ool of Natural Resources
gricultural Sciences

Annual Report

2002

Lamb's quarters, *Chenopodium album,* a common but tasty weed in Alaska gardens, is a wild relative of quinoa, *C. quinoa,* a South American crop grown for its grain and leaves. Field experiments have demonstrated that the presence of even a few weeds (particularly Lamb's quarters) diverts some grasshopper feeding away from the crop.

—PHOTO BY JAN HANSCOM, GEORGESON BOTANICAL GARDEN COLLECTION

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

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UAF UNIVERSITY OF ALASKA FAIRBANKS

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Letter from the dean:

September 10, 2003

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, 2002. 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.

This year 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. I hope you enjoy the new look and find this arrangement easy to understand and navigate.

Very respectfully,

Carol E. Lewis
Dean and Director

Addenda to High-Latitude Agriculture

animal husbandry

Reindeer Research Program Educational Outreach

Carrie Bucki, Greg Finstad

purpose

The ongoing program provides educational and vocational outreach to educators, students, and community members in Fairbanks and Nome.

approach

A one-credit UAF curriculum development course was conducted for Fairbanks educators. We also received support from the College of Rural Alaska for curriculum development in Nome. A one-credit UAF Reindeer Husbandry Internship course was provided in Fairbanks in a collaborative effort between the Reindeer Research Program and the Tanana Chiefs Conference. We continued to provide lectures to local Fairbanks schools and conduct campus farm tours.

progress

Successful curricula development for local schools resulted from the course. Establishing a working relationship with educators in Nome will give our educational outreach program diversity by utilizing traditional and cultural knowledge. We are also developing a vocational training program for local people interested in commercially raising reindeer.

impact

Developing and using curricula with hands-on teaching aids will provide educators with a unique approach to teach students a variety of subjects using reindeer and their rich connection with Alaska as a medium, while fulfilling requirements for Alaska state educational standards. Through our Reindeer Husbandry Internship program, we are providing basic husbandry skills to local people interested in raising reindeer.

AFES Statement of Purpose:

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

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

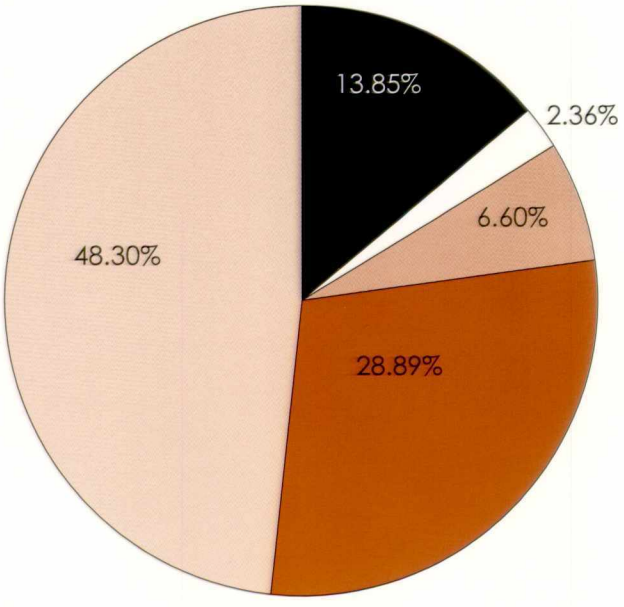
Administratively, AFES is an integral part of the School of Natural Resources and Agricultural Sciences at the University of Alaska Fairbanks. This association provides a direct link between research and teaching. Scientists who conduct research at the experiment station also teach, sharing their expertise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

The Fairbanks Experiment Farm. —FILE PHOTO

Financial statement

Expenditures: July 2002 through June 2003

The following statement of expenditures of federal and state funds for the fiscal year beginning July 1, 2002 and ending June 30, 2003 (FY 03) is not an accounting document.



48.30% State Appropriation/Program Receipts
$ 3,503, 887

28.89% Other Grants and Contracts
$ 2,096,102

6.60% McIntire-Stennis Formula Funds (federal) $ 478,643

2.36% Hatch Multistate Formula Funds (federal) $ 171,220

13.85% Hatch General Formula Funds (federal) $ 1,004,418

Total funds: $ 7,254,270

Grants

GRANTS & CONTRACTS/SPECIAL FUNDS		
Forest Products II	Brackley	USDA
USDA/UAF Forest Prod Prog FY01 (UAS)	Brackley	USDA
LTER IV	Chapin	NSF
Global Climate Variability	Sparrow, E.	DNR/NASA
Integrated Phenology	Sparrow, E.	Utah State Univ
ARS Research Support Staff FY03	Fielding	ARS
Control of AK Grasshoppers	Fielding	ARS
Satellite Telemetry	Finstad	BIA
Reindeer Herding	Finstad/Greenberg	NSF
AK Residents Statistics Program	Fix	DOT
Gold Run Pass	Helm	Usibelli Coal Mine
GBG Children's Garden	Holloway	UA Foundation
Foundation Botanical Garden	Holloway	UAF Foundation
Environmental Changes	Juday	Columbia Univ
ACIA 3 (IARC)	Juday	NSF
Cooperative Agreement Between IARC & NSF	Juday	NSF
Wilmking Scholarship	Juday/Wilmking	CNPSS
Alaska GAP	Karlsson	Cornell Univ
Rural Development/AK Native Berry	Leiner	USDA
New Crops III	Lewis	USDA
New Crops Opportunities II	Lewis	USDA
New Crops I	Lewis	USDA CSREES
Capital Virus Free Seed Potato FY03	McBeath	Dept of Comm
FY04 Seed Potato	McBeath	Dept of Comm
Virus Free Seed Potato FY03	McBeath	DLED
Robertson Task Order FY03	Mitchell	USDA/ARS
Biocomplexity	Ping	NSF
Winter C-Flux	Ping	NSF
Wet Soils Monitoring	Ping	USDA SCS
Fuel Load Analysis	Rupp	ANC Fire Dept
Landscape Fragmentation	Rupp	DOA
High Latitude Terrestrial	Rupp	NSF
Assessing Vulnerability	Rupp	USDA
Computer Model	Rupp	USDI
Forest/Climate change	Rupp/Yarie	NSF
RUSLE Plant Data	Sparrow, S.	NRCS
Global Change Education	Sparrow, E.	NSF
Alagnak Wild River	Todd	UAA
High Latitude Terrestrial	Verbyla	NSF
EOS Training Workshop	Verbyla	Univ of MT

Global Plant Waves	Verbyla/Sparrow, E.	NSF
Global Plant Waves—Participant	Verbyla/Sparrow, E.	NSF
Global Change Student	Vogel	Global Change
Changes in Climate (ITEX)	Walker	NSF
ITEX-REU (Stipend)	Walker	NSF
LTER Forest Research II, PNW	Walker	USDA/PNW
Natural Resources Fund		
Model Restatement for Boreal Forest Mgmt Regulations	Bader	NRF
Circumpolar Regional Database	deWit	NRF
Management plan for UA experimental forest	Fox	NRF
Model for Forest Disturbance & Re-growth	Juday	NRF
UA/MIT Agreement/NRF	Lewis/Trent	NRF
AFES Plant Research	Mitchell/Sparrow, S./Zhang	NRF
Forestry Inventory in Southcentral AK	Packee	NRF
Forestry Symposium	Walker	NRF
FORMULA FUNDING, FEDERAL Oct 1 to Sept 30 Fiscal Year		
Hatch Multistate		
Regional Administration		Lewis
Soilborne Plant Pathogens		McBeath
Reproductive Performance in Domestic Ruminants		Shipka
Hatch General		
Production Practices		Carling
Raised Reindeer		Finstad
AK Natural Resources		Greenberg
Spatially Modeling Dist of Beef Cattle		Harris
AFES Horticulture Crop		Holloway
Natural & Supplemental Light		Karlsson
Cultivar Selection		Leiner
Plant Microbe Interactions		McBeath
Forage & Turfgrass		Mitchell
Black Spruce Forest Soils		Ping
Domestic Ruminants		Shipka
Potential Forage Crops		Sparrow, S.
Variety Testing		Sparrow, S./Zhang
Enviromental Decisions		Todd
McIntire-Stennis		
Forest Timber Harvest		Fox
Ectomycorrhizae		Helm
Foresty Ecology		Juday
Forest Stand		Packee
Soil Carbon Balance		Valentine
Satellite Change Detection		Verbyla
Forest Ecosystem Monitoring		Yarie
Animal Health		
Mineral Flux in Reindeer		Finstad

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.

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.

Geographic Information

Perceptual geography of Alaska

Cary de Wit

purpose

Where do popular perceptions of Alaska come from? Alaska is one of the most recognized states in the Union, and yet one of the most inaccurately perceived. Since before Alaska statehood, news stories, popular books, popular films, and advertisements have filled American minds with images of Alaska as a wild, exotic land full of rustic sourdoughs, Eskimos, polar bears, and igloos. A remarkably consistent montage of Alaska imagery appears today on a national scale through advertising, postcards, place mats, greeting cards, product labels, magazines, television shows, and films. This study examines popular nonresident perceptions of Alaska.

approach

I am collecting imagery from advertising, postcards, films, television programs, and other sources of widely disseminated images of Alaska. I am categorizing and analyzing images according to source, intended purpose, location of production, and type of Alaska image portrayed.

progress

Collection of samples is ongoing. Two presentations were given to the Association of American Geographers: "Frontier Ideology Expressed in the Alaskan Cultural Landscape" and "Postcards from L.A."

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's political and evironmental issues to assess whether accurate perceptions of those issues are being conveyed to state and federal lawmakers and to the voting public, whether the citizens of Alaska or of the United States.

climate research

Assessment of the MODIS leaf area index product in Alaska

Dave Verbyla

purpose

As part of a new Earth Observing System, NASA is producing estimates of leaf area from a satellite sensor called the Moderate Resolution Imaging Spectrometer (MODIS). Leaf area estimates are used by terrestrial ecosystem models at regional to global scales to estimate water and carbon flux for global climate change research.

MODIS leaf area estimates are produced every sixteen days for the entire globe at 1km grid cell resolution. However, because of unique properties at high latitudes, such as low sun angle, heterogeneous vegetation canopies, and cloud contamination, these estimates may be unreliable.

approach

I evaluated the 2002 MODIS leaf area index product by comparing the pattern of leaf area values during the spring greenup period, and by examining the leaf area values across an elevational and latitudinal gradient.

progress

As expected, the leaf area index estimates increased significantly during the spring greenup period. However, I found leaf area estimates that were too high in some areas of Alaska, such as the foothills of the Alaska Range and some tundra locations in the Arctic. Theses unrealistic leaf area values were primarily due to broadleaf shrubs strongly influencing the reflectances detected by the satellite sensor.

impact

This is the first research that investigated the validity of the MODIS leaf area estimates at high latitudes. Because there are

several significant problems with this product, and therefore it may overestimate leaf area in Alaska, it should be used with caution in terrestrial ecosystem modeling.

1950–2000 lake level changes across Alaska

Brian Riordan, Dave Verbyla

purpose

The research is part of a NASA Land Cover Change Project examining the impact of climate-related land cover change in Alaska.

approach

We used USGS maps, historic aerial photography, and satellite data to examine the change in the lake levels in several areas in Alaska, including the Copper River Basin, Kenai Peninsula, the North Slope, Innoko, and Yukon Flats.

progress

We found significant, widespread lake level decline and loss of small ponds in most areas of Alaska that are permafrost-free or have discontinuous permafrost. The USGS maps were unreliable in mapping ponds in many areas of Alaska, so we used the original aerial photography from the 1940s and 1950s to develop a more realistic GIS theme of historic lake and pond levels.

impact

The decrease in closed-basin ponds and lowering of lake levels may be due to an increase in regional evapotranspiration associated with climate warming, especially since the early 1980s. This is consistent with tree-ring research and covers an extensive area of Alaska. The Yukon Flats experienced a dramatic decrease in surface water with a loss of over fifty percent of pond numbers in some areas.

fire

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

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

purpose

The risk of wildfire 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

Using a Geographic Information System we developed and analyzed maps of historical fire regime, current land cover, and US census data on housing and population density, and identified vulnerable human settlement areas for a test region in Northern Lower Michigan. This work was submitted to the peer-reviewed *Journal of Forestry* and is currently in press. We are currently developing a spatial model for evaluating fuel treatment plans using genetic algorithms as a novel optimization strategy. This ongoing work will result in a peer-reviewed journal article in early spring 2004.

impact

The 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.

Convective available potential energy relative to Alaska lightning strikes

Dorte Dissing, Dave Verbyla

purpose

Most of the area burned in Alaska is from lightning-caused wildfires. Research on thunderstorms and lightning has been primarily at lower latitudes, and some of this research is not applicable to Alaska. By understanding the climatology of Alaska thunderstorms, we could improve our prediction of future wildfire ignitions under climate change scenarios.

approach

We investigated the unique climatology of Alaska thunderstorms by using a meterological index called Convective Available Potential Energy (CAPE). CAPE maps were produced using a model based on atmospheric soundings, weather station data, and satellite data for interior Alaska. We compared these CAPE maps with maps of lightning strikes from the Alaska Fire Service Lightning Strike Detection Network.

progress

Unlike lower latitudes, CAPE values in Alaska can be low during intense thunderstorm days. This is probably due to a relatively dry atmosphere in eastern interior Alaska. The comparatively dry atmosphere produces a high number of dry thunderstorms relative to lower latitudes. Most of the wildfires started by lightning in Alaska are from these dry thunderstorms.

impact

If the summer climate of interior Alaska warms, one might expect an increase in the frequency and extent of lightning

strikes. Expansion of boreal forest to the tundra may act as a positive feedback mechanism by decreasing albedo and increasing sensible heat flux, leading to increased convection and thunderstorm development. However, with increased wildfire, increased area of broadleaf forest could lead to a negative feedback of decreased sensible heat flux, decreased convection, and fewer thunderstorms.

Mapping burn severity in interior Alaska using satellite imagery

Justin Epting, Dave Verbyla

purpose

Mapping burn severity is important in assessing the potential regeneration of major browse species such as willow and aspen. However, most algorithms for estimating burn severity from satellite imagery have been developed primarily in warm regions at low latitudes. Our objective was to test these algorithms under Alaska conditions.

approach

We used satellite imagery from four wildfire burns in interior Alaska to generate maps of burn severity using the thirteen algorithms. The maps of burn severity were then compared with field measurements to determine which algorithm was best for these Alaska burns.

progress

The Normalized Burn Ratio was consistently the best algorithm to map burn severity. The accuracy of burn severity estimates improved when unforested areas were ignored in the mapping.

impact

We confirmed that the Normalized Burn Ratio would be useful across the interior Alaska region, with only slight modifications required for each individual burn. By using Normalized Burn Ratio as a standard technique for mapping burn severity, researchers and managers could compare different burns from different locations and times in interior Alaska.

livestock and range management

An evaluation of the effectiveness of cattle distribution practices in grazed watersheds

Norman R. Harris; Melvin R. George (Univ. of California Davis); Douglas E. Johnson (Oregon State Univ.); David C. Ganskopp (USDA ARS, Eastern Oregon Agricultural Research Center); Derek W. Bailey (Montana State Univ.)

purpose

This program is a multistate, collaborative effort to understand and predict animal movement and landscape use for a variety of ecosystems throughout the western United States.

approach

Animal movement and activities are recorded using global positioning collars. Factors are identified that control or influence the spatial/temporal pattern of livestock use on the landscape, such as topography, solar radiation, forage availability, and management practices. Research findings will be integrated into a comprehensive livestock distribution and forage utilization model for rangelands. The model will predict areas on the landscape that will receive more or less intensive use by domestic grazing animals and will indicate how distribution might change with management techniques such as strategically placed water or supplemental concentrate feeds.

progress

Animal distribution data and data for influencing factors has been collected from research areas in California, Idaho, Montana, and Oregon. Data analysis is ongoing and a preliminary model based on multi-criteria evaluation has been developed. A second phase involving model prediction and collection of validation data sets has begun.

impact

This model will allow ranchers and land managers to more effectively graze watersheds, while reducing undesired effects on vegetation and water quantity and quality. The model will allow assessment of impacts before the actual introduction of livestock into new landscapes, which can promote informed decisions and prevent adverse publicity and possible litigation.

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. Making these data available year round through a web browser increases the herders' capacity to view records and make management decisions before summer or winter handlings.

approach

We ported the existing reindeer records from the proprietary database to a more internet-friendly MYSQL database on the Reindeer Research Program's server. We intend to provide Data Entry, Query, Browsing, and Report Generation of each reindeer herder's records through a collection of password-protected web pages.

progress

We have moved all active herd records into the new MYSQL databases on the Reindeer Research Program's server. We developed a draft data entry system and used it to enter all of the reindeer records collected at the summer 2002 reindeer handlings. We have also developed a basic report generation system to create reports summarizing reindeer handling statistics.

impact

Reindeer herders will now be able to query and browse herd records year round, via the internet. Seward Peninsula

reindeer herders will soon be able to browse individual animal records on line and select animals for culling or breeding based on production history.

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 time.

approach

The satellite collar telemetry data is collected, processed, and archived automatically on the Reindeer Research Program's 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, 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 that allows the user to select satellite collar IDs, 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 allows range management by both assessment of range utilization and monitoring grazing over time.

Radio telemetry and range management workshop

Greg Finstad

purpose

Satellite telemetry and a method to view and track animal movements can increase the effectiveness of range management and reduce number of animals lost to predation.

approach

The Reindeer Research Program and the Natural Resource Conservation Service worked together to conduct a radio telemetry and range management workshop in Nome to educate reindeer herders on the application of satellite telemetry technology on the Seward Peninsula. Reindeer herders were introduced to basic range management and satellite telemetry concepts, computerized mapping software, and the internet.

progress

Reindeer herders became familiar with how a telemetry system functions. The internet makes telemetry data and reindeer herd location information available to reindeer herders twenty-four hours a day.

impact

To further develop and expand the reindeer industry in Alaska, reindeer producers must integrate new concepts and technologies into their management systems. Through workshops and a close working relationship with the Reindeer Research Program, reindeer herders are more knowledgeable and proficient in utilizing emerging technology in their operations.

Satellite radio telemetry and reindeer herding

Greg Finstad, Darrell Blodgett, Heather Oleson

purpose

Many herders lose track of their reindeer in fall and winter when travel across the tundra is difficult because of freeze-up conditions or bad weather. The Reindeer Research Program, in collaboration with the Natural Resources Conservation Service, USDA, and the Reindeer Herders Association, is continuing to develop an animal location, automated mapping, and internet management system. This system will help reindeer herders locate and manage their animals when travel is difficult and weather conditions are poor.

approach

Locations of reindeer fitted with satellite collars are obtained by the National Oceanic and Atmospheric Administration satellite system. The locations are mapped with an automated mapping system developed by the Reindeer Research Program and placed on a designated, herder-accessible website. Just prior to herding activities, the herder views current locations of reindeer and caribou on the internet. Animal location records are examined to evaluate range utilization and seasonal grazing patterns of reindeer.

progress

Reindeer in twelve herds were equipped with thirty-three satellite collars and their movements monitored and mapped during 2002. Herders accessed locations of collared reindeer through the internet and based their management decisions on this information.

impact

A more efficient management system is possible by integrating radio telemetry with traditional herding methods. 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.

High-Latitude Agriculture

New Crops Opportunity: inoculated woody seedlings: a new Alaska crop for Alaska revegetation

Dot Helm; David Ianson (USDA)

purpose

The primary objective of this project is to determine if soil inoculum used by local producers to grow mycorrhizal-inoculated seedlings in the greenhouse needs to be from the same latitude as the final planting site, as would be the case with seeds, or whether inoculum from other latitudes would be suitable.

approach

We collected seeds and soil inoculum from three latitudes. We plan to grow seedlings in the greenhouse in their own soil, soil from the other two sites, sterilized soil, and sand with no inoculum. One set is inoculated in the field at the time of planting. We will be able to compare several treatments, evaluate improvements, and compare these results with those for plants that might not have any mycorrhizae at time of planting.

progress

We collected seeds and soil inoculum from near Palmer (southcentral Alaska), Healy (interior), and Nolan (Brooks Range), then cleaned the seeds in preparation for winter planting in the greenhouse.

impact

Better understanding of latitudinal variation in mycorrhizal inoculum and plant interactions will allow growers to produce a value-added product to compete with large greenhouses outside Alaska now growing woody plants for Alaska revegetation.

agronomy

New Crops, canola

Hans Geier

purpose

Although canola has successfully been grown in interior Alaska, the characteristics of the crop have never been documented. This project will determine the crop's potential.

approach

Approximately 500 pounds of canola were crushed, yielding over 20 gallons of oil. The oil will be mixed with concrete and tested by the Engineering Department of the University of Alaska Fairbanks. Oil, meal, and seed samples were sent to SunWest Food Lab in Saskatoon, Saskatchewan, for analysis.

progress

Initial results have shown an amazing fifty-four percent oil content in the seed, with very low chlorophyll. Protein is slightly lower than found in Canadian canola. This may be due to the extremely high oil content present in the seed sample. The oil showed similar positive results for quality.

impact

This study is showing that Alaska grown canola is of high quality. Additional long-term tests for yield and variety should be undertaken by the university. Growers may be interested in considering this crop, due to the superior characteristics exhibited in the canola produced in this study.

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

Stephen D. Sparrow, darleen t. masiak

purpose

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

approach

We seeded six varieties of cicer milkvetch and one variety of forage galega (only one released variety of this crop currently exists) at Delta Junction, Fairbanks, and Nenana in 2002. At Fairbanks we also established a harvest management trial with Oxley II cicer milkvetch and Gale forage galega. We were unable to obtain sufficient seeds of lupinaster clover to plant full plots, so we planted individual rows with various small seed lots at Delta Junction and Fairbanks.

progress

Establishment of these crops was slow and they did not produce enough growth during the 2002 growing season to harvest. Over-winter survival was so poor at Delta Junction and Nenana that we abandoned the plots. We intend to harvest the plots at Fairbanks in 2003 and will analyze samples for forage quality, but do not yet have results to report.

impact

If these crops prove successful as viable crops for interior Alaska, they will provide farmers with additional options for crops to include in their management systems.

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

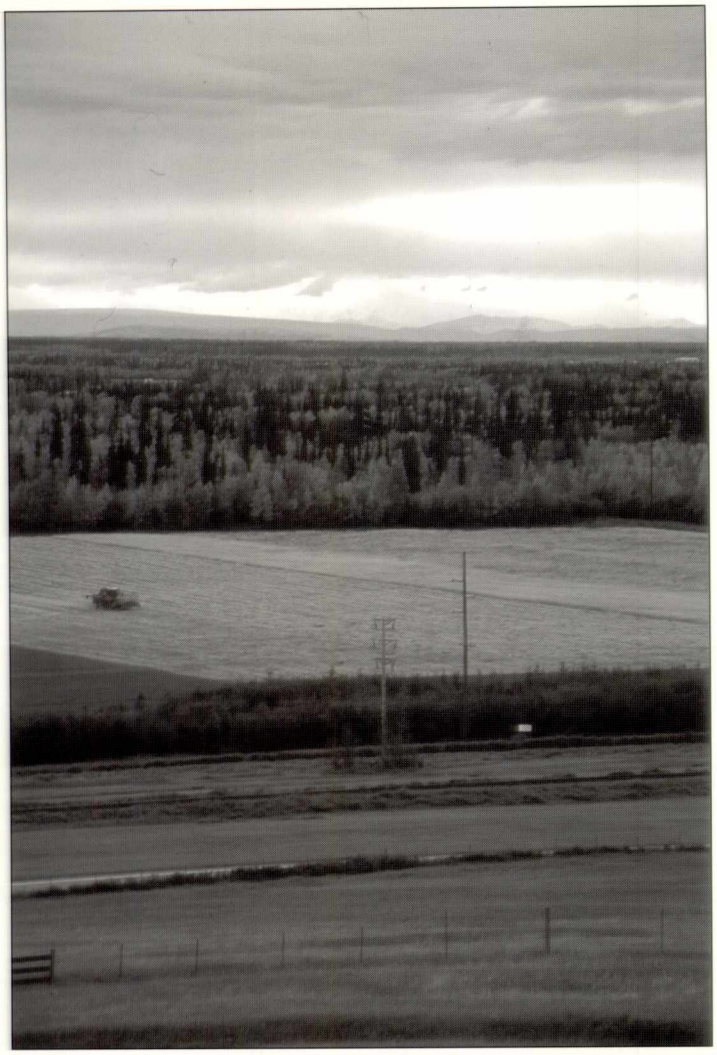
Stephen D. Sparrow, darleen t. masiak

purpose

The objective of this project is to determine optimum cutting height and time of second seasonal harvest for smooth bromegrass and alfalfa in interior Alaska.

approach

We initiated a harvest trial on smooth bromegrass at Delta Junction in 2002 and established plots for future trials of smooth bromegrass and alfalfa at Fairbanks. We harvested all plots at Delta Junction in mid-June of 2002, and then did different harvest treatments for the second harvest. Treatments consisted of harvesting at different dates (two weeks apart) beginning in early July until late September and at three different clipping heights, which were: low (approximately two inches above ground surface), medium (approximately four inches),



Fields at the Fairbanks Experiment Farm, fall 2002. Experiments with alfalfa, barley, canola, oats, smooth bromegrass, Sunwheat (a type of sunflower), wheat, and other crops are conducted here.

—PHOTO BY DEIRDRE HELFFERICH

and high (approximately six inches). We intend to harvest the plots again in 2003 to determine how the previous year's cutting treatments affected forage yield and quality. We will also begin similar trials at Fairbanks.

progress

Average yields in 2002 ranged from 0.8 tons/acre at the early July sampling to 2.0 tons/acre for the late September harvest and from 1.3 tons/acre for the high-cut treatments to 2.1 tons/acre for the low cuts. Acid detergent fiber (an indicator of forage quality, with lower values indicating higher quality than higher values) in 2002 ranged from 28.8 for the early July high cut to 35.6 for the late September low cut. Neutral detergent fiber (another indicator of forage quality) showed a pattern similar to acid detergent fiber. We have not yet analyzed samples for protein concentration.

impact

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

Long-term tillage study

Stephen D. Sparrow, Charles W. Knight, Carol E. Lewis

purpose

Our objective for this study was to determine the effects of various long-term tillage and crop residue management practices on grain yield and various soil properties in a subarctic environment.

approach

We collected soil samples during the sixteenth and seventeenth years of a long-term tillage study established near Delta Junction, Alaska. Treatments sampled included three tillage treatments (disked-twice, once in spring and once in fall of each year; disked-once each fall; and no-till) and two crop residue treatments (all residues removed and all residues left in the field). The study site was cropped to barley in all years except for occasional years when chemical fallow was used to control perennial weeds. We measured bulk density (an indicator of soil compaction), wet aggregate stability (an indicator of ability of soils to resist erosion), pH, organic carbon, total organic nitrogen, inorganic nitrogen, microbial biomass carbon and nitrogen, and mineralizable carbon and nitrogen in the soils. These are all considered good indicators of soil quality that can be influenced by management.

progress

Grain yields over the seventeen years of the study averaged 0.8 tons/acre for the disked twice treatment, 1.0 for the disked once treatment, and 0.8 for the no-till treatment. Yields were similar for the various crop residue treatments. Soil organic matter, as indicated by amounts of soil carbon and nitrogen, was highest in the no-till and lowest in the disked-twice treatments. Other soil quality indicators were generally higher in the no-till and disked-once treatments than in the disked-twice treatment.

impact

Results of this study will provide information for farmers and agricultural advisors about best management cropping practices to conserve soil in interior Alaska.

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

Robert M. Van Veldhuizen, S.D. Sparrow

purpose

This study is a continuing collection of information that provides yearly updates on new and better adapted crop varieties, and the response of agronomic crops to dryland farming conditions.

approach

Variety Trials: Four 2-row and three 6-row hulless barley varieties (*Hordeum* sp.), three hulless oat varieties (*Avena* sp.), and three hard red spring wheat varieties (*Triticum* sp.) were selected from northern Canadian sources for evaluation against standard Alaska varieties (Thual hulless barley, Toral oat, and Ingal hard

red spring wheat). Replicated trials were planted in the spring of 2003 at Fairbanks, Delta Junction, and Palmer, Alaska.

Barley breeding selections: There were 50 selections from a hulless barley cross that were made from 200 single row plots in the fall of 2002. These were planted out at the Fairbanks location for evaluation compared against one of the parents, Thual.

Sunwheat selections: There were 150 single head selections made from the dwarf, open-pollinated Sunwheat. These selections were primarily for early maturity. The seed will be hand harvested, threshed, cleaned, and bagged for distribution to local gardeners and farmers for testing and evaluation next season. Eventual release as a named variety is expected in the winter of 2005.

progress

Spring weather at all three locations was warmer and dryer than average. There was sufficient soil moisture from winter snow cover at the Fairbanks and Palmer locations, but a lack of winter snow cover at Delta Junction resulted in low soil moisture. This resulted in good emergence, heading, and maturity for the Fairbanks and Palmer, but poor plant growth characteristics at Delta Junction. High precipitation events at physiological maturity for the Fairbanks and Delta Junction locations resulted in a high percentage of lodging and late tillers. Harvest is expected to be delayed as a result.

impact

The study provides information to local producers who want to determine the economic viability of these crops. Future studies of the effects of irrigation on these agronomic crops will broaden this information database.

animal husbandry

Feed ingredients from fish processing

Peter Bechtel (ARS/USDA); Subramaniam Sathivel, Alejandra Oliveira, Scott Smiley (Univ. of Alaska); Jerry Babbitt (National Marine Fisheries Service); Ronald Hardy (Univ. of Idaho)

purpose

More than sixty percent of the total fish harvested in the United States comes from Alaska. The three major species harvested are pollock, Pacific cod, and salmon. Processing these fish generates more than one million metric tons of fish wastes, most of which could be used for aquaculture and animal feed. Currently, the major wastes (heads, viscera, skin and frames) are underutilized and often create disposal problems and environmental concerns. Simultaneously, fish protein feed ingredients and palatability enhancing agents are needed for use in aquaculture systems. This project seeks to improve the utilization of these wastes by creating byproducts for use in livestock and aquaculture diets.

approach

The chemical and nutritional properties of pollock, cod, and salmon fish processing wastes were analyzed. The composition of dried whole fish, heads, viscera, frames, fillets, and skins were analyzed for protein, fat, and ash content, amino acid profiles, and soluble protein percentage in relation to pH. Methods will be developed for the collection, segregation, processing, stabilization, storage, and formulation of the feed ingredients.

progress

Analysis of the amounts, types, location, and refinement of the wastes has been completed and used to identify important areas for future studies. Chemical and nutritional properties of waste components that are produced in large quantity have been determined. Feeding trials are being completed using trout and other animals. Specialized feed ingredients made from fish skin and fish viscera components are being characterized and evaluated.

Also, the USDA/ARS was one of the sponsors for the Second International Seafood By-product Conference held in Anchorage, Alaska, November 11–13, 2002. More than 125 people from seventeen countries participated. Media coverage resulted and papers from the conference are in press.

impact

It appears possible to create products to fit niche markets by using different byproducts or by combining selected by-products to create higher value products, such as low-ash feed ingredients and ingredients with different degrees of protein solubility, fat, and protein content, etc. Successful research efforts can reduce waste and environmental concerns, lead to new income sources for processors and harvesters, and provide additional feed ingredients for the aquaculture and livestock industries.

Locally produced feed ingredients for use in captive reindeer diets

Carrie Bucki, Greg Finstad

purpose

We tested formulations of reindeer feed composed of Alaska-grown ingredients to determine in what proportion they can be used by Alaska reindeer producers to curtail their production costs while maintaining good nutritional balance.

approach

Whitefish meal, salmon meal, and Thual and Finaska barley were evaluated for animal performance and nutrient content. Soybean meal and whitefish meal were evaluated for palatability.

progress

During summer, reindeer had greater intake rates with whitefish meal and Finaska barley, but there was no difference in weight gain between animals fed the two barley varieties or fishmeals. Reindeer showed a preference for soybean meal during the winter trial.

impact

Continuing to evaluate locally grown components of our reindeer diet will provide insight into reindeer nutrition and

determine what diets will produce the greatest performance at the lowest cost for Alaska producers.

Regional economic impacts of the Alaska reindeer industry

Joshua Greenberg, Stefanie Carlson

purpose

The reindeer industry plays a significant role in both the cash and noncash sectors of the regional and village economies of the Seward Peninsula, Alaska. However, recent reindeer-caribou interactions in northwestern Alaska caused by changes in wild caribou migration are affecting the viability of the industry. The declining number of reindeer is harming the already stagnant or declining economies of the region. This study is designed to quantify the value of the reindeer industry to the Seward Peninsula regional economy and the changes felt by the communities in the region as the presence of caribou increases and continues to affect cash income.

approach

The economic aspects of the reindeer industry on the Seward Peninsula are quantified using information gathered directly from reindeer herders, people who work with the herders, and existing research. An IMPLAN input-output model is used to study the impact of changes in caribou migration on the reindeer industry. The model captures the overall economic impact on the regional economy. A final report will be published in 2003.

progress

The baseline IMPLAN regional economic model for the Seward Peninsula region has been developed. Results of impact scenarios using IMPLAN include estimates of direct, indirect, and induced effects of an economic activity. Results show that for each one dollar reduction in reindeer industry output, the Seward Peninsula region loses an additional estimated $0.576 through multiplier effects.

impact

The regional economic model built for this study provides a detailed view of the link between reindeer industry output and regional economic activity. This study provides a tool for quantifying the economic importance of the reindeer industry to the region and the consequence of lost output from the industry. Knowing the economic value of the reindeer industry to the region is a critical component of an informed discussion on the industry's future.

Similarities and differences in composition and selected sensory attributes of reindeer, caribou, and beef

Robert G.C. van Buuren, Greg L. Finstad

purpose

The objectives of this study were to determine composition and sensory properties of Alaska reindeer meat, the effect of cooking temperature on it, and to compare these to caribou and beef.

approach

In winter 2002, six reindeer and caribou were butchered in the field on the Seward Peninsula. The reindeer, caribou, and six beef loins were frozen and shipped for analysis. Analysis included pH, color, chemical composition, shear force, and sensory evaluation by a trained sensory panel.

progress

The results show that reindeer and caribou meat contain less fat and more water, and are a darker color than beef. The sensory panel found reindeer and caribou meat more tender with a less intense meat flavor and a more intense off flavor (livery) than beef. Both tenderness and juiciness decreased as the cooking temperature increased.

impact

This study shows that reindeer and caribou meat are a nutritious and wholesome Alaska product. Reindeer and caribou have the advantage of being more tender and lower in fat than beef. This study was essential for future research to improve or optimize meat quality of reindeer and game animals.

Endocrinology of gestation in reindeer

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

purpose

This study provides a description of seasonal endocrine changes and validates a radiotelemetric estrous detection system in farmed Alaska reindeer. Radiotelemetric estrous detection provides a detailed description of male breeding behavior and important information on the precise time of mating and the length of gestation in reindeer.

approach

This study started on Sept 1, 2002. We collected jugular blood samples three times weekly during the breeding season. Females were placed in harem with radiotelemetric transmitters attached to their rumps. Beginning Oct 29, blood samples were collected once per week until mid-March. After mid-March, sampling was increased to three times weekly to monitor endocrine changes prior to calving. Blood plasma is assayed for progesterone, estradiol, and estrone. The endocrine data will be used to validate radiotelemetric detection of estrus.

progress

Radioimmunoassay for progesterone has been completed. Radiotelemetry accurately identified 7 of 10 matings and females became pregnant following only one or two mounts of one to three seconds in length.

impact

This study provides the only current description of the endocrinology of pregnancy in reindeer in Alaska and the only definitive estimate of the length of gestation in reindeer. The data demonstrate the efficacy of radiotelemetry to detect estrus and mating in reindeer.

Estrous synchronization of musk ox cows

M.P. Shipka, M.C. Sousa, Janice E. Rowell

purpose

Muskox bulls are dangerous and difficult to manage during the breeding season. During the harem period, a producer has limited ability to handle the cows for feeding or health reasons. In an effort to shorten the harem period, we investigated the use of progesterone to synchronize estrus (time of ovulation) in muskoxen.

approach

This study started on Aug 1, 2002. We used Controlled Internal Drug Releasing (CIDR) devices to synchronize estrus in female muskoxen. Blood samples were analyzed for progesterone, and were used to established the timing of ovulation, estrous cycle length, synchrony of estrus among cows and, in the bred group, pregnancy. In addition, radiotelemetry provided additional information on mounting activity and estrous behavior in the bred group.

progress

The modified CIDR coupled with bull introduction resulted in close synchrony of estrus. Eight of nine cows conceived during one week. Radiotelemetry correctly identified breeding activity among those muskox cows with 100 percent accuracy.

impact

This study demonstrates the effectiveness of using modified cattle CIDRs for estrous synchronization in muskox cows and that synchronization successfully shortened the harem period without loss of fertility. We have also clearly demonstrated the accuracy and effectiveness of radiotelemetry for the remote identification of estrus and breeding.

Estrus in non-pregnant reindeer

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

purpose

This project was set up specifically to examine seasonal endocrine changes in non-pregnant adult reindeer from the beginning of the breeding season through the cessation of estrous cycles in the spring.

approach

This study was initiated Sept 1, 2002. We collected blood samples three times weekly during the breeding season and then weekly from Oct 22 until early May, 2003. Using progesterone and estrogens in the blood, we can determine whether the cow is still experiencing normal estrous cycles. Females remained separated from a bull throughout this entire period.

progress

Blood samples have been assayed for progesterone. Results show that female reindeer remain fertile into late winter/early spring. Two different endocrine patterns characterized the onset of anestrus (period of no estrous cycling activity); progesterone falling to zero and staying at that level or long-term elevated progesterone.

impact

Unbred females must be managed as a sexually segregated group throughout the winter in order to avoid out-of-season breeding activity and the risk of late-born calves. The significance of the two different patterns of progesterone at the onset of anestrus is unknown. The result of both patterns is the same for the deer farmer; cessation of estrous cycles.

flowers

Flowering response to day length in *Cosmos bipinnatus*

Patricia Holloway, Grant Matheke, Janice Hanscom

purpose

Cosmos require exposure to long nights (about fifteen hours) to initiate flower buds. Because of nearly twenty-four-hour day length in early summer, cosmos in interior Alaska often bloom late in the season or not at all. Considerable difference in response to dark treatments exists among cultivars of cosmos. The purpose of this project was to identify cultivars of cosmos that will bloom early in the season with and without treatments to lengthen the dark period.

approach

We grew twenty-one cultivars of cosmos *(Cosmos bipinnatus)* seedlings in the greenhouse and treated half with an extended, fifteen-hour dark period using blackout cloth. The treatment occurred daily for two weeks just before transplanting. We compared flowering dates and the number of flowers produced by the control and treated plants.

progress

Individual cosmos cultivars varied significantly in response to dark treatment. Three cultivars (Daydream, Sweet Dreams, and Yellow Garden) did not bloom at all without dark treatment, and Campus Apricot produced an average of only one bloom in late August. All other cultivars bloomed with or without dark treatment, but blooming was delayed as much as four weeks in eleven cultivars. All cultivars tested produced more blooms when given the dark treatment, except for Versailles Mix, Sensations Mix, and Sensations Radiance, which were bred to be less sensitive to long daylight conditions.

impact

This information is useful for the greenhouse industry and home gardeners in selecting for appropriate cosmos cultivars to grow for season-long color. It will also be useful for growers of field-grown cut flowers who may want to select early-blooming cultivars.

Salt tolerance of Alaska wildflowers, grasses and weeds

Pat Holloway, Amy Davis, Diane Hunt

purpose

This project aimed to determine tolerance levels of thirty Alaska wildflowers, grasses, and weeds to four salts: sodium chloride, magnesium chloride, urea, and calcium chloride.

These salts are commonly used on roadways and airport runways for de-icing.

approach

This experiment has two parts: the first analyzes the effects of salts on seed germination. Each species was sowed in replicated trials in the greenhouse, and percent and speed of germination were recorded. A second experiment tested the effects of salts on established plantings in the field. Plants of each species were grown in replicated field beds in 2002. In spring 2003, salts were added to the soils at snow melt before field surface moisture subsided. Midsummer data collection included percent survival, plant height, and biomass.

progress

We completed the seed germination experiments in spring 2003. Data analysis is in progress. Data were collected on the field plots during summer 2003 and will be analyzed in 2004.

impact

This project will provide guidelines for revegetation specialists interested in using wildflowers and native grasses in roadside landscaping. It will also show how salts influence establishment of roadside weeds.

Peonies as field-grown cut flowers

Pat Holloway, Janice Hanscom, Grant Matheke

purpose

The objective of this project is to identify methods of growing peonies for field-grown cut flower production.

approach

Thirty peony cultivars were planted in 2001 in replicated trials. Data were collected on survival, bloom time, bloom quality, and productivity in 2002 and 2003. Additionally, Sarah Bernhardt peonies were planted at three spacings and on soils amended with Lemeta peat and municipal sludge in 2002. Data will be collected during the next ten years.

progress

Peonies bloomed from 30 June through 4 August 2002. Flowering stem height ranged from 32 cm to 63 cm during the second year, and flowers ranged from five per plant to none. All but six cultivars showed some bud blast due to powdery mildew. The spacing and soil amendment experiment was planted in July 2002.

impact

This project will provide guidelines for local growers interested in cultivating peonies as cut flowers for export.

Supplementary greenhouse light and flowering of black-eyed Susan

Jeffrey Werner, Meriam Karlsson

purpose

A commonly used light source for greenhouses is high-pressure sodium lamps. Compared to daylight, light from high-pressure sodium lamps has limited blue and far-red wavelengths. Regular incandescent bulbs produce lots of far-red wavelengths and may improve high pressure sodium light for plant growth. We sought to test this hypothesis.

approach

The Toto series of black-eyed Susan was grown at 16 daily hours of high pressure sodium light alone, or with small amounts of incandescent light added.

progress

When incandescent light was added to high-pressure sodium light, flowering was one week faster and the average flower diameter increased from 2.6 to 2.8 inches.

impact

Incandescent bulbs significantly enhanced the light of high-pressure sodium lamps for more efficient greenhouse crop production. Growers who use artificial light can use this information to increase their yields.

Day length and flowering of forget-me-not

Meriam Karlsson, Jeffrey Werner

purpose

Florist customers desire and ask year round for flowers of forget-me-not. Accurate production guidelines are necessary to consistently and efficiently produce high quality forget-me-not flowers all year. Our objective was to find out the best conditions (day length and light intensity) to get forget-me-not to produce blooms.

approach

Flowering was evaluated at short (8-hour) and long (16-hour) days with two intensities of light.

progress

Flowering was faster under long-day conditions than short days. Light intensity had small effect at long days, but higher light during short days accelerated flowering.

impact

This knowledge will aid producers. Under (natural) short days (less than 12 hours), they can add supplemental lighting or increase the day length for faster flowering of forget-me-not.

fruit

Container-grown raspberries

Meriam Karlsson, Jeffrey Werner

purpose

A technique to extend the season for fresh raspberries is to grow raspberry canes in containers. To extend the season for varieties such as Tulameen that are not frost hardy, raspberries may be grown in containers and then moved without having to be planted in the ground. Our objective was to determine if production differed between growing potted raspberries in permanent or temporary greenhouse structures.

approach

Long canes of the red raspberry Tulameen were planted in three-gallon pots. The yield in a simple, seasonal plastic structure

was compared to the productivity of the container-grown raspberries in a traditional greenhouse.

progress

Yield during the first season averaged more than 500 grams, or three half-pints of fresh high-quality raspberries. During a second and third season, the raspberry production substantially increases. The average fruit size was 4 grams with individual berries up to 9 or 10 grams. The yield and size of berries were similar in the two greenhouse structures.

impact

This study showed that economical, seasonal temporary greenhouses can easily be adapted and used to extend the local production of high-quality fresh raspberries. A temporary plastic greenhouse structure can be set up on a parking lot, lawn or any other flat area. By using a greenhouse, the raspberries will flower and set fruit earlier than in a field situation and will continue to produce berries beyond the regular season in the fall.

Fertilizer to greenhouse strawberries

Meriam Karlsson, Jeffrey Werner

purpose

To efficiently produce greenhouse strawberries for off-season markets, proper fertilizer recommendations are necessary.

approach

Strawberries grown in a hydroponic bag system were fertilized with 100, 200 or 300 parts per million (ppm) of nitrogen from a complete fertilizer.

progress

Average yield for plants of the variety Aromas was 32 ounces, for Diamante 38 ounces, for Fern 34 ounces, and for Seascape 41 ounces, independent of the nitrogen level.

impact

Since the amount of nitrogen did not substantially affect yield, growers do not need to use more to increase their crop. Phosphorous and potassium levels for efficient greenhouse strawberry production will be evaluated in future studies.

Raspberries grown in experiments to extend the growing season.

—PHOTO COURTESY MERIAM KARLSSON AND JEFFREY WERNER

Some antioxidants in berries and vegetables

Roseann Leiner, Abe Smyth, Rudy Candler, Pat Holloway

purpose

Inside plant cells are phytochemicals that are reported to have antioxidant activity and health benefits in the human diet. The goal of our study is to survey some Alaska berries and vegetables for high levels of phytochemicals with antioxidant activity.

approach

The AFES laboratory in Palmer routinely analyzes plant tissue for chemical elements. We investigated methods to measure chemical compounds in plant tissue using HPLC (High Performance Liquid Chromatography).

progress

Phytochemicals can be extracted from frozen berries by putting berries in a blender, then spinning the solution in a centrifuge and filtering the clear liquid. A set of nine phytochemicals have been detected with our HPLC procedures, and further method development is planned.

impact

The health benefits of eating berries and vegetables is more than mere calories, and when local sources of antioxidants are reported, consumers can choose to include more in their diet.

pest control

Integrated pest management (IPM) for Alaska agriculture: Grasshoppers

Dennis Fielding, Sultan Begna, Alberto Pantoja (ARS)

purpose

Current research focuses on grasshoppers, which regularly infest small-grain crops and during sporadic outbreaks cause

considerable damage. In 1990, losses for the Delta Junction area barley crop were estimated at fifty percent. The options for grasshopper control in the area are restricted by the mix of state and private lands (protected areas and areas designated for agriculture). Needed to resolve grasshopper problems are new cultural and biological tactics, as well as the ability to predict outbreaks. Because the economic cost/benefit ratio of crop protection actions is unknown, experiments at the ARS fields in Delta Junction were conducted to evaluate the effect of grasshoppers and weeds, and their interaction on growth and yield of barley and oats.

progress

Field data from 2000 and 2002 were analyzed and used to validate models of grasshopper growth and development under subarctic conditions.

Field experiments demonstrated a strong effect of both grasshoppers and weeds on barley yield, but also that the presence of even a few weeds (particularly Lamb's quarters) diverts some grasshopper feeding away from the crop.

Methodology for sampling grasshopper populations has been developed primarily for use on rangelands, and these methods are not suitable for sampling in the typically dense vegetation of cultivated crops. As a solution, we have evaluated windowpane and pan traps. Results suggest that grasshoppers are actively attracted to the traps. Field assays determined that both dead insects and fragrances in the soap increased the attractancy of the water pans used to collect the grasshoppers.

Predicting grasshopper outbreaks requires a thorough understanding of the parameters affecting their growth and reproduction. An ongoing project involves development of a computer model as a research tool for integrating information from many different levels of grasshopper ecology (individual, population, community, ecosystem). The individual-based model incorporates an evolutionary algorithm that allows individual grasshoppers to evolve various attributes in response to changing environmental conditions. The life-history solutions evolved by virtual grasshopper populations have been compared to solutions provided by thoroughly analyzed mathematical models in the literature of life-history evolution.

impact

For Alaska farmers developing a hay-grain-livestock based industry, the tools to avoid preventable losses are vital to the success of their fledgling row-crop industry. Information from the field experiments will contribute to informed decisions about the cost/benefit ratios of crop protection programs. Information about high-latitude populations will lead to more robust models of grasshopper development that can be used to predict outbreaks and be included in an individual-based model of grasshopper populations used for research purposes. Much of the information generated in Alaska will be directly relevant to grasshopper population management in other areas.

Integrated pest management (IPM) for Alaska agriculture: Invasive weed research

Jeff Conn, Alberto Pantoja (ARS)

Economic and environmental effects of invasive weeds include weed control costs, decreased rangeland quality, and loss of ecological diversity. The spread of invasive plant species in the United States has been deemed a national emergency. Although Alaska has fewer invasive plant species than other states, eradication efforts have been undertaken by various state and federal agencies to eliminate or halt the spread of some species. Exotic and invasive weeds recently introduced include Canada thistle, Japanese knotweed, garlic mustard, and orange hawksbeard. White sweetclover has invaded the floodplain of the Stikine River Wilderness, threatening ecological diversity. Many invasive species migrate to new areas along rivers, and Alaska has more river miles and lakeshores than any other state.

Research efforts will aim to determine distribution and extent of invasive plants in Alaska; how invasive plants affect agricultural and native ecosystems; which exotic plants warrant further research because they have invasive potential; which invasive species growing at high latitudes but not yet in Alaska could survive under Alaskan conditions; how invasive species are introduced to Alaska; what strategies can prevent further introductions; and, how to eradicate or prevent the spread of selected invasive plant species.

progress

The invasive plant research program began in January 2003, when ARS led an interagency task force to set the research priorities for invasive plant management on private and government-managed land in Alaska. A report on research priorities will be included in the comprehensive plan for State of Alaska Invasive Plant Management.

impact

Basic information on invasive species in Alaska is necessary for coordinated and effective control efforts. Compared to other states, Alaska's ecosystems are relatively intact. With relatively few invasive species to contend with research can focus on strategies to prevent the introduction of more, which is more cost effective than research aimed at controlling plant invasions.

Alternative disease control

Jenifer McBeath

pupose

Pink rot of potato (caused by *Phytophthora erythroseptica*), potato late blight (caused by *Phytophthora infestans*), gray mold (caused by *Botrytis cinerea*), and damping-off (caused by *Rhizoctonia solani*) are all economically destructive diseases. For many years, their control relied primarily on the use of chemical fungicides. Increasing awareness of the development of fungicide-resistant strains of pathogens, chemical residues in the food chain, and the adverse effects of pesticides on

human health profoundly affects the management of plant diseases. With a diminishing number of means to control disease, growers are seeking alternatives that are both safe and environmentally benign. *T. atroviride* is a versatile, aggressive hyperparasite that can parasitize a wide spectrum of pathogenic fungi, including *Phytophthora erythroseptica, Rhizoctonia solani, Phytophthora infestans* and *Botrytis cinerea*.

progress

T. atroviride has a temperature range of 4° to 33° C and prefers high humidity. Results of compatibility studies show that *T. atroviride* growth is not adversely affected by common fungicides and/or herbicides, even at field-applicable levels. However, performances of *T. atroviride* are limited by high soil temperatures and suboptimal dosages. A coordinated biochemical response has been observed in *T. atroviride* during biocontrol of plant pathogenic fungi. Production of chitinases, chitosanases, and glucanases seemed to play a significant role in hyperparasitism involved in disease suppression.

impact

Potato is an economically important crop in Alaska and elsewhere in the United States. Identification of molecular markers associated with disease resistance and adaptability to extreme northern climates may help molecular breeders in the development of cultivars more suitable to these conditions. Osmotins (the particular gene groups) represent a multigene family that has been implicated in disease resistance and cold tolerance. Isolation and characterization of osmotin genes may promote understanding host-pathogen interactions and the development of enhanced biological control agents for the control of plant diseases.

White mold control with Contans WG

Roseann Leiner

purpose

Contans WG is a biological control product that was recently registered for use against white mold, a plant disease caused by the fungus *Sclerotinia sclerotiorum*. We had field trials to study the effectiveness of Contans WG in our cool soils.

approach

We treated soil with Contans WG and observed the effect on survival and spread of *Sclerotinia* white mold, which survives in soil as black structures called sclerotia and spreads to plants when sclerotia produce cup mushrooms (called apothecia) that release many spores into the air. Contans WG contains spores of a different fungus that can decompose black sclerotia and thereby decrease the number of cup mushrooms spreading white mold.

progress

Treatment with Contans WG reduced the number of cup mushrooms per square foot in some cases, but not enough to stop disease pressure in these field experiments. The number of sclerotia that survived during the summer was usually greater than fifty percent and not reduced by treatment with Contans WG in our trials.

impact

Contans WG showed a small effect on white mold disease that causes wet rot on many vegetables and flowers in Alaska. This information will help Alaska growers looking for control products for white mold.

vegetables

Baby greens with different fertilizer rates

Roseann Leiner

purpose

Young leaves of plants in the cabbage family (*Brassica* spp.) are popular for gourmet salad mixes. The production practices for growing these baby greens are being studied in field experiments at AFES in Palmer.

approach

We planted seeds of five varieties of baby greens and compared three rates of fertilizer (10-20-20): 0, 600, and 1200 lb/Ac. We harvested individual leaves three to five weeks after planting to compare yield and quality.

progress

Yield from individual plants ranged from 0.6 to 5.9 grams, which predicts production up to half a pound per square foot. Although the time to harvest is short, the lower rate of fertilizer was sufficient for good plant growth. Plant density, irrigation, and days to harvest also affect yield.

impact

Baby greens can easily be grown in Alaska, with low inputs of fertilizer. Specialty market farms and home gardens can produce baby greens throughout the summer to supply consumers with healthful salads that are fresher by far.

Green storage cabbage variety trials

Roseann Leiner

purpose

Big cabbage varieties (O.S. Cross) are winners at the Alaska state fair, and other varieties are chosen for fast growth for fresh market sales during the summer season. Still other varieties mature slowly and store well into the winter months. In field experiments in Palmer, we compared twenty varieties of these green storage cabbages.

approach

We transplanted cabbage seedlings in June and harvested heads of cabbage in September and October. The cabbage were placed in refrigerated storage through the winter to observe changes in quality.

progress

Some cabbage plants showed nitrogen deficiency symptoms in September, indicating that low fertility may limit yield late in the growing season. Varieties that mature in 80

Cabbage fields at Palmer.

—PHOTO BY ROSEANN LEINER

days (Cheers, Gideon) stored well to November, and varieties that mature in 100 days (Arena, Lennox, Safekeeper II) looked fresh in January and beyond.

impact

The storage quality of cabbage is related to slow growth over a long season. The season for cabbage sales can be extended through the winter with adapted varieties and production practices that promote storage quality.

Carrot variety trials

Grant Matheke, Patricia Holloway, Janice Hanscom

purpose

Carrot trials were begun in 2001 to identify new cultivars useful in home and market gardens.

approach

Sixteen carrot cultivars were evaluated for yield and fruit size using a randomized complete block design over a three-year period. Taste tests were also performed.

progress

Yield was statistically comparable for each year among the four cultivars of baby carrots tested, and among the twelve cultivars of large carrots tested. However, we observed large differences in yield in both groups of cultivars among test years. In the taste test the cultivar Nelson, an early nantes type carrot, was preferred for taste, texture, and appearance by a majority of participants.

impact

These trials indicate to growers that the choice of a cultivar from among those tested can be made on the basis of individual preference, because it probably will not greatly affect yield.

Head lettuce variety trials

Roseann Leiner

purpose

Variety selection is an important management decision in vegetable production, because some varieties are better adapted to the long days and cool soils characteristic of Alaska. We compared varieties of head lettuce for differences in yield and quality, including resistance to tipburn damage.

approach

We transplanted eleven varieties of head lettuce at two times and two locations on farms in the Matanuska Valley. At harvest, we measured head weight and diameter, and then scored for marketability, tipburn damage, and disease incidence.

progress

The varieties Cypress and Lobos had over eighty percent marketable heads in most plots and compared favorably with the variety Alpha, which is commonly planted for commercial production in the Matanuska Valley. In contrast, a variety susceptible to tipburn damage had fewer than twenty-five percent marketable heads, which demonstrates the importance of tipburn resistance.

impact

These field trials provide information on lettuce varieties and their potential for good crop production in Alaska to supply local markets.

Tomato variety trials

Grant Matheke, Patricia Holloway, Janice Hanscom

purpose

New tomato cultivars developed for northern climates were tested in a three-year study to expand the number of outdoor tomatoes identified as hardy for interior Alaska.

approach

Eight tomato cultivars were evaluated for yield and fruit size using a randomized complete block design over a three-year period ending in 2003. All new cultivars were compared with Subarctic 25, a standard, locally-bred cultivar.

progress

Of the eight cultivars tested, only Moskvich had significantly lower yields than Subarctic 25, a commonly grown outdoor cultivar. Prairie Fire, with 1.5 to 2-inch diameter fruit, outweighs Subarctic 25 by more than 300 percent. Prairie Fire matures about one to two weeks later than Subarctic 25. Kootenai, Northern Delight, and Stupice also had larger fruit than Subarctic 25 and similar yields.

impact

This study identifies new tomato cultivars available to home gardeners and bedding plant producers of field-grown tomatoes in interior Alaska.

Soil carbon balance following disturbance by wildfire and logging in interior Alaska forests

David Valentine

purpose

The objective of this study is to quantify disturbance impacts, especially fire and logging, on soil processes affecting soil carbon balance in boreal forests.

approach

We measured soil respiration at burned black spruce sites and comparable unburned control sites.

progress

The main focus of the project has been the C4 watershed within the Caribou Poker Creeks Research Watershed. Since the experimental wildfire (Frostfire) in the summer of 1999, our measurements have clearly shown a persistent and growing decline in soil respiration in burned areas compared to control areas. In 2002, we began measurements to quantify to what extent the loss of root respiration may account for the decrease. Our results from 2002 indicate that root respiration cannot account for all of the decrease, suggesting that that fire also decreases the contribution of heterotrophic respiration (organic matter decomposition) to total soil respiration.

impact

In response to the Kyoto Protocol, carbon-credit markets have been established in the United States and throughout the world. The Alaska legislature currently is considering a bill (H.B. 196) that would authorize investigation of carbon credits in boreal forests and elsewhere as potential sources of revenue for state coffers. Our results shed light on key dynamics governing carbon balance following fire, the major disturbance type in interior Alaska.

Fire impacts on boreal forest soil carbon bioavailability

Sarah Masco, David Valentine

purpose

The objective of this study was to evaluate whether and how wildfire changes the quality of organic matter remaining at the soil surface following wildfire.

approach

Soil samples were obtained from the lower part of the organic surface horizon. Subsamples were incubated in the laboratory at three temperatures for six months. Respiration rates, total amounts of respired CO_2, and temperature sensitivity of respiration rates were determined, then compared with chemical analyses of the soil organic matter.

progress

Soil organic matter from burned sites respired slightly but significantly more slowly than soil organic matter from unburned control sites. Differences in respiration rate and temperature sensitivity did not correlate well with soil organic components. Burned soils had higher net nitrogen mineralization rates than unburned soils, possibly as a result of lower immobilization rates.

Jason Downing setting up a permanent photo point in the Survey Line Fire burn area, for long-term observation of decomposing logs.

—PHOTO COURTESY DAVID VALENTINE

impact

This study points to a mechanism by which wildfire may reduce decomposition (heterotrophic production of CO_2) in boreal forests, thereby limiting post-fire release of carbon.

Boreal black spruce and soil carbon exchange along an elevation gradient

Jason Vogel, David Valentine

purpose

The objective of this study was to evaluate the 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 studied the relationship between decomposition and aboveground plant growth, total soil respiration, and heterotrophic respiration near Fairbanks, Alaska. Our sites consisted of three similarly structured black spruce forests underlain by feathermoss that varied in aspect, elevation, and depth to permafrost. These characteristics drive complex differences in annual temperature at the soil surface and throughout the soil profile. For example, the two "warmer" sites are warmer during the summer, but are much colder during the winter, resulting in permafrost rising to within 50 cm of the soil surface. We hypothesized that ecosystem CO_2 uptake (aboveground increment) and loss (total soil respiration and soil heterotrophic respiration) both increase with decomposition rates. We looked

at the decomposition rates of black spruce needles and two standardized proxies for litter (filter paper and wooden tongue depressors).

progress

Although both aboveground tree increment (418-548 g CO_2 m-2 y-1) and heterotrophic respiration from trenched plots (122-137 g CO_2 m-2 y-1) were significantly correlated to the decomposition indices, total soil respiration was not. These results imply either that black spruce allocates less carbon below ground in warmer sites, or that the warmer soils sequester more carbon.

impact

Whether and how black spruce forest soils will alter their soil carbon balance in a warmer climate depend on the balance of production and decomposition. This study demonstrated that warming temperatures will likely increase decomposition and decrease tree carbon allocation below ground, which may constitute another mechanism by which soil carbon balance may become more negative with a warming climate.

Soils associated with frost boils in arctic Alaska

Donald Walker, (Institute of Arctic Biology, UAF); John Kimble (USDA Natural Resources Conservation Service); Yuri Shur (Department of Civil Engineering, UAF); Chien-Lu Ping, Gary Michaelson

purpose

The purposes of this project were to establish the relationship between soil development and landscape position in mid-arctic Canada, and to determine the carbon dynamics in the frost boil system. A frost boil is a non-sorted circle of mineral soil commonly found on alpine and arctic regions. On the ground, the fresh soils form a circle, or strip that looks like mud "boils" surrounded by tundra vegetation. Frost boils form due to differential frost heave. In early studies, frost boils were found more frequently in the moist nonacidic tundra (MNT) than the moist acidic tundra (MAT) in the Arctic Coastal Plains and the Arctic Foothills of Northern Alaska.

approach

Sites were selected in association with the vegetation plots of the National Science Foundation Biocomplexity project. Soil morphological description follows the *USDA Soil Survey Manual.* Soil samples from each horizon were sent to the laboratory for physical and chemical characterization using the USDA National Soil Survey laboratory procedures.

progress

The preliminary results of a NSF Biocomplexity study indicate that frost boils are widespread in both land cover types. On the surface, there appear to be more fresh frost boils in the MNT than MAT; but our findings indicate that more frost boils occur under the MAT and the vegetation cover masks them. The active layer, the section of soil that is subject to seasonal freeze and thaw, is deeper under the boil than under the interboil area. In cross section, the frost boil is defined by the permafrost table that has a bowl shape. Frost boils in the MAT are still active as indicated by chunks of cotton grass *(Eriophrum vaginatum)* at various stages of decomposition being frost-churned downward along the slopes of the "bowl." In the lower active layer and upper permafrost, a concentration of frost-churned organic matter mixed with gleyed mineral horizons occurs. Thus, the frost boil process can be regarded as a controlling factor for sequestering surface organic carbon into the upper permafrost.

impact

This sequestered carbon accounts for at least one-half of the total terrestrial carbon stored in arctic ecosystems and has not been previously reported. As permafrost thaws and this sequestered carbon is released, the input of global warming gas from into the atmosphere will be more than the current model 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 consulting 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 50 cm 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 challenge the 5° C threshold and were presented to the National Technical Committee on Hydric Soils. The committee 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."

Wet soils monitoring in Alaska

Chien-Lu Ping

purpose

The objective of this project is to establish baseline data for soil moisture, soil temperature, and soil properties as reference points for climate change studies. Soil monitoring stations were set up in key regions of the state, including arctic, interior, southwest, and southeast Alaska.

approach

In 2002, soil monitoring stations were added to the UAF forest Permanent Sample Plots near Tok, the Ward's Elk Farm in Delta Junction, and the Knight's Farm in the Nenana Valley. Telemetric access was also added to these stations and those in southwest Alaska so that users can get real-time data. The installation and operation of these stations are in cooperation with the SNRAS Forest Growth & Yield program, the United States Department of Agriculture—National Resource Conservation Service (USDA-NRCS) state and area offices, the USDA-NRCS National Soil Survey Center, and land owners. The project also includes cooperation with the USDA Forest Service Forest Science Laboratory in Southeast Alaska in setting up monitoring systems in Juneau, St. Petersburg, and Prince of Wales Island for slope hydrologic study for wetlands classification.

progress

In 2002, three monitoring sites (Tok, Delta Junction, and Nenana Valley) were added to the monitoring network. Initial monitoring data has been downloaded for analysis by the collaborator, the USDA National Climate Center.

impact

In addition to basic research, the data collected will benefit the local soil and water conservation districts, farmers, foresters, and land managers, including Native villages for land and resource planning. It will contribute to improved farming practices, such as irrigation and planting, silvicultural practices, and fire management.

Management of Ecosystems

climate and global change

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

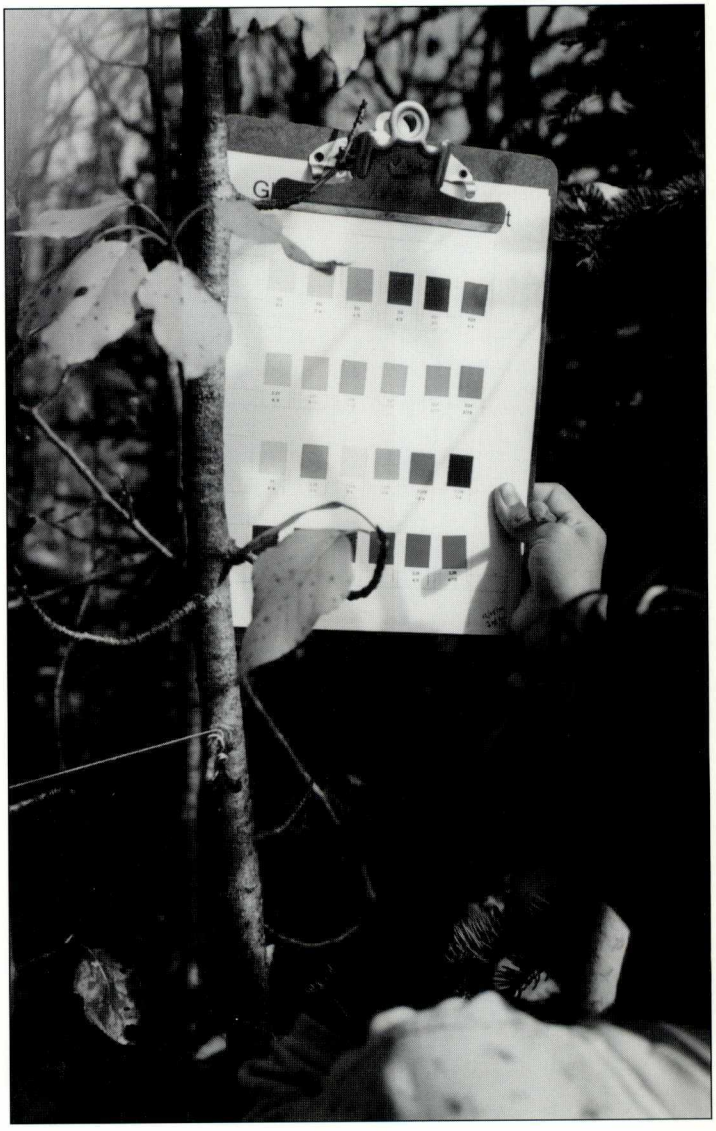
Elena B. Sparrow, Rick Foster, Joseph Hawkins, Steve Horn, Sidney Stephens

purpose

The overall objectives of this project are: to increase public (adults and children alike) understanding of the nature of global climate variability and its relevance to Alaska communities through informal learning venues; and to strengthen the teaching and learning of related subjects in K-16 classrooms.

approach

We have formed an Alaska Earth System Science Education Alliance of the earth and environmental education institutions in Alaska that are involved in systemic improvement



Student gathering data in a GLOBE-related phenology project, using a leaf color chart.

—PHOTO BY ED SILCOX

of science education, training, and distance learning. These institutions and organizations include the University of Alaska, Alaska school districts and schools, the Global Learning and Observations to Benefit the Environment (GLOBE) Alaska partners, 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, Schoolyard Long Term Ecological Research (SLTER), and the Alaska Environmental Education Outreach (AEEOP).

progress

The UAF and Campbell Creek Science Center GLOBE Partnerships, together with the Alaska Partners in Teacher Enhancement Program, conducted a GLOBE workshop in a rural site. The UAF GLOBE Partnership and OLCG personnel conducted followup workshops that featured scientists and Native experts on climate change and best teacher practices, to support teachers' implementation of local climate change studies in their classrooms. Teachers (participating in GLOBE, OLCG, SLTER and AEEOP projects) came from rural and urban schools for the followup sessions. With the help of the Center for Alaskan Coastal Studies, KBNERR also conducted some teacher workshops on climate variability and has modified existing classroom activities to make them more relevant to the Alaska community. The Alaska Space Grant Consortium has begun pre-service educator enhancement efforts through UAF, Alaska Pacific University, and UA Southeast. A new GLOBE partner, CLCA is gearing up to provide GLOBE workshops and followup support to teachers in the Kenai region. We have collaborated with the UAF Oral History Program to create an interactive, multimedia computer program (Project Jukebox), presenting multiple perspectives on climate change in the north. Digitized interviews of two Alaska elders on their observations and knowledge on climate change are available on the OLCG website (http://www.uaf.edu/olcg on the Native Knowledge section).

impact

Progress in strengthening the teaching and learning of science in the K-16 classrooms and coordinating Earth system science and climate change education efforts in Alaska will contribute greatly to a long-term, sustainable education effort on global climate change variability and its effects in Alaska.

Arctic Climate Impact Assessment

Glenn Patrick Juday, Valerie Barber, Steve Sparrow, Scott Rupp, Carol Lewis

purpose

The Arctic Council, representatives of the arctic nations of Canada, Russia, Iceland, Norway, Sweden, Finland, Denmark (Greenland), and the United States, launched the Arctic Climatic Impact Assessment (ACIA) three years ago. In the Arctic, climate strongly affects human living and work conditions, the managed living resources, and the health of ecosystems in one of the most naturally variable climate regions in the world. Strong climate warming has occurred across much of the Arctic in recent decades and possible future climate warming is predicted to be greatest in the far north.

approach

The member nations have provided funding for an international scientific synthesis involving over two hundred authors on the effects of climate change and increased ultraviolet light from ozone depletion in the Arctic region. The scientific document describes our current understanding of past climate changes and their effects, recent trends the arctic climate, risks and vulnerabilities to society from climate change, and an analysis of the effects of five climate change scenarios. The Agricultural and Forestry Experiment Station is providing the lead author and contributing authors for the chapter on Forests, Land Management, and Agriculture.

progress

A coordination meeting with the executive team and chapter lead authors took place in Asker, Norway, and a synthesis workshop was held for all authors at the University of New Hampshire. Review drafts of all chapters were completed.

impact

ACIA is an important summary and information reference for the public, natural resource managers, scientists, and policy makers in anticipating, planning for, and dealing with consequences of climate change in the Arctic. Climatic limitations on agriculture would be removed under the scenario conditions used in the ACIA analysis across large areas of the north, but agricultural production would likely be constrained by other social and economic factors. Across the circumpolar north, warm years on the eastern margins of the continents occur at the same time as cold years in the western portion and vice versa. This opposite temperature behavior is strongly influenced by the major ocean current and atmospheric wind systems. Scenario climate conditions would reduce tree growth on several site types in western North America and central and eastern Siberia because of moisture limitation. Tree growth would increase primarily at marginal treeline sites. The risk of large-scale insect-caused tree death in productive stands would increase greatly under the scenarios. Collaborative, broad-based international scientific and policy groups are already planning new investigations and reports on priority topics that have emerged from the work so far.

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; 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

This project analyzes 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 that can be used to direct 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

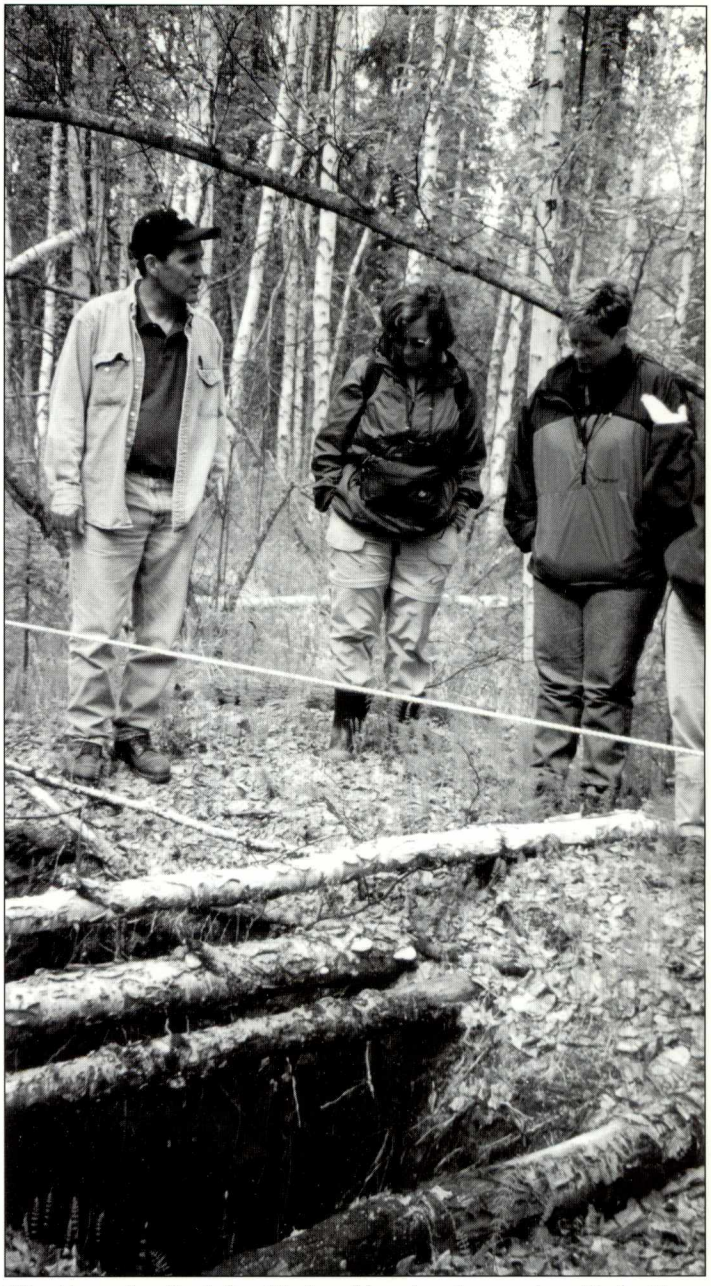
We will evaluate the performance of a regional climate model, an ecosystem modeling framework, and a large-scale hydrological model. Our focus is on Alaska, which will allow us to assess how well the models close the water and energy budgets for the region, simulate exchange of CO_2 with the atmosphere, and evaluate the linkages between the atmosphere, the land, and the ocean.

progress

The second year of this study focused on initial data set development and delivery, and preliminary component model evaluation. Conceptual and structural development of model coupling strategies was formalized at a project science meeting held in August 2002 in Montana; implementation is ongoing. Preliminary model simulations and data archiving are ongoing in preparation for a project science meeting fall 2003 in Seattle.

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 water and energy exchange with the atmosphere, the exchange of radiatively active gases with the atmosphere, and the delivery of fresh water to the Arctic Ocean.



Wes Alexander, Sr., left, a Native elder, showing teachers Kathy Ernst and Annie Huddy a hole left by melted permafrost.

—PHOTO BY ELENA B. SPARROW

Global change education using western science and Native observations/knowledge

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

purpose

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

approach

Rural and urban Alaska pre-college teachers participate in the "Observing Locally, Connecting Globally" (OLCG) program. The teachers are provided professional development through a summer institute and ongoing support programs that use Native knowledge to scaffold and enhance local environmental change studies; scientific measurements developed by the Global Learning and Observations to Benefit the Environment (GLOBE) program and Alaska climate change scientists; and best science education practices. Teacher support includes a website (http://www.uaf.edu/olcg), as they implement the program in their classrooms. Attitude and achievement assessments, including teacher and student journals, are used to evaluate the program.

progress

The third OLCG science institute was conducted. To date, 39 teachers and 800 students have participated in this program. Results of pre- and post-institute assessment showed an increase in teacher comfort level with teaching science. Teacher journals through the school year indicated that the program had positively influenced the math and science teaching methods and

curriculum of participating teachers. Their teaching included more Native knowledge, engagement of their students in scientific procedures and research, and performance assessments and inquiry. 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.

impact

Students of participating teachers in OLCG showed the greatest improvement in their ideas about the water cycle and weather and their perceptions of how much they learned about science, the local environment, and from having a Native elder visit the classroom. Parts of the program model have been used in national professional development workshops for teachers.

forests and fire

Alaska Birch and Black Spruce Tree Growth and Climate

Glenn Patrick Juday, Valerie Barber, Rob Solomon

purpose

Black-spruce-dominated forest or woodland is the main tree species on fifty-five percent of Alaska's boreal forest, and Alaska birch is dominant on another fourteen percent. The objectives of this study were to determine whether there is a significant relationship between climate and the growth of Alaska birch and black spruce, and if so, what factors best promote and most limit growth.

approach

We cored birch trees at the Live Birch reference stand in Bonanza Creek Experimental Forest and the Spinach Creek Watershed. We cut disk sections of birch at properties near Fairbanks, and from over 100 black spruce east and west of Fairbanks. We measured ring width along two or three radii from the bark to the center of the tree. We correlated the mean growth per year of each sample site to the Fairbanks temperature and precipitation record.

progress

Alaska birch were found to have two opposite growth responses to climate. At the Live Birch site, made up of positive responders, trees grow more in warm summers and less in cool summers. The other three sites were dominated by negative responders, or birch that grew best in cool summers and worst in warm summers. For negative responder birch, warming of 3° to 5° C (5.4° to 9° F) would produce years with a predicted growth of zero, suggesting that the trees would not be able to survive. Black spruce have the greatest diversity of climate response types seen in boreal Alaska trees to date, with four climate predictive relationships identified. One black spruce population is dominated by positive responders that grow best following warm late winters, two are made up of trees with a negative response to midsummer warmth, and one is dominated by trees that respond to a mixed climate signal which is positive for late winter warmth and negative for late spring warmth. For negative responder black spruce, warming of 3° to 5° C (5.4° to 7° F) would produce years with a predicted growth of zero. For positive responder black spruce the warming produced by the Hamburg climate scenario would increase average growth about fifty percent by the year 2100. However, the Hamburg scenario would, within the next century, thaw the permafrost under sites with positive responding black spruce, probably leading to widespread tree death on such sites.

impact

Scientists and policy makers are intensely interested in the climate sensitivity of the boreal forest, because it is an important factor in taking up and storing carbon dioxide in the atmosphere. How it will function in a warmer climate is not well known. Equations developed in this project are providing long-term, ground-based data to help answer this question.

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

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

purpose

A problem facing scientists trying to predict responses of northern landscapes to climatic change is 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-km2 area. Spruce did not recolonize the region until 2000 years later.

approach

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

progress

In winter 2002–2003, a project science meeting was held in Seattle and a conceptual strategy for data integration was formalized. Field data collection was completed in summer 2003. A new seed dispersal algorithm was developed and implemented. A graduate student from the Statistics Department will develop model algorithms to simulate the response of trees to climate change as his thesis project. Preliminary field data was collected from the Erickson Creek fire to begin work on developing a model of charcoal dispersal. This model is a major component of a PhD thesis by Phil Higuera at the University of Washington.

impact

The improved understanding of boreal forest-tundra dynamics in Alaska is an important step in understanding

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

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

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

purpose

Interior Alaska contains 140 million burnable acres and includes 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

We are developing 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

We have recruited a MS student, Tom Kurkowski, in addition to our PhD student, Paul Duffy. A new model version was developed that simulates interannual fire and vegetation dynamics. Preliminary model simulations were published in the peer-reviewed journal *Frontiers in Ecology and the Environment,* and were used successfully in a proposal to the National Science Foundation for investigation of human impacts on the fire regime.

impact

Our 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. The model will serve as an integrative and adaptive planning tool for land managers designing fire-management plans that can safeguard both human and natural values.

The ecology of post-fire morel mushrooms

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

purpose

In interior Alaska, valuable morel mushrooms can fruit prolifically in the year following wildfire, yet little information is available on this high-potential nontimber forest product. We don't know the species of morels that occur here, nor the fundamental aspects of their ecology, such as whether their mycelia exist on the site prior to the fire or their spores colonize it afterwards.

approach

We documented the productivity of the Survey Line Fire Area (south of Fairbanks) for morels, using plot sampling methods developed by the USDA Forest Service Forest Mycology Team in Corvallis, Oregon. We also began a long-term examination of such factors as burn severity, soil moisture, May and June precipitation levels, and pre-fire vegetation composition for their effect on morel production.

progress

We found a mean production of 980 mushrooms per hectare on the Survey Line Fire, for 6 kg/ha fresh weight. Morels were more likely to be found in better-drained areas of the Survey Line Fire site, and were commonly associated with another fungal species, *Geopyxis*.

impact

Morel productivity on the Survey Line fire was similar to other documented burn areas in Oregon and Washington, suggesting that the potential exists for commercial harvest of this mushroom. An average of 1 million acres burns annually 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; Layne Adams, Kyle Joly (USGS Alaska Biological Science Center); Bruce Dale, Bill Collins (ADF&G)

purpose

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

approach

We are developing a spatially-explicit succession model 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 extended and will be further developed under another project funded by the Joint Fire Sciences Program. A graduate student from the Statistics Department was hired, on a summer assistantship, to calibrate, test, perform, and analyze model simulations. The model has been fully calibrated

and tested. The results identified a high degree of consistency between observed and simulated fire regimes. Current model simulations will test the influence of fire on foraging habitat and calculate metrics to be evaluated by caribou biologists and land managers. The results of this work are being prepared for a peer-reviewed journal article to be submitted fall 2003.

impact

Changes in the 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 management issues as well as those in the foreseeable future.

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

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

purpose & 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

In a detailed field campaign in 2002, MS student Dan Cheyette completed inventorying fuel types across the Anchorage Bowl.

Preliminary custom fuel models were developed in April and employed by the Anchorage Fire Department and Alaska Division of Forestry for the 2003 fire season. Final data analysis and model sensitivity is ongoing.

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.

How white spruce survives: growth, reproduction, fire, and climate variability

Glenn Patrick Juday, Valerie Barber, Martin Wilmking

purpose

For more than a generation, focused studies of the boreal forest have been producing results in particular lines of research. With these results now available from many different studies it is possible to synthesize the results and gain new insights that were not obvious from the studies taken in isolation.

approach

Long-term records of white spruce radial growth, seed production, climate data, and fire records were compared to understand the causes and interrelationships among these factors.

progress

Interior Alaska climate alternates between one to four decade-long periods with either warm and dry or cool and moist summer climates. Summer climate during the nineteenth century (before instrument-based records) was reconstructed from carbon isotope and latewood density measurements of white spruce at Bonanza Creek Experimental Forest and Long-Term Ecological Research (LTER) site. This project has identified the pattern of climate regimes, and developed a standard numbering system for the summer temperature regimes of Interior Alaska. The isotope/density record agrees with ring-width measurements on productive upland sites across Interior Alaska. The late twentieth century was the warmest period since 1800, although two intervals nearly as warm are reconstructed in the mid-nineteenth century. For at least 200 years interior Alaska white spruce have grown about twice as much during cool-moist periods compared to hot-dry periods. White spruce cone crops are infrequent and are generally associated with the first strong warm-dry year, or years following a few years of strong growth. The climate factors that are associated with initiating large cone crops also promote wildland fires. A major synthesis was completed on the control of climate over white spruce growth and reproduction.

impact

This reproductive system appears to be an adaptive strategy to maximize the odds that white spruce seed crops are released into landscapes in which fires have recently occurred.

Natural regeneration of white spruce at Reserve West

Glenn Patrick Juday, Rob Solomon

purpose

This study is a long-term monitoring project that measures survival and height growth of seedlings and saplings in an area burned in the 1983 Rosie Creek Fire. Data from 2002 are the fourteenth year of measurement in the study. The vast majority of Alaska's boreal forest regenerates following fire disturbance, and the events and controls over regeneration after fire literally have made the forests that are managed today. This long-term study and data base identifies factors that promote and hinder white spruce establishment and early growth.

approach

All white spruce seedlings in a 100m by 100m hectare (2.47 acres) have been mapped and annual survival and height growth measured since 1988. All seedlings belong to the 1983, 1987, or 1990 seed crops.

progress

The germination year in the database for all seedlings was reviewed and corrected. Mean 2002 growth of 1983 seed crop seedlings was the greatest yet (26 cm) reflecting the third year of optimum cool and moist summer weather. Average height of 1983 seedlings was 192 cm (76 in) and 71 percent of 1983 seedlings were greater than breast height (137 cm or 4.5 ft), a height that serves as a benchmark for likely future success in becoming part of the dominant tree canopy. Average height of 1987 seedlings was 66.5 cm (26 in), and 6% were taller than breast height, the first significant numbers of that seed crop year to reach that height.

impact

Regenerating white spruce is generally the biggest reforestation problem in the boreal forest region. With another year's data, the first predictive equations of white spruce height growth will be developed related to climate, seed crop year following fire, and other factors. These numbers may be useful in setting natural reforestation standards, in calibrating models of forest growth, and in predicting forest growth under different climate scenarios.

Opposite treeline growth responses in white spruce and a temperature threshold

Glenn Patrick Juday, Martin Wilmking

purpose

High-latitude forests provide important feedbacks to global climate because increases in tree growth and forest area enhance CO_2 uptake. Replacement of tundra by evergreen conifers, however, decreases albedo (reflectivity of the earth's surface), which enhances warming. The treeline margin between tundra and forest should be a particularly sensitive environment to detect effects of climate change.

approach

We analyzed tree ring samples from 1155 trees older than 100 years collected at seven sites in the Brooks Range and six sites in the Alaska Range of Alaska. We compared ring width to climate at Fairbanks using clustering procedures.

progress

The analysis showed three populations made up of trees that: increased in growth with spring (March/April) warmth; decreased in growth with previous July warmth; and did not respond to temperature. About eighty percent of trees belonged to the first two response types (forty percent each). The response pattern repeated itself at each of the thirteen sites in both mountain ranges. The negative growth response to warm temperatures is particularly surprising since warmth is usually reported to enhance tree growth at cold treeline sites and facilitate treeline advance. Growth decreases in the negative responding trees began for mean July temperatures at Fairbanks greater than 16° C (61° F). Temperatures above this threshold were more common after 1950 than before.

impact

These types of tree response to climate appear to be valid across most of the mountain boreal regions of Alaska. This information can help resource managers determine the current health and possible future performance or survival of white spruce in the parks, refuges, and resource management areas that dominate the mountains of Alaska.

Stream temperature response to timber harvest activities in interior Alaska

John D. Fox, Jr.

purpose

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

approach

A variety of simple to complex models are being used to explore the many interacting variables that can influence stream temperature and ice thickness, making field studies difficult to interpret.

progress

A comprehensive annotated literature review has been compiled. From this and freeze-thaw models based on the St. Paul equations with a snow layer, we conclude that ice-bridge construction should not take place in upwelling locations or when river cross-sections have less than two meters of water depth. Also, summer changes in stream temperature (observed longitudinally in the channel from headwaters to mouth) can largely be explained by the simple model of solar energy input along the water surface.

impact

Information gained to date has contributed to the 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 prinicipal investigator and a colleague have been delivered.

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.

impact

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

Ectomycorrhizae on disturbed lands in southcentral and interior Alaska: a comparison of regional similarities and differences

Dot Helm

purpose

To grow in the wild, most woody plant species in Alaska need ectomycorrhizal fungi (fungi that help plants absorb nutrients and moisture from soil and receive carbon as an energy source from the plant), which may not be found on nursery or greenhouse transplants used in revegetation because of the high nutrient content of growth media in commercial growers' operations. The primary objective of this project is to compare ectomycorrhizal communities in early successional sites across a latitudinal gradient in Alaska to determine whether there are similarities among ectomycorrhizae. This information can be used to assess feasibility of a common inoculum or strategy for revegetation.

approach

Roots and surrounding soil or soil/litter cores are collected in the field and washed in the laboratory. Morphotypes of root-fungi combinations are described and compared among early successional sites ranging from Kenai Peninsula to Brooks Range.

progress

In 2002 I collected more roots and surrounding soil from early succession sites at Exit Glacier, Knob Creek, Caribou-Poker Creek Research Watershed, and Bonanza Creek study areas. Laboratory analyses continue on them. At least some mycorrhizae appear to be the same across sites, although preliminary results suggest that differences occur.

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.

Arctic Plant Germplasm Introduction and Research project (APGIR)

Dave Ianson, Nancy Robertson, Donald Carling, Alberto Pantoja (ARS)

purpose

The National Plant Germplasm System (NPGS) of the ARS is a cooperative effort by public (state and federal) and private organizations to preserve the genetic diversity of plants. The National Arctic Plant Genetic Resources Unit, Alaska Plant Materials Center in Palmer, Alaska, is the first systematic effort by a U.S. agency to preserve high-latitude and high-altitude plant germplasm.

The primary mission is to acquire, propagate, store, and distribute plant germplasm of agricultural and nonagricultural plant species from arctic, subarctic, and alpine regions of the world. The plant materials center also serves as a grow-out site for seed and clonal samples for certain cool-season accessions from other plant germplasm repositories within the NPGS. The mission also includes research on certain diseases and the physiological features of regional species. Alaska plant diseases, both indigenous and introduced, are not well documented. Comprehensive surveys in agricultural and nonagricultural plants species are few, especially for plant viruses, although viral and other contagious diseases can have a significant negative impact on crops other plants. The physiological aspects of plant adaptation and survival in these environments also require additional research.

progress

Fifteen additional accession of rhubarb *(Rheum rhababarum)* were added to the existing collection. This brings the total rhubarb accessions to fifty-one. Most of these are currently available to other scientists for research.

Barley and oat plants were surveyed in the Matanuska Valley for plant viruses identified using the molecular PCR technique and serology (ELISA).

Cereal yellow dwarf virus (CYDV) was detected for the first time in Alaska in 2002, and was only found in oats. Barley yellow dwarf (BYDV)-PAV was found in barley (2001–3) and oats (2002). The number of total diseased plants among the fields varies from about 10 to 100 percent, providing a source for more infections to overwintering wild grasses and new small grain crops the next growing season.

Six native Alaska plants have been identified for the first time to have plant viruses. A new carmovirus was detected in native lupine growing and is presently confined to a small region along the Little Susitna River. This is the first carmovirus found in the Fabaceae family in a temperate climate. Two viruses have been isolated and partially characterized from another native plant, *Streptopus amplexifolius*, growing in natural environments (2001–3) and near a residential site (2003); this is the first report of virus(s) infecting *S. amplexifolius*. Other native plants discovered for the first time to have plant viruses (2003) include *Angelica lucida* (Kodiak, Buffalo) and *Sorbus scopulina* (Skwentna).

impact

Plant disease research adds to the biological knowledge of plant pathogens in native plants found in both isolated sites and near agricultural and residential sites.

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.

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

Tricia L. Wurtz (USDA Forest Service, BECRU); Knut Kielland (UAF Institute of Arctic Biology); Tom Hanley (USDA Forest Service, Juneau Forest Sciences Laboratory)

purpose

The objective of this study is to look at the effects of herbivory by moose and hares on the establishment of white spruce on the Tanana River floodplain. Although moose don't browse on spruce, their effects on other species, particularly willows, can have cascading effects on vegetation communities along the floodplain.

approach

Past research by Kielland and Bryant has shown that when moose are excluded from floodplain plant communities, willows grow larger and persist far longer through succession, and the establishment of alder is delayed. We decided to establish new exclosures and to focus on rates of spruce colonization within and outside them.

progress

In 2002, we established twelve chain-link moose and hare exclosures in early successional communities along the Tanana. We sowed spruce seed at forty-eight spots inside and outside each exclosure.

impact

This study is still in its beginning stages. We hope it will ultimately increase our understanding on the role of mammalian herbivory on floodplain vegetation dynamics.

Natural Resources Use and Allocation

forests

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 items for sale to tourists as *objets d'art*. 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. Bark harvest occurs without landowner permits along all roads. Commercial harvesting, with raw bark sold, occurs. Natives tend to harvest strips 1 to 2 feet wide; commercial harvesters peel strips 4 to 6 feet wide. Square inches of a peeled sheet of bark range from less than 100 to over 1200. Peeled tree diameter averaged 5 to 7 inches. Typical baskets contain 19 to 121 sq. in. of bark. Retail price of individual items ranges from $20 to over $300. Retail value of bark in a finished basket ranges from $0.25 to $0.45 per sq. in. Artists commonly receive less than one-half the retail value for their effort.

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 brown bark, after an unknown number of years, sloughs off revealing once again the white, peelable bark.

Patterns of $\delta^{18}O$ variation in twig water from late winter through early summer in interior Alaska

Lola K. Oliver

purpose

The purpose of this study was to find out when the sap starts to rise in the spring, and if the isotopic signatures were stable or fluctuated throughout the year, indicating different water sources for the sap or a change in the signature of the water that formed the sap.

approach

From February 2002 through July 2002, weekly samples of twigs were taken from three white spruce *(Picea glauca)* and three paper birch *(Betula papyrifera)* trees at two different sites near Fairbanks, Alaska. The field fresh twigs were stripped of foliage, weighed into exetainers, and analyzed for $\delta^{18}O$ composition (an isotope of oxygen used to identify the water source) of the water content using the methods outlined by Scrimgeour (1995).

progress

Although a test of six twigs from each of six trees (three birch and three spruce) taken at one time from one site showed very little consistency for $\delta^{18}O$ levels, a single twig sample taken weekly per tree over a period of several months showed replicable trends in $\delta^{18}O$ changes that were consistent for species and site. Oxygen isotope ratios in birch became heavier, and changes in spruce in early spring were directly proportional to air temperature changes. Absolute values of $\delta^{18}O$ were different at the two different sites, but the patterns of change were the same for each species.

impact

This test indicates that over a long enough sampling period, the isotopic signatures of tree water samples can be usefully studied by this quick and relatively easy method. This is a possible technique for finding changes in water source or changes in physiological processes that affect the water in a living tree. The tests showed radical change in the spring, which may be due to sap rise. Further tests will be necessary to determine if this is the case. (Sap rise time is important if you are interested in tapping the tree).

Alaska birch sap production

Glenn Patrick Juday, Kimberley Mahr

purpose

Alaska birch trees produce a sugar sap that can be tapped and sold as a natural product or distilled as a syrup. The potential for these products requires a better understanding of how much the trees produce under various conditions and the amount of properties desired by consumers (minerals, sugars) are present in the products.

approach

During the 2002 sap season nine sites (ninety trees total) were measured for phenology of sap season and daily sap production (volume and quality). Nine sites were fully instrumented with seven sensors at each site. Sensors were installed to measure air temperature, soil temperature, volumetric water, and soil-water tension.

progress

The 2002 sap season was very different than 2001 with a much later start; once the sap did start flowing, the reduced length required a major project effort to keep up with events. Sap season started April 30 (ten days later than 2001) and data collection ended May 17 (two days earlier than 2001). Total sap production was less in 2002 than 2001 for the three sites that were tapped both years. Tree cores in these prime producing stands have earliest tree rings that date to the late 1930s at breast height, indicating that optimum production stands are in the range of 65 to 85 years old.

impact

This project is working closely with Alaska birch sap producers to advise them on expected rates of Alaska birch sap production, chemical properties of sap, climate control, and desirable characteristics of producing stands.

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. The objective of this study is to determine potential (type, quality, and quantity) of chemicals contained in Northern Forest species, extractive processes, and potential markets.

approach

The effort primarily involves a review of the literature and contact with various scientists and entrepreneurs.

progress

Tree components (bark, wood, foliage, reproductive tissue) have different chemical properties. Birch bark contains betulin or betulinic acid, but the wood does not. Tests suggest that betulinic acid or betulin may cure herpes. The quantity of these and other chemicals in Alaska birch (different species) is unknown. We delivered Alaska birch bark samples, from the Interior, Southcentral, and the Kenai Peninsula, to the University of Minnesota Duluth to compare with Minnesota birch. Seed and foliage samples from five trees at each of four sites from the three areas for chemical and genetic analyses were sent to colleagues. We completed a literature review on birch bark growth and renewal; the final report is anticipated in 2003. Financing for a wood refinery is still being pursued by others.

impact

The extent of forest biomass available for phytochemicals suggests that the opportunity for family-size through large (350 ton/day) facilities and attendant employment is possible for Alaska. Ethanol for energy may be reduced to by-product status. Betulin and betulinic acid may be higher for Alaska birches than Lake States birches.

An alternative to clearcutting in floodplain forests of interior Alaska

Tricia Wurtz (USDA Forest Service, BECRU); John Zasada (USDA Forest Service, North Central Experiment Station)

purpose

The study compares different levels of overstory retention in the harvest of white spruce along the Tanana River. We

compared clearcutting with two levels of partial cutting, and compared three different methods of post-harvest site preparation, examining their effects on soil temperature and forest regeneration.

approach

The study was begun in 1980, when a series of timber harvesting and site preparation treatments were established on a large island in the Tanana River, near Bonanza Creek Experimental Forest. Following the initial evaluation of the experiment, it has lain dormant until 1999, when we began a re-evaluation.

progress

In 2002 we completed the three-year re-evaluation of the treatment effects. We documented natural regeneration of white spruce and other tree and shrub species, determined the fate of the retained overstory trees, and measured the long-term effect of harvesting and site preparation on the island's soil temperature regime.

impact

This work has yielded valuable information on the costs and benefits of a number of silvicultural manipulations. For example, retaining evenly dispersed overstory trees in harvested units reduces the soil warming that usually accompanies timber harvesting. Warmer soils lead to faster growth among young trees, so retaining part of the overstory slows regeneration. By 2001, forty-three percent of the retained overstory trees were dead, and all but one of these had either blown over or snapped off. Overstory trees were thus providing a long-term source of coarse woody debris to the harvested unit, but were a declining source of seed.

Black spruce growth and yield

Edmond C. Packee, Sr., Carolyn Rosner

purpose

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

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 and individual tree volume are measured every four feet from a six-inch stump. Tree volume data will be used for wood volume, bark "volume," 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 natural resources management MS thesis effort.

progress

Volume measurement data for 885 trees and stump and breast-height ages for 450 trees were entered into spreadsheets and verified. For site index (a measure of potential productivity) two distinct types of stands, upland and lowland, were identified. Draft site index curves were finalized and are being reviewed. Twenty stands were selected for PSPs; sixty PSPs were established.

impact

Site index curves are used to measure productive capability 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

How many years does it take white spruce to reach breast height (4.5 feet) in Alaska? Is early height growth affected by distance between trees or overstory competition? Objectives are to determine years required for planted, open-grown, and understory trees to reach breast height; tree height at twenty years; and impact of overstory competition on seedling and sapling height growth.

approach

For free-to-grow-white spruce, Levels-of-Growing Stock (LOGS) plantations with five espacements (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, eight white spruce plantations six to ten years old that had trees growing under three conditions: a) free-to-grow, b) aspen overstory, and c) birch overstory. The height of twenty-five trees for each condition was measured. This study is a natural resources management senior thesis project.

progress

Jamie Hollingsworth's MS thesis for the Free-To-Grow portion of the study was completed. For open-grown white spruce, minimum average age to reach breast height is eight years on average or better quality sites. Andre Collins is addressing the impact of overstory competition on height growth portion of project for his BS thesis. For the latter, 600 trees were measured, data entered for analysis, and a literature review completed.

impact

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

Espacement effect on early diameter of white spruce stems

Craig W. Bosveld, 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. Our objective is to determine the effect of espacement on diameter growth.

approach

Two Levels-of-Growing-Stock plantations, established May 1986 west of Fairbanks with five espacements, were measured in spring 2001 to obtain fifteen-year breast-height diameters. Regression analysis determined if statistically significant differences occurred between the two plantations and between espacements.

progress

Craig Bosveld's BS thesis was completed. Regression analysis 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). Annual remeasurement was completed.

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 espacements 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

Jeffrey McArthur's BS thesis was completed. Based on empty galls, a specialist identified the causal agent as either *Pineus similis* Gill. or *Adelges abietis* L. The seedlings were grown in Alaska, so the insects are not imported. We found gall abundance to be heavier on whorls below breast height and on the wider espacements; gall abundance was not affected by overstory shading.

impact

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

Forest Vegetation Simulator (FVS) model

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

purpose

Forest managers use stand or individual tree models to forecast probable results of alternative silvicultural prescriptions. No such models are currently used on public and private lands in Alaska's Northern Forest. Our objectives are to select model(s) suitable for Alaska forests, determine data requirements, and initiate implementation.

approach

We selected the FVS model, which includes the Stand Visualization Simulator. Selection criteria included: quantitative and visual outputs, ability to handle wide range of silvicultural treatments, minimal data inputs, and user friendliness.

progress

No variant exists for Alaska's Northern Forest; it must be developed or adapted from an existing variant. Contact will be made with the USDA Forest Service expressing our interest in a variant. FVS was presented to Alaska foresters in a short course. Inventory plot data were obtained from Tanana Chiefs and Alaska Division of Forestry that will be used along with this program's Permanent Sample Plots.

impact

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

Individual tree volume equations

Edmond C. Packee, Sr., Thomas Malone

purpose

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

approach

We measure felled-tree diameters at four-foot intervals, calculate volumes for individual sections and then the tree, and use regression to develop single-stem individual tree volume, bark thickness, taper, and cambial area equations. Tom Malone is using this project for MS thesis.

progress

A literature review is in progress. Data entry for all white spruce has been completed; 90 aspen and 33 birch trees were sampled.

impact

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

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

We obtain basic data from existing plots (e.g., inventory, timber sale cruise, PSPs, LOGS) and collect supplemental data (stand basal area, tree diameters) from densely stocked stands. Finally, we calculate SDI values for pure and mixed species stands using the summation method.

progress

Other sources of data are being sought. 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 FVS model (see Forest Vegetation Simulator, above).

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.

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 1993 (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 LOGS plantations provided the basis for one MS thesis (Jamie Hollingsworth) and three BS theses (Craig Bosveld, Jeffrey McArthur, Andre Collins). Plots were cleaned of competing aboveground vegetation and remeasured.

impact

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

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 public meetings and written comments. An Environmental Impact Statement (EIS) will be written, subject to NEPA requirements, analyzing the impacts of each alternative. Public meetings will be conducted to obtain comments on the EIS, and these will be used to complete draft and final plans for the river. The plan is scheduled to be completed in 2005.

progress

A survey of river users and an inventory of concessions within the boundary of the wild river corridor are currently being conducted.

impact

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

Are maps being used to their full potential in planning and environmental mediation?

Laura Walker, Susan Todd

purpose

The purpose of this research was to examine how maps are used planning and mediation when the case involves spatial data.

approach

A web survey was sent by e-mail to planning agencies as well as nonprofit planning and mediation organizations. Respondents were asked to indicate how often they used maps for activities such as orienting participants and developing an agreement in the form of a single negotiated map. They were

also asked to rank the relative importance of maps compared to text in developing an agreement and to suggest ways in which the use of maps could be improved.

progress

Most respondents felt that maps should be used more frequently and that the use of maps increases the likelihood that a group will reach agreement. Almost eighty percent of the respondents felt maps were at least as important—if not more important—than the text of an agreement. They felt that the most common barrier to using maps more extensively in consensus-building was a lack of skill in making them. One respondent cautioned that maps should not be overused, because people "will believe anything they see on a map, but they are a lot more skeptical when it comes to text."

impact

This study should increase the efficiency and effectiveness of planning and environmental mediation by improving their use of maps. It also reports new and creative ways that people are using maps in planning and mediation. Finally, it highlights the need for planners, mediators and resource managers to strengthen their mapmaking skills.

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 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 using aerial photography/imagery and ground photographs of the lake and lake shore. An interactive model has been created that captures the general dynamics of the lake water balance.

impact

Over the years there has been recurring interest in the Harding Lake issue. Information that I have collected has been shared with members of management agencies and the newly formed Harding Lake Watershed Council. This information is being used by the Natural Resources Conservation Service and the Salcha-Delta Soil and Water Conservation District in designing and planning for a control structure on the divergent stream. This study should provide an opportunity for a senior thesis project.

Recreational use impacts on arctic wilderness lakeshore vegetation, Brooks Range, Alaska

Adam J. Liljeblad, Edmond C. Packee, Sr.

purpose

Camping may negatively affect shoreline plant communities of Walker Lake, a designated Wilderness Lake in the southern foothills of the Brooks Range and within Gates of the Arctic National Park and Preserve. Objectives were to determine camping impacts on shoreline plant communities by comparing affected with unaffected sites for three distinct environmental settings: North (mature, open white spruce without aspen), South (young, open white spruce with aspen, and Peninsula (mature, open black spruce) and to suggest management actions.

approach

Vegetation, species, and cover class for each environmental setting was sampled using a paired plot technique. Similarity indices and the "t" test were used to identify differences between areas affected by camping and control (unaffected) areas.

progress

Adam Liljeblad's BS thesis was completed. No negative impacts on tree species were found. The three environmental settings differed significantly. For the North, the control had more species than the camping affected area; for the South, the reverse was true, and on the Peninsula the number of species was the same. However, nontree species differences occurred between the controls and affected areas. *Spiraea* coverage was consistently greater on affected areas; dwarf birch cover was greater in control plots on the peninsula and greater on impacted sites at the other two sites.

impact

If camping negatively affects shoreline vegetation, managers can use this information to address the effects of recreational use and indefinitely maintain biological diversity and the integrity of an area. Because exposed mineral soil cover was consistently greater at affected sites, camping should be concentrated to a few areas having soils with a high sand and gravel content to minimize this negative effect.

Alaska Residents Statistics Program

Peter Fix

purpose

Recreational use of public lands has increased greatly since World War II and is expected to continue to grow. This trend, which indicates increased appreciation of the benefits of publicly provided outdoor recreation, should be monitored by public land managers, and by public agencies that provide the infrastructure to transport recreationists to these public lands. Without monitoring, negative environmental effects may result, the quality of the experience may be diminished, and facilities may not match the desires of the public.

approach

This project will assess travel and recreation patterns of Alaska residents, barriers to participation, desired future direction of recreation development, and attitudes and values regarding public land. Currently the survey instrument and sampling plan are being developed.

Economic impacts of the Alaska snow crab fishery

Joshua Greenberg, Hans Geier, Mark Herrmann, Chuck Hamel

purpose

The snow crab fishery in the Bering Sea Aleutian Islands is a major Alaska fishery, with the fleet of catcher boats and catcher processor boats mainly based in Kodiak, Unalaska, Dutch Harbor, Seattle, and Oregon. Our objective was to determine the economic impact of the fishery upon the communities of St. Paul, Dutch Harbor, Kodiak, and Seattle.

approach

Very intensive surveys were developed for catcher boats, catcher processor boats, shore-based processors, and floating processors. The surveys were administered to collect data for estimating the cost of operating these businesses and determining their impact on the communities of interest. IMPLAN regional economic models were developed for the communities of interest to gauge the effect of the 1999 and 2000 seasons.

progress

Two out of three regional economic models have been constructed. The econometric price model is being completed. Surveys are arriving from the various fishing and processing entities.

impact

Using this study, members of the snow crab fishery will be able to demonstrate their importance in local and state economies. In doing so, agencies and participants in the fishery can show their economic importance to the state.

Sustainable development

Hans Geier

purpose

Two community pro forma budgets are being prepared: one for an arts and crafts cooperative in the Copper River Valley, another for a furniture manufacturing business in Aniak.

approach

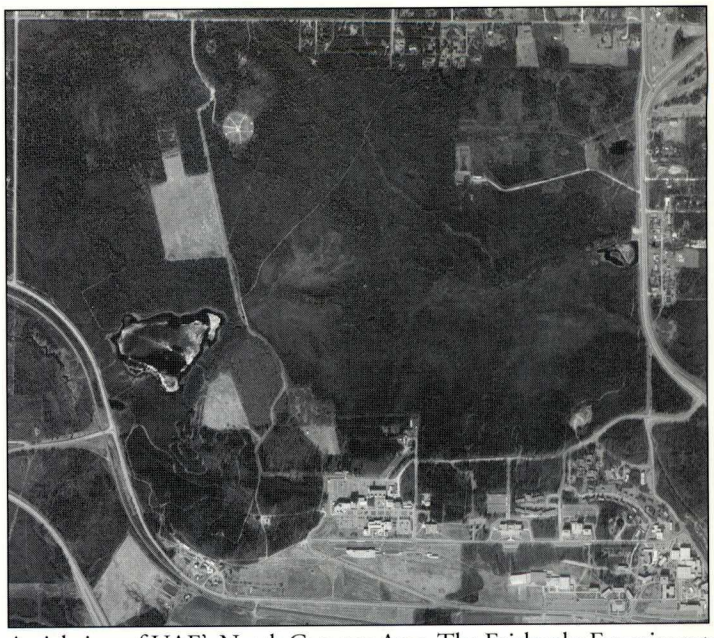
Cash flow budgets are being developed for each enterprise, using intensive community interviews and gathering data on prices of goods and shipping. The budgets will show interested parties what each enterprise will cost, and what their possible benefits will be to individuals and organizations. Potential problems will be identified.

progress

Final reports for both pro forma budgets will be published in 2003.

impact

Individuals and organizations in Aniak and the Copper River Valley may use the results of this study to decide if it is feasible for them to pursue these projects for sustainable community economic development.



Aerial view of UAF's North Campus Area. The Fairbanks Experiment Farm is visible in the lower left, below Smith Lake.

—PHOTO COURTESY PETER FIX

UAF North Campus

Peter Fix

purpose

This project assists the University of Alaska Fairbanks' (UAF) Master Planning Committee in developing a management plan to minimize conflicts among users of the UAF North Campus Area (NCA).

approach

The NCA provides valuable research, education, and recreation opportunities for the community and UAF faculty, staff, and students. Increased use of this area has resulted in increased conflicts among users. We are documenting use, assessing users' current and future needs, and developing a GIS database for this documentation.

progress

To date, focus groups with users were conducted, public meetings were held, and a GIS database documenting education, research, outreach, and recreation uses was developed.

impact

The completed management plan will help minimize conflict among users and preserve the value of the NCA for them.

Students

May 2003 Graduates

Baccalaureate Degrees

Mark Edward Adams, BA, Geography
Allegra Banducci, BS, Natural Resources Mangement: Resources
Sean Barry, BA, Geography
Tia R. Callison, BS, Natural Resources Management: Plant, Animal, and Soil Sciences
Andre Emanuel Collins, BS, Natural Resources Management: Forestry
Tara L. Collins, BS, Natural Resources Management: Plant, Animal, and Soil Sciences
Tracy Teal DeGering, BS, Geography: Environmental Studies
Marya Katherine Lewanski, BA, Geography
Adam J. Liljeblad, BS, Natural Resources Management: Resources
Tammy M. Massie, BS, Natural Resources Management: Plant, Animal, and Soil Sciences; Honors Program
David Milne, BS, Natural Resources Management: Resources
Yvette O'Connor, BS, Geography: Environmental Studies; Golden Key Honor Society
Daniel Pistor, BS, Geography: Environmental Studies
Kyle Saltzman, BA, Geography
Glenda J. Smith, BS, Natural Resources Management: Plant, Animal, and Soil Sciences; Golden Key Honor Society, cum laude
Jared Storm, BS, Geography: Environmental Studies
Nicholas A. True, BS, Natural Resources Management: Forestry
Alexander J. Wait, BS, Natural Resources Management: Forestry
Catherine Lili Webb, BS, Geography: Environmental Studies
Robert Bryan Wiskeman, BA, Geography; cum laude

Masters Degree

Susan L. Vogt, MS, Natural Resources Management

Statistics

Degrees conferred spring commencement 2003

1 master of science, 20 baccalaureates (5 bachelor of arts, 15 bachelor of science degrees)

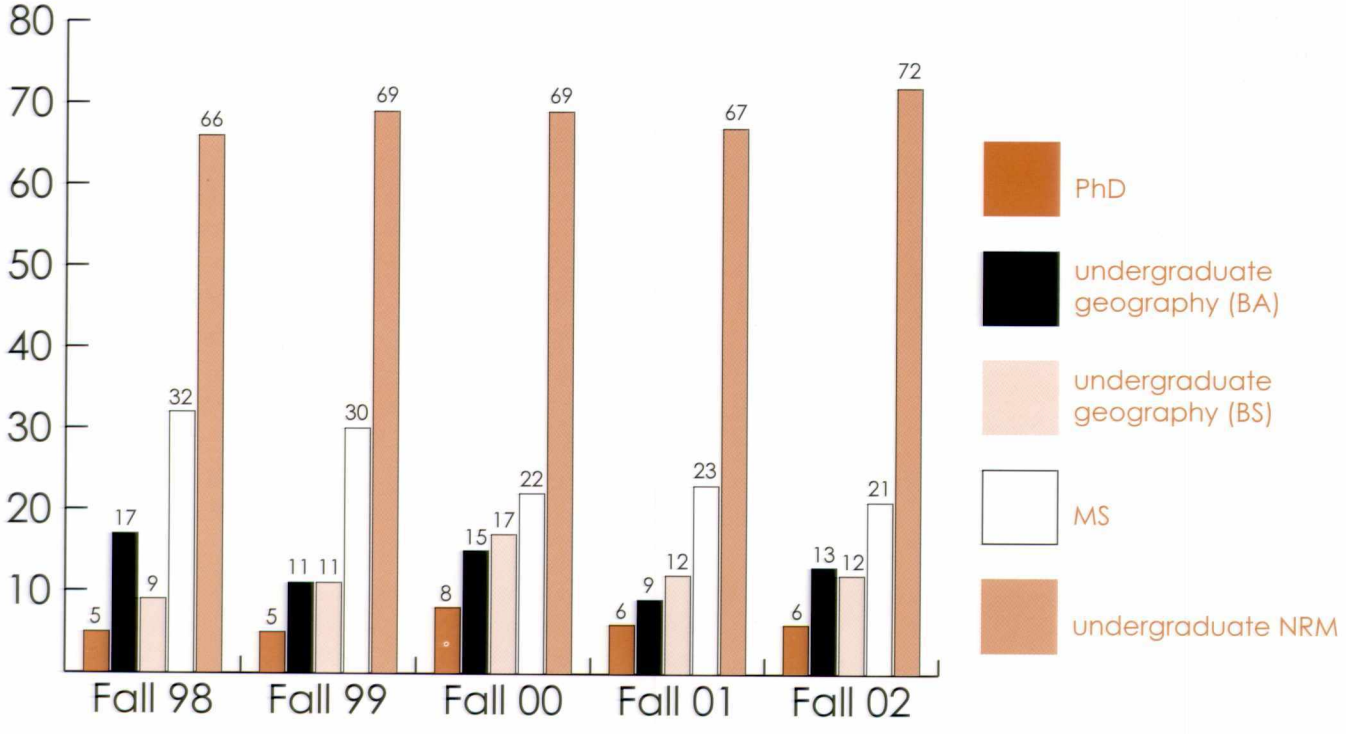
11 Natural Resources Management degrees
- 1 master of science
- 10 baccalaureates
  - 3 Forestry
  - 4 Plant, Animal, and Soil Sciences
  - 3 Resources

10 Geography degrees (baccalaureates)
- 5 Geography, BA
- 5 Environmental Studies, BS

Closing enrollment, spring 2003

BA Geography: 15
BS Geography: 13
BS Natural Resources Management: 74
MS Natural Resources Management: 22
PhD Interdisciplinary Studies: 6

Five-year enrollment history



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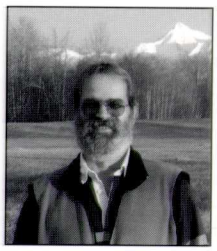

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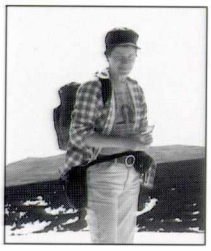

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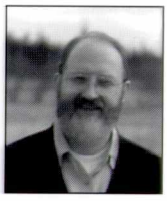

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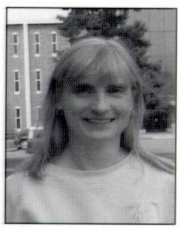

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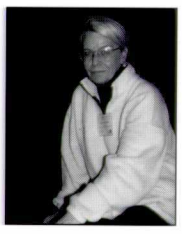

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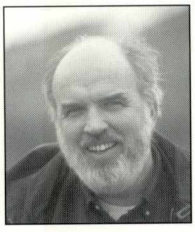

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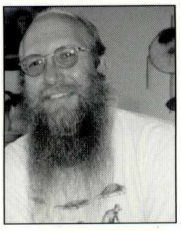
www.uaf.edu/snras/forest_sciences/faculty/rupp.html



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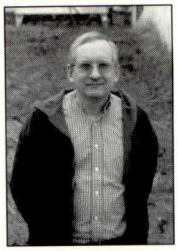

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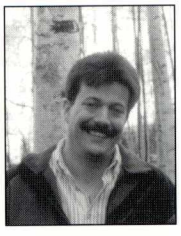

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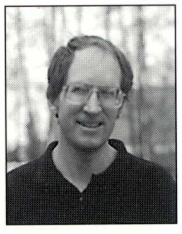

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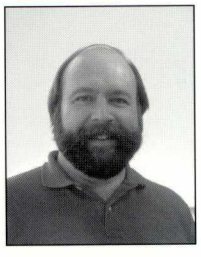

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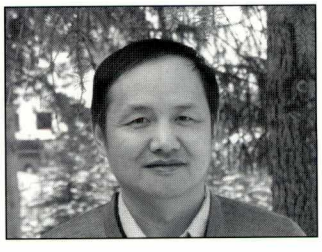

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Wild rose growing on West Ridge of the UAF campus.

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