

School of Agriculture and Land Resources Management
Agricultural and Forestry Experiment Station

Vol. 31, No. 2: The Annual Report

Fall 1999

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June 30, 1999

The Honorable Tony Knowles
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 Agriculture and Land Resources Management, University of Alaska Fairbanks, for the period ending December 31, 1998. 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 colleges 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.

Very respectfully,

A handwritten signature in dark ink, which appears to read "G. Allen Mitchell". The signature is fluid and cursive.

G. Allen Mitchell
Interim Director

AFES Statement of Purpose

The Alaska Agricultural and Forestry Experiment Station (AFES) provides new information to manage renewable resources at high latitudes, and to improve technology for enhancing the economic well-being 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 Agriculture and Land Resources Management (SALRM) 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.



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Agroborealis Contents

Vol. 31, No. 2
 ISSN: 0002-1822
 Fall 1999

Constructed wetlands for treating wastewater	4
Faculty profile	5
Research achievements	6
Faculty publications	33
FY 99 research funding	37
Achievements, activities, news	39

3

About the cover: The Chugach Mountains provide a dramatic backdrop for this Palmer-area field. The summer months in Alaska's Matanuska Valley are a time of abundant daylight and rapid crop growth.



The photos in this publication are by Neal Muirhead or are AFES file photos.

Project Profile: Using Constructed Wetlands for Treating Wastewater

by Neal Muirhead and Dave Maddux

Researcher Dave Maddux is developing a method of treating sewage wastewater that may significantly benefit rural Alaska communities. Maddux, who is working toward a Ph.D., is using constructed wetlands, seeded with plant species indigenous to Alaska, as biological filters to remove pollutants from wastewater. His goal is to develop a low-tech solution for treating wastewater that will be efficient, economical, and culturally compatible for Alaska villages.

The cells were planted and flooded in August, 1997 and by spring of 1998 the number of plants had increased considerably through recolonization. The colonization success varied from a four-fold increase to a fifteen-fold increase, which meant that more than 70 percent of the water surface was covered with vegetation after one year of growth. This is an important benefit of the design, because an effective wetland can develop from relatively few plants.



The research site for the project is an old hayfield at the Fairbanks Experimental Farm, and consists of a series of five cells, which are small rectangular ponds (6 feet by 60 feet). Four of the cells are planted with identical combinations of wetland species and one cell is an unplanted control. A pumping system moves sewage effluent through PVC pipes into the cells. The effluent comes from swine pens, part of the animal husbandry research that also takes place at the farm.

Maddux chose five wetland plant species for his ponds, selecting plants that had a known ability to remove pollutants from wastewater and were abundant in Alaska: *Typha latifolia* (cattail), *Menyanthes trifoliata* (buck-bean), *Carex rhynchocephysa* (sedge), *Scirpus latifolia* (bulrush), and *Arctophila fulva* (pendant grass). All five species occur south of the Brooks Range, and *Carex* and *Arctophila* also grow north of the range.

In June of 1998, Maddux began water quality tests of the effluent (samples were sent to an independent laboratory). The main parameters for local, state, and federal wastewater testing are Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and Fecal coliform. For most of the tests, the levels for these were below the requirement of 30 mg/L for BOD and TSS (TSS was below 10mg/L in most tests), and 200 colonies/100 ml for Fecal coliform. The main obstacle during the first year was algae—sporadic blooms occurred which adversely influenced the effectiveness of the wetland. Maddux is working on minimizing this problem during the second field season.

In general, the constructed wetland has worked well. Maddux is expecting increased plant growth during the wetland's second growing season, and with better control of the algae, seems well on his way to providing an effective and economical method of treating wastewater for rural communities in the far North.

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Research Achievements

Plant, Animal and Soil Sciences

Common plants of the Seward Peninsula

Purpose: In spring 1998, the Reindeer Research Project (RRP) designed a course to teach students the common plants and plant families of the Seward Peninsula. The course can be taught as a brief, one-credit course, or expanded to include more field, lab and classroom time.

1998 Accomplishments: The course is designed to teach students to recognize common tundra plants in areas surrounding their communities, and covers the importance of these plants as food for wildlife and humans. Plant taxonomy, botanical terminology and use of botanical keys are introduced to aid in field identification of indigenous plants. The course provides a basic knowledge of scientific terminology and keying experience to allow identification of plants students have not previously encountered. They can then continue to learn plants on their own, with the assistance of a reference book on Alaska plants, such as Hulten's "Flora of Alaska".

Impact: Some students may have been involved in reindeer handlings or in harvesting indigenous plant foods and so may already recognize useful plants. Many plants on the tundra around Nome are used by reindeer in different seasons and some have been traditionally harvested by native Inupiat Eskimos. Following the course, students are able to name, identify and harvest indigenous plants of the Seward Peninsula.

• *Maria Berger*

Disease-tested cultivar acquisition, maintenance, and evaluation

Situation: Alaska has long enjoyed a reputation as a relatively disease-free region for production of seed potatoes both for in-state and possible export markets. This project, working cooperatively with the Alaska Plant Material Center, is one of a number of efforts to ensure the maintenance of quality seed potatoes.

Purpose: The purpose of this project was the acquisition, disease testing, and propagation of desirable cultivars and distribution to cooperating growers.

1998 Accomplishments: The collection consists of 226 cultivars. Of those, 50 in vitro and 25% of field grown were tested for Potato Virus X, Y, A, S, M, and Leafroll. Additionally, the in vitro material was tested for Bacterial Ringrot. Of the total 7000 plants tested, only Leafroll and Virus S were found on four cultivars with the rest of being tested virus-free. Tested seed were supplied to eight Alaska growers and five out-of-state growers. Seed from 171 named and numbered cultivars were supplied to the Experiment Station for evaluation using standard production practices. These varieties showed no observable virus or other disease symptoms. Yield and quality data will be made available when analyses are complete.

Impact: The work will result in enhanced availability of disease-tested seed for Alaska seed potato producers.

• *Donald Carling, William Campbell, and Allen Mitchell*

Mapping the Seward Peninsula reindeer grazing system

Situation: Reindeer are allowed to range freely over the grazing lands of the Seward Peninsula. Identifying and mapping the components of the reindeer grazing system landscape is essential to understanding the processes influencing animal productivity.

Purpose: The Natural Resources Conservation Service and the Reindeer Research Program (RRP) have previously mapped the vegetation of the Seward Peninsula. However, the pattern of nutrient and energy flow from the environment to plant tissue is a dynamic process both at the species and landscape levels.

1998 Accomplishments: The RRP refined and enhanced the existing vegetation maps to reflect the seasonal changes in fiber, crude protein, macro-mineral, and micro-mineral concentrations in reindeer forage plants. The temporal changes in the chemical composition of reindeer forage plants was integrated with the species composition of ecotypes using a Geographical Information System (GIS).

Impact: Reindeer herders can use the mapping capabilities of the GIS to assess range characteristics throughout the year and move animals to areas with a high nutrient output, in order to maximize utilization of the range resources. Seasonally critical grazing areas can be identified for protection from development and overgrazing.

• *Greg Finstad*

Exclosures measure impact of caribou herd range extension

Situation: The reindeer industry has existed on the Seward Peninsula since the turn of the century. Ownership of reindeer by Native Alaskans has become important in the villages of western Alaska both culturally and economically. Reindeer herding provides one of the few remaining opportunities for the people to interact directly with the ecosystem in which they live and is commonly the most important economic industry in the smaller villages. Reindeer herding has generated millions of dollars in revenue critical to the economies of rural Alaska communities. Reindeer meat production has been stable and will remain stable indefinitely if range resources are managed for sustained yield.

Purpose: Since 1976 the Western Arctic Caribou Herd (WACH) has increased from 75,000 animals to the present day level of 485,000 animals. During this time, seasonal migratory pathways of the WACH have shifted westward from the Nulato Hills onto traditional reindeer ranges of the Seward Peninsula. In November 1996, an estimated 90,000 caribou crossed the Darby Mountains and into the Fish River Flats. Many species of plants in this area, especially lichens, have undergone little or no grazing pressure by any mammalian herbivore for some time. Now, with the range extension of the WACH and the subsequent increased grazing pressure, species composition of the plant communities are likely to alter dramatically. Traditional reindeer ranges typically undergoing light or moderate use will now suffer intense grazing and trampling by tens of thousands of caribou.

1998 Accomplishments: Two exclosures were erected in the Fish River Flats in 1998, in a collaborative effort between the Reindeer Research Program, UAF; Kawerak; the Long Term Ecological Research program, UAF; and the Bureau of Land Management. The purpose of these exclosures is to determine the impact of caribou grazing on ecosystem properties of the Fish River Flats. Data of lichen productivity, biomass removal by caribou, nutrient cycling, climate change and the revegetation of overgrazed areas are collected annually.

Impact: Monitoring the ecosystem responses to the severe increases in grazing pressure provide researchers, land managers, and reindeer herders with basic knowledge to understand and manage the effects of grazing on Arctic systems.

•Greg Finstad and Knut Kielland

Usibelli vegetation studies

Situation: Usibelli Coal Mine has funded several vegetation inventory and revegetation studies since

1985 to use the most recent knowledge and plant materials in a continuing effort to improve revegetation on their mined sites.

Purpose: A study was initiated in 1991 to evaluate growth of grass species on different growth media on windy, south-facing slopes for cover, nutrient absorption, and decomposition. An additional study was implemented in 1995 to assess the effects of fertilization for varying numbers of years.

1998 Accomplishments: The fourth year of plant cover were obtained for the fertilizer frequency study in 1998. Norcoast Bering hairgrass (*Deschampsia beringensis*), a cultivar developed at the Agricultural and Forestry Experiment Station, has maintained better cover than most other species on the once-fertilized plots. Cover of many other species has declined substantially on these plots. Alder is colonizing the seeded plots, especially the halves that were seeded and fertilized initially. Little colonization has occurred on plots that were not fertilized in the first seeding/fertilization treatment but were later reseeded and re-fertilized.

In addition to plot studies, we have also been helping Usibelli Coal Mine monitor their revegetation progress. Woody plant colonization increased substantially between 1994 and 1998.

These studies are funded by Usibelli Coal Mine, Incorporated.

•Dot Helm

Establishment of woody plants on disturbed lands

Situation/Purpose: The objectives of this study include evaluating long-term (5–10 yr.) effects of growth media or mycorrhizal inoculum on woody plant growth, and natural colonization on three mined sites. The southernmost site, a proposed coal mine near Palmer, contains woody cuttings and seedlings planted in 1989 on four growth media: three soil materials and one glacial till (overburden) material.

1998 Accomplishments: Densities of colonizing woody seedlings were counted during 1998, the 10th growing season for these plots. This summary only deals with the southernmost site.

Species composition was similar between unseeded and seeded plots after 10 years, largely because the native bluejoint reedgrass (*Calamagrostis canadensis*) and fireweed (*Epilobium angustifolium*) dominated the colonization. Woody seedling colonization was greatest on the paper birch (*Betula papyrifera*)-white spruce (*Picea glauca*) site and least on the lowland meadow site where cow parsnip (*Heracleum lanatum*) and tall fireweed out-competed the colonizing seedlings as well as some of the planted species.

Grass variety trials to evaluate species for erosion control and for low competition with woody plants were monitored for 10 years. Most grass species and mixes were barely detectable after seven years, but Nortran tufted hairgrass (*Deschampsia caespitosa*) and a mix of this grass with Arctared red fescue (*Festuca rubra*) were still visible after 10 years, although the seeded species are gradually losing vigor on those plots.

Results of this woody plant establishment and grass variety trial after 10 years showed that grasses could be used for erosion control without seriously affecting native colonization on topsoiled sites. But when rooted cuttings or seedlings of woody species were planted, the successional pathway was altered to desired woody communities within a few years, in contrast to the herbaceous communities that established otherwise.

Project funding has been received from McIntire-Stennis funds, Usibelli Coal Mine, Inc., Idemitsu Alaska, Inc., and Alaska Science and Technology Foundation.

•Dot Helm

Ecological recovery following a burn

Situation: Fire alters vegetation and microbial communities either directly or through changes in soil and environmental characteristics. Mycorrhizae are symbioses among plant species and certain fungi in which the fungi help the plant absorb nutrients and moisture from the soil, and the plant provides carbon (energy substrates) for the plant. Post-fire relations among vegetation and mycorrhizal communities depend on pre-fire conditions as well as severity of burn.

Purpose: Frostfire is a prescribed burn planned for the Caribou-Poker Creek watershed, originally in 1998 although it was postponed until 1999. Understanding the post-fire recovery will depend on documenting pre-fire plant-mycorrhizal relationships.

1998 Accomplishments: Roots were collected from hardwood (paper birch, aspen) and black spruce communities using a corer in the proposed burn site in June and August 1998 and June 1999 prior to the fire. The fire was still pending as of June 1999. The samples were divided by obvious horizons in the substrate, although this differed among the sites. Mycorrhizae are being described and the mycorrhizal communities quantified on sites prior to the burn.

G. Laursen of the Institute of Arctic Biology is collaborating with this study by collecting and identifying mushrooms prior to the burn. Some mushrooms are the fruiting bodies of the mycorrhizae.

This study is funded by the National Science Foundation.

•Dot Helm

Transgenic potatoes and their enhanced resistance to soft rot disease.

1998 Accomplishments: Plant promoter phenylalanine ammonia-lyase (PAL) from *Arabidopsis* and proteinase inhibitor II (PiII) from potato were used to construct chimeric gene cassettes consisting of PAL-Secretory signal-MB39 (PAL-S-M) and pYH145 containing PiII-S-M. For selection of the transformed potato lines, kanamycin and hygromycin were used as selective mark genes for pYH145 and pYH105, respectively.

Potato variety Russet Burbank was first transformed with pYH105 by *Agrobacterium* mediated transformation. After screening 30 different transgenic lines by inoculation with *Erwinia carotovora* pv *carotovora*, the one line that gave the highest level of resistance was selected and further transformed with pYH145. The double transformed plant lines were evaluated with soft rot pathogen at concentrations of 10^5 , 10^6 , 10^{10} cfu/ml and showed enhanced disease resistance to this pathogen.

•Yong Huang and Jenifer H. McBeath

Off-season raspberry production

Situation: Raspberries are a high-value crop with seasonal availability. During the winter months, fresh raspberries are flown in from production areas in the Southern Hemisphere. Raspberries are extremely perishable and easily damaged during transport. As a result, the quality is often poor. High-quality raspberries can potentially be locally grown in greenhouses during the winter months. Earlier attempts to produce winter raspberries have usually failed due to inadequate pollination and pest control. Today bumblebee hives are commercially available and bumblebees are even more efficient pollinators for raspberries than honeybees.

Purpose: Opportunities to produce raspberries in Alaska during the winter months are being evaluated. Earlier research at Cornell University identified the variety 'Tulameen' as most suitable for greenhouse production.

1998 Accomplishments: Among several greenhouse grown varieties, 'Tulameen' was most productive with the highest rated fruit flavor and quality. Plants of 'Tulameen' were planted in 3-gallon pots in early June and grown outdoors during the summer. When the plants had dropped their leaves, they were placed in a cooler at approximately 40°F. Plants were brought into the greenhouse at various times from

five to ten weeks of cooling. The greenhouse was kept at 60°F and lighted for 16 hours each day. Bumblebees were used for pollination. All plants produced high-quality raspberries within 12 to 15 weeks in the greenhouse.

Impact: Biological control agents have evolved as safe alternatives to pesticides for greenhouse food crops.

•Meriam Karlsson and Jeffrey Werner

Flowering of German primrose

Situation: The production of German primrose (*Primula obconica* Hance.) is increasing. The primary reason for the renewed interest is the significantly decreased risk for allergic skin rash problems with newer varieties. The plants with flowers in soft pastel colors are popular as focal points in color bowls or as flowering potted plants.

Purpose: Although German primrose has been produced for many years, there is no available information on day length requirements for flower formation.

1998 Accomplishments: The rate of flower initiation and development was determined at short days (8 hours) or long days (16 hours). The effects of day length were studied at 60°F and the recommended 68°F for production. In addition, plants were moved within each temperature from one day length to the other at weekly intervals. The moved plants remained at the second day length until flowering.

Long days resulted in faster appearance of flower buds and flowering than short days. Flower bud formation under long days occurred at a similar rate although flowering was significantly faster at 68°F than 60°F. The initiated flower buds failed to develop into flowers under continuous short days at 68°F. Two weeks of long days at the plant stage of five to six leaves were sufficient to limit the delay caused by short days at 68°F.

Impact: German primrose appears to be day neutral with respect to flowering at temperatures below 60°F and a long day plant at higher temperatures.

•Meriam Karlsson and Jeffrey Werner

Flowering in fairy primrose

Situation: The fairy primrose (*Primula malacoides* Franch.) has been grown for many years as a flowering potted plant. Recommended growing conditions are similar to those used for English primrose (*Primula acaulis* L.).

Purpose: Several studies have examined temperature requirements while the information on day length is limited for the newer varieties.

1998 Accomplishments: Plants of Fairy primrose were grown at short (8 hours) or long (16 hours)

days. Flower buds first appeared 80 days from seeding at 60°F and after 100 days at 68°F independent of day length. Less time was required for the continued development to open flowers at long compared to short days. Fastest flowering (110 days) was observed at long days and 60°F. Short days delayed flowering five or six days. At 68°F, open flowers were recorded 120 days from seeding with long days and 138 days with short days. For plants shifted to the second day length, flowering was gradually faster with longer exposure to long days while short days delayed flowering.

•Meriam Karlsson and Jeffrey Werner

Improved lettuce transplant quality

Situation: High-quality transplants are essential for the local vegetable industry.

Purpose: A good transplant should be compact with good root development. Various types of flats, growing media, and methods were evaluated in efforts to identify techniques that consistently produce lettuce seedlings suitable for transplant and high yields.

1998 Accomplishments: The germination rate was higher and the growth more uniform for lettuce seedlings grown in the peat-based medium Premier Pro-Mix BX covered with a thin layer of perlite, as compared to seedlings grown in the medium with no covering. The length of the stem between the roots and the first developing leaves (hypocotyl) is an important characteristic for transplant quality. For the lettuce transplants grown with a layer of perlite, the hypocotyl also grew shorter.

Amount and frequency of irrigation are other considerations in transplant production. Lettuce seedlings grown in Pro-Mix, Pro-Mix covered with perlite, or a medium consisting of coconut coir were irrigated either once or four times each day. The hypocotyl grew longer with less frequent watering of Pro-Mix and Pro-Mix covered with perlite. There was no difference in hypocotyl length for the seedlings grown in coconut coir. The length of the roots increased with more frequent watering in all media.

•Meriam Karlsson and Jeffrey Werner

Irrigated and dryland variety trials for small grain and oilseed crops

Situation: Spring grains, principally barley and oats, combined with grass hay constitute a majority of the feed base for domestic livestock in interior Alaska.

Purpose: Following several years of moisture deficit, Alaska farmers have shown increased interest in irrigating grain crops. Little information is available on crop response to irrigation in interior Alaska.

1998 Accomplishments: In 1998, varieties of spring grains and oilseed from Alaska, Canada, Sweden, Norway and Finland were evaluated at three locations: Fairbanks, North Pole, and Delta Junction, Alaska. At the Delta Junction site, trials were replicated under both dryland and irrigated conditions. Spring soil conditions were dry at all locations and irrigation essentially doubled yields of all crops at the Delta Junction site. Considering the best variety of each crop, average yields (lb/acre) under irrigation vs. dryland were: feed barley (4464 vs. 2362), malting barley (4444 vs. 1936), wheat (2904 vs. 552), oats (3731 vs. 1997), and canola (2350 vs. 1050). Response to irrigation will need to be evaluated for several years to determine if irrigation is economically feasible for grains in this area.

Impact: We are continually evaluating early maturing varieties of small grains and alternative crops from other northern areas for improvements in yield, disease resistance, and adaptation to our short growing season.

• Charles Knight

Constructed wetlands

Situation: In more southern climates, constructed wetlands are commonly used as biofilters for cleaning up wastewater before it is released into natural waterways.

Purpose: Constructed wetlands require little maintenance and are very effective for runoff from parking lots and other urban areas, as well as for a final treatment of municipal sewage effluent. However, no information is available on the types of vegetation that might be used in northern constructed wetlands nor on their effectiveness in tolerating contaminants or cleaning them from the wastewater.

1998 Accomplishments: We have conducted greenhouse studies to evaluate five different genera of plants indigenous to Alaska: *Typha latifolia*, *Menyanthes trifoliata*, *Carex rhynchophylla*, *Scirpus latifolia* and *Arctophila fulva*. The plants were watered with solutions contaminated with cadmium, copper, lead and zinc. Plant tolerance to each metal was evaluated, and the plants were harvested and plant parts are being analyzed for accumulation of metals. Also, an experimental wetland has been constructed using these plant genera. Wastewater effluent from a swine waste lagoon on the Fairbanks Experiment Farm is being circulated through the constructed wetland and water quality is being monitored before and after treatment.

Impact: This research should be finished in 1999 and the results should be valuable for wastewater treatment in rural villages and remote mines.

• Charles Knight and David Maddux

Comparing tillage methods

Situation: Winter precipitation usually provides good springtime reserves of soil moisture in interior Alaska. Conservation of that moisture is important for both meeting the needs of summer crops and reducing the wind erosion potential of our silty soils.

Purpose: Too much tillage dries out the soil resulting in reduced crop yields and increased soil erodibility. However, too little tillage often results in an infestation of perennial grassy weeds that cannot be controlled with herbicides. Farmers often bale the straw from grain fields and sell the straw for livestock feed and bedding. Straw removal decreases snow capture during the winter and increases evaporative losses during the summer. However, it also reduces the immobilization of nutrients in the soil and reduces fertilizer requirements for the following crop.

1998 Accomplishments: A study comparing tillage methods, straw removal treatments, and N fertilization rates was conducted on continuous barley near Delta Junction since 1983. To date, straw removal has had no measurable effect on soil properties. However, high rates of tillage have caused a slight reduction in soil organic matter content.

Impact: For continuous cropping of dryland barley, current recommendations are to apply 65 to 70 lb fertilizer N per acre; plant using no-tillage unless perennial weeds are a problem, then disk once prior to planting, and leave the standing portion of the crop residues in the field over winter to trap snow.

• Charles Knight and Stephen Sparrow

Evaluation of lettuce varieties for disease resistance.

Situation: Tip burn, a physiological disease caused by calcium deficiency, is one of the most important diseases on lettuce in Alaska. The rapid growth of lettuce due to the extremely long day length during the growing season makes lettuce particularly prone to this disease. Basal rot caused by *Sclerotinia sclerotiorum* and grey mold caused by *Botrytis cinerea* can also be very severe under certain environmental conditions.

Purpose: Damage to lettuce production caused by these diseases has resulted in great economic losses to lettuce farmers each year. Treatments such as applications of calcium in the soil or top dressing were all found to be ineffective.

1998 Accomplishments: A lettuce variety trial was initiated in 1991, in collaboration with Ms. P.

Giaugue (lettuce farmer in Palmer) and Mr. P. Sorreal (lettuce breeder, Harris Moran Co.). In Palmer, 84 lettuce varieties and breeding lines were evaluated in early- and mid-July. Approximately 50 seedlings were planted for each lettuce line. Disease occurrence of tip burn on lettuce was fairly severe. Several varieties and breeding lines were found to possess fairly good resistance to the disease. Infestation of *B. cinerea* and *S. sclerotiorum* was very mild. A few lettuce heads displaying mosaic type symptoms were noticed.

•Jenifer H. McBeath

Using *Trichoderma atroviride* to control *Sclerotinia sclerotiorum*

Situation: *Sclerotinia* stem rot, caused by *S. sclerotiorum*, is one of the most serious diseases on many garden flowers in high latitude regions. This disease is especially devastating on petunia (*Petunia* spp.), one of the most popular garden flowers in Alaska. In many cases, this disease is so severe that it makes the cultivation of petunias impossible.

Purpose: Control of this disease is extremely difficult. Only systemic fungicides, e.g. Topsin M, showed some effects. All of the popular cultivars are extremely susceptible to the disease.

1998 Accomplishments: Results of dual cultures and other laboratory tests indicated that *Trichoderma atroviride* is an effective hyperparasite of *S. sclerotiorum*. The hyphae of *T. atroviride* penetrate the hyphae of *S. sclerotiorum* and cause lysis and death of the pathogen.

Greenhouse trials were conducted in 1996 and 1997. Seven four-week-old petunia seedlings were transplanted to each tray containing potting mix of various treatments. To ensure that the population of *S. sclerotiorum* in the potting mix was sufficient for the establishment of the disease, the potting mix was amended with high doses of *S. sclerotiorum* inoculum and incubated for seven days. Treatments of *T. atroviride* and Topsin M were applied to the potting mix at the time of transplanting. These experiments were repeated three times. No diseased petunia plants were found in any of the treatments (including the blank and *S. sclerotiorum* controls). Plants remained healthy in all of the trials conducted.

The association of *T. atroviride* with the tissues of petunia were studied. Except for the Topsin M treatment, *T. atroviride* was found on and in the root and stem tissues of petunia plants in all treatments, including the blank control and *S. sclerotiorum* control. This result explained why no diseased plants were found in these treatments.

Impact: The finding of *T. atroviride* present inside the petunia stem tissues indicates that *T. atroviride*

is capable of providing more than topical protections against *S. sclerotiorum*.

•Jenifer H. McBeath, Xizhi Dou and Young Ha

Effects of *Trichoderma atroviride* on *Phytophthora capsici* on pepper

Situation: Peppers, both sweet and chili, are important crops in the United States. One of the most devastating pest problems on peppers under irrigation is *Phytophthora* blight and root rot, caused by *P. capsici*. There is no effective control of this disease; to compensate for the anticipated losses, producers are forced to increase acreage of cultivation.

Purpose: *Trichoderma atroviride* is a fungus found in Alaska that is capable of parasitizing a wide range of plant pathogenic fungi. The fungal host range includes *Phytophthora infestans* (causal agent of late blight of potatoes and tomatoes), *Phytophthora cactorum* (causal agent of ginseng, apples), etc.

1998 Accomplishments: Results of dual culture and other laboratory tests indicated that *T. atroviride* is an effective hyperparasite of *P. capsici*. At the macroscopic level, the expansion of the *P. capsici* colony was arrested upon contact with the mycelia of *T. atroviride*. As the mycoparasitism progressed, the entire *P. capsici* colony was destroyed by the *T. atroviride*. The hyphae of *T. atroviride* were observed microscopically to penetrate the hyphae of *P. capsici*. Lysis of the vegetative hyphae of the pathogen was observed. No sporangia and zoospores were found.

Efficacy studies of *T. atroviride* on *Phytophthora* blight and root rot disease on chili peppers were conducted at 28°C, a condition favorable to the development of disease. Results of the efficacy studies indicated that chili peppers treated with *T. atroviride* at different dosages have significantly lower rates of mortality than the non-treated control. Furthermore, *T. atroviride*-treated plants were more advanced in their development than the control. The size of cotyledon, date of true leaf emergence, size of the true leaves, and number of true leaves per plant were found to correlate directly with the dosages of *T. atroviride* applied.

Impact: The findings strongly suggest that *T. atroviride* is an aggressive, effective biological control agent of *P. capsici*.

•Jenifer H. McBeath and Young Ha

Affects of *Trichoderma atroviride* on *Phytophthora infestans*

Situation: *Phytophthora infestans* is an extremely aggressive plant pathogen. It has a temperature range of 4°C–26°C. Under high relative humidity

conditions, *P. infestans* can cause severe late blight disease on potato plants and result in heavy economic losses.

Purpose: Presently, management of late blight disease relies primarily on chemicals. Because none of the fungicides is curative, to achieve control, complete and repeated coverage of foliage with fungicide is needed prior to disease pressure. This practice is costly economically and environmentally. Furthermore, increasing evidence indicates that diseased seed tubers or pre-cut seed pieces play a significant role in the dissemination of *P. infestans*. None of the fungicide treatments appeared to be effective in reducing tuber rot in storage or late blight spread in pre-cut seed pieces.

1998 Accomplishments: *Trichoderma atroviride*, *T. harzianum*, *T. viride* and *Gliocladium virens* have been found capable of parasitizing *P. infestans*. Among the hyperparasites, *T. atroviride*, with a temperature range of 4°C–33°C, seemed to be most effective. Studies on the application of *T. atroviride* showed mixed results. In studies of *T. atroviride*'s efficacy in controlling *P. infestans* under field conditions, no significant differences were found between it and the control. The failure might be the result of interference of saprophytic bacteria with the germination of conidia of *T. atroviride* on leaf surfaces.

Impact: *T. atroviride* showed promise in providing protection to potato tubers under storage and to pre-cut seed pieces. In these studies, *T. atroviride* treatment reduced the incidences of *P. infestans* infestation significantly.

•Jenifer H. McBeath and Young Ha

Development of premium-quality Alaska seed potatoes

Situation: Geographic isolation and harsh winters provide Alaska an environment relatively free of diseases and pests. In Alaska, contaminated seed potatoes are the primary source of virus, bacterial ring rot, and late blight disease.

Purpose: The objectives of this project are to identify the sources of disease by conducting field disease surveys and lab tests and by assisting producers in their efforts to produce premium-quality seed potatoes.

1998 Accomplishments: In the summer of 1998, more than 100,000 data points were collected from seed lots of 11 farms. We found seven farms completely free of the six virus diseases tested: potato virus X (PVX), potato virus Y (PVY), potato virus A (PVA), potato virus M (PVM), potato virus S (PVS), and potato leaf roll virus (PLRV).

Potato plants displaying symptom characteristics of late blight disease were found on two farms in Palmer during one of the routine disease survey and

plant sampling activities conducted in mid-August, 1998. At the time of discovery, this disease was not found in any seed lots originating from Alaska although some of them were planted in adjacent lots. Late blight was not found in Delta, Nenana, Fairbanks, Talkeetna, or any other part of the State.

Bacterial ring rot (BRR) was found on several seed lots in one farm in Palmer. A high percentage of PVS was also found in these seed lots. On this farm, BRR was also found at a very low rate of contamination in two seed lots originating from Alaska which were lab-tested free of BRR in previous years. BRR was not found in any other farms tested.

In another potato farm in Palmer, plants displaying typical symptoms of aster yellow disease were found. This disease had never been found in the State of Alaska previously. Aster yellow can be transmitted through contaminated seed tubers.

Another objective of this project is to evaluate the performance of Alaska seed potatoes grown under Taiwan's environmental conditions. In field trials conducted at four locations in Taiwan, seed potatoes from Alaska consistently outperformed seed potatoes (same variety) produced locally. Alaska seed potatoes also appeared to possess stronger resistance to diseases.

Impact: By incorporating this information in their management, many potato producers have been able to produce seed potatoes free of viruses, bacterial ring rot and late blight diseases. This project is sponsored by the State of Alaska as a part of the Produce Certification Program.

•Jenifer H. McBeath, Aining Shi and Young Ha

Dairy research at northern latitudes

Situation: This is the first year of a three-year multidiscipline dairy project.

Purpose: This project is designed to document a broad range of production inputs that include best management practices for land application of dairy waste, production of adapted forage and feed crop varieties, alternative feeds for dairy calf nutrition, and to transfer resulting technology to users.

1998 Accomplishments: The dairy waste trials are being carried out at the Palmer Research Center and forages trials at the Point MacKenzie and Delta Junction research sites. Dairy waste trials included variables of rate, time, and method of application of manure on both perennial and annual forages. Comparisons are being made with commercial fertilizers and crop requirements to determine nutrient release, availability, and fate in the soil, and application practices that will meet crop needs but minimize chances of nutrient leaching and runoff. The potential of perennial and annual forage legumes is being evaluated under conditions where dairy farms are currently located in interior and

southcentral Alaska. Technology transfer will be initiated in the fall of 1999.

Impact: Since project research will be relatively preliminary, initial outreach efforts will focus on previous research in Alaska and information from sources outside the state.

• *Allen Mitchell, Ray Gavlak, Charles Knight, and Stephen Sparrow*

Applied radiotelemetry with reindeer on the Seward Peninsula

Purpose: Locating reindeer allows for monitoring dispersal activities under the influence of the Western Arctic Caribou Herd.

1998 Accomplishments: Deployment of radio collars was continued with the Seward Peninsula reindeer. Locations provided two primary functions. First, seasonal patterns of movement continued to be monitored establishing a greater probability of finding reindeer without telemetry in the future. Second, locating reindeer provided information on habitat selection and the opportunity to sample preferred reindeer forage for an ongoing range utilization project.

Impact: This information allows for direct management of the reindeer and developing strategies for management of range use.

• *Todd Nichols*

Reindeer feeding trials

Purpose: There are concerns about the efficiency, in regards to economics and growth rate, of diets formulated with "high" levels of forage which reindeer cannot completely consume.

1998 Accomplishments: From December 1997 to April 1998, 20 female calves were individually penned for two trials comparing the intake between varying percentages of brome hay and alfalfa as formulated in our base diet (14% crude protein-rolled barley with soybean meal and beat pulp). Varying levels of either forage type did not influence dry matter intake (DMI) significantly. This indicates that up to 30% forage (the highest level used in both diets) could be used in formulating reindeer diets. However, by volume, we observed proportionate amounts of course forage material with the refused feed. This is consistent with the known pattern of preference for hay, either long stem or chopped.

From May through July different concentrations of calcium were incorporated into diets (with four groups rather than individually) to monitor effect on antler growth. There was no significant difference in weight or scoring measurement of antlers among the groups. From July to October the four groups were retained to evaluate the diet formulated with two

different protein sources and two levels of crude protein (CP) for each (fish meal and soybean meal, each with 14% and 18% CP). Although the observed weight gain was greater with both 14% sources, there was no significant difference between the groups. Variance in DMI and weight gain may have been confounded with time (season), being penned versus group feeding (greater DMI variance and weight gain in group situations), stress before and after arrival at the farm, and small sample size. Currently, the 14% fish meal diet (10% forage) is used in lieu of the original base diet (consisting of 16% forage) for maintenance.

Impact: The common winter plateau in growth rate, and sometimes weight loss, is observed regardless of a consistent ad-lib supply of a balanced diet.

• *Todd Nichols*

Production and harvest of quality forage at northern latitudes

Situation: Production of forage for hay or silage in the subarctic is difficult both in establishment and harvest. Growing seasons are short and cool and harvest periods generally tend to be wet.

Purpose: We are investigating a range of practices including tillage requirements for establishment, harvest timing, drying agents, and appropriate sampling procedures for quality analyses.

1998 Accomplishments: In 1998, sufficient moisture was available early in the season; however, cold soil temperatures limited growth and drying conditions were unfavorable for optimum yield and quality. Among the observations made was a positive response of annual legumes to residual nitrogen. Timothy did best when planted with Lana vetch as a companion crop, producing 2.2 tons/acre, compared to 0.9 tons/acre with forage rape as a companion crop. Overall in 1998, timothy did not perform as well as brome grass and reed canarygrass although some Norwegian varieties showed promise. No-till clovers, particularly red clover, yielded as high as 4.8 tons/acre. In 1999 a companion-cropping system using high-yielding reed canarygrass and red clover will be tested.

Impact: Anticipated success of this system could almost double the hay/silage yields dairy farmers currently get at Point MacKenzie and significantly reduce off-farm feed costs.

• *Michael Panciera, Ray Gavlak, and Beth Tillman*

Wet soils monitoring and hydric soils study in Alaska

Situation: Baseline data in Alaska is needed to assess the impact of global/regional climate changes on soil properties and to establish relationships

between soil morphological properties and hydric soils criteria for wetland classification/delineation.

Purpose: We are monitoring soils across Alaska to establish baseline data. Research data indicated that both microbial and plant activity occur at temperatures at or below freezing. It has been the conventional belief that biological activity ceased at 5°C, thus 5°C was considered as the "biological zero". In Alaska and other regions with soil temperatures colder than cryic, the biological zero is set at 0°C.

1998 Accomplishments: Soil temperature and moisture probes were set up to monitor the active layer dynamics within two meters. Permafrost temperatures were also monitored in the deep boreholes (60 to 80 m) at the North Slope and Brooks Range sites. One of the findings is that the permafrost table fluctuates from year to year in response to ambient temperature and the depth and thermal properties of snow. This presents problems for the newly-adopted Gelisol order in Soil Taxonomy (for soils affected by permafrost) if the permafrost table fluctuates in and out of the control section. Even under perennially frozen conditions, soil temperatures in the upper permafrost fluctuate more than five degrees from year to year. There is considerable unfrozen water even when the soil temperature drops well below freezing point. This unfrozen water is believed to support microbial activities in the permafrost. Monitoring data from Douglas Island indicated that there are two aquifers that control the hydrological cycles in soils along the hill slopes: a surface water table and a confined water table.

Impact: Based on data collected in arctic and subarctic Alaska, the national hydric soils definition was revised regarding permafrost affected soils.

This project is supported through the Global Change Initiative program of the USDA-NRCS National Soil Survey Center (NSSC) and is in cooperation with USDA-NRCS Alaska State Office, Geophysical Institute of the University of Alaska Fairbanks, USDA Forest Service Region 10, and the Forest Science Laboratory in Juneau.

•Chien-Lu Ping

Winter carbon flux in arctic tundra

Purpose: We are characterizing the soils of the winter carbon flux study sites and relating the winter CO₂ flux to soil organic matter (SOM) composition.

1998 Accomplishments: A total of 180 soil profile samples from study sites at Barrow (Flux tower site), Atqasak (Flux tower and Walker vegetation plot sites) and Tbolik flux site (near Toolik LTER) were collected in the summer and fall of 1998. All samples were analyzed for water content, bulk density, coarse fragments, organic matter, carbon, nitrogen, and carbon storage parameters. Data was

transferred to the NISDC data bank. Work on complete physical and chemical analyses for all samples is currently in progress.

Preliminary data indicates there are significant differences in SOM quantity and quality at the Barrow and the Atqasak Flux sites. Quantity of carbon stored at the Atqasak site was generally higher than found at the Barrow site. Carbon stocks (to 60 cm) for the Atqasak site ranged from 17 to 48 kgCm⁻² depending on the position on the frost polygons. The 60 cm C-stocks at the Barrow tower site are more uniform and averaged 27 kgCm⁻². Quality analysis of extractable SOM revealed that the stocks of active fraction SOM for the soils of the two locations mirrored the total C stocks, with 33% more active hydrophilic fractions in Atqasak soils than in Barrow soils. The lower active layer stocks of interest for winter flux activity were also higher for Atqasak compared to Barrow (28% higher).

Low temperature incubation trials are currently underway using soils collected from the ATLAS study sites of Barrow and Atqasak along with a soil of the Toolik (soil and winter flux monitoring, and LTER) site, all collected during the 1998 field season. The incubation-respiration trials are designed to investigate soils from the lower active layer of the soil profile (18-55 cm) where the cold-season conditions are most favorable for respiratory activity. Treatments are temperature (5, 0, -5 and -10 °C), moisture content (field moist, and 125% field moist) and dissolved organic carbon (DOC) added (at 125% field moist levels). Results from the first two weeks of monitoring CO₂ respiration activity indicate a consistent depression in activity with temperature, and a strong interaction between soils and response of respiration to moisture and DOC additions. Respiration is detected at all temperatures for all soils although rates are depressed with falling temperature. Preliminary data indicates that DOC has positive effect on soil respiration at the -5° and -2°C temperatures.

This study was funded by the National Science Foundation Arctic System Science program.

•Chien-Lu Ping and Gary Michaelson

Characterization and bioavailability of soil organic matter in tundra soils.

Situation: With global warming, the tundra soils may have a greater potential to contribute to greenhouse-gas emissions and could become the net source of greenhouse gases.

Purpose: The quality and quantity of soil organic carbon (SOC) and their relationships to gas fluxes in the arctic ecosystem is being assessed.

1998 Accomplishments: Carbon store was calculated from carbon (C) contents and bulk density

of each soil horizon. The quality of soil organic matter (SOM) was assessed by SOC fractionation according to the tandem XAD resin techniques after extraction by alkaline solution. Carbon stores were found to range from 16 to 94 kgC/m³ with average values of 62 kgC/m³ on the coastal plain and 44 kgC/m³ in arctic foothills. The C stores were evenly divided between the active layer and upper permafrost. Stores were more than double those previously reported for arctic soils. The alkali solubility of SOM was generally less than 20% in the organic and 30% in the mineral horizons which is indicative of the relatively low degree of decomposition of SOC. The dominant fraction of the soluble SOC was humic acids (HA), followed by fulvic acids (FA), hydrophilic neutrals (HPO), low molecular-weight acids (LWA) and hydrophobic neutrals (HIN). Hemicellulose dominated the insoluble SOC.

Bioavailability of different SOC fraction was assessed by respiration which showed the order of: HIN > HPO > LMA > FA > HA. Evaluations of dissolved organic C in spring-thaw soil runoff showed a similar trend. In the extractable organic fractions from an organic soils on the Arctic Coastal Plain, the neutrals (LMN, HIN and HON) were the most bioreactive fractions which represent 25% of the total extractable C. However, they account for 77% of the CO₂ evolution of the total extractable fraction, whereas, humic and fulvic acids are the most stable fractions. They account for 64% of the total extractable C, but contributed 7% of the CO₂ evolution of the total extractable fraction. LMA is in between with 11% of the total extractable C and 10% of the CO₂. Hence, in the extractable fraction, neutrals are the most important contributors to the changable pool. This agrees with the previous postulation based on chemical composition.

This study was funded by the National Science Foundation Arctic System Science program.

•Chien-Lu Ping, Gary Michaelson and Xiaoyan Dai

Stream water quality and primary productivity in Rock Creek watershed

Purpose: We are relating soil biogeochemical equilibrium to soil hydrology and soil water chemical composition and in turn, relating the stream water quality to primary productivity.

1998 Accomplishments: Soil saturation and reduced conditions were confirmed at the Permafrost, Meadow, and Willow sites, indicating the presence of hydric soils. The dominance of hydrophilic vegetation classifies these riparian units as wetlands. Hydric soils are the highest producers of DOC and nutrients within the watershed. Soils of the Meadow and Permafrost sites contribute higher amounts of soil water chemical constituents to the

stream water than those of the Alder and Willow sites. Higher input rates of DOC (Permafrost site) and nitrate (Meadow site) to stream water from the soil water results from soil conditions that foster increased rates of biogeochemical reactions. Despite the low proportion of soil water contributions to the stream water chemistry, temporal variations in stream water chemistry agree with temporal variations in soil water chemistry, suggesting a connection between the two. However, these temporal variations in soil and stream water chemistry do not correlate in a significant manner, likely due to the scale of the soil water sampling sites in relation to the area of the entire Rock Creek watershed. Low periphyton biomass levels and low diversity and density values for secondary productivity indicate that the Rock Creek system is limited by some factor. The undetectable phosphorus levels in the stream water correlates well with the limiting nutrient findings in this study, indicating that phosphorus is the limiting nutrient to aquatic productivity.

Impact: Correlations among both chemical and physical measures of stream ecological variables show that physical factors such as organic matter retention, stream discharge, and channel morphology are more significant in acting to limit the secondary productivity of Rock Creek.

This project is funded by the USDI Geological Survey-National Biological Research and is in cooperation with the Denali National Park and Preserve and the USDA-NRCS Alaska State office.

•Chien-Lu Ping, Alexander Milner, and Lisa Popovics

Data collection for reindeer handlings

Situation: Reindeer in western Alaska are rounded up either once or twice a year for antler harvest, vaccinations, etc. The Reindeer Research Program (RRP) personnel attend handlings and record data for herd monitoring and a variety of program projects. Data for some herds extends back to 1984 providing a valuable long-term database. During handlings, reindeer are processed individually, and RRP personnel record the ear-tag number, vaccinations, any treatments administered, any abnormalities, reproductive status, antler weight, and when possible body weight.

Purpose: Collecting high-quality data is necessary for research projects as well as to give herders accurate information. However, severe time constraints and adverse weather make data collection difficult. Uses for this information have included monitoring changes in body weight, antler weight, demographics, and reproductive rates, as well as estimating survival rates, assessing the effect of various treatments, and modeling growth rates.

1998 Accomplishments: We tested the use of

laptop computers to improve the quality and quantity of data collected, and to make the data instantly available to herders for making management decisions during handlings. During the 1998 winter handlings we entered the data directly into a laptop computer with a customized Lotus Approach database program.

Impact: Two herders were given copies of their herd records and taught to use the computer program. The computer entry worked well even under adverse weather conditions. Herders were able to get information on individuals while animals were still in the chute allowing them to decide which animals to harvest and castrate.

•Alex Prichard and Greg Finstad

16

Modeling production and income of reindeer herds

Situation: Free-range reindeer in western Alaska are managed for both antler and meat production. Optimum management should maximize the income generated from both meat and antler production while managing the herd at levels below the carrying capacity of the range.

Purpose: Meat harvest precludes future antler production, therefore harvest decisions should reflect antler and body growth rates, current antler and meat prices, natural survival rates, and population demographics.

1998 Accomplishments: We created a user-friendly computer model to generate estimates of production and gross income under different harvest levels and market conditions. Input variables include sex-specific and age-specific survival rates, harvest levels, antler weights, body weights and recapture rates, as well as reproductive rates, antler price and meat price.

We used estimates of parameters based on current research to model population growth. Mark-Recapture analysis was used to estimate survival rates. The model was calibrated using reindeer herd records from 1984–1997. Output includes changes in herd size and composition, meat production, antler production, and predicted income over a thirty-year period. This allows users to see the long-term effects of management decisions on the population and income levels. It also allows various management plans to be evaluated and compared.

Impact: Parts of this model were used to develop and review a business plan for a potential reindeer herder in Inuvik, Yukon Territories. The model clearly demonstrates the importance of adult female survival on herd size and income levels. In order to maximize herd growth, herders should maximize adult female survival.

•Alex Prichard and Greg Finstad

Life history consequences of early reproduction in Alaska reindeer

Situation: The Seward Peninsula contains excellent reindeer forage leading to heavy birth weights and rapid summer weight gain in calves. These unusually large female calves frequently breed their first fall and give birth as yearlings (12 months). In other reindeer herds this early reproduction has led to negative effects such as decreased future weight gain and reproduction.

Purpose: During 1998 we used the Reindeer Program long-term database to gain valuable insight into the life history costs of reproduction in female reindeer and to explore the role of nutrition on population dynamics.

1998 Accomplishments: We analyzed reindeer data collected on the Seward Peninsula between 1987 and 1997 to determine what effect calving as yearlings had on future weight gain, reproductive rates, and survival. Reindeer were rounded up during June and early July. Individual ear tag numbers were recorded, females were visually inspected for the presence of a distended udder, and some animals were weighed. Females with distended udders as yearlings had subsequent recapture rates, survival rates, weight gain, and future reproductive success comparable ($P > 0.10$) to females that did not have distended udders as yearlings. Females apparently had adequate nutrition to meet the high costs of growth and reproduction with no negative long-term effects.

Impact: These findings suggest that the beneficial effects of increased calf weight gain outweigh potential negative effects of early reproduction in these reindeer. This may be due to high-quality range leading to heavy calves and the ability of females to maintain body reserves during lactation. Calf weights and female reproductive rates should be monitored to detect future changes in range quality.

•Alex Prichard and Greg Finstad

Factors affecting velvet antler weight

Situation: Reindeer are an important livestock species in western Alaska. Antler sales generated approximately 564-thousand dollars for local economies in 1996.

Purpose: Knowledge of how date, sex, reproductive status, and body weight interact to determine antler weight can be utilized in order to time round-ups and devise management strategies to maximize antler production. Reindeer on the Seward Peninsula are free-ranging throughout the year. Animals are rounded up from late May to early July and antlers are harvested.

1998 Accomplishments: During 1998 we used data collected from 1987 to 1997 to determine how

antler weights of male and female reindeer varied with age, year, reproductive status, Julian date, and body weight. Male antler weights increased with age up to age five, and were lower in steers than in bulls. There was a significant positive relationship between body weight and antler weight in both sexes. Lactating females had lower antler weights than non-lactating females, but this effect is better explained by differences in body weight. Female antler weights increased with age until at least age nine. Antler weight of yearlings was a better predictor of two-year-old antler weight than was yearling body weight.

Impact: We determined that antlers should be harvested as late in the summer as possible without compromising antler quality. We used estimated antler weights in a model of annual income and herd size under different harvest scenarios.

•Alex Prichard and Greg Finstad

Establishing no-till forage

Situation: No-till planting techniques have been developed for barley in Alaska. Advantages of no-till forage planting include erosion control and conservation of soil moisture; however, no systematic evaluation of no-till forage establishment has been conducted in this environment.

Purpose: This project identifies low-input methods to improve the efficacy of perennial and annual forage establishment, thus reducing financial risk, and minimizing soil erosion and yield reductions associated with establishment.

1998 Accomplishments: Two test sites each were established on farmed fields in interior Alaska, southcentral Alaska, and the Kenai Peninsula. Drought conditions in interior Alaska resulted in minimal establishment in 1998. In southcentral Alaska perennial grasses responded positively to N rates and no-till grass yields were greater than conventional tilled yields regardless of N application rate. Companion crop yields were considerably greater in tilled than in no-till treatments. Results for the initial year are preliminary and will continue to be evaluated over the next two years.

Impact: The on-farm nature of these trials and cooperation with Alaska Cooperative Extension and the Natural Resources Conservation Service will ensure transfer of results to area farmers.

•Stephen Sparrow, Ray Gavlak, and Beth Tillman

Long-term tillage practice effects on soil properties

Purpose: The objectives of this study are to determine the effects of long-term tillage and small-grain crop residue management practices on total

carbon (C) and nitrogen (N) (indicators of soil organic matter), microbial biomass C and N and mineralizable C and N (indicators of potential organic matter turnover), pH, and aggregate stability (indicator of soil structural stability and thus resistance to erosion) in soils in a subarctic environment. The study is part of a long-term tillage and crop residue management study which is in its 17th year in central Alaska.

Cropping consists of continuous barley except for occasional years when chemical fallow has been used to control perennial weeds. Tillage treatments consist of conventional till (disked in fall and spring), chisel plowed in fall, disked once in fall, and no-till. Crop residue management treatments consist of leaving all residues on the plots following harvest, removing loose residues but leaving standing stubble, or removing all above ground residues.

1998 Accomplishments: For purposes of this study, we sampled only the conventional till, disked once, and no-till treatments and the treatments with all crop residues removed or all residues left on the plots. Soil samples were collected in spring (prior to tillage operations and planting) and in fall (following barley harvest but prior to tillage operations) in 1998. Total soil C and N and mineralizable C were lowest in the conventional till treatment and were similar in the disked once and no-till treatments, and were little affected by crop residue treatment. Microbial biomass C was highest in the no-till and lowest in the conventional till whereas microbial biomass N was lowest in the conventional till and similar in the disked once and no-till treatments, with no differences between crop residue treatments for these parameters. Wet aggregate stability was highest in the no-till and lowest in the conventional till treatment.

Impact: This research is important because it helps us to understand how crop and soil management practices affect important soil properties in a subarctic environment. The field aspects of this study will be done for one more year.

•Stephen Sparrow and Charles Knight

Managing bluejoint

Situation: Bluejoint grass (*Calamagrostis canadensis*), a native Alaska grass, can be a serious weed on pasture land in Alaska because it often outcompetes introduced forage grasses. Bluejoint produces fairly good-quality forage early in the growing season, and thus can be a useful forage grass. However, its forage quality decreases rapidly as the season progresses.

Purpose: This study will determine if various mowing treatments, combined with various nitrogen (N) fertilizer treatments, would improve the late season forage quality of bluejoint or control its

growth, thus allowing more desirable species to grow.

1998 Accomplishments: Fertilizer treatments included no N fertilizer, N fertilizer applied once at the beginning of the growing season, or split applications where N fertilizer was applied once early in the season and again at time of the first mowing. Mowing treatments included none, single, or triple cuttings done at different times during the growing season. The study was done near Delta Junction in interior Alaska. Addition of N fertilizer resulted in substantial yield increases but only small increases in late season forage quality indices. Mowing in June resulted in a fair amount of regrowth; mowing in mid-July or later resulted in little regrowth of bluejoint. Mowing did not seem to have much effect on long-term survival of bluejoint.

18 Impact: This study could be important to land managers wishing to control bluejoint without use of herbicides and to farmers wishing to use bluejoint for grazing or for hay.

• *Stephen Sparrow and Michael Panciera*

Third Circumpolar Agricultural Conference

Purpose: The conference was organized around volunteered oral and poster sessions on various aspects of circumpolar agriculture, including crops, soils, land reclamation, animal agriculture, northern community development, agricultural and land-use policy, and marketing.

1998 Accomplishments: The 3rd Circumpolar Agricultural Conference was held in Anchorage, Alaska in October 1998. Participants included researchers, educators, students, producers, and policy makers from the north circumpolar countries including Greenland, Iceland, Norway, Sweden, Finland, Russia, the United States, and Canada. There were more than 70 oral presentations and 40 posters. In addition, invited keynote and plenary speakers from various circumpolar countries opened each day of the conference with overview talks on the topics of the day. Tours included trips to view agriculture and land use on the Kenai Peninsula, the Matanuska Valley, and the Anchorage area. Delegates of the Circumpolar Agricultural Association met during the conference and elected Dr. Thorsteinn Tómasson, of Iceland, as the association's next president. Akureyi, Iceland was selected to host the 4th Circumpolar Agricultural Conference in 2001.

Impact: This conference was an opportunity for people from the circumpolar north to share information and ideas about agriculture in high latitude environments. The 3rd Circumpolar Agricultural Conference was sponsored by the Circumpolar Agricultural Association and was hosted by the Alaska Agricultural and Forestry Experiment

Station, the Alaska Division of Agriculture, and the Alaska Farm Bureau.

• *Stephen Sparrow and Carol E. Lewis*

Forage legumes on Delta Bison Range

Situation: The Delta Bison Range was established to encourage the free-roaming Delta bison herd to avoid farmed fields until farmers have finished fall harvest. The range, which is managed by the Alaska Department of Fish and Game (ADF&G), was planted to domesticated forage grasses to serve as high-quality pasture for the bison. However, lack of funds has not allowed ADF&G to optimally manage all of the bison range. Nitrogen fertilization is a major expense in maintaining the range.

Purpose: The purpose of this project was to study the potential of forage legume crops (which are capable of obtaining their own nitrogen from the atmosphere and therefore need little or no N fertilizer) for providing high-quality forage on the Delta Bison Range.

1998 Accomplishments: Several forage crops, including clovers, alfalfas, vetches and milkvetches were planted at several locations on the range in 1992 and have been maintained since. Survival of the forage legumes in open, unprotected parts of the bison range has been poor, but Anik alfalfa and Altaswede red clover have persisted, even under annual harvest, on protected parts of the range. Results of this study indicate that forage legumes have limited potential for use in open-range situations in the Delta Junction area of Alaska.

Impact: This study's results will be useful for farmers and land managers wishing to use forage legumes for pasture or for ground cover in non-intensively managed situations in interior Alaska.

• *Stephen Sparrow and Michael Panciera*

Climate stress in white spruce

Purpose: Our previous research used three independent lines of evidence (ring-width, x-ray density measurements of wood, and carbon 13 isotope content of annual layers of wood) to establish that the growth of upland stands of white spruce is limited by moisture stress in the Bonanza Creek Long Term Ecological Research site west of Fairbanks. Those results also suggested that moisture stress has reached extreme and unprecedented levels in recent years.

1998 Accomplishments: In order to test how consistent and widespread those results are, additional tree-ring samples were collected at Dune Lake and Jan Lake for intensive study, and a data base of tree-ring measurements from white spruce trees on productive sites across interior Alaska was assembled.

The data base contains annual ring-width data for 269 trees in 20 stands. The stands were made up of trees that contributed annual rings from 1905 to either the time of sampling (1994–96), or the death of the stand from fire (1983) or logging (1987). The earlier results were confirmed. Radial growth is significantly negatively related to mean summer temperatures, that is, ring-width is greatest in the coolest years and smallest in the warmest years.

The specific temperature factors that are significantly correlated with ring-width are (1) temperature of May in the year of ring formation, (2) May through August temperature in the year prior to ring formation, and (3) August temperature two years before ring formation. These results indicate that medium-term trends of warm weather have long-lasting effects in reducing growth of spruce. Temperature factors associated with density of wood occur at the beginning and end of the growing season in the year of ring formation, specifically either May and August temperature or May and July temperature, depending on the site studied.

Impact: The years since 1977 have been the warmest sustained period of the 20th century, and probably the last several centuries. The finding of drought stress and reduced growth of spruce on productive upland forest sites is now confirmed across much of low-elevation, east-central Alaska. A

drought-induced radial growth slowdown is the dominant feature of the recent history of white spruce on productive commercial type forest sites at low elevations in central interior Alaska.

• Valerie Barber and Glenn Juday

Comparison of three satellite-based fire detection methods

Purpose: Three satellite fire detection models were compared and evaluated using NOAA-11, -12, and -14 AVHRR data of interior Alaska's boreal ecosystem. The effects of fire size, sensor scan angle, and time of imaging on fire detection accuracy were analyzed. The fixed threshold model compared the radiant temperature of each pixel to predetermined threshold values. The contextual model compared the radiant temperature of each pixel to its surrounding (background) pixels. The fuel mask model is similar to the contextual model, but pixels were tested for fuel availability according to pre-fire vegetation index values. Fire location data from the Alaska Fire Service was used to assess the accuracy of the fire detection models.

1998 Accomplishments: Fire detection accuracy was highest using the fuel mask model, was lowest using the fixed threshold model, increased as fire size increased, was not adversely affected by large sensor scan angles, and was considerably greater in afternoon images than morning or night images. Afternoon fire detection accuracy was considerably greater than morning or night detection accuracy for all model types. Because of rising temperatures, decreasing fuel moisture, and increasing winds, there is a greater probability of new fire ignition or existing fire intensity escalation in the late afternoon. A surprising find was the increased detection accuracy of night images over morning images, possibly because of increased contrast between the fire and its surrounding environment during the night.

• Steven Boles and Dave Verbyla

Landscape interactions with thunderstorms

Situation: Lightning from thunderstorms is the dominant fire-starting mechanism for large wildfires in interior Alaska.

Purpose: How do landscape properties influence thunderstorm development and subsequent lightning distribution? In general, mountains enhance thunderstorm development due to differential heating and orographic promotion of convection. The distribution of boreal forest relative to tundra within mountainous areas may be another important factor promoting convection since boreal forests generally have higher sensible heat fluxes compared to tundra areas.

1998 Accomplishments: We divided interior Alaska into regions, based primarily on physical landscape features such as topography and the major rivers (e.g. the Yukon Flats, Tanana Flats, White Mountains, Copper River Flats, etc.). The highest density of lightning strikes occurred in the east-central interior of the state. This zone is characterized by comparatively hot summers which have been suggested to have enough available moisture, due to large-scale advection, to fuel thunderstorms.

The coastal areas have milder climate with more stable air masses, less surface heating, and warmer air aloft, prohibiting extensive convective activity. In addition, some of the common triggering mechanisms in the interior region—the thermal trough or the high pressure ridges—do not occur frequently at the coastal regions. A few zones south of the Alaska Range, the Copper River Flats and the Talkeetna Mountains still report more strikes than their surrounding regions.

We compared the lightning strike distribution to the land surface cover, combining the vegetation types into three major types; “tundra”, “shrub” and “boreal forest” for all of interior Alaska. Boreal forest had a significantly higher density of lightning strikes relative to either tundra or shrubland classes. This may be due to a higher sensible heat flux within the boreal forest region. We are currently analyzing fires scars to determine how a change in the boreal forest landscape might impact a change in lightning strike distribution.

Impact: Preliminary results of this study were highlighted in the December 12th, 1998 issue of the New Scientist Magazine, and can be viewed at: <http://www.newscientist.com/ns/981212newsstory12.html>.

•Dorte Dissing and Dave Verbyla

Watershed modeling and landscape-level management

Situation: Forest management has experienced a paradigm shift in recent years from a tree and stand management orientation to an ecosystem and landscape management orientation. Associated with this shift is a better appreciation of the linkages between the terrestrial and aquatic components of the ecosystem and the need to forecast the effects of land management activities and natural changes on streams and stream life. This is currently reflected in the federal and state focus on “watershed analysis” and recent reviews and revisions of the Alaska Forests Practices Act and Regulations. Preliminary to understanding the effect of timber harvest on salmon is a basic understanding of the hydrologic connection between vegetation, energy, and water.

Purpose: This research focused on developing a tool that could be used to estimate the effects of

landscape-level vegetation changes, whether human-induced or otherwise, on stream hydrology.

1998 Accomplishments: From the scientific perspective, the general model has been found to be useful for estimating the effects of timber harvest, fire, defoliation, and climate change on annual and monthly streamflow and on the depths and rates of soil freezing and thawing. The key to detailed modeling of the water and energy balances in cold climates was found to be surface temperature. A method of extrapolating from air temperature to surface temperature was developed but was limited by the half-day time increment in the model. An hourly time increment is recommended to better capture the diurnal and seasonal temperature dynamics.

While the project focused on writing and refining a computer model of forest hydrology incorporating soil freeze-thaw algorithms (HYFORFT, Hydrology of FORests with Freeze-Thaw), the desire was to make this model more useful and “friendly” to the non-expert and general forest manager, by incorporating a graphical user interface, easy interaction with GIS files, and possibly a web-based platform. Progress is being made along these lines but has been limited by the investigator’s computer programming skills. In the meantime, a simpler, though less powerful, spreadsheet model of the local water balance has been developed that can be used by managers with little training or sophistication. Two publications are in preparation, one regarding model testing and the other dealing with insights gained through model use.

Impact: Once the final versions of these models are complete they will be made available to state, federal, and private managers along with recommendations for their rational use. Our hope is that such tools will allow better planning and more efficient assessment of environmental impacts due to human-induced changes in the landscape vegetation, and will allow managers to test alternative practices and policies prior to implementation. Thus we may ultimately help protect our streams and aquatic resources while deriving economic and amenity values from our forests. Insight gained through this research has already been shared with the Alaska Division of Forestry and the Alaska Department of Fish & Game, via the investigator’s participation in the ongoing committee to classify streams and review forest practices in region III.

•John D. Fox, Jr.

Dynamics of white spruce treeline forests in relation to climate

Situation: Alaska contains extensive areas of

forest and tundra. As a result, a broad area of treeline representing the interface between tundra and forest is present in many different regions in Alaska. The movement of forest into tundra can affect many different wildlife species and opportunities to obtain subsistence resources. Treeline also generally has been found to be a sensitive indicator of the direction of climate change (warming vs. cooling).

Purpose: This study reviewed the evidence of recent treeline change associated with climate in four regions of Alaska where treeline monitoring has been established.

1998 Accomplishments: Treelines in Alaska show a strong response to the climate warming that has occurred since the end of the Little Ice Age in the early 1800s. The population structure of treeline white spruce in the central Alaska Range and southcentral coastal mountain regions shows steady upslope recruitment of spruce; that is, as one moves upslope the trees are gradually younger. The general consensus of studies of past climates in Alaska is that the climate has been warming since the mid-1800s. The age structure of white spruce treelines suggests that treelines have been moving higher in altitude in response to the past 200 years of warming.

White spruce established since the Little Ice Age at the limit of tree growth in northwestern Alaska appear to be growing faster today than spruce established earlier in colder conditions. Only a small proportion of treeline spruce in the mountains of southcentral Alaska are currently limited in radial growth by the lack of summer warmth. The elevation at which white spruce in the mountains of southcentral Alaska could grow today is probably substantially higher than the current elevation of established trees. The explanation appears to be that the climate has warmed so rapidly that new seedling establishment has not kept pace and that the tundra mat is temporarily preventing or reducing the establishment of spruce seedlings.

White spruce at the northern and upper elevation treeline in Alaska are generally vigorous and have been able to produce seeds at periodic intervals since the beginning of the 20th century or earlier. Years with particularly favorable weather for triggering white spruce cone crops include 1912, 1915, 1926, and especially 1940. Many of the well-established treeline trees of today in central Alaska appear to date from the 1941 seed crop which was triggered by warmth in 1940. Conditions equal to 1940 or even more favorable for triggering cone crops have occurred several times in the 1980s and 1990s. Most recently, strong climate warming has occurred widely across Alaska, especially since 1976. Some locations, such as the central Brooks Range, have

experienced increased summer precipitation along with the increased temperatures, so white spruce treeline trees have experienced a more favorable climate for growth in those locations.

Impact: An index of moisture stress composed of summer temperature and annual precipitation at Fairbanks shows sustained, high levels of moisture stress since 1976. A low-elevation treeline in contact with grassland occurs in the dry central interior portion of Alaska, and white spruce in those locations have experienced a much less favorable climate for growth. If recent warming and drying trends there persist (or intensify), direct and indirect effects of moisture stress could result in the elimination of white spruce and the expansion of grassland or aspen parkland.

• Glenn Juday, Valerie Barber, and David Valentine

21

Regional climate change assessment of the forestry sector in Alaska

Situation: The "Global Change Research Act of 1990" (P.L. 101-606) requires the preparation of a national assessment which analyzes the effects of global change on the natural environment, agriculture, energy production and use, land/water resources, transportation, human health and welfare, human social systems, and biological diversity. The goal is to provide planners, managers, organizations, and the public with the information needed to increase resilience to climate variability and cope with climate change.

Purpose: The U.S. Global Change Research Program, in cooperation with the White House Office of Science and Technology Policy, have commissioned overview papers and convened a series of 17 regional workshops across the U.S. to produce the assessment. The Alaska regional workshop on scientific themes and assessment of evidence of climate change and risks and vulnerabilities took place in 1997.

1998 Accomplishments: Using the report on Alaska forest ecosystems as a base, an assessment of the Alaska forestry sector was conducted, emphasizing the current conditions, risks, and vulnerabilities to the Alaska forest products industry and communities affected by forests and forest management activities. Issues and vulnerabilities were divided into short-term, medium-term, and long-term.

One of the critical short-term vulnerabilities in Alaska is fire in the urban/wildland interface. If climate change continues as projected and settlement patterns continue their current trends, forest fires could periodically impose increasing damage in southcentral and interior Alaska. Whether or not the costs continue to escalate however, depends critically on how public institutions respond to the challenge.

Federal, state and local agencies may implement a variety of policies for reducing the risk.

Three alternative strategies are possible. The first is public expenditures to reduce public risk. This strategy would use taxpayer-supported initiatives to manipulate the forested landscape to make it less prone to fire and to increase capacity for fire control. Salvage and sanitation logging would be subsidized by public provision of roads and other infrastructure. Public road networks would be expanded to increase fire-suppression capability. Where logging was not feasible, controlled burns would be implemented periodically to create buffers around settled areas. Public fire-control teams would have to obtain significantly increased funding.

The second strategy is incentives to reduce private risk. The state or boroughs would create special rural fire protection districts for residents of risky areas that would be supported by a special property tax applied to such areas. Public authorities would require fire insurance providers to assess different rates for rural areas depending on the forest fire risk, not just on whether fire departments could theoretically respond to a house fire. Residents of rural fire-prone areas would be encouraged to form volunteer fire and emergency response cooperatives at their own expense.

The third strategy is a settlement policy to reduce cost and risk. The most aggressive strategy for reducing the cost of climate-influenced fire risks would be to rethink the policy on infrastructure for economic development. Dispersion of settlement has been assisted by publicly-funded access roads and subsidized public utilities and infrastructure for suburban and rural areas, mainly in the Tanana Valley, Susitna Valley, Western Kenai Peninsula, and near Haines. Assisting communities with infrastructure is needed only in areas that are already densely settled, and would at the least help to minimize new risk of fire damage.

Impact: The key to coping with future climate change for the forestry sector is to meet uncertainty with broad adaptability of tree genetic material and flexible institutional responses. Enhanced programs of investigation of genetic structure of Alaska tree populations, maintenance of genetic selections in seed orchards, and even possibly some transfer of genes of native tree species to new localities in response to rapid climate change may be additional costs for future forest management in Alaska.

• Glenn Juday, Matt Berman, Roger Burnside

Regeneration of upland white spruce: a comparison

Situation: The most important and expensive step in managing much of the boreal forest of Alaska for

sustained wood production is regenerating a new stand of high-quality trees of the desired tree species at an appropriate density.

Purpose: This study provides the first systematic evaluation of the long-term results of different methods for site preparation, and after harvest and regeneration techniques for white spruce. This study was funded by the Alaska Legislature and was conducted on two upland sites which were burned in the 1983 Rosie Creek Fire at the Bonanza Creek Long Term Ecological Research site and then salvage logged in 1985.

1998 Accomplishments: The sites received four scarification treatments: (1) disk-trench scarification in one direction, (2) double-pass disk trench scarification in perpendicular directions, (3) blade-patch scarification, and (4) control (no scarification or only spot scarification at the point where seed was sown). Regeneration methods included container-grown planted seedlings, broadcast seeding, control (natural seedfall regeneration), and spot seeding with and without clear plastic cone shelters.

Success of white spruce regeneration did not differ among the four scarification methods, for both five and ten years after site preparation and planting, but success did tend to be lower with no scarification. Most of the mortality of container-grown planted seedlings took place within three years; survivorship of container-grown seedlings was about 93% with scarification and 76% without scarification. Broadcast seeding was also a successful regeneration technique. At 12 years following site preparation one or more seedlings occurred on 80% of the scarified subplots and on 60% of the unscarified subplots regenerated by broadcast seeding. Natural regeneration after 12 years exceeded expectations, with seedlings on 50% of the subplots 150 m from a seed source and on 28% of the subplots 230 m from a seed source. After five years, 37% of the scarified unsheltered seed spots and 52% of the scarified seed spots with cone shelters had one or more seedlings, but only 16% of the unscarified seed spots had seedlings, with and without funnel shelters. Growth rates for all seedlings, no matter the regeneration technique used, were higher than on similar unburned sites.

Impact: The results show positive effects of site burning on seedling growth in interior Alaska, suggesting that there is a purely economic rationale (in addition to ecological benefits) for post-harvest site burning. The results also show that planting seedlings, broadcast seeding, and natural seedfall, alone or in combination, are appropriate techniques for regenerating similar sites. These techniques differ significantly in cost, suggesting that forest managers should define levels of white spruce regeneration adequate for defined management

objectives in a given area, and then apply the lowest-cost techniques of site preparation and regeneration with a high probability of meeting their objectives.

•Glenn Juday and Roseann Densmore

Tree-ring indicators of climatic change at northern latitudes

Situation: Understanding the causes and effects of climate changes on the world's boreal forests is important for policy makers and others. Most evaluations of possible climate warming or of environmental change in general recognize the critical role that the world boreal forest plays.

Purpose: The boreal forest is important because it is one of the most extensive forest regions on earth. Under certain kinds of climates boreal forests would remove carbon dioxide from the atmosphere and put it into long-term storage, thus reducing the climate effect of adding carbon dioxide to the atmosphere from burning fossil fuels. Under other kinds of climate changes the world boreal forest could become a net source of climate-warming carbon dioxide. The simplest way to find out the recent direction of these possible changes is to measure the climate-related growth trend of boreal trees on a global basis.

1998 Accomplishments: An annual reconstruction of Northern Hemisphere temperatures, based on tree ring widths from northern North America, Scandinavia, Siberia, and Mongolia indicates that annual temperatures increased during the early 20th century, peaked in the mid-1940s, and after a relatively small decrease in the 1950s and 1960s, have risen in the 1990s to the highest levels of at least the last three centuries. Drought stress, partly due to higher temperatures, is now a factor limiting growth at many northern tree locations. The recent warming combined with drier years in some locations is altering the response of parts of the boreal forest to climate. In the past several centuries when the climate was warmer the northernmost trees in the boreal forest grew more. In the warmer climate of today the northernmost trees still generally grow more in warmer years, but they fail to grow as much with each unit of extra warmth as they formerly did. Some far-northern trees, now grow less in warmer years than they do in cooler years.

Impact: The world boreal forest is already adjusting to a much warmer climate than it has experienced in several centuries, and the changes are not always in the direction anticipated, or may not even be widely believed.

•Glenn Juday, Gordon Jacoby, and Roseann D'Arrigo

Spruce killed or growing: a forest disturbance and regrowth model

Situation: The boreal forest of Alaska experiences

a very high rate of natural disturbance. Millions of acres of boreal forest have burned in natural fires or have experienced tree mortality from insect outbreaks in recent decades. Funding is available to enhance natural tree regeneration on only a tiny fraction of this area.

Purpose: In order to obtain some idea of likely future forest conditions on large areas of naturally disturbed forest, Alaska forest managers need a tool to rapidly assess extensive areas of disturbed forest and predict the amount and kind of new forest that will regrow on it. A new spatially-explicit computer model called SKOG (the Scandinavian word for forest) from the title "Spruce Killed Or Growing?" is being developed to provide these answers. SKOG produces data on establishment, growth, and development of Alaska boreal tree species in actual real-world spatial configurations.

1998 Accomplishments: In the first phase of its development, SKOG is being calibrated with data from the Bonanza Creek Experimental Forest Long Term Ecological Research (LTER) site and similar representative areas of commercial forest sites in interior Alaska. Most of the first-year effort has been focused on developing the reseeding and early seedling growth parts of the model, since these are disproportionately important to forest development. In the boreal forest of Alaska nearly all new trees are established immediately following disturbance and relatively little tree recruitment takes place once the stand is about 20 years old.

SKOG is a spatially-explicit model that both describes processes important in determining the response of white spruce forest to disturbance at a particular place and is simple enough to permit tests over relatively large areas of landscape. Models that include too many variables, especially those that grow trees individually, become impossibly complex and would take impractically large amounts of time even on the fastest of supercomputers to produce output over large landscapes. Existing forest process models all seem to suffer from this limitation. SKOG tracks individual trees but is simpler (expresses growth relationships with fewer inputs and stores functions more compactly) than well-known physiologically-based models.

SKOG has been constructed as a series of data layers, with tree or forest-plot attributes that influence each other according to rules derived from real-world data sets. For example understory data layer seedlings persist for a number of years, but then die off if an opening from the random death of an overstory tree does not occur over a period of time.

SKOG is also sensitive to the time since the formation of a new stand. For example, white spruce trees have been set to grow at rates actually measured from tree-ring studies at Bonanza Creek LTER

for trees of a given age. Finally, SKOG data layers also interact with all of the factors according to real-world spatial arrangements. White spruce seeds are produced on the observed schedule (large crops every 12 years) in interior Alaska, and seeds are distributed across SKOG landscapes according to a formula that includes factors such as mean number of sound seeds produced per seeding canopy spruce in an excellent seed crop year. Other factors are for the size of the maximum seed crop in a given year, the fraction of sound seeds produced that are dispersed, and the number of seeding spruce that get established at various distance ranges from seed trees.

Impact: Test runs of SKOG "grow" forests with characteristics similar to real harvested stands. However, one early result of SKOG runs was that white spruce were consistently a minor or less than dominant component of the regenerated stand. SKOG can be made to produce spruce-dominated stands if spruce seeds are set to fall in much greater numbers at a given seed spot than hardwood seeds, or if a substantial reduction of hardwood stems as a result of moose and snowshoe hare browsing occurs. Current work on SKOG is focused on clarifying factors that allow white spruce to overcome hardwood competition and to obtain numerical estimates of those factors.

• *Glenn Juday and Carolyn Malmstrom*

Dendrochronology and GPS study of land surface uplift

Situation: Land surfaces in southeast Alaska have been rising relative to sea level for approximately the last 250 years. Rates of land uplift are greatest in northern southeast Alaska. Many southeast Alaska shorelines are marked with an actively prograding shoreline on which forest vegetation is colonizing land that has newly emerged from the intertidal range. Two processes contribute to the land surface uplift: 1) isostatic rebound in which the land is rising as the result of decompression after the weight of glacial ice has been removed, and 2) tectonic uplift from the sudden slippage (earthquakes) along the Fairweather Fault.

Purpose: The purpose of this project is to measure and apportion uplift between these two causes. Overall direction and the main scientific effort for the project is being provided by the University of Alaska Southeast and the UAF Geophysical Institute.

1998 Accomplishments: A tree-ring component of the study is addressing the issue of whether the uplift has been gradual or sudden. Sitka spruce trees are being cored on the gradually-sloping uplifted land surfaces to measure the earliest year of growth; the date is then used to determine the year of seedling establishment. Continuous recruitment of

trees would indicate gradual land uplift and clustered dates of tree establishment would be more consistent with sudden (earthquake-induced) land uplift.

Preliminary data at Graves Harbor in the outer coast section of Glacier Bay National Park indicate continuous recruitment consistent with gradual uplift is the nearly exclusive pattern. A few years display tree-ring abnormalities at most sampling localities, suggesting that the distinctive tree-rings in those years were produced by regional climate abnormalities.

Impact: A preliminary indication from inspection of tree ring-widths is that rates of growth may be higher in the late 20th century than during other times over the last 200 years.

• *Glenn Juday and Roman Motyka*

Top-down and bottom-up techniques for assessment of forest growth

Situation: Alaska has experienced a recent climate change generally characterized by summer warming and drying which has led to increased drought-stress, insect infestations, and wildfire outbreaks across interior Alaska during the 1990s. However, it is not clear that all boreal forest regions of Alaska and all major boreal tree species are being affected in the same way by this climatic shift. The boreal forest region of Alaska is poorly roaded and covers millions of hectares of landscape. Satellite remote sensing is the only cost-effective method of covering this huge region.

Purpose: A joint team from UAF and the Tanana Chiefs Conference Forestry program has developed a project plan and funding proposal to demonstrate how intensive, plot-based tree-ring research can complement satellite remote sensing of landscape-level growing conditions. The project involves the simultaneous application of "top-down" and "bottom-up" approaches to regional assessment of drought stress across Alaska's boreal forest. The bottom-up approach involves using tree-ring analyses (radial growth, carbon isotope, cell density) for white spruce, paper birch, and quaking aspen. The top-down approach involves calculating a moisture index from AVHRR satellite images.

1998 Accomplishments: We predict that a moisture index developed from the 1998 growing season satellite images is correlated across interior Alaska with tree-ring drought sensitivity as identified from the last 55 years of tree growth. We plan to test whether the remotely-sensed moisture index developed separately for six years shows the same locations of drought-stressed and well-watered trees in interior Alaska as the tree-ring methods. Finally we predict that tree-rings from collections across inte-

rior Alaska are sensitive to the same climate factors.

Impact: Results of this project would be important for predicting tree growth in forest management planning, for monitoring forest health across the region, and for calibrating information about the boreal forest used in global climate models. The general methodology in this study should have general applicability. For example, pollutants that stress vegetation on a regional scale could be expected to act in a manner similar to the drought stress studied here, and the methods for examining the scaling issues in those situations should be similar.

The development of rapid, comprehensive methods for predicting tree growth would be of real value in forest management planning across the region, especially given the cost of obtaining conventional growth measurement techniques in inaccessible parts of the Alaska.

• *Glenn Juday, David Verbyla, Robert Ott, and Valerie Barber*

Forest productivity

Situation: Good forest and wildlife habitat management decisions are based on the productive potential of the land. Existing productivity equations and curves for Alaska northern-forest tree species are suspect since they are anamorphic (based on an average guide curve) instead of polymorphic (variable shape curves).

Purpose: The purpose of this study is to develop productivity equations based on tree height over age (site index) for the northern-forest species in Alaska.

1998 Accomplishments: For aspen, sampling and stem analyses were completed for 62 sites (248 trees), data was entered and verified, and analyses were begun. Initial equations suggest curves are polymorphic and not amorphic. For black spruce, seven additional sites were identified for sampling in 1999 and existing data was entered and verified. For balsam poplar/black cottonwood, equations and curves were published. Current work involves correlating site quality with soil profile, physical, and chemical characteristics.

Impact: When completed, the equations will permit objective determination of site productivity for each species so that sites can be ranked for management and investment purposes.

• *Edmond C. Packee*

Reforestation stocking standards

Situation: Initial search of the literature indicates that espacement (distance between trees) impacts forest stand yield, size of trees, and wood quality. Yield effects depend on species, and wood quality effects depend on species and end-product

uses.

Purpose: The purpose of this study is to determine for Alaska northern-forest species the effect of planting espacement (levels-of-growing-stock plantations) on stem size (height and diameter) and per acre fiber yields, and the effect of stocking (trees per acre) on wood quality.

1998 Accomplishments: The effect of espacement involves long-term plantation trials with black and white spruce, tamarack, and lodgepole pine. Ten-year survival of tamarack at Bonanza Creek is poor due to environmental problems, including defoliators and possibly aphids; five-year survival of lodgepole pine at Tok is substantially less than that of the other three conifers. Damage includes hare browsing and winter "burn"; squirrels clipping mostly lateral branches and a species of bud insect have damaged white spruce at Bonanza Creek. At all sites spruce-gall aphid infestations are moderate to heavy. Height growth at the two Bonanza Creek white spruce sites parallel one another (one site is more productive than the other); both sites at 12 years show less height growth for the 4-foot square and 12-foot square espacements.

Initial search of the literature confirms that impact of espacement or stocking on wood quality varies by species and end-product use. Early stocking affects knot size, frequency, associated distorted and reaction wood, ring width, percent of corewood (juvenile wood) in a log, amount of undesirable reaction wood, log taper, crookedness, specific gravity, and micro-fibril angle. Preliminary espacement guidelines were confirmed and published in the Spring 1999 *Agroborealis*.

Impact: The levels-of-growing-stock plantations demonstrate that future management of tamarack and lodgepole pine needs further study. Long-term results for both black and white spruce will provide a factual basis for assessing the impact of espacement on tree diameter, height, and branch characteristics. Brazier's summary provides landowners with a qualitative decision model for making economic decisions based on individual management and marketing objectives.

• *Edmond C. Packee*

Permanent sample plots (PSPs)

Situation: Existing published yield tables and equations most likely will lead to erroneous per acre volume estimates and predictions. No forest management model adequately addresses in-growth of trees; there is no evidence that stands typically fill in with seedlings at a rate sufficient to become fully stocked. Except for detailed local efforts, information concerning ecosystem processes, functions, and structures in the Alaska northern forest is limited. A need exists

for a northern-forest network of plots upon which to base yield equations and to monitor forest growth, change, and health.

Purpose: The purpose of this study is to establish a network of regular re-measurement PSPs throughout Alaska's northern forest for development of growth and yield models and equations, silviculture/management/investment decision-making, modeling forest succession, and monitoring forest health.

1998 Accomplishments: Fifty-seven PSPs were established at 19 sites in the Copper River drainage, bringing the total PSPs to date to 211 with an additional 196 Sustained Yield Plots (SYPs) (treatment plots); 175 of 250 sample cores were aged and radial growth was measured. An additional 17 sites were located and permits applied for in the Copper River basin. Analysis of Tanana Valley PSPs was initiated using PC-ORD (TWINSPAN and DETRENDED CORRESPONDENCE ANALYSIS). Observations indicate that many stands are either overstocked or understocked; understocked stands probably originated as mixed stands in which the hardwood component died out, leaving too few conifer stems for full stocking.

Impact: Preliminary data suggests that many forest stands are capable of producing significantly greater amounts of fiber and that initial models inadequately explain succession. New models and equations will improve resource management.

• Edmond C. Packee

Forest health and protection

Situation: Forest health is a poorly understood concept. The health of Alaska's northern forest is questionable. Extensive areas of forest have been killed by insects, disease is a serious problem, and past deliberate exclusion of fire has exacerbated forest health problems.

Purpose: Current emphasis is threefold: 1) to develop and disseminate the concept of forest health for Alaska, 2) to determine the ecology of engraver beetles (*Ips*) and relationship to the harvest of spruce, and 3) to identify control options and ecosystem restoration options for the control of the spruce beetle (*Dendroctonus rufipennis*).

1998 Accomplishments: We helped develop a technical workshop: "Managing for forest condition in interior Alaska," which was presented April 9-10, 1998. We found that engraver beetles do not migrate far from slash piles and control is possible through trapping and good cleanup after harvest or fire. We also presented two papers at technical workshops.

Impact: A better understanding of forest health is now being presented to the public and aids in generating healthy debate. Control options for both the

engraver beetle and the spruce beetle have been documented and are available. Timber harvest with and without prescribed burning may be a less catastrophic surrogate to the spruce beetle; spruce beetle ecology suggests that future management of spruce may necessitate an entomological rotation that uses a 10- to 12-inch maximum diameter. Engraver beetles are less of a risk than spruce beetles and control techniques are available; risk due to the engraver beetle is much less than believed, with many concerns and the need for high-cost control measures alleviated.

• Edmond C. Packee

Forest ecosystem management

Situation: No consensus exists among professionals or the public as to what the concepts of ecosystem management, ecosystem and forest health, biodiversity, and sustainability really mean. Essentially ecosystem management can mean managing for biodiversity. Without consensus meaningful dialogue is stifled.

Purpose: The purpose of this project is to develop the concept of ecosystem management and integrate the concept with biodiversity, forest health and protection, and silviculture to better manage the forest resources of Alaska.

1998 Results: Definitions were adapted from the literature to address the Alaska situation. Findings were developed into permanent presentation formats and are now available for debate. We helped develop the workshop "People and the forest: Creating a partnership: A workshop about shaping the future of the forest responsibly," which was presented June 5-6, 1998.

Impact: This project increases acceptance of the paradigm change from managing forest resources for today's perceived demands to managing to ensure a legacy of biodiversity for future generations. Definitions formed the basis for two one-day professional workshops (one at the request of the Alaska Society of American Foresters) on ecosystem management. Also, information was used to develop a public presentation explaining how to adapt silvicultural systems to ecosystem management.

• Edmond C. Packee

Early height growth of white spruce

Situation: Growth of trees varies regionally; little information exists about the early height growth of white spruce in Alaska. Early height growth within a region varies from site to site and possibly with stocking. Knowledge of early height growth patterns is essential since many models do not include the first 10 to 20 years of growth and most are based on trees that have reached breast height (4.5 feet).

Purpose: The purpose of this project is to develop a model of the early height growth patterns of northern-forest tree species with initial emphasis on planted white spruce.

1998 Results: In addition to Levels-of-Growing-Stock (LOGS) plantation data, internodal height growth was measured for 25 planted white spruce on 99 temporary plots at 19 locations west of Fairbanks. Data were entered and verified for analyses.

Impact: The model will be used to predict expected height growth against which growth of other plantations can be assessed, approximate age at which trees reach free-to-grow status (escape over-story competition from shrub species), time for trees to reach breast-height age, and to help predict growth trajectory for yield forecasts.

• *Edmond C. Packee and Jamie Hollingsworth*

Individual tree volume equations and tables

Situation: Disagreement exists over the accuracy of existing equations and tables. The points of disagreement include concerns by purchasers and sellers of timber over accuracy, disagreement among tables for a given species, and methodology. Improved utilization of fiber requires greater accuracy and better utilization standards.

Purpose: The purpose of this project is to develop individual tree volume equations and tables for each species by biogeoclimatic zones.

1998 Accomplishments: All white spruce data for trees north of the Alaska Range were checked for errors, an additional 195 white spruce were measured, and equations were developed. The development of procedures to test for accuracy and allow for comparisons with other published equations is in progress. Data collection continues for other species.

Impact: New equations and tables, based on robust sets of data (e.g., ± 780 trees in the Tanana Valley measured at four-foot intervals along bole from a six-inch stump), will replace old equations and tables because of greater sample size, lack of statistical problems (small trees with negative volumes or more merchantable volume than total volume), closer utilization standards, and volume units being in cubic feet, cubic meters, tons, and long tons. Equations and tables will improve cruise estimates and flexibility in marketing wood, which will benefit both buyers and sellers.

• *Edmond C. Packee and Tom Malone*

Disturbance history in the Tanana Valley

Situation: Man has impacted ecosystems and biodiversity through time—sometimes unknowingly

and sometimes deliberately. To suggest that a condition at a particular point in time is pristine ignores this reality. In Alaska, much of the public is unaware of the human, aboriginal, and European activities that have led to the forests of today.

Purpose: The purpose of this study is to document historical information concerning man-caused disturbance of northern-forest ecosystems in Alaska and implications for forest resource planning and ecosystem management.

1998 Accomplishments: Findings demonstrate that contrary to state and national public beliefs, human impacts on interior Alaska forest have been much greater than accepted or anticipated. Major human-caused disturbances include: aboriginal and modern use of fire; fire control to exclude or minimize the historical role of fire; and timber harvest (including extensive clearcutting) in riparian zones, especially for sternwheeler fuel and on both floodplains and uplands for general fuel, power generation, mine timbers, roads and bridges, rail ties and trestles, and personal and commercial structures. A journal paper has been accepted for publication. One paper was prepared and accepted for a peer-review journal.

Impact: Findings show that so-called pristine areas identified in planning documents are the result of timber harvest, and that, contrary to public statements, sternwheelers did ascend the Tanana River to more than 300 miles above Fairbanks. Thus timber harvest was not unknown in the riparian zone there. Findings also show that fire was used deliberately to burn extensive areas to produce game habitat and control insects (mosquitoes and gnats). These examples have been used along with a large poster display for professional public education efforts, to show that acceptable surrogates must be developed and to revise and improve forest-resource management plans.

• *James Roessler and Edmond C. Packee*

Seasons: the global plant waves

Purpose: The goals of this project are to improve science, math, and technology education of pre-college students, and to obtain on-the-ground data validation of satellite-based estimates of the start (green-up) and end (senescence) of natural plant growing seasons. The greenness index called the Normalized Difference Vegetation Index is typically scaled from less than 100 for non-vegetated areas to a maximum of 200 for areas with extremely high leaf areas. Change in length of growing seasons is a major potential indicator of climate change. Climate change is expected to be of greater magnitude in high-latitude areas such as Alaska.

1998 Accomplishments: A K-12 school-based

research project on plant phenology was initiated in 1998. We developed protocols for observing green-up and senescence of natural vegetation at school sites. Additionally, we also began work on the draft learning activities that would support the science concepts and skills embedded in the protocols. The protocols and learning activities are posted at the web site <http://www.lter.uaf.edu/~dverbyla/globe>. We trained teachers of participating schools in the Global Learning and Observations to Benefit the Environment (GLOBE) Program and the phenology protocols. The teachers subsequently trained their students. Students in four pilot schools in Fairbanks gathered data on timing of green-up and growth rate of leaves of key plant species at their GLOBE sites. Students in 14 pilot schools from across Alaska tested the draft senescence protocol in September 1998.

Impact: By next year we hope to have sufficient green-up and senescence data gathered by pilot schools across Alaska to begin verifying remote sensing images of green-up and the plant growing season. These data will help determine the appropriate satellite remote sensing greenness values that truly represent the growing season. The information gathered from this project will be useful to climate modelers and to stakeholders in Alaska.

• *Elena Sparrow, David Verbyla, Leslie Gordon and Heather Goldman*

Landscape radiant temperature changes due to wildfire

Purpose: A warmer and more heterogeneous landscape following wildfire may promote convection leading to increased lightning.

1998 Accomplishments: By examining the thermal channel of Landsat Thematic Mapper imagery, we found the radiant temperature of burn scars to be significantly higher and more variable than the area within 10 km surrounding each burn scar. This pattern of warm burn scars was consistent for one, three and ten years after fire. Why are the burn scars significantly higher in radiant temperature? Perhaps this is due to low transpirational cooling relative to the vegetation surrounding unburned areas. We are currently examining the pattern of lightning strikes before and following large fires. We are also examining satellite imagery for evidence of convection development from recent burn scars.

• *David Verbyla and Dorte Dissing*

Spatial Analysis of Alaska

Purpose: This research primarily addresses the carbon dynamics within the forests of Alaska. At this

time the model is being put together and tested on a definitive set of forest areas in interior Alaska.

1998 Accomplishments: The Spatial Alaskan Forest Ecosystem Dynamics (SAFED) model was validated across four of the most common vegetation types found in interior Alaska. The vegetation types were an alder (*Alnus* spp.) and balsam poplar (*Populus balsamifera* L.) site (FP2); an old-growth balsam poplar and white spruce (*Picea glauca* (Moench) Voss) site (FP3); a mixed deciduous (primarily birch (*Betula papyrifera* Marsh.), aspen (*Populus tremuloides* Michx.), and white spruce site (UP2); and a mature white spruce (UP3) site. The FP sites are common on the floodplain along the Tanana River and the UP sites are common in the uplands in interior Alaska. SAFED was based on the growth of trees, the amount of litterfall and its chemistry, and microbial efficiency for forest floor decomposition. The state factors (climate, topography, disturbance) are used to describe a broad-scale classification of the landscape to define basic limitations for the driving variables.

Impact: This work will give us the ability to test a variety of forest management techniques and potential changes in climate.

• *John Yarie*

Frostfire

Situation: The chief advantage of a simulated wildfire is that the natural wildfires never provide adequate notice for scientists to fully characterize the forest beforehand. This forces ecologists to infer pre-fire patterns and processes from surrounding, unburned forest. Thus the question, how similar were the forests before the fire? For example, why did the fire burn one area and not the other if they were so similar to begin with?

Purpose: My research continues to focus primarily on how disturbance affects boreal forest soil temperature, carbon content, and other variables key to understanding boreal forest productivity and its role as the Earth's "lungs."

1998 Accomplishments: As part of the Frostfire project, an 11 km² forested watershed within the Caribou Poker Creeks Research Watershed (CPCRW) is slated for a simulated wildfire as soon as prescribed conditions—both natural and administrative—are met. There is an estimated 50% probability that the fire will occur during summer 1999. Frostfire researchers have collected and analyzed pre-fire data. Members of the Forest Soils Laboratory established and characterized a series of 30 m by 30 m plots in three contrasting vegetation types (mixed hardwoods, open-canopy black spruce, and closed-canopy black spruce) in "burn" watershed, as well as in "control" sites elsewhere in the CPCRW.

Impact: A crucial question is whether processes

such as soil respiration in apparently similar sites actually behave in comparable ways. We have found that patterns and rates of soil respiration in our "control" sites closely track those of the "burn" sites within vegetation type. This confirmation of our site pairings—nearly unique in ecological studies—greatly strengthens our ability to infer short- and long-term effects of fire based both on comparisons between burn and control plots and between pre- and post-fire measurements.

Impact: With some dry weather and a bit of luck, we will be able to use these comparisons to learn how fire influences boreal forest dynamics. To learn more about this project and its progress, you can access project information over the internet at <http://www.lter.uaf.edu/~jirons/cpcrw> www.frostfire/frostfire.htm.

• *David Valentine*

An alternative to clearcutting in the boreal forests of Alaska

Situation: The natural disturbance of boreal forest is wildfire. The most common method of timber harvest in Alaska's boreal forest is clearcut logging. Some of the ecosystem effects of this type of harvest are similar to the effects of wildfire, and some are not. Both wildfire and clearcut logging result in markedly warmer soil temperatures, a key component of productivity in this ecosystem. At the same time, clearcut areas lack the numerous standing dead boles that characterize most burned sites. These boles are used by a variety of wildlife species, and they fall to the forest floor over the years following the fire, providing a constant, slow input of coarse woody debris to the site. Wildfires have irregular boundaries and typically leave patches of trees capable of producing seed. Clearcut areas lack such seed sources.

Purpose: This research examines two sites, one harvested in 1972 and one in 1984, to consider the long-term benefits and tradeoffs of green-tree retention in boreal forest ecosystems.

1998 Accomplishments: The retention of high-quality green trees in harvested areas can result in harvested areas that better mimic burned sites. In interior Alaska, regularly-spaced trees are subject to occasional broken tops and windthrow during sporadic wind events, resulting in slow input of woody debris to the forest floor in the decades following harvesting.

Impact: On both upland and floodplain sites, retaining high-quality green trees increases the number of natural conifer seedlings and saplings.

This research is being conducted in cooperation with the Tanana Chiefs Conference and the Alaska Boreal Forest Council.

• *Tricia L. Wurtz and John C. Zasada*

Resources Management

Reindeer-caribou competition legal analysis

Situation: This project addresses various potential legal liabilities posed by conflicts between wildlife and privately-owned animals.

Purpose: Project purposes include determining the rights and responsibilities of livestock owners as well as those of the state in the management of domestic animals and wildlife, when interactions between domestic animals and wildlife result in deleterious impacts to private property.

Impact: The benefits of this project will be to educate farmers, ranchers, and other herders on the extent of their legal rights when wildlife and domestic animals conflict. The study is completed and results are being submitted. This research project was funded by the U.S. Bureau of Indian Affairs and administered through Kawerak Native Corporation.

• *Harry Bader*

National parklands management legal analysis

Situation: This project addresses the legal limitations posed by constitutional and common law upon national park management discretion.

Purpose: Project purposes include analysis of the authority of the Park Service to regulate private behavior on, or affecting, national park lands.

Impact: Benefits of this project include educating both the federal government managers and the public on the extent of federal authority to regulate park resources and uses. The study is completed and the results are being submitted. This research project was funded by the National Park Service.

• *Harry Bader*

An economic assessment of the marine sport fisheries in Lower Cook Inlet

Situation: Cook Inlet Planning Area Oil and Gas Lease Sale 173 includes and abuts productive commercial, subsistence, and sport fishing grounds. While there is considerable information regarding the economic value and impact of commercial fisheries off Alaska, the economic value and impact of sport fisheries of lower Cook Inlet are the focus of a rapidly-expanding tourist economy.

Purpose: Sport fisheries produce non-monetary benefits to fishermen and monetary benefits to tourism-related businesses. Outer Continental Shelf exploration, development, and production activities could affect the quality of recreation opportunities and the demand for tourism-related services.

1998 Accomplishments: Our research developed a predictive model of participation rate changes that can be used in conjunction with a regional input-output model to measure the impact of marine sport fisheries on the Kenai Peninsula economy. The model can also be used to predict how those impacts will vary as variations in trip characteristics influence participation. In addition to a baseline corresponding to an average trip in 1997, the final report will describe the results of six simulations that will provide for increased (or decrease) angler success which could arise from changes in stock abundance or from changes in bag limits.

Impact: The Minerals Management Service will be able to use results from this study to predict effects of lease sales on the marine sport fisheries and ripple effects on the Kenai Peninsula Borough, Alaska, and U.S. economies.

**Hans Geier, Joshua Greenberg, Carol E. Lewis, Chuck Hamel, Mark Herrmann, Keith Criddle, and S. Todd Lee*

Alaska Grown products

Situation: Producers and consumers need information about the appearance, texture, flavor, and overall acceptability of "Alaska Grown" products.

Purpose: The classroom is used to test consumer acceptance of Alaska Grown products. In NRM 310: Agricultural Concepts, we have conducted sensory panels, prepared marketing strategies, and created logos for numerous agricultural products produced in Alaska and marketed under the "Alaska Grown" logo. These products include honey, carrots, barley pancake mix, salsa, and tomatoes.

1998 Accomplishments: In 1998 we conducted three additional taste panels. Two were at the Agricultural Appreciation Days held annually at the experimental farms in Fairbanks and Palmer. The Fairbanks tasters sampled sausage from Greatland Sausage in Fairbanks. The three types tasted were summer sausage, landjager, and Lebanon bologna. Our panelists preferred the overall appearance of the summer sausage and the landjager equally. They liked the texture of the summer sausage as well as its taste. The panelists least preferred the taste of the Lebanon bologna, which typically is somewhat sour.

Our Palmer panel compared locally-grown European cucumbers to those produced in greenhouses in California. The locally-produced cucumbers were

somewhat greener and brighter and had a milder and somewhat sweeter taste than the California cucumbers. Their texture was more juicy, somewhat more tender, but not as crispy.

Our third tasting panel was formed in cooperation with the Georgeson Botanical Gardens. Our objective was to determine the consumer acceptance of five cultivars of spinach provided by the Denali Seed Company of Anchorage for field trials to determine date of bolting. These were compared against Melody, the recommended cultivar for the Fairbanks area. Melody was most preferred for its attractive appearance and its flavor. None of the five cultivars in the field trial were preferred by our panelists for their appearance, taste, or texture, nor would they be likely to purchase them if Melody were offered.

Impact: We have started a series of publications through the Agricultural and Forestry Experiment Station that will highlight the products we have tested. Two brochures were completed; "How Sweet it Is: Alaska Carrots Certainly Are" and "A Taste of Honey: Alaska's Flavorful Gold." The brochures feature a summary of sensory panel results and also include vignettes that inform readers why taste is important; give information on the "Alaska Grown Program", the Georgeson Botanical Garden and the Agricultural and Forestry Experiment Station; and talk about how sensory work is accomplished by researchers at the Agricultural and Forestry Experiment Station.

**Carol E. Lewis*

Research is important to Alaska's agricultural industry

Situation: Alaska's agricultural industry has overcome the twin myths that it is alternatively a dead industry and a potential major industry in the state. It is an industry that is sustaining and enjoying modest growth. Alaska's agricultural industry is maturing despite the infrastructural impediment restricting it to regional (Alaska) markets. Farmers and other entrepreneurs have taken advantage of its unique isolation and climate to produce a wide range of products. It has moved from an industry dominated by milk production, typical of circumpolar, isolated regions, to one that exhibits diversity in its product mix. This diversity is beyond the traditional perception of agriculture.

Much of Alaska's agricultural industry has nothing to do with production of food and fiber. Alaska farmers do produce traditional farm products, but they are also involved in seed production, tourism, and raising horses and dogs for work and pleasure. Agriculture in Alaska is also helping improve the environment with research, demonstration, and technology transfer to aid in revegetation and use of

waste products.

Land sales and financial support by the state of Alaska from the mid-1970s through the early 1980s provided a catalyst for private investment in farms and symbiotic suppliers and processors. It also provided the impetus, voiced by citizens of Alaska, for the state to release more land for agricultural production. Additionally, it made opportunities available for private entrepreneurs that had not previously existed in the red meat and small grain segments. The state was able to keep Matanuska Maid in operation and resolve land title problems. Consequently, the infrastructure is now in place for future expansion in the dairy industry. Given the kick start, private investors are becoming more interested in the industry and the processing sector is expanding.

Impact: The federal government and the state support the century-old experiment stations in Alaska. They have benefited Alaska's farmers and provided them with information about the best management practices in traditional and non-traditional agriculture in the circumpolar north. The extension programs in Alaska continue to support this effort. Producers have used the flow of information from the experiment stations to improve production, management, and marketing since 1898. Individual farmers do not have the time or the impetus to design or test new technology. There is presently no private infrastructure to provide this support.

• Carol E. Lewis

Advancing extreme life systems

Purpose: We continued our work with advanced life systems for extreme environments, emphasizing safe water supplies and food production in controlled environments. Both are integral to obtaining adequate pure drinking water and disposing of liquid and solid waste in the Arctic.

1998 Accomplishments: A proposal was prepared to investigate the use of steam reformers that incorporate the Wiped-Film Rotating Disk (WFRD) distillation process in the processing of liquid and solid waste. An additional component of the proposal is to investigate the use of alternative energy sources in combination or as a replacement for conventional diesel systems now used in rural Alaska villages. Among these alternative sources are wind and solar power and fuel cells. Steam reformers are typically high energy users.

Impact: There are three products that result from reformation. One is a drastically reduced solid product, a second is grey water, and an important third is methane. The technology for using methane to power fuel cells is being developed and could be an important energy source for disposing of liquid and solid waste

in the Arctic.

• Carol E. Lewis and David Bubenheim

Advanced technology for remote complex regions: mining and forestry

Situation: The University of Alaska (UA) and Massachusetts Institute of Technology (MIT) continued their partnership to address technologies that are appropriate for resource development in Alaska. Alaska communities, even the larger urban centers, are remote from market centers, have complex cultures and land ownership patterns, and lack the infrastructure to efficiently produce and market value-added products. This is particularly the case in the mining and forest industries where raw product leaves the state with little or no value added processing.

Purpose: The objective of the UA/MIT partnership is to develop technologies to enhance the value added timber industry in Alaska and to develop either 'smaller' or more remote mineral deposits that are not now feasible to mine.

1998 Accomplishments: The focus this year was on two projects. The first is the conversion of gas to liquids to enable natural gas to be transported in the trans-Alaska pipeline. The second is investigation of a clean diesel fuel to meet increasingly stringent air quality standards. The partnership is also in the process of setting up a mechanism for data collection targeted at fuels, engine performance, and clean-air standards.

• Carol E. Lewis and Robert Trent

Global change education in Alaska

Situation: Global change is defined as those changes in the global environment that may alter the capacity of the Earth to sustain life. Natural and human-induced changes in the Earth's environment include alterations in 1) climate, 2) land productivity, 3) oceans and other water resources, 4) atmospheric chemistry, and 5) ecological systems. Understanding global change issues are vital in predicting the causes, impacts of, and potential responses to these changes. Global warming is expected to be of greater magnitude in the Arctic and will affect ecosystems, industrial development, and lifestyles in Alaska (http://www.besis.uaf.edu/global_warming/problem.html).

Purpose: The Global Learning and Observations to Benefit the Environment (GLOBE) Program was chosen to introduce and sustain global environmental change education curricula in K-12 classrooms in Alaska (<http://www.cgc.uaf.edu/>). GLOBE is an international environmental science and education program that joins students, educators and scientists in monitoring and studying the environment (<http://www.globe.gov>). Over 7,000 schools in more

than 80 countries throughout the world are involved in this hands-on school-based program.

1998 Accomplishments: We conducted a teacher training workshop on GLOBE and on climate change with emphasis on Alaska and the Arctic region. The teachers were trained in making environmental science measurements for long-term investigations of atmosphere, hydrology, land cover/biology, soils, and plant phenology. Participants came from 18 schools in nine Alaska school districts. These teachers in turn have been training their students in making GLOBE scientific measurements, entering data on the computer, submitting data to the GLOBE data server, analyzing and comparing their data with those obtained in other parts of the world, and doing the learning activities which support science concepts and skills.

Impact: Data gathered by GLOBE students will contribute to our scientific understanding of the earth. Teacher and student involvement in GLOBE and global change education will increase their environmental awareness and enhance student achievement in science, math and technology.

• *Elena B. Sparrow*

Storage temperature and quality of Alaska potatoes

Purpose: We investigated the affect of storage temperature and length of storage period on consumer acceptability of Alaska potatoes.

1998 Accomplishments: "Norkota" Russet potatoes were obtained from Schoen Farms in interior Alaska. They were stored at three temperatures: 35°F, 50°F, and 70°F for a period of eight weeks. Home testing was used to determine consumer opinions of quality. Panelists were asked to assess appearance, texture, and flavor of the potatoes after they had prepared them as bakers in their oven or microwave. They were also asked if they liked and would buy the potatoes. At the end of eight weeks, potatoes stored at 70°F were less uniform in appearance, blander, and less sweet tasting. Those stored at 35°F were creamier, sweeter, yellower, less moist, and had a tougher skin than those at the beginning of the experiment.

Impact: Our panelists agreed that despite the storage conditions or length of storage they liked and would buy the Norkota Russets if given the chance.

• *Sharon Tavernier and Carol E. Lewis*

History of Fire Control in Alaska

Purpose: The objective of this research is to provide a detailed history of fire suppression in Alaska and to determine if it followed the history of fire control over the course of this century. It is

important to document these if we are to fully understand the role humans have had in shaping Alaska's landscape.

1998 Accomplishments: The first attempts to control wildfire in the state took place close to settlements and roads in the Chugach National Forest, which was established in 1907. During the first half of this century, most fires were thought to be human caused. It was not until 1943 that the Alaska Fire Control Service officially acknowledged that lightning played an even larger role in igniting wildfires in Alaska.

World War II and the advent of the airplane brought more attention, more money, and more powerful technology to fire suppression in Alaska. For the first time, fire fighters were able to make a significant dent in acreage burned. However, in the 1960s many biologists began documenting the benefits of fire in the ecosystem and questioning the wisdom of viewing all fires as the "enemy." But it was not until the 1980s that "fire management" instead of "fire control" was recognized as a legitimate approach.

This study is expected to be completed by May of 1999.

• *Susan Todd*

Web Surveys as a Tool for Involving the Public

Purpose: This research will take a preliminary look at the pros and cons of web surveys and listservs as new tools for involving the public and for starting a dialogue on controversial issues.

1998 Accomplishments: Surveys have long been considered one of the best—albeit the most expensive—means of involving the public in resource and community planning. With the advent of the internet, a new means of surveying the public is available at a fraction of the cost of paper surveys. These potentially powerful new tools also have drawbacks. Researchers cannot claim to have a "representative" sample for instance, because the survey is available to anyone who wants to take it. Despite the drawbacks, the exponential growth in the popularity of the internet makes it possible to communicate frequently and inexpensively with an increasing number of stakeholders.

Impact: Public involvement experts have always recommended using a wide variety of means to communicate with the public. Now they have one more method that may add an exciting new dimension to public-involvement efforts.

• *Susan Todd*

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January 1998–December 1998

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Financial Statement

Expenditures — July 1998 through June 1999

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1998 and ending June 30, 1999 (FY 99). NOTE: This is not an accounting document.

FEDERAL		(percent of total)
Hatch General Formula Funds	\$ 936,963	15.8
Hatch Regional Formula Funds	93,461	1.6
McIntire-Stennis Formula Funds	420,466	7.1
OTHER GRANTS AND CONTRACTS	1,472,768	24.8
STATE APPROPRIATION/PROGRAM RECEIPTS	3,003,005	50.7
TOTAL	\$5,926,663	100.0 percent

FY 99 research funding

Grants and Special Funds; July 1, 1998–June 30, 1999

National Science Foundation

Chien-Lu Ping	Winter C-flux in arctic ecosystems
John Yarie	LTER: Successional processes in taiga forests of Interior Alaska
John Yarie, Dave Valentine	The role of wildfire in Alaska
Dave Verbyla, Elena Sparrow	Global plant waves

United States Department of Agriculture

Jenifer McBeath	Cooperative agriculture pest survey
Chien-Lu Ping	Wet soils monitoring studies in Alaska; (<i>SCS funding also</i>)
Chien-Lu Ping	Carbon storage in subarctic soils
Tricia Wurtz	Spruce and alder interactions

University of Alaska Natural Resources Fund

Stephen Sparrow	Continuation of a program in plant breeding and genetics
Pat Holloway	A plant propagation system for horticulture, forestry and phytoremediation in Alaska
Carol E. Lewis, Robert Trent	UA-MIT partnership
Jenifer McBeath	Support of potato industry in AK
Jenifer H. McBeath, Meriam Karlsson ..	Cultivation of ginseng in AK
Jenifer H. McBeath, Meriam Karlsson ..	Cultivation of ginseng, chavanbeimu, and huanggi in Alaska
Glenn Juday	Study of recent climatic stress on white spruce
Edmond C. Packee	Establishment of permanent sample plots
Edmond C. Packee	Initial forest stand density and wood quality attributes
Stephen Sparrow, Carol E. Lewis	Alaska hosts the third circumpolar agricultural conference
Stephen Sparrow	Agronomic and economic evaluation of forage crops for AK
Greg Finstad	Heavy metal concentrations in reindeer and caribou tissue
Meriam Karlsson	Light quality for off-season raspberry production
Meriam Karlsson, Jenifer H. McBeath ..	Evaluating ginsenosides in ginseng produced in AK
Edmond C. Packee	Continuous forest inventory
Don Carling	Late blight disease of potato
Glenn Juday	Development and calibration of SKOG

AK Department of Natural Resources

Tobi Campanella	Forestry students
Pat Holloway	Mulches for tree planting in Alaska landscapes
Jenifer H. McBeath	Virus free seed potatoes
Jenifer H. McBeath	Produce certification
Stephen Sparrow, Carol E. Lewis	Third Circumpolar Agricultural Conference

UA International Arctic Research Center (IARC)

Elena Sparrow	GLOBE: Global change education for K-12 students
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Bedding Plants Foundation, Inc.

Meriam Karlsson	Light intensity and temperature requirements for flowering and development of <i>Ranunculus</i>
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National Biological Survey — Chien-Lu Ping Rock Creek water quality

USDA Forest Service — John Yarie Forestry research

Environmental Protection Agency — Elena Sparrow Global change environmental education project

University of Nebraska Lincoln — David Valentine Modeling of methane

AK Science and Technology Foundation — Jenifer H. McBeath Seed potato

U.S. Army Corps of Engineers — Tobi Campanella Chena Lakes project

University of Alaska Foundation — Pat Holloway Georgeson Botanical Garden

Larry Burke Experimental farm

Sea Grant — Harry Bader Study design and field implementation protocols for the development of scientific evidence

37

- World Bank** — Harry Bader Bosnia forest damage
- NOAA/Technology Planning and Management Corp** — Harry Bader Analysis and synthesis support: socioeconomic characterization of Kachemak Bay, AK
- Kawerak, BIA** — Harry Bader, Greg Finstad Legal restraints in response to reindeer-caribou competition and commingling on the Seward Peninsula
- Fairbanks Private Industry Council** — Pat Holloway Summer youth employment
- Cornell University** — Meriam Karlsson Raspberry production
- Fred Gloeckner Foundation, Inc.** — Meriam Karlsson Day and night temperature requirements for cyclamen
- Fitzgerald Family Foundation** — D. Maddux, C. Knight Wastewater treatment in rural villages
- M.J. Murdock Charitable Trust** — D. Maddux, C. Knight Rural wastewater treatment study
- U.S. Geological Survey** — Glenn Juday Dendrochronological studies in national parks in Alaska
- U.S.G.S., AK Biological Center** — Dot Helm Ecological monitoring
- University of Montana** — David Verbyla EOS applications for AK natural resources management
- U.S. Fish and Wildlife** — David Verbyla Radar remote sensing of alluvial habitat
- David Verbyla Synthetic aperture radar
- Usibelli Coal Mine, Inc.** — Dot Helm Wishbone Hill revegetation plot monitoring
- Dot Helm Healy Valley pre-mining inventory
- Dot Helm Revegetation studies on Two Bull Ridge
- USDA-CSREES** — Donald Carling Screening accession of *Solanum* ssp.
- Donald Carling Alaska's NAPIAP program
- Fredric Husby, G. Allen Mitchell Dairy research
- G. Allen Mitchell Potato cultivars
- Stephen Sparrow SARE, no-till forage establishment to improve soil and water conservation

Formula Funds

Hatch General; USDA

- Harry Bader Comparative legal analysis of private property use and regulation in the rural U.S.
- Michael Panciera Maximizing forage quality at northern latitudes
- Chien-Lu Ping Hydric soil properties of permafrost-affected soils
- Stephen Sparrow Tillage and crop residue management effects on properties of a subarctic soil
- G. Allen Mitchell Palmer administration
- Meriam Karlsson Environmental plant physiology of greenhouse produced crops
- Carol E. Lewis Marketing Alaska's agricultural and processed seafood products
- Charlie Knight Alternative crops for the subarctic
- Don Carling Evaluation of production practices, cultivars, and some diseases of potato and vegetables
- Pat Holloway Horticulture crop production for AK
- Joshua Greenberg Regional economic modeling for rural AK
- Drew Shain Raised reindeer
- Susan Todd Resource Planning

Hatch Regional; USDA

- Fredric Husby Characteristics and feed value of barley and western protein supplements for swine
- G. Allen Mitchell Regional research planning and coordination, western region
- Jenifer McBeath Biological suppression of soilborne plant pathogens

McIntire-Stennis; USDA

- John D. Fox, Jr. Simulating the effects of forest harvest on soil freezing and thawing
- Edmond Packee Tree species growth and yield and site productivity of the Alaska northern forest
- Dot Helm Ecosystem for establishment of woody plants on disturbed lands
- Dave Verbyla Development of an Alaskan AVHRR wildland fire detection and mapping system
- Glenn Juday Forest biodiversity resources in AK: Identification, monitoring, strategies for management
- John Yarie Mechanisms of change in forest floor decomposition, element supply in successional forests of AK

Achievements, activities, news

Congratulations: 1999 B.S. Graduates

Stacy K. Clark, Anthony J. Drohan, Craig L. Fleener, Melissa S. Johnson, Rebecca A. Kellyhouse, Timothy A. Lauder, Thomas C. McMillen, Shawn F. Osborne, Courtney C. Richards, David G. Sanders, Susanne E. Trillhouse, Daniel G. Valentine

Congratulations: 1999 M.S. Graduates

Stephen H. Boles, Kory R. Cease, Brian S. Glaspell, Holly A. Jewkes

Congratualtions: 1999 Ph.D. Graduates

Frederick Foster, "Mapping Impacts of Education for Wilderness Management Planning"; Donald D. Pendergrast, "Evaluating Interpretive Services"

Retirements

Mary Boyd retired from the Agricultural and Forestry Experiment Station's Palmer Research Center after 33 years of service. She provided both administrative and field support for horticulture research in both the federal program of Dr. Curtis Dearborn and later for the university program of Dr. Don Carling. Mary is staying active with flower gardening, fishing, and working as the volunteer secretary at her church. She capped her retirement this summer with a trip to Ireland.

Keith Magoon retired from the Agricultural and Forestry Experiment Station's Palmer Research Center after five years of service. Mr. Magoon provided technical field support for the small grain breeding program of Dr. Steve Dofing. He plans to move to Oregon and pursue his interest with dogs, and perhaps farming

alternative crops for niche markets.

New Faculty Profile

Milan Shipka has joined the faculty of the School of Agriculture and Land Resources Management as an Assistant Professor of Animal Science. He and his wife Nancy, who now works as a teacher with the Fairbanks public school system, made the move to Fairbanks this summer. They have two daughters, Nikole and Molly, who attend Colorado State University.

Before coming to Alaska, Dr. Shipka was at Utah State University in Logan, Utah, where he was the director of the Caine Dairy Teaching & Research Center. Originally from northern Minnesota, he says that while Alaska has much in common with other northern states, it provides a unique opportunity to work with livestock production on a smaller scale.



Agriculture Appreciation Day

The Matanuska Experiment Farm was the site of Agriculture Appreciation Day on July 24, 1999. Despite persistent light rain, upwards of a thousand people enjoyed the music, games, farm tours, and free barbecue.

The annual event showcases agriculture in Alaska and is sponsored by the Agricultural and Forestry Experiment Station and the Alaska Cooperative Extension, as well as a number of local organizations.



Public Day at Georgeson Botanical Garden

The Fairbanks-area public turned out in force for a "Day at the Georgeson Botanical Garden" on July 17, 1999. Several hundred people attended the event, which included farm and garden tours, and a variety of activities and crafts hosted by local teens in conjunction with 4-H.





Every future farmer should own one of these. This pint-sized tractor was displayed by the Antique Power Club of Alaska during the 1999 Agriculture Appreciation Day in Palmer.