Fielding, Jeff Conn, Lori Winton, Alberto Pantoja (ARS)

Although the potential for agricultural expansion in the circumpolar region has received renewed attention in recent years, knowledge of best regional pest management practices is not well developed. Research is needed to improve management and to understand the biology of invasive plants, diseases, and insect pests in the Arctic and Subarctic. The development of IPM strategies for Alaska is of particular interest because global warming is expected to increase insect, disease, and weed populations. Since 1973, the winter temperatures in Alaska have increased by 2–3° C, resulting in increased concentrations of insects and diseases.

#### Grasshopper research

purpose

Grasshoppers are economically important pests in rangeland and crop agro-ecosystems throughout western North America, including parts of Alaska. During years of high grasshopper densities, barley crops can be severely damaged. In 1990, crop losses in the Delta Junction area were estimated at

50 percent. Options for grasshopper control are limited by the mix of state and private lands, and environmentally sensitive and agricultural areas. The development of new cultural and biological tactics will be a major step toward resolving grasshopper problems in Alaska.

approach

Development of strategies to reduce crop losses to grasshoppers is hindered by a lack of methods for sampling grasshopper numbers and species composition within the dense canopies of most field crops. Pan trapping (capturing grasshoppers that fall into pans of soapy water) may be an effective method. A grid of pan traps were placed in a barley field at the University of Alaska Agricultural and Forestry Experiment Station farm near Delta Junction, and numbers of grasshoppers captured were counted at ten-day intervals. By studying crop invasion in this way, the effects of air temperature, wind direction, and proximity of grasshopper sources on invasion patterns can be determined, leading to more effective management and reduced crop losses.

The causes of grasshopper outbreaks are poorly understood, but probably result from multiple interacting factors that differ among eco-regions. An individual-based model of grasshopper population dynamics, developed in previous years, was expanded to include predators, so that the effects of top-down (predator) population regulation, as well as bottom-up (food limitation) factors could be examined. Simulations indicate that even relatively low levels of predation may result in population regulation of grasshoppers, when food is non-limiting.

impact

In Alaska and throughout the western USA and Canada, habitats that are not cultivated every year, such as rangeland, roadsides, and Conservation Reserve Program lands, support populations of various grasshopper species that often disperse from their source habitats and invade nearby crops. Presently, there is no way of predicting when and how many grasshoppers will move into adjacent crops. The ability to predict their movement and the development of IPM tactics will be a major step toward resolving grasshopper problems. Much of the information generated in Alaska will also be directly relevant to grasshopper population management in other areas of North America. Model simulations indicate that even relatively low levels of predation may result in population regulation of grasshoppers, when food is non-limiting. Information and new control options are disseminated as developed, through growers' workshops and field days, through scientific publications and meetings, and through Internet-based information technology.

Invasive weeds

purpose

Nationwide, invasive weeds have resulted in increased control costs, decreased rangeland quality, and loss of ecological diversity. Several exotic and invasive weeds have recently

been introduced in Alaska, threatening ecological diversity. Eradication efforts have been undertaken by state and federal agencies. In Alaska the use of herbicides to control weeds is not only costly, but is complicated by cold soil temperatures that inhibit herbicide breakdown, injuring subsequent crops and increasing the potential for leaching. A strategic investment in integrated weed management tactics and prevention of invasive plants introductions would be much more cost effective than control or eradication programs.

approach

The distribution of white sweetclover (*Melilotus alba* L.) was determined on Alaska river floodplains, and its effect on the floodplains is being investigated. This species has escaped from agricultural fields and roadsides and has invaded the floodplains of three river systems.

impact

Information regarding invasive plant infestations, prevention, and control will be disseminated as developed through grower workshops, the annual Invasive Plant Meeting and Workshop sponsored by Alaska Cooperative Extension Service, through popular and scientific publications and meetings, and through the Internet.

The severely limited resources of the cooperative extension service in Alaska represents the greatest limitation on the durability of the technology developed by this project. Without long-term support for extension specialists in this area, the information generated by this project will be not be available to the majority of end-users.

Viral diseases of seed potatoes

purpose

In the continental USA, the presence of viral diseases and their vectors is considered the most severe limiting factor for seed potato production. Because of geographical isolation and climate, Alaska crops are relatively free of many insect pests and diseases. However, the taxonomical identity, biology, population dynamics, and distribution of insect pests and pathogenic microorganisms in the circumpolar region are lacking or poorly understood. Reviewed publications on the documentation of plant diseases are limited in Alaska, and no epidemiological studies exist for viruses/plants in their natural environment.

approach/progress

During this first year of the project, we collected insects for taxonomic identification.

**Managing plant-microbe interactions in soil to promote sustainable agriculture**

Jenifer H. McBeath

purpose

This research aims to reduce dependency on chemical fungicides for controlling plant diseases by developing superior (more effective and efficient) biological control agents and disease-resistant varieties.

approach

Biological control agents are under study to improve understanding of the underlying mechanisms of mycoparasitism that affect plant pathogens. Host improvement through the use of molecular markers to identify genes associated with disease resistance is another aspect in the understanding of plant-microbe interactions. Molecular markers in potato are under study, including osmotins to determine potential roles in resistance.

progress

Over seventeen years, this research has shown that *Trichoderma atroviride* is a cold-tolerant, versatile, aggressive hyperparasite that can parasitize a wide spectrum of pathogenic fungi, including *P. erythroseptica*, *Rhizoctonia solani*, *P. infestans*, *Microdochia nivalis*, *Myriosclerotinia borealis*, *Typhula* spp., and *Botrytis cinerea*. A coordinated biochemical response has been observed in *T. atroviride* during biocontrol of plant pathogenic fungi. Production of fungal cell wall enzymes, such as chitinases, glucanases, and proteases, seemed to play a significant role in hyperparasitism involved in the suppression of diseases.

impact

Economically important crops, such as potato, have been grown for many years using chemical fungicides, but the development of fungicide-resistant strains of pathogens, and the increasing awareness of the adverse effects of chemical residues in the food chain and of pesticides on human health means that growers are seeking safe alternatives. The use of biological control, e.g. *T. atroviride*, and disease-resistant varieties that are environmentally benign and safe to humans and animals may be suitable alternatives.

## High-Latitude Soils

### carbon in soils

#### Carbon cycling in three mature black spruce (*Picea mariana* [mill.] B.s.p) forests in interior Alaska

Jason Vogel, David Valentine, Steve Sparrow

purpose

This study evaluated relationships between local climate and soil carbon balance. In a warming climate, the temperature sensitivity of organic matter decomposition will accelerate soil carbon loss via soil respiration from cold boreal soils. Increased decomposition may also increase nutrient availability, plant productivity, and organic inputs to soils.

approach

We chose sites in three similarly structured black spruce feathermoss forests near Fairbanks that varied in aspect, elevation, and permafrost depth. We examined the relationship between decomposition and aboveground tree growth, total soil respiration, and heterotrophic respiration. At the surface and throughout the soil profile, these characteristics drive complex

differences in annual temperature. For example, the two lower elevation sites contain permafrost within 0.5m of the surface because they are very cold during winter, yet their surface soils are warmer during the summer than the higher elevation site. We hypothesized that ecosystem CO<sub>2</sub> uptake (aboveground increment) and loss (total soil respiration and soil heterotrophic respiration) both increase with decomposition rates measured on black spruce needles and two litter proxies. To measure heterotrophic respiration, a trench and barrier (to exclude roots) was inserted 1m into soil around three 3m x 2.5m plots in each study site, which were maintained in a plant-free condition.

progress/result

Aboveground tree increment (418-548 g CO<sub>2</sub> m<sup>-2</sup> y<sup>-1</sup>) and heterotrophic respiration from trenched plots (122-137 g CO<sub>2</sub> m<sup>-2</sup> y<sup>-1</sup>) were significantly correlated to the decomposition indices, but total soil respiration was not. This implies that either black spruce at the warmer sites allocates less carbon below ground, or that warmer soils sequester more carbon. The most startling result, however, was that over the course of three years, the trenched plots lost about 15 percent of their surface organic horizon. This resulted from one or more of the three major effects of trenching: loss of root inputs, increased soil moisture (no transpiration), and decreased temperature (probably from increased moisture). In any case, this dramatic loss of soil carbon illustrates the highly dynamic nature of root and carbon turnover in soils.

impact/implications

Whether and how warmer climate will change the soil carbon balance of black spruce forest soils depends on the balance of production and decomposition. This study demonstrated that soil organic matter turnover (root production and decomposition) in these soils is high and has a greater impact on total soil carbon than previously thought. It also shows that warming temperatures will likely increase decomposition and decrease trees' belowground allocation of carbon. This may constitute another mechanism by which a net soil carbon loss could occur.

#### Fire impacts on boreal forest soil carbon bioavailability

Sarah Masco, David Valentine, Stephen Sparrow

purpose

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

approach/method

Soil samples were obtained from the lower two subhorizons (F & H layers) of the organic surface horizon. Subsamples were incubated at three temperatures for six months. Respiration rates, total amounts of respired CO<sub>2</sub>, and temperature sensitivity of respiration rates were determined, then compared with chemical analyses (via pyrolysis GC/MS) of the soil organic matter.

progress/result

Incubated soil organic matter from burned sites initially respired more slowly than soil organic matter from unburned control sites, but for the rest of the time respiration rates were indistinguishable. Initial differences in respiration rate and temperature sensitivity did not correlate well with bulk soil organic components determined through pyrolysis GC/MS or through fiber analysis. Burned soils had higher net nitrogen (N) mineralization rates than unburned soils. This could have resulted from more rapid gross N mineralization in burned soils, or from more rapid gross N immobilization (higher N demand) in the unburned soils. These results suggest that the only major difference between burned and unburned organic soils is the presence in the unburned soils of a rapid turnover pool from recently dead roots that is no longer present in the burned soils.

#### impact/implications

The major impact of Ms. Masco's thesis is the information it provided on what mechanisms are not responsible for the patterns of respiration observed in the Frostfire experiment. Fire did *not* cause changes in the quality of bulk organic soil carbon, and differences in heterotrophic respiration observed in the field likely arose from other changes.

## Soil respiration following wildfire in lowland interior Alaska forests

David Valentine

#### purpose

In the Frostfire area of moderately burned upland forests, previous research showed that heterotrophic soil respiration declines following wildfire. This project looked at postfire respiration in a contrasting area of more severely burned lowland black spruce forest.

#### approach

Following the Survey Line Wildfire in 2001, soil respiration was tracked in burned and unburned lowland black spruce stands near the Tanana River in the Bonanza Creek Experimental Forest. Soil temperatures and moisture contents were tracked in tandem with the respiration measurements.

#### progress/result

Results were similar to those of the Frostfire project: a large and immediate decline in respiration from burned soils that persisted through 2003. In the unburned stands, root-free (heterotrophic) respiration was also routinely measured. Respiration rates in burned soil that had few or no live roots were 30 percent lower than unburned heterotrophic respiration rates measured in root-exclusion collars in 2003. These results reinforce the pattern found in the Frostfire project: fire reduces CO<sub>2</sub> evolution rates both by eliminating root respiration and by slowing heterotrophic respiration.

#### impact/implications

These results shed light on key dynamics governing carbon following wildfire in interior Alaska, where millions of acres can burn annually. Understanding Alaska's carbon balance is fundamental to the issue of carbon-credit markets, which

have been established worldwide. The Alaska legislature may authorize investigation of carbon credits in boreal forests and elsewhere as potential sources of state revenue.

## Soil respiration following wildfire in upland interior Alaska forests (Frostfire)

David Valentine

#### purpose

We hope to quantify the impact of the most important disturbance type (wildfire) on the largest pool of terrestrial carbon (soils) in upland black spruce and mixed hardwood forest types.

#### approach/method

At the Caribou-Poker Creeks Research Watershed, we have tracked soil respiration in black spruce and mixed hardwood stands before and since the 1999 experimental wildfire (Frostfire). Measurements continued through the 2003 growing season. We established root exclusion collars to separate the two major sources of CO<sub>2</sub> efflux: plant roots (autotrophic) and other sources, mostly microbial (heterotrophic). Soil temperatures and moisture contents were tracked in tandem with the respiration measurements.

#### progress

Soil CO<sub>2</sub> efflux decreased after fire by ~50 percent in mixed hardwood stands and by ~15 percent in stands dominated by black spruce, where photosynthesis by feathermoss partially offsets soil respiration. The initial decline in soil respiration coincided with the cessation of respiration by roots that no longer received sugars because aboveground photosynthetic parts were burned. Because faster decomposition would be favored by the warmer, wetter postfire environment brought about by canopy removal and soil blackening, postfire respiration rates were expected to increase after this initial decline. Although decomposition rates assessed in 2001 were indeed higher in burned than in unburned sites, slower soil respiration in burned sites persisted, and in 2001 the differences from unburned respiration were at least as large as in 1999. Also, heterotrophic respiration rates (where roots were excluded in 2003) were lower in burned than in unburned soils. This shows that the continued lower respiration at burned sites results from both the absence of root respiration and slowed heterotrophic respiration. In laboratory incubations, MS candidate Sarah Masco found that unburned soils initially showed higher laboratory respiration potentials than burned soils, but that difference did not persist in successive measurements over the course of six months. This suggests that there may exist a pool of high-quality organic matter that is depleted rapidly in the absence of new inputs (e.g., root exudates and turnover), but that fire has not altered the overall quality of soil organic matter.

#### impact

Collectively, these results imply that reduced heterotrophic respiration following fire may be tightly coupled to the loss of root turnover (production and decomposition), while respiration rates of the remaining soil organic carbon are relatively unchanged by fire. These results shed light on key dynamics

governing carbon following wildfire in interior Alaska, where millions of acres can burn annually. Understanding Alaska's carbon balance is fundamental to the issue of carbon-credit markets. The Alaska legislature may authorize investigation of carbon credits in boreal forests and elsewhere as potential sources of state revenue.

### Soils associated with frost boils in arctic Alaska

Chien-Lu Ping, Gary Michaelson

#### purpose

The purpose of this project was to characterize soils associated with frost boils.

#### approach

Soils were studied and sampled alongside of the NSF Bio-complexity vegetation plots in arctic Alaska and Canada.

#### progress

Soil nutrient dynamic studies along the transect of frost boil-interboil microassociations were conducted on five bio-complexity vegetation plots in arctic Alaska and four plots on Banks Island, Canada, where four soils characterization samples were taken. Soil characterization data was partially completed. Preliminary results indicate that all soils associated with vegetation plots in arctic Canada are carbonate saturated, and thus have high pHs.

#### impact

Soil characterization data provide the baseline soil data to the vegetation study group and also to the modelers. The total organic carbon stores in soils of the arctic island are higher than expected, which will increase the contribution of carbon from the Arctic to the global terrestrial carbon budget. Results from the soil morphological study suggest a mechanism of cryoturbation that is different than some of the models predicted.

## wet soils

### Hydric soil properties of permafrost-affected soils in northern Alaska

Chien-Lu Ping

#### purpose

The purpose of this study was to test the hydric soil indicators, to establish regional indicators, and to aid the delineation of wetlands. Biological zero, 5°C, is the threshold defining growing season for hydric soils and wetland hydrology as defined by the US Army Corps of Engineers' *Wetland Delineation Manual*, the USDA-NRCS Hydric Soils Indicators in the U.S., and the USDA-NRCS Wetland Institute web page. Based on the Normalized Difference Vegetation Index (NDVI) measured by satellite image and phenological data in arctic and subarctic Alaska, vegetation begins to grow and blossom when the soil temperature is still below freezing.

#### approach

Monitoring sites were selected in key areas by consult-

ing with local Soil & Water Conservation districts and the USDA-NRCS State Office. At each site the soil was described, sampled, and a monitoring instrument installed. Monitored parameters include air and soil temperatures, soil moisture at different depths, solar radiation, wind speed and direction, and, on some sites, reduction-oxidation potentials.

#### progress

When soils are saturated in late spring and early summer, soil temperatures at 50cm are below freezing. Both field measurement and laboratory experiments demonstrate that biological activities are occurring that cause reducing conditions when soil temperatures are below freezing. Unfrozen water in the seasonal frost and permafrost supports biological activity at subzero temperatures that causes reducing conditions.

Final results were presented to the American Society of Agronomy annual meeting in Charlotte, North Carolina, and to the National Technical Committee on Hydric Soils.

#### impact

Biological zero defined as 5°C lacks scientific credibility and is not valid in arctic and subarctic environments. My results challenging the 5°C threshold were presented to the National Technical Committee on Hydric Soils in 2003. The NTCHS members agreed to redefine biological zero as "the soil temperature at a depth of 50 cm below which the growth and function of locally adapted plants are negligible."

[Editor's note: The research for this project was completed in 2002 and was reported in the SNRAS/AFES *Annual Report 2002*; however, the results were presented, and the new definition accepted, in 2003. Hence, this report's reappearance here.]

### Wet Soils Monitoring in Alaska

Chien-Lu Ping

#### purpose

The purposes of this project are to establish baseline data for soil moisture, soil temperature, and soil properties as reference to climate change, and to provide on-time climate information for agricultural communities, Native villages, and forest managers.

#### approach

Soil monitoring stations were set up in key regions of the state, including arctic, interior, southwest, and southeast Alaska in cooperation with the UAF Forest Growth & Yield program, the USDA-NRCS state and area offices, the USDA-NRCS National Soil Survey Center, and land owners.

#### progress

With the cooperation of the USDA Climate Center in Portland, telemetric access was added to the monitoring stations in Tok, Nenana, and Aniak. The performance of different sensors was evaluated.

#### impact

In addition to basic research, the data collected will benefit the local soil and water conservation districts, farmers, foresters, land managers, and Native villages, for land and resource

planning, farming practices such as irrigation needs and planting dates, silvicultural practices, and fire management. The monitoring data contributed to the modification of hydric soils criteria in the *Wetlands Manual*.

## Management of Ecosystems

### climate research and global change

#### Arctic Climate Impact Assessment (ACIA) overview document

Glenn Juday, Valerie Barber, Stephen Sparrow, Carol Lewis, Scott Rupp, John Yarie, Paul Duffy, Martin Wilmking

##### purpose

This project examined the influence of climate and climate change on agriculture and forestry in the far north. The key controls of climate, and the history, risks, and opportunities of climate change and climate variability were identified.

##### approach/method

The results of scientific chapters on forests and agriculture and biodiversity conservation were extracted into an overview book for the general public. The results were organized into eight key findings.

##### progress/result

Climate across most of the northern boreal region has warmed significantly in the last thirty years, decreasing tree growth in dry subregions and increasing growth in cool and moist subregions. Persistent warmth has triggered large outbreaks of forest-damaging insects such as autumn moth, spruce bark beetle, and spruce budworm, but has increased the success of cold-limited crops. Likely additional effects include changes in forest fire regimes, shifting vegetation zones, and reductions of key biodiversity resources, such as older forest communities.

##### impact/implications

The ACIA is the most detailed and integrated climate assessment to date. The overview focuses on the effects of climate change on people and key resources. A followup organization will be launched to continue international collaboration in climate change assessment in the far north.

#### Alaska Earth Systems Science Education Alliance: Improving understanding of climate variability and its relevance to rural Alaska

Elena B. Sparrow, Rick Foster, Cathy Connor, Ted Munsch, Sidney Stephens

##### purpose

Project objectives are: 1) to increase public understanding of global climate variability and its relevance to Alaska communities through formal and informal learning venues, and 2) to strengthen the teaching and learning of related subjects in K-16 classrooms.

##### approach

An Alaska Earth System Science Education Alliance was formed, linking environmental science education institutions and existing programs (formal and informal), to augment existing capabilities and increase participants' scope and reach, particularly within rural Alaska. Participants include the University of Alaska (UAF, UAA, and UAS), Alaska Pacific University (APU), Alaska school districts and schools, the Global Learning and Observations to Benefit the Environment (GLOBE) Alaska Partnerships, the Alaska Space Grant Program, Kachemak Bay National Estuarine Research Reserve (KBNERR), the Challenger Learning Center of Alaska (CLCA), and other programs such as the OLCG/Global Change Education Using Western Science and Native Observations, the EPSCoR Alaska Rural Research Partnership (ARRP) Education Outreach, and the Schoolyard Long Term Ecological Research (SLTER).

##### progress

The UAF and Campbell Creek Science Center GLOBE Partnerships, with the Alaska Partners in Teacher Enhancement Program, again conducted a rural summer science institute using GLOBE and Native Observations/knowledge. A followup workshop was conducted by the OLCG Program and the UAF GLOBE Partnership personnel. Scientists and Native experts on climate change and education specialists on best teacher practices supported teacher implementation of local climate/environmental change studies in K-12 classrooms. Teacher participants in GLOBE, OLCG, SLTER, and ARRP programs came from rural and urban schools for this session. Assisted by the Center for Alaskan Coastal Studies, KBNERR also conducted teacher workshops on climate variability and has modified some existing classroom activities for more relevance to Alaska. Pre-service educator enhancement has been done at UAF and through APU (funded through the Alaska Space Grant Program). A new GLOBE partner CLCA has scheduled a GLOBE workshop for 2004 and will provide followup support to teachers in Kenai. UAS courses teaching GPS and GIS mapping techniques were offered in 2003 to train students to participate in interdisciplinary work (ethnology and geology). An interactive, multimedia computer program (Project Jukebox), presenting multiple perspectives on climate change in the north, was created in collaboration with the UAF Oral History Program.

##### impact

Results of UAS faculty and undergraduate 2003 summer research in Alaska Native Remembered Landscapes: Comparing Ethnology with Geology in Glacier Bay National Park were presented at the National Biological Society of America meeting in November. Undergraduate and pre-college students benefited from their own and teacher participation in the project programs. Digitized interviews, transcripts, Power Point presentations, and photos of five Alaskan elders and one scientist discussing their observations and knowledge of climate change, are available on the OLCG website ([www.uaf.edu/olcg](http://www.uaf.edu/olcg) in the Native Knowledge section). The coordinated



efforts on Earth system science and climate change education efforts in Alaska contribute to better understanding of Earth as a system and of global climate variability and its relevance to and effects on rural communities.

## Carbon cropping the boreal forest of Alaska: landscape modeling

John Yarie

purpose

The CENTURY and DAYCENT ecosystem models were calibrated for analysis of the carbon capture dynamics of Alaska forests. These two models are tools for analyzing carbon dynamics in interior Alaskan forests.

approach

Past, current, and future climate regimes were used to develop carbon balance estimates for interior Alaska using CENTURY and DAYCENT.

progress

CENTURY was run to model carbon dynamics with climate data from 1950 to 1980 and from 1980 to 2000. A comparison of carbon dynamics was completed for hardwood, white spruce, and black spruce forest types.

impact

Estimates of the effect of changing climate dynamics over the past two decades on carbon capture by interior Alaskan forests are now available. The CENTURY model has predicted that carbon capture in hardwoods has shown a significant decline, carbon capture in white spruce ecosystems has increased, and carbon capture in black spruce ecosystems has shown little change. These results were reported in a poster presented at the 2004 IBFRA meeting held in Fairbanks, Alaska.

## Climate change and Rangifer on the Seward Peninsula, Alaska

Greg Finstad (SNRAS); Knut Kielland (IAB)

purpose

People of the Seward Peninsula utilize reindeer in a commercial enterprise, while caribou are used as a subsistence food source. Climate change may have dissimilar effects on reindeer and caribou production because there are differences in life strategies, such as calving. Reindeer calve earlier than caribou by approximately four weeks, so any changes in snowmelt and greenup, which influence forage quantity and quality, may have implications for lactating females and calf nutrition.

approach

Snow fences and ground cloths were used to alter snowmelt and greenup patterns of tundra vegetation on the Seward Peninsula. Quality of forage over time was determined for early, control, and late snowmelt plots.

progress

Nitrogen concentration and digestibility of forage plants differed among simulated early or late snowmelt plots. This data was incorporated into protein and energy intake models

for lactating reindeer and caribou.

impact

Because of the difference in life strategies, seasonal nutritional demands on lactating reindeer and caribou are asynchronous. Based on our modeling, early snowmelt may encourage reindeer production, while late snowmelt may promote caribou production, with implications for both economic development and subsistence activities in the region.

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

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

purpose

Scientists trying to predict responses of northern landscapes to climatic change need to know the extent to which the distribution of the boreal forest is driven solely by climatic factors or by feedbacks among climate, vegetation, and fire. Palynological records from central Alaska reveal a perfect natural experiment to explore this issue. During the early Holocene, white spruce expanded rapidly into Alaska from northwest Canada, reaching its western limit in central Alaska approximately 9000 years ago. Within 500–1000 years, spruce populations declined or disappeared across a 1 million-km<sup>2</sup> area. Spruce did not recolonize the region until 2000 years later.

approach

An integrated data-model approach will be applied to understand the mechanisms that caused a complex shift in spruce treeline in central Alaska during the early-to-mid Holocene.

progress

A statistical technician has been hired to develop model algorithms to simulate tree response to climate change. Ongoing field data was collected from interior Alaska fires to develop a model of charcoal dispersal. This model is a major component of a PhD thesis by Phil Higuera at the University of Washington. Model simulations for the study region (1900–2001) are currently being analyzed and driving datasets have been developed to pass to the charcoal dispersal model. This work will be incorporated into a manuscript to be submitted in October 2004 to a special issue resulting from the International Boreal Forest Research Association conference held in Fairbanks in May 2004.

impact

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

## Collaborative research: Modeling the role of high-latitude terrestrial ecosystems in the Arctic System: a retrospective analysis of Alaska as a regional system

A. David McGuire, T. Scott Rupp, David Verbyla, Donald Walker (SNRAS); Gordon Bonan, Amanda Lynch, James Maslanik, Wanli Wu (Univ. of Colorado); Jerry Mellilo (Marine Biological Laboratory, Woods Hole); Steve Running, John Kimball (Univ. of Montana); Charles Vorosmarty, Richard Lammers, Steve Frolking (Univ. of New Hampshire)

purpose

To analyze the performance of three climate models when applied to Alaska, providing a synthesis mechanism for field-based and modeling research in the Arctic, and communicate results for directing future research on the Arctic System. State-of-the-art data set development will provide coherent data sets for other researchers. Model evaluation will establish credibility for applications of models to the pan-Arctic in future climate change scenarios.

approach

The performance of a regional climate model, an ecosystem modeling framework, and a large-scale hydrological model will be evaluated. The focus on Alaska will allow assessment of how well the models close regional water and energy budgets, simulate exchange of CO<sub>2</sub> with the atmosphere, and evaluate linkages between atmosphere, land, and ocean.

progress

The study's third year focused on model verification and validation. Conceptual and structural development of model coupling strategies is ongoing. Simulations are being completed to investigate the sensitivity of the simulated fire regime to different climate driver datasets. Manuscript preparation for a project special issue is underway and will be submitted in March 2005.

impact

Analyses by the Intergovernmental Panel on Climate Change project that the buildup of greenhouse gases in the atmosphere is likely to lead to increases in mean annual temperature of between 1.0 and 3.0 degrees C by 2100, with increases greater at high latitudes. The responses of high-latitude terrestrial ecosystems to global change have important consequences for the Arctic System that are associated with (a) water and energy exchange with the atmosphere, (b) the exchange of radiatively active gases with the atmosphere, and (c) the delivery of fresh water to the Arctic Ocean.

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

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

purpose and approach

Increasing fire suppression has changed human-fire interactions from a positive feedback to a negative one, in which people attempt to reduce fire frequency. This change has implications for the climate system at high latitudes, because it

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

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

progress

In this first year of the project a scoping meeting was held in September 2003. All relevant personal (postdocs and programmer) have been hired. A community workshop was held in Huslia this past winter and historical archives have been searched. Initial modeling scenarios have been assembled and will be used to develop a manuscript fall 2004.

impact

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

## Global Change Education using western science and Native observations/knowledge

Elena B. Sparrow, Sidney Stephens, Leslie S. Gordon

purpose

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

approach

Rural and urban teachers participate in this Global Change Education program, also known as "Observing Locally, Connecting Globally" (OLCG). Their professional development includes a summer institute, a December followup workshop, and ongoing support programs. They learn to incorporate Native knowledge into local environmental change studies, use scientific measurements developed by Alaska climate change scientists and by the Global Learning and Observations to Benefit the Environment (GLOBE) program, and use best science education practices. Support includes a website ([www.uaf.edu/olcg](http://www.uaf.edu/olcg)), classroom visits and ongoing phone and e-mail communication. Program results are evaluated using attitude and

achievement assessments, including teacher and student journals.

progress

The fourth OLCG Science Institute was conducted in June 2003. To date, 51 teachers and 930 students have participated. Results of pre- and post-institute assessment showed that teachers were more comfortable about teaching science and integrating Native knowledge in the classroom. Teacher journals showed a positive influence on math and science teaching methods and curriculum. Student attitude and achievement assessments showed a significant increase between pre-test (beginning of the school year) and post-test (end of school year) scores.

27 impact

Participants are including more Native knowledge in lessons in their teaching practice, engaging students in scientific procedures and research, conducting performance assessments, and using an inquiry approach. Students improved most in their understanding of the water cycle and weather and their perceptions of how much they learned about science, the local environment, and Native knowledge. Parts of the program model have been used in other Alaska and national professional development workshops for teachers.

### Seasons: The global plant waves

Elena B. Sparrow, David Verbyla, Leslie S. Gordon

purpose

The project goal was to engage students in scientific research as a way of learning science, math, and technology in K-12 classrooms by providing an opportunity for scientists and students to collaborate on a research project of significance to scientists who track plant phenological changes as an indicator of global change.

approach

Plant phenology measurements (protocols) of green-up and green-down were developed, pilot-tested, and revised several times with input from teachers and GLOBE personnel. Related learning activities were adapted or developed: Green-up Cards, Budburst, First Look at Phenology, Beginning Look at Photosynthesis, and Investigating Leaf Pigments. Teachers learned and practiced the GLOBE protocols so their students could use them to collect data and report it on the GLOBE site for other students and scientists.

progress

Protocols and learning activities were aligned to national and Alaska science standards and incorporated in the “Earth as a System” chapter in the 2003 *GLOBE Teacher Guide* (published, distributed in book or CD format, and also posted on the GLOBE website, [www.globe.gov](http://www.globe.gov)). Two of the six journal articles published to date were published this year. K-12 students in the United States and ten other countries have been using the materials developed. Data analysis is in progress.

impact

Scientists now have access to global plant phenology data—ground-based observations that previously have been

very rare. Pre-college students from 77 schools in 11 countries have engaged in plant phenology research and entered green-up/green-down data on the GLOBE web server. These students included those in Alaska and 17 other states in the United States. In Alaska, phenology protocols and learning activities are being used by teachers and students who participate in different NSF-funded science education programs, such as the Schoolyard Long Term Ecological Research Project, the Global Change Education Using Western Science and Native Observations (OLCG) Project, the Alaska EPSCoR Rural Research Partnership, and the NSF/NASA-funded Alaska GLOBE program. Thus, collaborative efforts in research and education among science education projects in Alaska schools have been facilitated.

### Using reindeer for educational outreach and curriculum development

Greg Finstad, Carrie Bucki

purpose

The reindeer educational outreach program is designed to augment school curricula by using reindeer as a platform to integrate region-specific information and knowledge with conventional disciplines such as math, science, and geography.

approach

The project supplies information, lesson plans, and a supporting educational kit for use in the classroom by teachers. Data and information generated by Reindeer Research Program projects is used to develop math and science lesson plans meeting Alaska state standards to give students a real world science experience. Reindeer Research Program staff made presentations with a live reindeer at local schools to complement classroom study.

progress

Information and lesson plans have been added to the reindeer curriculum, which has been formatted for publication in print and on line. Demand for both the reindeer curriculum and presentations have increased while teacher and student satisfaction remains high.

impact

Region-specific information and locally generated data from a unique Alaska agricultural industry has been used to increase knowledge of local natural resources, while increasing interest and competency in math and science.

### forests and fire

#### Can Kenai Peninsula white spruce resist beetle attack?

Tricia L. Wurtz, (USDA Forest Service, BECRU); Jeff Graham, John Alden (Alaska Dept. of Forestry); Matt Macander (ABR, Inc.)

purpose

Our objective is to examine the phenomenon of geneti-

cally based resistance to spruce beetles that may exist in trees that survived the infestation.

approach

In the 1980s, John Alden collected seed from spruce at 40 locations on the Kenai Peninsula, from stands not yet affected by spruce beetle infestation. In 1998, in concert with an exceptionally good spruce seed crop statewide, seeds were collected at 27 of the original 1980s sites from uninfested or lightly infested trees. Collection trees were marked and their locations recorded. Seedlings were grown and outplanted in June 2000. In this experiment, trees grown from seed collected in the 1980s will function as the “control” group. The level of resistance to beetle attack inherent in this group should be no different than the overall pre-infestation population. Trees grown from seed collected in 1998 will function as the “presumed resistant” group. By virtue of the survival of their parent trees to 1998, we hypothesize that this group has some genetically based ability to resist beetle attack.

progress

In 2003 we documented growth and survival of the trees in the plantations.

impact

The plantations preserve the two spruce genomes (pre-infestation and postinfestation) for various types of future experimentation. When the trees have grown large enough that phloem samples can be harvested without unduly injuring them, resistance will be evaluated in the laboratory using extracts made from the phloem (a type of plant tissue). When the boles of these trees reach about 10 cm (4 in) in diameter, they will be open to attack by spruce beetles. This could happen naturally or be induced experimentally in the plantations. This research will improve understanding of the infestation of Kenai Peninsula spruce by beetles.

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

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

purpose

Interior Alaska contains 140 million burnable acres and the largest national parks and wildlife refuges in the country. On average, wildland fires burn one million acres in interior Alaska each year and threaten the lives, property, and timber resources of Alaska’s sparse but growing population. Wildland fires threaten human values, but they also are crucial for the maintenance of forest ecosystems. To better manage wildland fire in Alaska for the mutual benefit of humans and natural ecosystems, we undertook the development of tools for creating fire management plans.

approach

Under development is a computer model to assist land managers who design and implement fire-management plans in the boreal forest of interior Alaska. This model will integrate fuel buildup, vegetation, climate, and fire-management policy with real geography over time scales of years, decades, and centuries.

progress

MS student Tom Kurkowski and PhD student Paul Duffy both plan to complete their research and graduate in fall 2004. Duffy’s first thesis chapter has been accepted for publication by *Ecological Applications*. The project was highlighted by the Joint Fire Science Council in their annual summary to Congress.

impact

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

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

John Yarie

purpose

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

approach

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

progress

Based on average yearly tree basal area growth over the past decade, rainfall elimination was found to have no effect on growth in upland locations, but in floodplain locations, tree growth was reduced.

impact

This study is clarifying the effect of precipitation distribution on vegetative growth and contributes to better predictions of how climate change affects forest dynamics in interior Alaska.

## Evaluating influences of varied wildland fire regimes on caribou forage lichen abundance through state and transition models

T. Scott Rupp, Mark Olson (SNRAS); Layne Adams, Kyle Joly (USGS Alaska Biological Science Center); Bruce Dale, Bill Collins (ADF&G)

purpose

Caribou wintering in Alaska's boreal forest ecosystems forage primarily on climax stage fruticose lichens. Because wildland fires chronically burn boreal forests, reducing the availability of forage lichens for decades, factors affecting fire regime on caribou winter range may influence caribou nutritional status by influencing lichen availability.

approach

A spatially explicit succession model was developed to evaluate specific objectives relative to influences of various fire and climatic regimes on abundance and distribution of caribou forage lichens in the eastern Tanana Hills and Tetlin Flats.

progress

This project has been completed, but will be further developed under another project funded by the Joint Fire Sciences Program. A graduate student from the Statistics Department worked on this project for his thesis final project. The results of this work are being prepared for a peer-reviewed journal article to be submitted fall 2004. Results suggest that increased fire frequency on the winter range of the Nelchina Caribou Herd in eastern interior Alaska will result in large decreases of available foraging habitat, relative to currently available habitat, in both the short- and long-term future.

impact

Changes in frequency and distribution of wildland fires have obvious implications for caribou nutritional and population status. Exploring the influences of various fire regimes on caribou winter range will aid in addressing current and future management issues.

## Fuel load analysis and fire risk assessment for the Municipality of Anchorage

T. Scott Rupp, David Valentine, Dan Cheyette (SNRAS); Sue Rodman (Anchorage Fire Department)

purpose and approach

The objectives of the project are to inventory the fuels present in Anchorage's wildland-urban interface, create custom fuel models that accurately describe the fuels inventoried, model the expected fire behavior were a wildfire to occur in the wildland-urban interface under current forest conditions, and identify fuel conditions that should, according to our model, lessen the extent and/or intensity of the predicted fire.

progress

MS student Dan Cheyette completed custom fuel models for the Anchorage Fire Department and Alaska Division of Forestry for the 2004 fire season. Cheyette anticipates defending in summer 2004 and graduating in fall 2004.

impact

Research has demonstrated that fuel management practices will reduce the predicted fire behavior and/or severity.

The goal of this research is to model the expected fire behavior in the Anchorage wildland-urban interface and to identify fuel inputs that can be proactively managed so as to minimize Anchorage's risk and exposure to any such fire. This research should immediately benefit Anchorage fire managers, who can use the results for that purpose.

## Growth of Alaska birch

Glenn Juday, Valerie Barber, Rob Solomon, Kimberley Maher

purpose

Alaska birch (*Betula neoalaskana*) is the dominant tree in about 14 percent of the boreal forest of Alaska. Birch, along with white spruce and aspen, make up nearly all the boreal forest with commercial potential. The goal of this project is to determine the growth rate and climate requirements of birch.

approach/method

Ring widths were measured and de-trended to remove the effect of age and geometric bias and then correlated with monthly temperatures at Fairbanks. The best climate prediction of growth was developed.

progress/result

Tree cores were collected from four commercially productive birch stands (8 to 22 trees per stand). Growth in all four stands was highly negatively correlated to temperature (growth was less in warm summers, greater in cool summers). Future growth of birch on these sites, derived from these empirical relationships with past temperature, has been developed for five Global Circulation Model climate scenarios for the twenty-first century.

impact/implications

Although other birch could respond differently, the twenty-first century climate scenarios for these four populations produce climates in which they would not survive, because predicted rates of growth would approach zero within 70–100 years. Warming of 3°C on the most sensitive site and 5 to 6°C on the least sensitive site would eliminate birch. If climates similar to the scenarios occur in the next century, many of the better interior stands of birch are not sustainable.

## Human-fire-ecosystem-climate interactions: regional biocomplexity and the vulnerability of the Alaska boreal forest

T. Scott Rupp, F. Stuart Chapin, III, Amy Lovcraft, A. David McGuire (SNRAS); David Natcher (UAA); Sarah Trainor (Univ. of Chicago)

purpose

Fire management issues are increasingly important as human populations progressively expand into wildland areas. The same natural fire regimes (i.e., fire frequency, intensity, and size) that underlie the structure and function of many wildland areas also threaten human life and property. An understanding

of the processes that control fuel accumulation, including the role that socioeconomic activities play, is crucial for designing sound, effective management policies.

approach

The proposed research program will develop a conceptual understanding of the interactions of fire with climatic, ecological, and socioeconomic processes in interior Alaska forests. An interdisciplinary research team will quantify the sensitivity of the region's boreal forest to human perturbations of the "natural" fire regime and identify the impact of human activities on short- and long-term frequency and extent of fire. The proposed modeling approach aims to develop plausible scenarios of future changes in Alaska's fire regime and its societal effects. This whole-system model provides an overarching research framework and provides a synthesis tool to apply understanding of the system to management and decision analysis issues.

progress

This funding was a seed grant to assist in development of competitive proposals to NSF and other federal funding agencies. The resulting proposal was funded by NSF. Several meetings were facilitated with these funds.

impact

Wildland fires threaten human values, but also are crucial for boreal forest maintenance. Our proposed work is important because it directly addresses this issue. The whole-system model will serve as an integrative and adaptive planning tool.

### Landscape fragmentation and forest fuel accumulation: effects of fragment size, age, and climate

William Gould, Grizelle Gonzalez (International Institute of Tropical Forestry, USDA Forest Service); Andrew Hudak (Rocky Mountain Research Station, USDA Forest Service); Teresa N. Hollingsworth, Marilyn Walker (USDA Forest Service BECRU)

purpose

This study examines the fuel load accumulation of forests and how it is affected by fragment size, stand age, and climatic differences.

approach

One hundred twenty transects were visited in interior Alaska, 120 transects in northern Minnesota, 240 in Idaho, and 240 in Puerto Rico. Across these transects live and dead fuel loads were measured. Across a subset of the transects, decomposition experiments were set up.

progress

All transects have been visited and data analysis is underway.

impact

This study will shed light on how fragmentation affects fuel accumulation and decomposition across a large climatic gradient.

### Log decomposition in interior Alaska

John Yarie

purpose

In natural forest ecosystems, logs represent a significant input into the forest floor. This input affects 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

A series of logs are being positioned on the forest floor to observe long-term decomposition. Fifteen four-meter logs are placed on the forest floor in six replicate stands for each major upland and floodplain vegetation type, and will be resampled during the next 100 years. The ten-year sampling period was started in 2004.

progress

Currently all time zero-, two-, and five-year samples have been collected. Chemical analysis is continuing on the collected samples and should be completed by the end of 2005. Also, sites that represent floodplain black spruce sites and burned white and black spruce sites have been established.

impact

At this time it is not clear what effect coarse woody debris has on the carbon dynamics of taiga forest in interior Alaska. The results of this study will clarify the effects of log decomposition dynamics on the carbon balance of forests in interior Alaska.

### Natural regeneration of white spruce

Glenn Juday, Robert Solomon

purpose

This is a long-term study of white spruce that have regenerated naturally following the 1983 Rosie Creek Fire. Data from 2003 are the fifteenth year of measurement in the study. This is the longest and most detailed look at the exact amount of tree regeneration and what conditions are associated with successful natural tree regeneration in boreal Alaska.

approach

All seedling white spruce in a 100m by 100m plot in the Bonanza Creek Experimental Forest LTER, Reserve West plot, were mapped and measured at the end of the 2003 growing season. Growth of a subsample was measured weekly.

progress/result

Mean height growth of 1983 seed crop seedlings in 2003 (19.4 cm) was less than the previous year for the first time since 1998. Hot, dry weather stopped height growth by early to mid-June. Despite the wettest July in the last century, height growth did not resume. For the 1983, 1987, and 1990 seed crops, the number of seedlings taller than 100 cm amounted to 84 percent, 34 percent, and 5 percent, respectively; mean total height was 207cm, 84cm, and 42cm, respectively. Seedlings taller than 100cm in the early years of regeneration have overtopped shrubs and herbs and have good potential to be-

come part of the canopy if they are not overtopped in turn by hardwood trees.

impact/implications

Data from this study provide the probability statistics that trees will reach specific height benchmarks in a given year, and show the very great advantage of immediate seed crops following forest disturbance. The best-positioned 1983 seedlings accomplished about 40 percent of their total height in the three climatically favorable cool and moist years of 2000–2002, demonstrating that there is not a typical seedling height growth following fire, but highly variable growth depending on climate.

## 31 Permanent Sample Plots (PSPs) for stand characterization

Edmond C. Packee, Sr.

purpose

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

approach

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

progress

To date, since inception of the program in 1995, 516 PSPs have been established in groups of three, which equals 172 stands. Five-year remeasurements are well underway and in 2004 the first 10-year remeasurement will begin. PSP data are included in three MS theses and are providing support for one PhD dissertation. Soil description and sampling to USDA Natural Resources Conservation Service standards was initiated in 2002 in interior Alaska.

impact

PSP data are used to define and characterize vegetation community types, model and predict forest stand succession

and growth trajectories, truth satellite imagery interpretations, and to assess wildlife habitat and forest health conditions. PSPs also provide stand data for development of forest management plans, including basic inventory data, growth and mortality information, and stand condition data that are essential in developing timber management plans and thus sustainable multiple-use forest management plans.

## Regional variability and biodiversity of black spruce communities in interior Alaska: linking vegetation, carbon, and fire

Teresa N. Hollingsworth, Marilyn D. Walker (USDA Forest Service BECRU); F.S. Chapin III (IAB); E.A.G. Schuur (Department of Biology, Univ. of Florida)

purpose

This study examines local and regional patterns of variability in plant composition and diversity in black spruce communities in interior Alaska. It includes assessing the important environmental controls driving the species composition of these communities at both the local scale and regional scale and linking vegetation composition to soil carbon patterns and patterns of fire history.

approach

Various environmental, stand, and compositional data were collected from 150 black spruce stands that span from the Alaska Range to the Brooks Range. Soil and fire history indices from each site also were collected.

progress

Three theses chapters have been written, two of which are in manuscript form to be submitted.

impact

This study sheds new light on the environmental controls of plant communities that are strongly linked to soil mineral pH on the landscape scale. The study links species composition to soil carbon patterns, and quantifies two fire history components that are important to current vegetation composition: a ground fire component and a tree fire component. This has implications for vegetation classification, fire and fuel loads management, and carbon sequestration in black spruce forests in interior Alaska.

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

John Yarie, Keith Van Cleve

purpose

In the late 1960s, fertilization and thinning studies were initiated in age groups that represented young, middle, and old age classes for major forest types in interior Alaska. Both climatic and tree growth monitoring of these stands has continued through 2004. These records represent a long-term record of tree growth and climate data from an age sequence of forest stands.

approach

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

progress

A manuscript in the final stages of preparation will detail the 35-year results of eight separate studies and will include the 15-year results of the Bonanza Creek Long Term Ecological Research sites.

impact

The completion of the 35-year manuscript will yield a significant long-term perspective of forest growth dynamics within interior Alaska.

32

### Stream temperature response to timber harvest activities in interior Alaska

John D. Fox, Jr.

purpose

This study looks at summer stream temperature and winter ice thickness regimes in response to changes in riparian vegetation, timber harvest, and ice-bridge construction.

approach

Several simple to complex models are being used to explore the many interacting variables that can influence summer stream temperature and winter ice thickness.

progress

A comprehensive annotated literature review has been compiled on ice thickness and ice bridges. Freeze-thaw models contributed to a general recommendation that water depth be greater than two meters for ice-bridge sites and that upwelling areas be avoided. Literature review, modeling work, and stream water temperature data indicate a strong association between air and water temperatures for mid-sized to large streams and, for small streams exposed to direct solar radiation, a systematic temperature increase longitudinally from headwaters to mouth.

impact

Information gained to date contributed to development and passage of revised riparian management standards for interior Alaska. A well-attended riparian management workshop was conducted in 2002 and two additional presentations developed by the PI and a colleague have been delivered. Information was provided to the Science & Technology Committee of the AKDNR-DOF for their review of Region II, southcentral Alaska riparian standards. Techniques and models developed that relate to soil freezing and thawing may contribute to assessment of climate change effects on the allowable number of oil-industry work days on Alaska's north slope tundra, which are limited by thresholds of snow cover and depth, and soil frost in the fall and spring.

### Treeline white spruce growth in future climates

Martin Wilkming, Glenn Juday

purpose

We previously found that some treeline white spruce grow best in cool summers, and some grow best in warm springs. The purpose of this study was to sum up these individual tree growth changes and relate them to scenario predictions of twenty-first century climate to see if overall growth expected for white spruce in the Brooks Range would increase or decrease during the century.

approach

Growth was calibrated to climate for 687 white spruce trees at seven treeline sites, including high-density forest, low-density forest, and floodplain. Growth during the twenty-first century was calculated as a percentage of twentieth-century basal area growth using five Global Circulation Model scenario outputs for twenty-first century climate.

progress

Compared to twentieth century growth, treeline basal area growth was projected to increase 25–50 percent in the western Brooks Range, increase 4–11 percent in the central portion, with growth decreasing up to 11 percent in the eastern portion. The overall net change in projected twenty-first century basal area growth at each site seems to be controlled by the relative proportion of trees performing best in warm versus cool climates.

impact/implications

These results highlight the importance of regional scale investigations of biosphere-climate interactions, because they indicate that a substantial gain in aboveground biomass will result from future warming only in the western regions, while in the eastern regions climate warming will decrease overall wood production and therefore carbon uptake potential.

## succession and revegetation

### Abandoned mined land revegetation monitoring

Dot Helm

purpose

Monitoring state-directed revegetation on abandoned mined lands north of Palmer provides information to the Alaska Division of Mining, Land, and Water (DMLW) on which treatments should be continued for their ongoing revegetation. Effects of three commercially available organic fertilizers (slow release) on overburden growth media were compared with more traditional mineral fertilizer treatments on overburden and soil materials.

approach

Plots established by DMLW were measured for cover and photographed each year.

progress

We have not found significant benefits for plant growth



by using three commercial organic fertilizers compared with traditional mineral fertilizer. The best growth occurred on the soil with grubbed materials.

impact

The DMLW uses the results to evaluate revegetation techniques in the Sutton area and determine if some new techniques or products are worth using.

## Arctic Plant Germplasm Introduction and Research Project (APGIR)

Dave Ianson, Nancy Robertson, Alberto Pantoja (ARS/USDA)

33 purpose

The mission of APGIR is the acquisition, propagation, storage, and distribution of plant germplasm for agricultural and nonagricultural plant species from arctic, subarctic, and alpine regions of the world, and research on certain diseases and physiological features of this germplasm. APGIR also serves as a grow-out site for seed and clonal samples for certain cool season accessions from other plant germplasm repositories within the National Plant Germplasm System (NPGS). This project is an important part of National Program 301 (Plant, Microbial, and Insect Genetic Resources, Genomics and Genetic Improvement), and contributes most of the efforts to the Plant Genetic Resource component of this program.

activities

The detection and identification of turnip mosaic virus (TuMV) in rhubarb plants from the germplasm collection represents the first report of TuMV in Alaska, and is especially noteworthy since the virus has a large plant host range.

The unit provided petiole material from some of our *Rheum* accessions to the Matanuska-Susitna Borough. The borough is working on the development of an Agricultural Processing and Product Development Center for Rhubarb. The proposed program will allow interaction with the Home Economics Program of the University of Alaska, Fairbanks.

Diseased *Streptopus amplexifolius* plants are infected with two viruses, singly or together. One virus has previously been identified as a unique member in the family Potyviridae, and this year the other virus was confirmed to be a member in the genus *Carlavirus* with some sequence identity to several other carlaviruses and a close serological relationship to a carlavirus. The carlavirus has serological relatedness and sequence similarity to several carlaviruses. Diseased plants occur in forests, along roadsides near crops, and are either doubly or singly infected with each virus. Nearly all the documented sites contain over 50 percent incidence of infection. This is the first report of viral infection in *S. amplexifolius*.

Phylogenetic relationships of Alaska isolates of Barley yellow dwarf virus-PAV and cereal yellow dwarf-RPV were analyzed with each other within the same field, between fields, and between 2002–2003. A cluster of six unique Alaska RPV isolates was determined from a phylogenetic tree comparing Alaska isolates with other members worldwide.

We collaborated with University of Alaska scientists to study the effects of the biotic component of soil inocula on seedling growth, transplant survival, and establishment of *Shepherdia canadensis* from Sutton, Alaska (61° N) to Healy, Alaska (63° N) and up past the Arctic Circle to Nolan, Alaska (67° N).

Plants indigenous to the Aleutian Islands and other isolated areas of the state were collected. The Aleutian Islands exist in a unique environment and some areas have restricted access, therefore this effort proved doubly important.

The effects of acid scarification, cold stratification temperature, and time on *Oplopanax horridum* (Devil's Club) were conducted. This represents an initial phase of research into preserving this medicinal plant.

Field planting for the National Arctic Plant Germplasm Resources Unit included 272 accessions comprising 75 genera. The bulk of the accessions came from the following genera: *Poa* (38 taxa), *Juncus* (27 taxa), *Carex* (73 taxa), *Calamagrostis* (16 taxa), *Artemisia* (12 taxa). The rest of the collection that was planted for increase ranged from cuttings of native medicinals like *Oplopanax horridum* (Devils Club) and Alaska Ginseng to seeding six taxa of *Crepis* (Hawk's beard).

For the first time in Alaska, Barley yellow streak mosaic virus (BaYSMV) infections were documented in barley plants and the existence of its vector, the brown wheat mite (*Petrobia latens*) was verified. Since the mite thrives under drought conditions, the incidence of BaYSMV infection will probably increase under the increasing drought conditions in central Alaska.

For the first time in Alaska, Barley yellow dwarf disease was documented and the causal agents determined (barley yellow dwarf virus-PAV and cereal yellow dwarf virus-RPV) in barley and oats. Sequences obtained from clones of over 100 isolates identified a unique cluster of six RPV isolates. The Alaska PAV and RPV populations have different spatial and temporal population genetic structures. This suggests that they are affected by different agroecological factors.

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

Viruses or virus-like agents were identified for the first time in the following native plants: 1) *Delphinium glaucum*, 2) *Pyrola asarifolia*, 3) *Angelica lucida*, and *Sorbus scopulina*.

impact

Plant disease research adds to knowledge of plant pathogens in native plants found in both isolated sites and near agricultural and residential sites. Plant diseases in Alaska, both indigenous and introduced, are not well documented. Although viral and other contagious diseases can have a significant negative impact on agricultural and nonagricultural crops adapted

to arctic, subarctic, and alpine environment, comprehensive plant disease surveys in agricultural and nonagricultural plants species are few, especially for plant viruses.

Physiological aspects of plant adaptation and survival in arctic, subarctic, and alpine environments is an important area for new research.

To date there has been no systematic effort by any U.S. agency to preserve high-latitude and high-altitude plant germplasm. Benefits resulting from the preservation and study of arctic, subarctic, and alpine plants are unknown, although any future use of these species depends on their preservation.

The Alaska location of the plant materials center is important because some high-latitude and high-altitude plants are difficult or impossible to grow at relatively warm, short-day, low-latitude sites. The long growing season days at the Palmer site may also reduce the time necessary for seed production of certain accessions from other NPGS sites. For example, in Palmer, cauliflower seed is produced in the first year rather than in the expected second year for a biennial.

### Ectomycorrhizae on disturbed lands in Southcentral and Interior Alaska: a comparison of regional similarities and differences

Dot Helm

purpose

Most woody plant species need ectomycorrhizal fungi (fungi that help plants absorb nutrients and moisture from soil and receive carbon as an energy source from plants) that may not be found on nursery or greenhouse transplants used for revegetation. This study compares ectomycorrhizal communities in early successional sites across a latitudinal gradient in Alaska to evaluate similarities among ectomycorrhizae to assess potential for a common revegetation strategy.

approach

Roots and surrounding soil or soil/litter cores are collected from early successional sites, morphotypes of root-fungi combinations are described, and samples from the various sites are compared.

progress

In 2003 more roots and surrounding soil from early succession sites at Exit Glacier and Bonanza Creek were collected. Differences to date may be related to plant species rather than latitude.

impact

Successful revegetation using woody species in Alaska usually requires formation of ectomycorrhizae. Inoculation with fungal propagules may facilitate this process, but it is unknown whether soil inoculum characteristics vary across latitudes. This study will provide information important to revegetation efforts.

### Effects of herbivory on white spruce establishment in floodplain plant communities

Tricia L. Wurtz (USDA Forest Service, BECRU); Knut Kiel-

land (UAF); Tom Hanley (USDA Forest Service, Juneau) purpose

To study the role of herbivory, principally by moose, in the establishment of white spruce in the primary successional sequence of floodplain plant communities of the Tanana River.

approach

Moose and hare exclosures (fenced areas), in which vegetation can develop in the absence of herbivory, are used so that floodplain succession and spruce establishment, with and without herbivory, can be observed.

progress

In 2002 and 2003, twelve new moose exclosures were established on the floodplain. Inside and outside the exclosures, spruce seedlings were planted and spruce seed was sowed.

impact

This work will improve understanding of the role of herbivory on floodplain succession.

### New Crops Opportunity: Inoculated woody seedlings, a new Alaska crop for Alaska revegetation

Dot Helm, AFES; David Ianson, USDA

purpose

This study was designed to determine if soil inoculum used by local producers to grow mycorrhizal-inoculated seedlings in the greenhouse must be from the same latitude as the final planting site, as would be the case with seeds.

approach

Seeds and soil inoculum were collected from three latitudes. Seedlings were grown indoors with several inoculum treatments, then planted. Plants will be harvested over two years and treatments compared based on plant height and mycorrhizal formation.

progress

Indoor-grown seedlings were planted on mined sites in Alaska near Palmer, Healy, and Nolan. A subset of the plants was measured and harvested in August 2003. Results so far have been insignificant.

impact

Better understanding of latitudinal variation in mycorrhizal inoculum and plant interactions will help Alaska growers produce a value-added product that is competitive with large greenhouses outside Alaska that now supply woody plants for Alaska revegetation.

## Natural Resources Use and Allocation fisheries management

### Regional economic impact assessment of the Alaska snow crab fishery

Joshua Greenberg, Mark Herrmann, Hans Geier, Charles Hamel

purpose

The goal of this work was to estimate the economic impact of the Alaska snow crab fleet to the communities in Alaska and Washington, and inform fishery managers of the potential economic effects associated with changes in snow crab fishery policy.

approach

An input-output model of the snow crab harvesting sector was constructed for Alaska and Washington communities using IMPLAN. This model was then linked to a international supply and demand equilibrium model for Alaska and Canada snow crab, which was estimated using the three-stage least squares (3SLS) econometric method.

35

progress

The preliminary snow crab harvesting sector input-output model for Alaska and Washington communities was completed. The international market model of the Alaska snow crab was estimated. These models will be linked and scenarios constructed to inform snow crab managers of policy induced effects on fishery participants and dependent communities.

impact

The constructed models should benefit future analyses of the effects that major management changes have on Alaska communities and the Alaska sector of the industry. The snow crab market model will be useful to analyses of changes in fishery management that affect the size, scope, and timing of the fishery harvest. It may assume a position of particular prominence in 2005, when a crab rationalization program goes into effect that relies on price arbitration in which dockside price is set by an third party arbitrator.

## forests and trees

### Alaska birch sap production and properties

Kimberley Maher, Glenn Juday, Robert Solomon

purpose

In 2003 six companies harvested birch sap and produced birch syrup products in Alaska. This study assessed sap volume, timing, chemistry, sugar concentrations, and components to help producers understand and market their product. Environmental factors that are associated with good sap production are also under study.

approach/method

In 2002 and 2003 sap flow volume and timing (start and end of useful flow) were measured in three transects up an elevation gradient near Fairbanks. Sugar content and concentrations and cation (chemical element with a positive charge) content were measured in the AFES Palmer lab.

progress/result

Flow started significantly later and more sap was produced over a longer time in a cool spring (2002), than in a warm early spring (2003), but sugar content was relatively stable between the years. The percentage of galactose (0.40 percent) and glu-

cose (45 percent) of the total measured carbohydrates in the sap was consistent throughout the 2002 sap season. During the season the fructose component increased from 42 percent to 54 percent as the sucrose component dropped from 13 percent to 0.40 percent. Arsenic was present only in low amounts, and we concluded that birch does not concentrate this poisonous element.

impact/implications

This project has identified the basic characteristics that affect birch sap production in central Alaska, and producers now know the characteristics of the most productive stands, trees, and climates. This project has developed a chemical profile of the birch sap product that should improve its competitiveness in various markets.

### Birch bark use in Alaska

Mark T. Fortunato, Edmond C. Packee, Sr.

purpose

People of the circumboreal north historically used birch bark to make baskets, plates, and pails. Today, emphasis has shifted from the utilitarian to art objects for sale to tourists. Our objectives were to determine extent of birch bark harvest, characteristics of trees harvested, amount of bark used per item, and retail price of items.

approach

Peeling activity along Tanana Valley roads was inventoried and distances of peeled trees from the road were measured. At three locations, number of trees, peeled and unpeeled, and the diameter and width of bark peeled were determined. Retail outlets were visited to determine prices and square inches of bark per item.

progress

Mark Fortunato's BS thesis was completed in spring 2003 and developed into a poster presentation for the Society of American Foresters 2003 National Convention in Buffalo, NY.

impact

Based on the square-inch value of bark and the labor, there is insufficient value to establish a permit system based on bark quantity harvested; a practical approach to manage bark harvest on public lands is to use an exclusive area-use permit. Careful peeling of the bark does not scar the tree permanently nor create serious disease or insect mortality; the remaining brown bark, after an unknown number of years, sloughs off revealing once again the white, peelable bark.

### Black spruce growth and yield

Edmond C. Packee, Sr., Carolyn Rosner

purpose

Because small black spruce has potential as a raw material for phytochemicals, e.g., high-value pharmaceuticals and ethanol, individual tree and stand volume tables, growth equations, and a community type classification are needed.

approach

Stand productivity equations and individual tree volume data collection include total and breast-height age, stump-height age, tree height, stand volume, and community characteristics. Trees for site index (a measure of potential productivity) and individual tree volume are measured every four feet from a six-inch stump. Tree volume data will be used for wood volume, bark thickness taper, cambial area, and stem biomass equations. Regression is used to develop the equations. (See reports on Permanent Sample Plots [PSPs] and Northern Forest Productivity.) This study is a School of Natural Resources and Agricultural Sciences MS thesis effort (completion expected in mid 2004).

36

progress

Volume measurement data for 885 trees and stump and breast-height ages for 450 trees were entered into spreadsheets and verified; initial equations were tested. For site index two distinct types of stands, upland and lowland, were identified. Draft site index curves were revised resulting in polymorphic curves. Twenty stands were selected for PSPs; sixty PSPs were established.

impact

This information is necessary for evaluating commercial potential of forest stands. Site index curves are used to measure potential productivity of sites. Volume tables are essential for calculating allowable harvests and biomass. Years-to-breast-height is essential for determining rotation ages.

### Early height growth of white spruce

Edmond C. Packee, Sr.

purpose

This study examines the effect of overstory competition and distance between trees on early height growth by determining years required for planted, open-grown, and understory trees to reach breast height (4.5 feet); tree height at twenty years; and the effect of overstory competition on seedling and sapling height growth.

approach

For free-to-grow white spruce, Levels-of-Growing Stock (LOGS) plantations with five spacings (distance between trees) were established at Bonanza Creek (west of Fairbanks) and Red Fox (Tok); overstory competition is removed regularly. Height growth is measured annually through age twenty, thereafter at five-year intervals. LOGS research heights were compared to operational plantation heights. To determine the impact of overstory competition, the height of twenty-five trees for each of several conditions in a stand was measured at eight white spruce plantations six to ten years old. Trees were growing under three conditions: a) free-to-grow, b) aspen overstory, and c) birch overstory.

progress

Andre Collins' senior thesis addressing the impact of overstory competition on height growth was successfully completed, using measurements from 600 trees. Results show that paper birch and aspen have approximately equal impacts on white spruce height growth, about a 25 percent reduction.

impact

This data improves the ability to predict the age at which planted white spruce reach breast height and free-to-grow status. It will improve modeling of early growth trajectories for yield forecasts and response to ecological changes.

### The ecology of post-fire morel mushrooms

Tricia L. Wurtz (USDA Forest Service, BECRU), Jane Smith (USDA Forest Service); Nancy Weber, Dave Pilz (Oregon State Univ.); Richard Winder (Pacific Forestry Centre)

purpose

The goal of this project is to document the productivity and fruiting patterns of burned sites in interior Alaska for morel mushrooms.

approach

A strip-plot sampling method developed by Pilz et al. is used to investigate the role of pre-fire forest type, slope, aspect, burn intensity, soil temperature, soil moisture, and soil type in mushroom fruiting body production.

progress

The morel productivity of the West Fork and Livengood fires in 2003 have been documented.

impact

Widespread commercial harvesting of edible mushrooms began in the (U.S.) Pacific Northwest about fifteen years ago. In 1992, approximately 1.8 million kg of wild mushrooms were sold there, 590,000 kg of which were morels. Experts in the commercial harvest of nontimber forest products predict that trade in such products from Alaska forests will increase substantially in the coming years. Forest managers need basic information about these products in order to properly manage this forest use.

### Espacement effect on early diameter of white spruce stems

Edmond C. Packee, Sr.

purpose

Growing space and age affect diameter growth of trees. The effect of espacement, distance between planted seedlings, on early diameter growth of white spruce is not well documented. The objective is to determine the effect of espacement on diameter growth of individual trees.

approach

Two Levels-of-Growing-Stock plantations, established May 1986 west of Fairbanks with five spacings, were measured beginning in spring 2001 to obtain fifteen-year breast-height diameters. Regression analysis is used to determine if statistically significant differences occur between the two plan-

tations and between spacements.

progress

Annual remeasurements were made in 2002 and 2003. Regression analysis on the first measurement demonstrated that significant differences existed between the two plantations; the warmer, drier, southerly slope had smaller diameters (mean diameter range: 22–37 mm) than the cooler, moister, easterly slope (mean diameter range: 35–55 mm).

impact

Knowing diameter-espacement relationships addresses economics (planting costs), early wood quality (e.g., juvenile wood, knot size), and early growth (essential for forest stand prediction models)—information essential for forest management.

### Gall aphids on Alaska white spruce

Jeffrey D. McArthur, Edmond C. Packee, Sr.

purpose

Gall-forming aphids, not true aphids, on planted white spruce can be a serious forest health and landscape problem because they stunt growth, curl twigs, delay budburst, and cause small, brown abnormalities on branches. We are seeking to identify the causal agent(s) and determine infestation levels as related to espacement and overstory shading in interior Alaska.

approach

Two Levels-of-Growing-Stock plantations with five spacements at Bonanza Creek west of Fairbanks were used. Each sample tree was divided into a lower and upper crown section (below and above breast height, respectively) and assigned an infestation level. Also, infestation levels for the 8x8-foot espacement were compared with those on trees planted at the same time with overstory shade. Analysis of Variance and "t" test were used to analyze data.

progress

Galls were noted at the Red Fox (Tok) Levels-of-Growing-Stock plantations. Based on empty galls from both the Bonanza Creek and Red Fox sites, a specialist identified the causal agent as either *Pineus similis* Gill. or *Adelges abietis* L. Aphid activity in 2003 was essentially nonexistent at both locations.

impact

Results may influence nursery practices, seedling treatment, or planted seedling espacement.

### Individual tree volume equations

Edmond C. Packee, Sr., Thomas Malone

purpose

Accurate individual tree volume equations are essential for marketing forest fiber; often overlooked is their importance for ecological applications. In addition to wood volume for forest products, tree volume equations can be used for determining biomass, carbon sequestration, and biodiversity functions and processes. For Northern Forest species, existing equations are

questionable; no equations exist for black spruce, tamarack, or balsam poplar. This study develops new, single-stem, cubic-foot volume equations to replace existing equations for the major commercial species (white spruce, paper birch, aspen).

approach

Felled-tree diameters are measured at four-foot intervals and volumes calculated for individual sections and then the tree. Regression is used to develop single-stem individual tree volume, bark thickness, taper, and cambial area equations. Tom Malone is using white spruce, paper birch, and aspen and Carolyn Rosner is using black spruce for their MS theses.

progress

A literature review continues. Data sets to date include: 2,024 white spruce, 1,050 black spruce, 136 aspen, 274 birch, >250 balsam poplar/black cottonwood. Draft white spruce and black spruce equations have been developed.

impact

Improved equations will contribute to improved management practices, including growth and yield forecasts, forest fiber product sales, ecological modeling, and wildlife habitat manipulation.

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

Edmond C. Packee, Sr.

purpose

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

approach

LOGS plantations were established at Bonanza Creek near Fairbanks in May 1986 (white spruce and tamarack—the latter was abandoned because of insect-caused mortality) and at Red Fox (Tok) in August 1992 (white spruce, black spruce, tamarack, lodgepole pine). Espacements are 4x4, 6x6, 8x8, 10x10, and 12x12 feet. Plots (0.1 acre) are remeasured annually for the first 20 or 25 years.

progress

The Bonanza Creek white spruce and the Red Fox LOGS plantations were remeasured. Tamarack mortality at Red Fox is in groups and appears to be related to soil characteristics.

impact

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

### Phytochemicals from the Northern Forest

Edmond C. Packee, Sr.

purpose

Alaska's Northern Forest consists of high-value fiber, but much is in small-sized trees having little traditional value. Phytochemicals, chemicals derived from the forest, have potential high value as pharmaceuticals, human food components, industrial chemicals, and biofuels. This study aims to determine potential (type, quality, and quantity) of chemicals contained in Northern Forest species, extractive processes, and potential markets.

approach

Tree components (bark, wood, foliage, reproductive tissue) have different chemical properties. For example, it is unknown which phytochemicals and their quantities are present in Alaska birch (different species than Lake States and Russia) or balsam poplar/western black cottonwood. Species, genetic, and environmental differences mandate qualitative and quantitative analyses of Alaska materials. Compounds such as betulin and betulinic acid have pharmaceutical potential; quantities in Alaska birch bark are hypothesized to be greater than in *Betula papyrifera* of the Lake States. Pursuit of finances by others for a wood refinery continues. The effort primarily involves a review of the literature and contact with scientists and entrepreneurs.

progress

Drafting of a contract was begun with the University of Minnesota Duluth Natural Resources Research Institute to analyze Alaska bark samples previously provided. The taxonomic literature reports four tree species of birch in Alaska: *Betula papyrifera* only in Southeast Alaska; *Betula neoalaskana* on the northern portion of the Kenai Peninsula and dominant throughout the rest of northern and southcentral Alaska; *Betula kenaica* dominant on the southern two-thirds of the Kenai Peninsula and scattered throughout the rest of Alaska; and *Betula occidentalis* found locally in northern and southcentral Alaska.

impact

The extent of uncommitted forest biomass available for phytochemicals suggests that the opportunity for family-size through large (350 ton/day) facilities and attendant employment is feasible for Alaska. This is supported by increased Canadian interest in phytochemicals from their forests of the same or similar species. The preliminary evidence suggests that Alaska must adequately finance the needed research and develop partnerships with private and public phytochemical chemical organizations. Because of the high value of such phytochemicals as betulin and betulinic acid from birch bark and antioxidants from spruce, ethanol for energy may be reduced to byproduct status.

**The potential of lodgepole pine: An interdisciplinary study**

Glenn Juday, Alina Cushing, John Alden (USDA Forest Service - Retired), Robert Solomon

purpose

Lodgepole pine is native to northwest Canada not far from the Alaska border, and was introduced into interior Alaska in experimental plantations in the mid-1970s to mid-1980s. The

goals of this project are to measure the performance of these plantations, evaluate risks, public attitudes, and the experience of lodgepole introduction in other northern nations, and to determine the growth response of the species to climate.

approach

Old field notes and data files on height growth and survival in plantations were entered into a new database. Interviews were conducted in Iceland (17) and Sweden (9). Tree cores were collected from oldest plantations in Alaska (5), Sweden (2), and Iceland (6). All cores have been measured and correlated with nearby climate data for each site.

progress

Lodgepole ring widths in Alaska in the 1980s and '90s were 2 to 4 mm per year, an excellent rate of early growth. Few reservations or concerns were expressed about lodgepole pine introduction in Iceland, but both support and opposition were expressed in Sweden. Lodgepole pine shows climate sensitivity in Iceland and Alaska, but not Sweden.

impact/implications

The best seed sources of lodgepole pine grow as well or better than native conifers in their early years of life in Alaska. Warm fall and cool spring weather is correlated with best lodgepole growth in central Alaska. Public attitudes, risks, and cost of introducing the species may be the decisive factors in whether or how much additional lodgepole pine is introduced into Alaska.

**Site index of birch in Alaska**

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

purpose

Site index is the major tool for quantifying forest stand productivity and provides access to other mensurational stand tables. Published site index curves for birch in Alaska are anamorphic and not well suited for modeling. The objective of this project is to develop new polymorphic site index equations and curves for birch (*Betula neoalaskana* and *B. kenaica*) using a standard breast height index age of 50 years.

approach

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

progress

Equations are distinctly polymorphic. During 2003 drafting of paper for publication was initiated; initial curves from M. Hoyt's MS thesis are being reworked; a final paper for submission is expected in 2005.

impact

New curves will better define birch productivity on various sites. They will improve stand treatment prescriptions, fi-

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

### Site index of trembling aspen in Alaska

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

#### purpose

Site index is the major tool for quantifying forest stand productivity and provides access to other mensurational stand tables. Published site index curves for aspen in Alaska are anamorphic and not well suited for modeling. The objective is to develop new polymorphic site index equations and curves for aspen using a standard breast height index age of 50 years.

#### approach

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

#### progress

Equations are distinctly polymorphic. During 2003 a penultimate draft of paper was prepared for publication; editorial review and final revision are planned for 2004 submission. Soil description and sampling to USDA Natural Resources Conservation Service standards was initiated in 2003.

#### impact

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

### Stand Density Indices (SDIs) for Alaska's Northern Forest

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

#### purpose

SDI is a measure of stand stocking that indexes stand density to the number of trees per acre when mean diameter equals 10 inches. It is independent of age and site quality. The goal is to determine SDI maximum and self-thinning values for pure and mixed stands.

#### approach

Using basic data from existing plots (e.g., inventory, timber sale cruise, PSPs, LOGS) and supplemental data (stand basal area, tree diameters) collected from densely stocked stands, SDI values are calculated for pure and mixed species stands using the summation method.

#### progress

Other sources of data have been obtained. The use of SDI with all-aged, mixed-species stands was successfully addressed

and documented through a review of the literature. SDI was presented at short course; a poster was presented at a state professional meeting.

#### impact

SDI are used to determine and predict stand competition, wildlife habitat, understory vegetation quantity and density, fire management conditions, and stand treatments (e.g., spacing, thinning). It is an essential component of the Forest Vegetation Simulator model.

## policy, use, and planning

### Alagnak Wild River management plan, Katmai National Park

Susan Todd

#### purpose

The purpose of the project is to complete a management plan for the Alagnak Wild River, which is managed by the National Park Service. The plan will address the following management questions: 1) How can the important natural and cultural resources best be protected and enhanced, while providing for continued use of the river by present and future generations? and 2) What level and type of use is appropriate and consistent with the purpose for which the river was designated under the Wild and Scenic Rivers Act?

#### approach

An interdisciplinary team will be established to develop alternatives for management of the river, based on prior and new public meetings and written comments. Plan completion is scheduled for 2005.

#### progress

A detailed list of issues and options regarding management of the river corridor was completed.

#### impact

The National Park Service will use the plan to guide the management and use of the popular river corridor.

### Alaska Northern Forest Cooperative

Edmond C. Packee, Sr.

#### purpose

Our goal was to promote information exchange among forest scientists, forest managers, and forest landowners about Alaska's Northern Forest, which includes boreal forest and taiga extending over much of mainland Alaska, but excludes the coastal spruce-hemlock forest.

#### approach

We created a cooperative group with a technical focus that, while neither a political nor advocacy organization, also recognizes the value of nontechnical or traditional knowledge in forest management and that learning occurs by collaboration among scientists, landowners, and forest managers. The group meets twice a year (spring and autumn) for business and

sponsors at least one workshop or field trip each year.

progress

In late 2002 formation of the cooperative was discussed. Representatives of three entities (Alaska Division of Forestry, USDA Forest Service, University of Alaska) met as a steering committee to formulate goals and objectives and organized two meetings to further develop the concept. In May 2003 the cooperative was formed. The first cooperative effort was to initiate a compendium of research activities; a draft compendium was produced in late 2003.

impact

Collaboration and information sharing should make forest management more effective on both public and private lands.

40

### Alaska residents statistics program

Peter J. Fix, Quinn Tracy

purpose

This study will assess travel and recreation patterns of Alaska residents, barriers to participation in outdoor recreation, desired recreation development (or lack thereof), and attitudes and values regarding natural resource management. This study is in cooperation with several federal and state agencies (BLM, USDAFS, NPS, AKDOT, AK State Parks, ADF&G), and the resulting information will be incorporated into their planning processes.

approach

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

progress

During 2003, we constructed the strata, explored possible sampling frames, and developed topic areas to be addressed on the questionnaire.

impact

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

### Carbon sequestration market opportunities in Alaska

Joshua Greenberg, Jennifer Duvall

purpose

Carbon sequestration and carbon credit markets introduce an important opportunity for the state. In addition to potential revenue streams from selling carbon credits sequestered in our lands, carbon sequestration may be a possible vehicle for rural economic development. This project will identify opportunities for the state to participate in carbon credit markets.

approach

This study relies on an extensive review of the literature to understand carbon credit markets and opportunities for Alaska participation. Once candidate opportunities have been

identified, a first stage economic feasibility analysis will be conducted. This partial feasibility study can then be used to evaluate which opportunities in carbon credit markets should be pursued further.

progress

This study was begun in October 2003 and therefore was still in its initial phase, involving extensive research on the science of global warming and the resulting emerging market for carbon credits. To evaluate the opportunities available to Alaska for participation, the structure of the market and “the rules of the game” must be clearly understood by both buyers and sellers.

impact

The study will provide important information to the state and its legislature about how a carbon credit market could work in Alaska.

### Community-based ecotourism in the Valdivian Rain Forest of Chile: Benefits to biodiversity conservation and local communities?

Scott Harris, Glenn Juday

purpose

This study examines the conditions necessary for a community-based ecotourism that conserves biodiversity while providing for the interests of the human community in the cool temperate rain forest region of Chile. The product will be a set of guidelines to help conservation and development organizations create successful ecotourism programs in similar circumstances.

approach

Field research (interviews, market survey, and site visits) was conducted between October 2002 and March 2003. Two months were spent in the Valdivian Ecoregional Office of the World Wildlife Fund.

progress

A chapter titled “Community-based Ecotourism in the Valdivian Temperate Forests, Chile” has been accepted for publication in the book, *Native Forests and Local Communities of Southern Chile*. Site visits to five ecotourism projects, interviews of 23 conservation planners and rural community members, and 298 surveys of ecotourists were completed.

impact/implications

This survey was the first in the temperate rainforest region of Chile specifically designed to quantify the preferences and motivations of nature-oriented tourists. It will be a valuable asset to conservation and rural development organizations that are considering ecotourism as one of their strategies.

### 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 the historic lake levels and lake level changes at Harding Lake 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 obtaining aerial photography/imagery and ground photographs of the lake and lake shore, and finding original survey meander corners.

progress

An interactive model has been created that captures the general dynamics of the lake water balance.

impact

Collected information has been shared with members of management agencies and the newly formed Harding Lake Watershed Council. This information is being used by the AK Dept of Fish & Game, NRCS and the Salcha-Delta Soil and Water Conservation District to design and plan a control structure on the divergent stream. Legal controversies exist regarding "ordinary high water level" and the ownership status of beach areas recently exposed by declining lake levels. This project is relevant to the resolution of this issue and can provide guidance should the control structure be installed. This study is providing the basis for a senior thesis project.

## Sustainability of arctic communities: Advancing the science of integrated assessment

Gary Kofinas with twenty-one other project members. (Project PI J. Kruse, Univ. of Alaska Anchorage)

purpose

Project goals are to improve the ability of communities and scientists to discuss how community life may change in the future and how communities may be able to shape changes to reflect community values. It is a long-term integrated assessment of the implications of global change on small subsistence-based communities of the North American Arctic. Primary funding came from the U.S. National Science Foundation; other sponsors were the Canadian Ecological Monitoring & Assessment Program (EMAN), and Environment Canada.

approach

The study region is the range of the internationally migratory Porcupine Caribou Herd. The project started in September 1995 and is ongoing to June 2004. Both local knowledge and the results of research science are used to help explain how the most important elements of community life may change in the next 10 to 40 years. Sustainability was defined by the project's four partner communities as: 1) use of and respect for the land and animals in their homelands; 2) a cash economy compatible with and supporting continued local use of land and animals; 3) local control and responsibility for what is done in village homelands and what happens to resources used by the community; 4) education of younger people in both traditional knowledge and western science, and educa-

tion of the outside world about community goals and ways of living; and 5) a thriving culture that has a clear identity, is based on time on the land and language, and which honors and respects elders. An integrated assessment approach was organized through study teams focusing on developing models for Arctic System components (i.e. vegetation, caribou, and household economies). A Synthesis Model was constructed to explore scenarios of climate change, oil development, tourism, and changes in government spending. A user-friendly, web-based edition of the Synthesis Model was created and posted, providing community members and the public at large an opportunity to game various combinations of scenarios, explore their projected outcomes, and provide user feedback on model results and assumptions.

progress

2004 was the project's final year. The focus in this phase has been scaling from the community level to the regional level to construct a Regional Synthesis Model that simulates the consequences of external forces for changes, as well as the interactions among the region's communities (e.g., out-migration from communities to regional centers because of changes in employment opportunities, intercommunity sharing of caribou harvests). Scenarios were constructed to capture regional change, including construction and operation of the in-progress Mackenzie Valley Pipeline Project.

impact

The caribou population model and an interactive workshop of the Sustainability Project are now being used by the Porcupine Caribou Management Board to develop a harvest management plan in Canada. Integrated Assessment using local knowledge and science provides a viable method for developing partnerships with indigenous communities and university scientists, and exploring the implications of global change for questions of community and regional sustainability. (See more on the project and the Possible Futures Model at [www.taiga.net/sustain](http://www.taiga.net/sustain).)

## UAF North Campus

Peter J. Fix, Michael Hay

purpose

The North Campus Area (NCA) of the University of Alaska Fairbanks provides valuable research, education, and recreation opportunities for UAF faculty, staff, and students, as well as the surrounding community. However, the UAF Master Planning Committee has not officially adopted a management plan for the area. This project contributed to development of a management plan for the NCA.

approach

Use and users' current and future needs were assessed. A database of uses and their locations was developed, criteria for appropriate use of the area were defined, and a process for project approval was developed.

progress

A draft plan was completed for review by North Campus

# 2003 Publications

## Abstracts

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Willows in bloom. Young willow leaves, particularly those with fuzzy catkins, are high in protein and are favored by moose, caribou, and reindeer. SNRAS are investigating the regrowth of forage and herbivory by ungulates. For reports on revegetation and herbivory, see [page 10](#).

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