

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

Vol. 32, No. 2: The Annual Report

Fall 2000



June 30, 2000

The Honorable Tony Knowles
Governor of Alaska
P.O. Box 110001
Juneau, Alaska 99811-0001

Dear Sir:



2 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, 1999. 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,

G. Allen Mitchell
Acting 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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About the cover: *Delphinium*, or larkspur, is a commonly-planted ornamental in Alaska, grown in gardens and roadside beautification projects. Larkspur also grows wild in the state. *Georgeson Botanical Garden photo by Cal White*

Back cover: The Fairbanks Experiment Farm has nearly 300 acres of research fields for agricultural and forestry research, and currently maintains a reindeer herd used in animal science research. Smith Lake appears in the upper part of the photo. *AFES file photo*

Can mulch mats help regenerate beetle-killed spruce forests?

Tricia L. Wurtz and Wade W. Wahrenbrock

Over the past fifteen years, three million acres of south-central Alaska and Kenai Peninsula forests have been infested with spruce beetles (*Dendroctonus rufipennis*) (van Hees and Larson 1991). It has been called the largest insect infestation in recorded history (Packee 1997). In some areas, such as around the town of Homer, mortality of spruce trees ranges from 90% to 100%. Foresters seeking to regenerate these forests face a large and complex job.

One of their biggest obstacles is the grass *Calamagrostis canadensis*, commonly known as blue-joint. Small amounts of this grass occur naturally in the understory of Alaska's white spruce (*Picea glauca*) forests (Reynolds 1990, Viereck and others 1992). In small amounts, *Calamagrostis* is not problematic for forest managers. But if the tree canopy opens up, either as a result of beetle infestation or another disturbance such as timber harvest, *Calamagrostis* spreads aggressively. In only two or three years, it can account for 80% of the plant cover present and grow to be six feet tall. It competes aggressively with slow-growing spruce seedlings. In autumn, when the grass dies back, it can effectively bury the seedlings beneath it, a phenomenon known as snow-press. Thousands of acres of the Kenai peninsula are now dominated by *Calamagrostis* growing in dense stands beneath a forest of dead and dying white spruce (fig. 1).

Though grass-dominated sites can be converted to stands of young trees by mechanical site preparation, broadcast burning and herbicide applications (Newton and Cole 1987), all these methods have



Figure 1. Much of the Kenai Peninsula now supports dense stands of *Calamagrostis* beneath dead and dying spruce trees.

their limitations. *Calamagrostis* readily survives all but the most severe fires and will rapidly recolonize burned sites. At the same time, many people object to herbicide use on public lands. The purpose of the present study was to investigate a new option: fabric and plastic mulch mats.

Mulch mats have been used extensively in agriculture for many years (Clarkson and Frazier 1957, Mattheke and Holloway 2000) but have only been marketed for reforestation applications since the early 1990s. Mulch mats control the growth of competing vegetation in the area immediately surrounding planted seedlings, typically allow water to pass through them, and can improve the moisture and temperature conditions of the soil. They are installed over newly planted seedlings. They are

Table 1. Four different mat types and sizes tested.

	Black, woven plastic			Arbortec "Brush Blankets"		Burlap	
Material	High UV-stabilized polypropylene			IRT-76 plastic		Burlap	
Advertised benefits	Water permeable, long-lasting			Suppresses weed growth like black plastic, but allows for soil warming like clear plastic. "Microperforations" allow water and air passage.		water permeable, biodegradeable	
Available sizes	2'x2'*	4'x4'*	6'x6'	1m x1m*	2'x2'	18"x18"	2'x2'*
Cost per 1000 ¹	\$420	\$1270	\$2400	\$328	\$204	\$380	\$420
Cost of staples needed per 1000 mats ¹	\$189	\$265	\$265	\$212	\$212	\$189	\$189
Sold by:	International Reforestaton Suppliers, Eugene, OR			Arbortec Industries, Penticton, BC Canada		Rusher's Services, Wasilla, AK	

¹1992 prices.

* The sizes used in this study

then fastened to the ground with wire landscape staples or wooden stakes.

Early results from trials of mulch mats were promising. For example, on the Klamath National Forest in northern California, 190,000 mats were installed around planted Douglas-fir and Ponderosa pine seedlings on a dry, grass-dominated site in 1990 (Blessing 1991). Mats measuring 4 ft by 4 ft increased first-year seedling survival from 4% to 75%. While unmatted seedlings grew about 15% in height and increased in diameter by as much as 23%, matted seedlings increased in height by 57% and increased in diameter from 23% to 55%. Results such as these, and the need to address Alaska's backlog of unregenerated lands, led to the present study.

Methods

We installed plantations at five locations near Soldotna, Alaska, during the summer of 1991. All five sites supported well-established *Calamagrostis* growing in mixtures with variable amounts of beetle-infested white spruce. A pulaski was used to hand-scarify a one-foot-square area to a depth of 3 to 4 inches, and nursery-grown white spruce seedlings were planted in the scarified areas. We used two types of containerized planting stock: seedlings grown for one year at the nursery (1-0 stock) and seedlings that had spent two years at the nursery (2-0). Foresters sometimes use the larger, two-year-old stock in difficult reforestation situations (Cole and others 1999).

Mulch mats were installed around the seedlings and secured to the ground with wire landscape staples (fig. 2). Four different mat types and sizes were tested in this study (table 1). The survival and growth of the seedlings was followed for five growing seasons.

Results

Mat installation and persistence

All the mats used in this study were time-consuming to install, with the larger-sized mats being especially cumbersome. The IRT-76 material was thin and fragile; care was needed to avoid tearing it during installation. Though all types of mat prevented snow-pressure following the first growing season (fig. 3), grass shoots were observed growing up through the burlap mats the following spring. Within five years, many of the burlap mats had decomposed substantially, while the mats made of synthetic material had degraded very little.

Seedling survival, growth, and vigor

Over five years, the mats used in this study had little effect on spruce survival or growth (figs. 4 and 5). The only statistically significant effect occurred in 1-0 planting stock: those with 4 ft by 4 ft black plastic mats grew more in diameter than the unmatted control trees.

Mat cost

The cost of the mats and staples we tested varied from



Figure 2. Seedlings were planted, and mulch mats installed around them, in summer, 1991.



Figure 3. Larger mats prevented the Calamagrostis from covering the seedlings when it died back at the end of the growing season.

\$0.54 to \$1.53 per seedling (Table 1). At the time we began this study, production and shipping of 1-0 containerized seedlings averaged about \$0.18 per tree in Alaska (Maisch and others 1994). Thus, including 4 ft by 4 ft mats in a plantation would increase the material costs by more than 800%. Add to that a substantial, though undocumented, cost of installation. We estimate that including mulch mats in a tree plantation would triple its installation time.

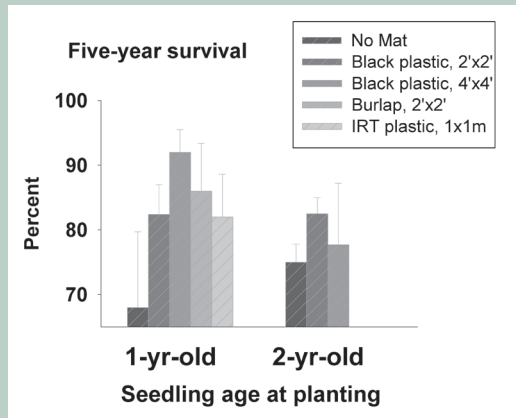


Figure 4. Survival over five years of seedlings planted with four different types of mulch mats on the Kenai Peninsula.

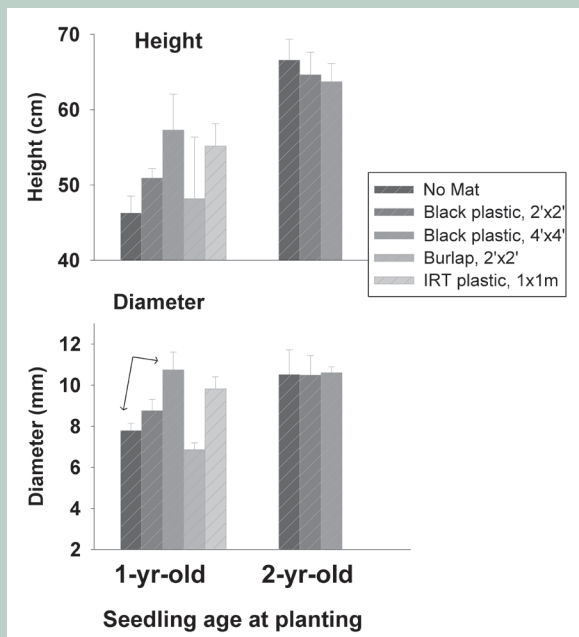


Figure 5. Total height and stem diameter at the soil surface after five growing seasons. Seedlings grown in the nursery for two years are larger at planting than those kept in the nursery for a single year. Arrow indicates the only statistically significant difference.

Discussion

The commercial introduction of mulch mats for forestry applications in the early 1990s prompted our study and several others around the country. Many of these projects have since been summarized by Windell and Haywood (1996). The results are largely consistent with the results presented here: larger mats are more effective than smaller ones. On many sites, only mats 4 ft by 4 ft in size *or larger* have a significant effect on seedling growth or survival. For example, McDonald and Fiddler (1993) compared mats as large as 3x3m with smaller mats and with unmatted controls in a ponderosa pine plantation

in Sequoia National Forest. After five years, only the 3 m by 3 m mats led to a significant increase in growth. In general, as the size of a mulch mat increases, its biological effectiveness improves, its cost rises, and its handling and installation become more difficult (Windell and Haywood 1996).

In our study, the largest mats led to only a modest increase in diameter growth. Mats had no effect on height growth or survival. Considering their substantial cost and the low stumpage value of Alaska's white spruce timber, mulch mats are unfeasible for forestry applications in Alaska under the conditions tested in this study. The use of mulch mats may be justified in limited, high-value locations, when other methods such as mechanical scarification have been ruled out.

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Research Achievements



Reindeer educational outreach

Objective: We implemented an educational outreach program in 1998 for Fairbanks schools, to increase awareness of reindeer research and the reindeer industry in the state of Alaska. We continued the program in 1999.

Approach: We begin our presentations with a slide show on the history of reindeer introduction to Alaska, reindeer biology and current herding practices. Afterwards, we conduct a "hands-on" session, using props, to reinforce facts presented during the slide show and to set the stage for an informal question and answer session. In Fairbanks-area schools, we also introduce Elsa, the tamest of 17 reindeer maintained by the Reindeer Research Program at the UAF campus.

Progress: In 1999, we expanded the educational outreach program to include schools in communities on the Seward Peninsula, where the majority of Alaska's estimated 20,000 reindeer roam. We gave presentations to grades K-12 in the community of White Mountain. Many students there have attended reindeer corrallings and are able to contribute their experiences to the discussions. We also again visited several Fairbanks schools.

Impact: Many students have studied northern ungulates in the portion of the school curriculum dealing with Alaska animals. Our educational outreach program seeks to augment their curriculum by introducing students to the research and economic activities supported by reindeer in the state. In 2000 we plan to be accompanied by a reindeer during presentations to Nome area schools.

•Maria Berger

Reindeer range on the Seward Peninsula

Objective: We expanded our evaluation of reindeer forage plants in 1999. Our goal is to enhance understanding of reindeer habitat and forage choices, by incorporating data on biomass of each forage plant species available seasonally in different habitats.

Approach: Habitats providing important summer forage for reindeer and accessible from the road system were delineated on the Seward Peninsula reindeer range map. Prior to greenup, we randomly established transects in discrete stands within each habitat type. We positioned data loggers monitoring

growing-degree days in the vicinity of each transect. During each sampling bout, we randomly chose five locations along each transect. Major reindeer forages were clipped and bagged for later oven drying and weighing. Following weighing, plants were analyzed for nitrogen, fiber and mineral concentrations.

Progress: During 1999, a total of 12 transects representing five habitat types were sampled throughout the growing season (early June to mid-August) to document changes in biomass (usually of six to eight major forage plant species). Four bouts of sampling were completed. We anticipate sampling additional habitats during 2000, while maintaining some of the 1999 sites to compare production among years.

Impact: Reindeer are highly attuned to changes in forage plant availability and quality. We plan to continue this line of research for several growing seasons, to ultimately document seasonal biomass changes of forage plants in 15 major summer foraging habitats.

•Maria Berger

Metam sodium for weed control

Objective: High rates of metam sodium can eliminate weed seeds from soil but vegetable growers have not adopted this practice. The primary reason for grower reluctance appears to be the high cost of treatment. More grower interest has been shown in using lower rates incorporated into the uppermost layer of the soil profile

Approach: Metam sodium at rates of 0, 47, 94, 140, 187, 234, or 468 L/H was applied to plots in a replicated field trial in 1999. The metam sodium was tilled into the top 8-10 cm of soil with a rototiller, followed by a packer/roller.

Progress: Two weeks after application (to allow time for the poison gas to dissipate), 30-day-old lettuce seedlings were transplanted into each plot. Lettuce plants were observed for symptoms of phytotoxicity and comparative weed development was monitored. Although there was a slight delay in weed seed emergence at the higher rates of application, by mid-August all plots were more than 90% covered with weeds. The lower three rates were probably too low to effect any measurable weed control, but the higher rates were expected to show some positive effect. It is not clear why this effect was not observed.

Impact: At the edges of plots where metam sodium was applied but not tilled in, a more effective killing of surface weeds was observed. It may be that surface applications of metam sodium to the surface of properly prepared soil will prove to be an effective method for controlling weeds on an annual basis.

•Donald E. Carling

Potato germplasm evaluation

Objective: This study identifies sources of resistance to potato disease that may be used in future traditional and molecular breeding programs.

Approach: One hundred eighty lines of potato provided by the Potato Germplasm Bank in Sturgeon Bay, Wisconsin and representing 15 species of *Solanum*, 160 clones and 20 commercial varieties were screened for resistance to Black Scurf disease of potato caused by the plant pathogenic fungus *Rhizoctonia solani*. The screening was conducted in the field and consisted of determining the relative tolerance of the 180 lines. Generally speaking, commercial varieties were used as controls. Although most lines appear to be highly sensitive to *R. solani*, some appear to possess at least a moderate level of resistance.

•Donald E. Carling

Effect of packing on tuber greening

Progress: The primary source of gradeout in the potato variety Russet Norkotah is greening. It was hypothesized that elimination of the packing of the planted row may reduce the amount of green tubers produced. Treatments included replicated packed and non-packed plots. Preliminary evidence suggests that packing may contribute to greening, but that Russet Norkotah is prone to this problem because of shallow set and generally small vines. This study will be repeated in the 2000 growing season.

•Donald E. Carling

Potato variety trials

Progress: Comparative yields of thirty cultivars of potatoes were tested in an irrigated field trial in 1999. For the second year running, these trials have not included a nonirrigated dimension. The 1999 growing season in southcentral Alaska was a good one for potato production. Emerging plants were seen before June 1, 1999. Later in the season there were many cloudy, misty days of the type conducive to late blight development. However, no late blight was observed. Average total yield of the thirty cultivars tested was 19.5 tons per acre and the average US#1 yield was 16.1 tons per acre. Top cultivars in total yield included Chieftain (24.0 tons per acre), Superior (23.2 tons per acre) and IditaRed (22.6 tons per acre) whereas the cultivars with the highest US#1 yield included Superior (20.3 tons per acre), Chieftain (19.7 tons per acre) and Hilite Russet (19.3 tons per acre). The Siberian variety Kameronovskii was among the top producers with a US#1 yield of 18.9 tons per acre and a total yield of 22.5 tons per acre. Kameronovskii and other varieties originating in Russia will be tested again in 2000.

•Donald E. Carling

Russet Norkotah evaluation

In a continuation of a 1998 study, yields of line selections and other seed sources of Russet Norkotah

were compared in a replicated field trial in 1999. A total of 18 treatments were tested, including lines from Colorado, Texas, and Montana, and sources from New York, Alberta and Alaska. Total yields ranged from 15.9 to 24.3 tons per acre and US#1 yields ranged from 13.7 to 21.4 tons per acre. The top yielding treatment was a line selection from Colorado (21.4 tons per acre US#1 and 24.3 tons per acre total yield) with line selections from Texas and New York yielding somewhat less. The tuber type of the top yielding Colorado line selections was somewhat more varied than any other treatments. Percent #1 and specific gravity levels were uniform across treatments.

•Donald E. Carling

Rangifer species tissues sampled

Objective: The people on the Seward Peninsula live a subsistence lifestyle where a high percentage of their diet comes from local plants and animals. The people in the villages are particularly concerned that contaminants from air pollution (arctic haze), mining operations, and dumpsites are concentrating in the tissue of subsistence animals and pose a health risk.

Approach: Personnel from the Reindeer Research Project will attend reindeer slaughters for six different herds on the Seward Peninsula during the winters of 1998-1999. We will also collect tissue samples from animals killed during village hunting activities. Soft tissue samples consisting of kidney cortex, liver and neck meat will be collected using sterile techniques. Antlers will be removed from the skulls of killed animals using a bone saw. Samples will be sent to the plant and animal laboratory in Palmer for cesium, cadmium, lead, zinc, and iron analyses.

Progress: Preliminary data suggests that concentrations of potentially harmful heavy metals are much lower in reindeer tissue from the Seward Peninsula than levels found in other circumpolar reindeer and caribou herds, and pose no health risk. Tissue samples from western arctic caribou are presently being analyzed.

Impact: Little information on the potential for environmental contamination of subsistence foodstuffs exists for the Seward Peninsula. This project is a preliminary survey of possible contamination, which will be used to determine whether a more detailed examination of subsistence foodstuffs is necessary.

•Greg Finstad, P. Terzi, M. Berger, and T. Nichols

Climate and caribou range extension

Objective: Since 1976 the Western Arctic Caribou Herd has increased from 75,000 animals to the present level of 485,000. During this time, seasonal migratory pathways of the WACH have shifted westward onto traditional reindeer ranges of the Seward Peninsula. Now, with the range extension and the subsequent increased grazing pressure, species composition of the plant communities are

likely to be altered dramatically.

Approach: The extent of lichen biomass removal by caribou was monitored in 1999 by two exclosures in place on the Fish River Flats. Weather data was collected in 1999 at two locations associated with the Fish River Flats grazing system. The weather stations were built on the coast near Golovin. The construction was a collaborative effort between the UAF Reindeer Research Program, the UAF Long Term Ecological Research program, Kawerak, and the USDA Natural Resource Conservation Service. The weather data is sent to the Natural Resource Conservation Service (NRCS) office in Anchorage where the data is publicly posted on the NRCS web page.

Progress: Data for lichen productivity, biomass removal by caribou, and weather data was collected during 1999. Additional years of data are needed to establish trends in climate and caribou grazing patterns.

Impact: The intensity of grazing and its effects on vegetation communities may be ameliorated or exacerbated by climatic conditions. Monitoring the interaction between climate and grazing will provide researchers, land managers, and reindeer herders with basic knowledge to understand the consequences of disturbance on arctic ecosystems.

•Greg Finstad and Knut Kielland

Quality forage at northern latitudes

Objective: High quality forages for dairy cattle nutrition remains a high priority for Alaska dairy farmers. We are evaluating management practices including no-till establishment, harvest timing, and grass-legume mixtures for long-term persistence and quality.

Approach: Perennial forage grass and legume varieties were established at two locations in Alaska using various seeding rates and tillage methods including no-till establishment. Grass-legume mixtures as affected by seeding rate and N application were evaluated for yield, quality, and persistence.

Progress: The 1997 no-till annual legume study was not harvested in 1999 due to severe weed infestation. A clover variety trial that was no-till seeded in 1997 indicated high potential yields following no-till establishment. Red clover varieties generally yielded more than alsike or white clover varieties. Legume and grass variety trials established in 1993 produced a range of yields with timothy, reed canary grass, and red clovers being the largest producers. This indicates potential for long-term persistence and high yields for perennial forage crops in suitable locations in southcentral Alaska. A seeding rate and N application study with interseeded red clover and reed canary grass was initiated in 1999. Total yield was not affected by red clover seeding rate; but canary grass had a maximum yield of 1.4 tons/A at 10 lb/A seeding rate. This data

supports current recommendations. Effects of red clover seeding rate will be evaluated in subsequent years.

Impact: This study will benefit Alaska dairy and hay farmers by determining minimum tillage techniques for forage establishment under dry spring conditions. Production systems being developed could greatly increase hay/silage yield and protein content of dairy diets at Point MacKenzie and reduce off-farm costs.

•Ray Gavlak, Steve Sparrow and Beth Tillman

Usibelli revegetation studies

Objective: This study evaluates plant species and growth media for revegetation of a new mine site at Usibelli Coal Mine.

Approach: Usibelli Mine funded a study beginning in 1991 to evaluate growth media and plant species on a backfilled test pit. The six growth media included three mineral substrates: A and B soil horizons (Atopsoil), sandstone (simulated overburden), and a mix of the two. These three materials were also mixed with an organic mat. A fertilizer frequency study was initiated in 1995 by fertilizing during years 1; 1 and 2; 1 and 3; and 1, 2, and 3.

Progress: Norcoast Bering hairgrass, a cultivar developed at the Agricultural and Forestry Experiment Station, grew better than other species on the once-fertilized 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 refertilized.

Sandstone materials were a better growth media than the topsoil material for the first two years under these growing conditions. During the third year, no significant differences were detected, and beyond the fourth year, the topsoil materials appeared better.

In the fertilizer frequency study, fertilizing at least two years was better than one fertilization, but which years made little difference.

Impact: This study provided the mine company with much-needed information as to what plant species and growth media to use on a new mine site with different aspect and soil materials compared to prior sites.

•Dot Helm

Woody plants on disturbed lands

Objective: This study evaluates combinations of plant species and growth media to achieve wildlife habitat, slope stabilization, and plant diversity on a proposed mine site in the Matanuska Valley Moose Range.

Approach: Rooted cuttings or seedlings of seven woody plant species were selected for availability, ease of propagation, and suitability for moose habitat and were evaluated on four growth media selected for their biological properties (seed, rhizome, and soil

microorganism banks) beginning in 1989. Grass trials were also conducted to evaluate cultivars that could control surface erosion and undesirable colonizers, and that would not compete with woody transplants and desirable colonizers. All sites were fenced except the upland meadow to protect the plants from moose browsing during establishment.

Progress: After 10 years, plant growth was best on the paper birch–white spruce site. The combination of browsing plus acid topsoils resulted in poor growth for the poplar and feltleaf willow on the upland meadow site, but the Barclay willow was still vigorous despite the browsing.

Woody transplants have grown sufficiently to overcome most competition from bluejoint regenerating from rhizomes. Species composition was similar between unseeded and seeded plots after 10 years. Woody seedling colonization was greatest on the paper birch–white spruce site and least on the lowland meadow site.

Most seeded species had virtually disappeared by year 7, suggesting that they do not impede natural colonization in the long term. Only Nortran tufted hairgrass and a mix of it with Arctared red fescue were still visible after 10 years, although the seeded species are decreasing in vigor.

Impact: Knowing that upland willows are more tolerant of browsing and acid topsoils is important for revegetation of this potential mine site. This study also demonstrates that grasses could be used for erosion control without seriously affecting native colonization on topsoiled sites. Also, when rooted cuttings or seedlings of woody species are planted, the successional pathway could be altered to desired woody communities within a few years.

•Dot Helm

Recovery following a prescribed burn

Objective: This study characterizes ectomycorrhizae by substrate in black spruce and mixed hardwood forests before and after a prescribed burn.

Approach: Frostfire was a prescribed burn in the Caribou-Poker Creek watershed in July 1999. This watershed is dominated by black spruce and mixed hardwood forests. Fire alters vegetation and microbial communities through changes in soil and environmental characteristics. Mycorrhizae are symbioses among plants 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. Understanding the post-fire recovery will depend on documenting pre-fire plant–mycorrhizal relationships, then following mycorrhizal succession over time.

Progress: We used a cylindrical corer to collect roots from hardwood (paper birch, aspen) and black

spruce communities inside and outside (control) the proposed burn site in June and August 1998 and June 1999 prior to the fire, and August 1999 after the fire. The samples were divided by obvious horizons in the substrate, although this differed among the sites. The roots will be washed free of soil and organic material in the laboratory, then the mycorrhizae are described and the mycorrhizal communities quantified on sites before and after the burn.

Impact: Understanding the types of ectomycorrhizal fungi that colonize after fire and the types of substrates they may use may help identify fungi suitable for revegetation or bioremediation applications.

•Dot Helm

Mineralization of organic matter

Objective: We examined the mineralization of nitrogen from silt loam soils amended with three forms of organic matter commonly used in garden soils, to learn about the rate of degradation of organic matter and whether enough nitrogen was released to benefit plant growth during the first year.

Approach: Fresh grass clippings, horse manure and Lemeta peat were incorporated into Fairbanks silt loam soils at a rate of 10% by volume. Soils were moistened and sealed into 1.5 mil plastic bags, then buried to a depth of 6 inches at the Fairbanks Experiment Farm. Bags were removed at weekly intervals from June 20 through September. Soils were dried and analyzed for total carbon, available ammonium and nitrate nitrogen.

Progress: Nitrogen levels decreased when fresh horse manure was incorporated into the garden soils. Peat-amended soils had a slight increase in available nitrogen, but not enough to benefit plant growth. Grass clippings decomposed rapidly and showed an increasing level of available nitrogen as the season progressed.

Impact: This study showed that even in subarctic cold soils, microbial breakdown of grass clippings can benefit garden soils during the first year.

•Katherine Mohrmann and Patricia Holloway

Sweet corn at cold temperatures

Objective: We explored whether nutrients, especially phosphorus, would improve germination of sweet corn grown at cold temperatures.

Approach: Seeds of sweet corn Yukon Chief were germinated hydroponically in rag doll germination tests. A one-week pretreatment at 70 °F or 50 °F was followed by 70 °F treatment until germinated. The 50 °F pretreatment was used to simulate cold soil conditions during the first stages of seed germination. Seeds were germinated in solutions of distilled water, a complete nutrient solution (Hoaglands full strength), or in Hoaglands solutions containing varying levels of phosphorus.

Progress: Seeds and seedlings showed no response to any nutrient levels within the first two

weeks of germination. Seedlings grew as well with fertilizer as they did without any nutrients added to the distilled water. The total weight of the two-week-old seedlings was less than the seed. This shows that corn seedlings use the stored nutrients within the seed rather than taking anything from the surroundings during the first two weeks of growth.

Impact: A soluble booster fertilizer applied at sowing will have no impact on seed germination or seedling establishment.

•Tristan Wagner and Patricia Holloway

Alaska wildflowers

Progress: We grew five Alaska wildflowers (forget-me-not, arnica, great burnet, Jacobs ladder and beautiful Jacobs ladder in 200-cell plug trays using two forms of nitrogen fertilizer: ammonium, nitrate, and a combination of the two at a total N level of 150 mg/l. We measured dry weight and leaf unfolding rates of the seedlings for eight weeks to determine which nitrogen source was best for seedling establishment.

Impact: Seedlings of all species grew equally well with ammonium or nitrate nitrogen or a combination of the two. Therefore, greenhouse growers do not need special fertilizers for the propagation of these wildflowers. Sources used for other bedding plants should work well.

•Brittany Bowers and Patricia Holloway

Cabbage, Broccoli and Carrot Trials

Objective: Eleven varieties of broccoli, thirteen cabbage and fifteen carrot varieties were grown at the Georgeson Botanical Garden to identify the best varieties for home and market gardens in the Fairbanks area.

Approach: Cabbage and broccoli varieties were grown as seedling transplants in the greenhouse and were transplanted into rows. Carrots were direct seeded into the garden. Plots were irrigated as needed throughout the summer until harvest.

Progress: Shogun broccoli outyielded all other varieties. Everest and Marathon produced an average 1.4 lb head, whereas all other varieties averaged 1 lb heads (Green Comet, Paragon, Saga, Early Dividend, Emperor, Everest, Marathon, Eureka, Green Valiant, Arcadia, Shogun). We can recommend all varieties tested for Interior Alaska gardens.

The earliest cabbage to mature was Savoy Express. Only one variety, Cardinal Red, cannot be recommended because it is susceptible to rot and has lower head density. Acceptable varieties listed in order of head weight are: Red Lasso, Dynamo, Red Express, Red Royale, Ruby Ball, Red Rookie, Sombrero Red, Red Acre, Red Jewel, Primax, Savoy Express, and Earliana.

All carrot varieties yielded well for their type and all may be recommended for Interior gardens. Baby Sweet yielded 2.3 lb per foot of row. All other

varieties yielded 1.0-1.5 lb per foot. Varieties included Baby Sweet, Little Finger, Minicor, Baby Orange, Royal Chantenay, Gold King, Ingot, Nelson, Scarlet Nantes, Sweetness II Sweetness, Touchon Deluxe, Gold Pak, and Thumbelina. Based on taste evaluations, Nelson was preferred for appearance and flavor over all carrot varieties.

•Grant Matheke, P. Holloway and C.E. Lewis

Greenhouse raspberry production

Objective: The focus of this project is to develop cultural and pest management practices to optimize raspberry production in northern greenhouses. Recent developments in year-round availability of bumble bees for pollination and biological controls for pest management make greenhouse production of exceptionally high quality raspberries possible. A more detailed understanding of raspberry flowering and fruiting is required to best utilize the resources of heat, light and biological pest control in various greenhouse systems.

Approach: We are developing cultural and pest management practices to optimize greenhouse raspberry production. By holding dormant plants in cold storage and bringing them out at staggered intervals for greenhouse forcing, raspberries can be made to ripen outside of the normal growing season.

Progress: We have determined that the cold requirement for proper flowering in the raspberry variety 'Tulemeen' can be satisfied with 1000 hours at 40 °F. We are also evaluating the opportunity to have single cane plants shipped from Washington or California for immediate greenhouse production. Handling and management are much easier with those plants and the production is similar to that of traditional multi-cane raspberry plants.

Impact: The shelf life of raspberries is extremely short and fresh raspberries flown in are often of poor quality. Identifying techniques that allow local early and off-season production would allow marketing of fresh raspberries to restaurants, grocery stores or directly to the consumers.

•Meriam Karlsson and Jeffrey Werner

Flowering forget-me-not

Objective: Local flower shops are continuously receiving requests for the state flower, forget-me-not (*Myosotis* sp.). Commercial availability of forget-me-not flowers is highly limited due to the short keeping quality and the lack of production guidelines and procedures for proper post-harvest handling. Suitable guidelines for forcing and flowering need to be developed.

Approach: Seeds of forget-me-not from several sources were germinated and seedlings were transplanted into four-inch pots. Nine weeks from seedling, the temperature was dropped to 42 °F. Plants were brought out three, six, nine or twelve weeks later and grown at 60 °F.

Progress: Flowers appeared faster with a longer cold period. Increasing the cold from three to six weeks reduced time to flower by two weeks. Another three weeks of chilling reduced flowering time seven more days and twelve weeks of chilling, another seven days. On average, 21 days were required at 60 °F for the appearance of the first flowers after twelve weeks of cold. Plants grown at 60 °F throughout without any chilling did not flower during the seven month duration of the experiment. Although the seed was marketed as *Myosotis alpestris*, there were large variations in response to chilling, rate of development and growth habit among the seed sources. Additional work is required to make selections based on growth habit, morphology, and source.

Impact: The strong interest and demand for flowers of forget-me-not provide opportunities for local production of the plants without competition from any other supplier.

•Meriam Karlsson and Jeffrey Werner

Flowering dwarf carnation

Objective: Recent breeding efforts have produced carnations with a dwarf growth habit suitable as bedding plants or for containers. Long days promote flowering and shorter days delay flowering in carnation.

Approach: Two cultivars in the Monarch series of dwarf carnation were grown at 60 °F and either short (9 hour) days or long (16 hour) days.

Progress: 'Monarch Yellow' flowered ten days faster (118 days from seeding) than 'Monarch Purple' under long days. With short days, flowering was delayed ten days in 'Monarch Yellow' and 16 days in 'Monarch Purple' compared to long days. Using ten short days immediately following transplant resulted in more branching and flowers per plant for 'Monarch Yellow' but there was no effect on branching or flowering in 'Monarch Purple'. The ten initial short days did not affect rate of flowering in either cultivar.

Impact: The different response to short days was unexpected since both cultivars are closely related and in the same cultivar series. Experimentation is necessary to predict the response of dwarf carnations to changes in day length.

•Meriam Karlsson and Jeffrey Werner

Flowering cyclamen

Objective: Recommended temperature for cyclamen (Persian violet, Alpine violet) is 68 °F until flower buds appear and then 60 °F. These recommendations were developed for cultivars that have been replaced by more recent selections.

Approach: In this study, cyclamen was grown for three, six or nine weeks at 60 °F or 68 °F and then moved to the other temperature.

Progress: Plant development was faster at 68 °F than 60 °F. Average time from transplant to flower buds was 42 days and to flower 68 days at

68 °F. At 60 °F, flower buds and flowering were delayed by 16 days compared to 68 °F. Three weeks at 60 °F resulted in similar flowering time as plants grown at 68 °F for nine weeks. Although flower buds appeared nine days earlier with three initial weeks at 68 °F, flowering occurred at the same time as 60 °F throughout.

Impact: The recommended 68 °F appears suitable for fast and complete leaf development and flower initiation. The final 60 °F period improves post-harvest quality and enhances flower color without severely affecting time to flower. Temperature guidelines developed for earlier cultivars are still suitable for cyclamen grown today.

•Meriam Karlsson and Jeffrey Werner

Height of black-eyed Susan

Objective: Black-eyed Susan or rudbeckia has been grown as a perennial for many years. *Rudbeckia hirta* usually does not survive cold winters but easily reseeds itself and is therefore often grown as an annual. Several dwarf cultivars are now available of *R. hirta* with plant heights of 10 to 15 inches. Although these cultivars are naturally compact, growth regulators may be required to produce plants proportional to small containers.

Approach: The growth regulator Bonzi (paclobutrazol) or Sumagic (uniconazole) was sprayed on the media surface prior to planting *R. hirta* 'Toto'. The recommended application rate of two quarts solution per 100 square feet was used. The rate was 40 ppm (parts per million) active ingredient for Bonzi and 10 ppm for Sumagic.

Progress: At flowering, Bonzi reduced overall plant height by three inches and Sumagic reduced height by two inches. Compared to a plant spray of the same rate, the Bonzi or Sumagic sprayed on the soil reduced plant height by one additional inch. There was no effect on flowering, branching or number of flowers.

Impact: Applying the growth regulator directly to the surface of the soil medium is an effective technique for producing proportional and high quality potted rudbeckia 'Toto'. This growth regulator application technique should also work well for many other container grown plants.

•Meriam Karlsson and Jeffrey Werner

Turfgrass care and survival

Objective: Turfgrass is very important for Alaska lawns, golf courses, parks, and recreation fields. The principal objectives of this study are to evaluate turfgrass species and varieties for growth and survival; to evaluate various fungicides for control of snowmold and other fungi on turfgrasses; and to compare a seedbed of 100% sand to a mixture by volume of 85% sand and 15% peat

Approach: We have constructed a putting green and planted separate sections of it to 'Nugget'

bluegrass and 'Penncross' bentgrass. On these sections, we have been evaluating fungicides for effectiveness. We have also constructed raised-bed plots with seedbeds of either 100% sand or a sand/peat mixture. These plots are subdivided into 200 subplots. The subplots are planted to 25 types and/or mixtures of turfgrasses.

Progress: Plots were seeded in early August, 1999. All turfgrasses are performing better on the sand than on the sand/peat mix, however, this appears to be related to phosphorus fertilizer availability and may be overcome with different fertilizer applications. Almost all grasses survived the first winter, but the application of fungicides considerably improved winter survival. Nugget bluegrass appears to be providing the best turf at this time.

Impact: This research will be valuable to thousands of homeowners in Alaska as well as golf course and recreational turf managers. Golf courses have become a multi-billion dollar industry in the United States and there are currently over a dozen golf courses in Alaska.

• Charles Knight

Constructed wetlands

Objective: Constructed wetlands are commonly used in more southern climates as biofilters for cleaning up wastewater. They are also very effective as a final treatment of municipal sewage effluent. However, no information is available for constructed wetlands in subarctic areas concerning the type of vegetation that might be used. Our objectives are to evaluate five different genera of plants indigenous to Alaska: *Typha latifolia*, *Menyanthes trifoliata*, *Carex rhynchochrysa*, *Scirpus latifolia* and *Arctophila fulva*.

Approach: In a greenhouse study, 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 analyzed for accumulation of metals. Also, an experimental wetland has been constructed and vegetated with these plant genera. Wastewater effluent from a swine lagoon on the Fairbanks Experiment Farm is being circulated through the constructed wetland and water quality is being monitored before and after treatment.

Progress: The indigenous plants have been very effective in cleaning nutrients and contaminants from the wastewater. Water treatment has been restricted to the summertime (May 15–Sept. 15) when plants are actively growing and icing is not a problem. However, as a low maintenance wastewater purification system, a constructed wetland appears to be adaptable to subarctic conditions.

Impact: Since this project has been started, wetlands have been constructed and information from this research has been used in several areas in Alaska.

• Charles Knight and David Maddux

Tillage methods for cropland

Objective: This study compares four methods of seedbed preparation, three levels of straw removal from the field and four levels of nitrogen fertilization for spring barley production.

Approach: This six-acre tillage study has been continued at the same location near Delta Junction since 1983. Factors monitored include: barley yield, weed populations, soil organic matter content and soil fertility.

Progress: A single disking operation immediately prior to spring planting has been the most effective tillage practice. Under no-till, perennial grassy weeds become so competitive that those plots must be chemically fallowed about every five years. Fall tillage knocks down too much stubble, resulting in loss of snow cover and less soil moisture. Straw removal practices have not yet shown a significant effect on either soil properties or grain production, although we expect continuous removal of crop residues to eventually reduce soil organic matter content. The current recommendation is to apply 65 to 70 lb fertilizer N per acre.

Impact: Approximately 6,000 acres of spring barley are grown in interior Alaska each year. This study helps in establishing recommendations for barley, as well as best management practices for fallowing soil and growing other crops in Alaska.

• Charles Knight and Stephen Sparrow

Grain and oilseed crops variety trials

Objective: Spring grains, principally barley and oats, combined with grass hay, constitute a majority of the feed base for domestic livestock in interior Alaska. Performance tests are conducted at several locations each year to evaluate released varieties and genetic materials from Alaska, Canada, Sweden, Norway, and Finland for adaptation to Alaska.

Approach: Replicated plots of small grains, oilseeds, and alternative crops are planted under dryland conditions at Fairbanks, Delta Junction and Palmer, and under irrigation at Delta Junction. New varieties from foreign countries and genetic materials developed from barley breeding work in Alaska are compared to standard varieties for grain yield, early maturity, and resistance to lodging and diseases.

Progress: A new variety of spring barley, 'Finaska', was developed for release in 2000. This is an early maturing six-row feed barley developed from a cross between two numbered lines from Finland, Jo1632 and Jo1599. Finaska matures one day earlier, yields 9% more, and has stronger straw than the standard variety 'Otal'.

Impact: New crops and improved varieties are important for Alaska farmers to meet production costs and remain competitive. Also, new varieties developed for Alaska are often beneficial to northern Canada and other circumpolar countries.

• Charles Knight

Seed production of native plant species

Objective: There is an increasing demand in Alaska for seed of native grasses, legumes, and wildflowers for use in revegetation and beautification projects. This study investigates seeding rates, herbicides, harvest practices and seed storage for several native revegetation species.

Approach: In 1997, plantations of *Agropyron macrourum*, *Agropyron violaceum*, *Hedysarum Mackenzii*, *Hedysarum alpinum*, and *Oxytropis campestris* were established in the Eielson Agricultural Project near North Pole, Alaska. Various methods of chemical and mechanical weed control are being tested on these plots. Seed yield is also being monitored as affected by time and rate of fertilizer applications.

Progress: Control of broadleaf weeds in grasses has not been a problem and several herbicides commonly used in small grains have label registration for use in wheatgrass (*Agropyron* sp.). We have been unable to chemically control other grasses, particularly foxtail barley (*Hordeum jubatum*), in the grass stands. Native legumes have a very low tolerance to herbicides and mechanical weed control has been most effective. Voles have been a problem eating the roots of *Hedysarum alpinum* and have nearly decimated that stand.

Impact: Although native seed production will likely remain a small niche crop for Alaska farmers, it is a high cash-value crop which can be grown with conventional farm equipment. Greater emphasis is being placed on the use of indigenous species with the inclusion of wildflowers in revegetation projects.

•Charles Knight

Enhancing potato resistance to late blight disease

Objective: *Phytophthora infestans* is an extremely aggressive plant pathogen. Under high relative humidity conditions, *P. infestans* can cause severe late blight disease on potato, tomato, eggplant and other Solanaceae plants and result in heavy economic losses. Presently, management of late blight disease relies primarily on chemicals, which are costly economically and environmentally.

Trichoderma atroviride, *T. harzianum*, *T. viride* and *Gliocladium virens* have been found capable of parasitizing *P. infestans*. Among the hyperparasites, *T. atroviride* seemed to be most effective.

Approach: We conducted experiments to study the mechanisms of disease resistance enhancement of potatoes to *P. infestans* due to *T. atroviride* application. Potato tubers were surface sterilized and then cut into 1 cm thick discs of various sizes. Plugs of *P. infestans* were cut from the margin of a vigorously growing *P. infestans* colony. *T. atroviride* at various concentrations was also prepared. When

potato discs received inocula of *P. infestans* (plug) in one pole and treatment of *T. atroviride* in another, late blight disease development in discs, as indicated by necrosis of cells, was more suppressed than in those without *T. atroviride* treatments, although no direct contact between *T. atroviride* and *P. infestans* was observed. A direct correlation was found between the intensity of disease suppression and the size of the *T. atroviride* population. Hyperparasitism and induced resistance seemed to be two of the mechanisms involved in the enhancement of potato resistance to *P. infestans*.

•Jenifer H. McBeath and D. Adams

Efficacy tests of *T. atroviride*

Objective: Trials to determine the effects of a *T. atroviride* application on potato sprouts were conducted in 1999 at MSU.

Approach: Three simulations tested were: 1) curative effect of the treatments on infested seed pieces, 2) infection of seed pieces occurring during cutting, and 3) the residue protection of seed piece treatment on stem and foliar infection.

Progress: In the first simulation we injected *P. infestans* into the periderm of healthy seed pieces before treatments. Seed pieces with various treatments were planted and maintained in 100% relative humidity. Seed pieces injected with *P. infestans* performed poorly—seedlings emerged slowly and final plant stands were reduced by 98%, compared to the non-inoculated healthy seeds. No significant differences in protection were observed among treatments.

In the second simulation we inoculated the cut surface of healthy seed potatoes with *P. infestans* and then treated the inoculated seed pieces with *T. atroviride*. Results demonstrated that *T. atroviride* is equal to or better than Maxim MZ (chemical fungicide). No difference was found between inoculated seed pieces treated with *T. atroviride* and the blank control as to the numbers of plants emerging. Also, plant emergence from seed pieces treated with *T. atroviride* was faster and more uniform.

In the third simulation we inoculated the plants with *P. infestans* after they emerged from treated seed pieces. Symptoms of late blight were found on leaves and stems of all plants inoculated with *P. infestans*. Applications of *T. atroviride* and Maxim MZ to seed tubers were found capable of providing protection to the lower leaves and stems of the potato plants.

•Jenifer H. McBeath, W. Kirk and B. Niemira

Effect of *T. atroviride* on *Botrytis cinerea*

Objective: Gray mold, caused by *Botrytis cinerea*, is one of the most important diseases on strawberry, grapes, tomatoes, cucumbers, pepper, tree seedlings and many other economically important crops.

Approach: Effects of *Trichoderma atroviride* on the growth and development of *B. cinerea* were studied under laboratory conditions. Four *B. cinerea* isolates were isolated from gray mold infested strawberries obtained at a local supermarket.

Progress: All of the isolates, found to be highly resistant to Captan and Benomyl (chemical fungicides), were found susceptible to *T. atroviride*. No differences were observed in their reactions to *T. atroviride* hyperparasitism. At the macroscopic level, the expansion of *B. cinerea* colonies was arrested upon contact with *T. atroviride*. As the hyperparasitism progressed, the entire *B. cinerea* colony was destroyed by *T. atroviride*. Microscopically, the hyphae of *T. atroviride* were observed to penetrate the hyphae of *B. cinerea*. Lysis of the vegetative hyphae of the pathogen was observed.

Impact: *Trichoderma atroviride* is capable of utilizing *B. cinerea* as a food source. *T. atroviride* conidia germinate readily and penetrate into the mycelium of *B. cinerea* for sustenance. No fungistatic effect from *B. cinerea* isolates to *T. atroviride* was observed.

•Jennifer H. McBeath and D. Adams

Effect of *T. atroviride* on grape bunch rot

Objective: Grapes bunch rot, caused by *Botrytis cinerea*, is one of the most important diseases on grapes. This disease not only causes severe yield losses, it also seriously affects wine quality. Presently, there is no effective control of this disease.

Approach: Field trials were conducted in a commercial vineyard in Mendota, CA, to determine the affects of *Trichoderma atroviride* on the development of Botrytis bunch rot on wine grapes. Suspension of *T. atroviride* was applied to a mile long row of Chenin blanc (one of the most susceptible wine grapes) at pre-bloom, pre-closing, veraison and 3-weeks before harvest. Treatment variables included: 1) *T. atroviride* and 2) blank control. At the time of veraison and one week before harvest, data were taken in ten 3-foot long “windows” from 1) the *T. atroviride* treatment row, 2) a row adjacent to the treatment row, and 3) blank control row. The total number of grapes bunches, presence/absence of disease on the bunches and severity of the diseases observed in these “windows” were recorded.

Progress: A significantly lower percentage of diseased bunches was found on grapes treated with *T. atroviride* at the veraison. The disease development then accelerated. Although fewer diseased bunches were observed in the treated row at the time of harvest, the difference was no longer statistically significant.

•Jennifer H. McBeath, S. Pilibos, W. Mao and C. Nguyen

Premium quality Alaska seed potatoes

Objective: 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. The objectives of this project are to identify the source of disease by conducting field surveys and lab tests.

Progress: In the summer of 1999, more than 300,000 data points were collected from seed lots of 11 farms. We found eight farms completely free of 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).

No late blight was found on any of the potato plants examined. Protective chemical fungicides were used in several farms in Palmer as a precaution. Low incidences of bacterial ring rot (BRR) were found in one tablestock potato farm in Palmer.

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, Alaska seed potatoes consistently out-performed those of seed potatoes (same variety) produced locally. Alaska seed potatoes also appeared to possess stronger resistance to diseases.

Impact: By incorporating the information in their management, many potato producers were 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.

•Jennifer H. McBeath, D. Adams, and M. Ma

Evaluation of lettuce varieties

Objective: Tip burn, a physiological disease caused by calcium deficiency, is one of the most important diseases on lettuce in Alaska. Basal rot caused by *Sclerotinia sclerotiorum* and grey mold caused by *Botrytis cinerea* can also be very severe under certain environmental conditions.

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 have been ineffective.

Approach: 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.).

Progress: 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 also very severe this year. In

another farm in Palmer, severe infestation of *S. sclerotiorum* was observed on cabbages.

•Jenifer H. McBeath, Philip Sorreal, and P. Giaugue

Premium quality ginseng in Alaska

Objective: *Panax ginseng* is one of the most valuable remedies in Chinese (oriental) traditional medicine. For thousands of years, Asians have used ginseng roots to improve digestion and to restore strength and vigor. As the public in the United States and other countries has become more health conscious, demand for ginseng-based products has increased.

Approach: Cultivation of Chinese ginseng in Alaska was initiated in 1996 by Drs. McBeath and Karlsson.

Progress: Accomplishments of this project to date have included development of appropriate water regimens, and standards for shading, ventilation and mulching. Chinese ginseng develops normal flower buds and produces mature seeds under prescribed environmental conditions. Also, Chinese ginseng seeds produced under Alaska conditions only require 6 months of stratification for germination compared to 18 months for seeds produced elsewhere.

The climatic conditions and isolation from other major herbaceous crop production areas reduce the threat of disease in Alaska. Because many of the diseases can be transmitted through contaminated seeds and plant materials, preventive measures and use of biological control agents are critical for maintaining a disease and pesticide free environment for ginseng production.

A broad-spectrum biological control agent, *Trichoderma atroviride*, developed by Dr. McBeath, has been found to be effective in the control of many ginseng diseases.

•Jenifer H. McBeath, M. Ma, M. Karlsson, and J. Werner

Dairy research at northern latitudes

Objective: Dairy production in Alaska has declined from a peak 31 million pounds in 1988 to approximately 15 million pounds in 1999. This project will assist in reversing this trend through establishment of best management practices (BMPs) in herd management, forage/feed production, and waste management.

Approach: Research trials in southcentral and interior Alaska are evaluating land application of dairy wastes, forage variety and production practices, nutrient value of dairy feeds and dissemination of dairy production information. Other research includes an economic and marketing analysis of processing canola meal as a dairy supplement.

Progress: Land application rates, methods and times of application of liquid and solid manure to brome grass and oats were compared to conventional

chemical fertilizers. In the first year of all studies, liquid manure produced greater yields than equivalent rates of chemical fertilizers and spring applications were superior to fall applications.

Preliminary soil profile analysis shows residual N, P, and K in the surface six inches at the end of the first growing season to be higher in all manure plots, than in the fertilized check. However, only in plots where the manure was mechanically injected or incorporated was there evidence of nutrient movement beyond six inches. Studies have been initiated at Palmer to examine mineralization and fate of organic N from soil application of lagoon manure using a buried bag technique.

Forage variety trials were initiated at Fairbanks, Nenana, Delta Junction and Point MacKenzie which included alfalfas, clovers, annual and perennial ryegrasses, timothy, brome grass and reed canary grass on six different soil series. Yield data has been collected and evaluations are in progress.

The Extension Dairy Specialist, through contact with dairy producers, will provide animal production information ranging from herd health to reproduction and nutrition.

Impact: This project will assist producers in meeting federal suggested criteria for Confined Animal Feeding Operations (CAFO). Establishment of BMPs for dairy waste nutrient utilization, optimum forage management and quality, and development of economically sustainable dairy diets will reduce potential for nutrient contamination of water and help reduce costs of dairy operations.

•Allen Mitchell, R. Gavlak, S. Sparrow, C. Knight, and M. Shipka

Satellite telemetry with reindeer

Objective: The recent expansion of the Western Arctic Caribou Herd overwhelmed the reindeer ranges of the Seward Peninsula. Already, thousands of reindeer have been lost to the Western Arctic Caribou Herd, and many more are on the brink of being lost. The objectives of this study are to monitor movement of reindeer commingling with caribou, and to obtain a consistent seasonal map of reindeer range utilization.

Approach: We placed satellite collars, in combination with VHF radio collars, on reindeer from three "critical herds" on the Seward Peninsula. Locations of the collars are obtained and transmitted to processing centers via two satellite systems. We map the locations and update collar locations on individual herd websites. Herders can then view current locations of reindeer on the Internet just prior to conducting herding activities.

Progress: Reindeer from the three herds have been equipped with satellite collars and their movements monitored.

Impact: A more efficient management system is possible by integrating satellite and radio-telemetry with traditional herding methods. Reindeer herders can monitor their herds for unexpected movements and quickly make adjustments in herd location to avoid migratory caribou, and can thus use range resources more efficiently.

• Todd Nichols, G. Finstad, P. Terzi and A. Prichard

Reindeer husbandry

Objective: The objectives of this study are to improve methods of raising reindeer in farm situations and develop a low-cost balanced diet from locally grown feed components.

Approach: A ten-acre pasture was fenced and a handling facility was built in 1999 at the Fairbanks Experiment Farm. Reindeer Research Program personnel developed a 14% crude protein diet that was fed *ad libitum* all year to our 17 reindeer.

18 During the winter the reindeer were given a supplement of long-stem brome hay. The base of the diet is rolled barley and chopped brome hay grown at the UAF farm, and fishmeal from Kodiak. The diet is balanced with a mineral and vitamin premix, limestone, dicalcium phosphate and urea. Molasses and corn oil is used for mixing consistency and energy.

Progress: Portable cow panels and tympar were useful for temporary holding pens and runs. Modifications were made to our portable squeeze chute allowing more efficient blood sampling of reindeer. Preliminary evaluation of our fishmeal and barley diet showed good growth rates and body weights.

Eight adult female reindeer were exposed to a newly acquired bull in September. All eight cows were successfully bred indicating weight and nutritional thresholds for breeding were met.

Future research will include slight modifications to the diet to maximize weight gain without compromising reproduction and to develop a lower cost maintenance diet.

Impact: A low cost balanced diet and efficient husbandry techniques are essential for profitability in raising farmed reindeer in Alaska. This research should benefit both free-ranging and captive management operations.

• Todd Nichols, Greg Finstad and Pete Terzi

Soils associated with ATLAS sites

Objective: Soil profiles were sampled and characterized at 11 National Science Foundation ATLAS study sites in the summer of 1999. Soil morphological properties were studied in the field and recorded in soil profile descriptions. All samples were characterized in the lab for physical, chemical and mineral properties.

Progress: Soils from both the Oumalik and Iivotuk sites are strongly cryoturbated and have morphological properties common to the soils in the

Arctic Foothills. Soils in the moist nonacidic tundra (MNT) are more affected by frostboils than those in the moist acidic tundra (MAT). Thus soils in the MAT have thicker organic horizons and soils in the MNT have more mineral soil exposure and thinner organic horizons.

In Oumalik, soils in both sites have nonacidic reactions. This indicates that the vegetation is very sensitive to base status. Soils in 3 of the 4 Iivotuk study sites have strongly acidic reactions. Rock fragments are abundant in soil profiles and on the surface due to frost heave.

Soils in the Council upland sites are not affected by permafrost but the cryogenic fabrics suggest strong seasonal frost. Soils of the Shrub, Open-woodland and the Forest sites have loamy texture, are base rich and have slightly acidic to nearly neutral reactions.

Soils of the Open shrub site form in colluvium due to active solifluction. The soils are strongly acidic. The parent material consists of glacial till mixed with fractured bedrock, mostly igneous in origin. Thus the soils have coarse texture.

Carbon stocks in the tundra sites of Iivotuk and Oumalik correspond to C stocks of study sites in the Arctic Foothills. Soils in the MAT generally have higher C stocks than that of the MNT. In the Council area the C stocks are low compared to the tundra sites, which corresponds to C stocks of the boreal forest in interior Alaska. The low C-stock is attributed to a lack of organic matter frost-churned into the lower horizons, as well as forest or tundra fires in the past.

• Chien-Lu Ping, G.J. Michaelson and X.Y. Dai

Carbon flux and soil organic matter

Objective: We are characterizing the soils of arctic ecosystems and relating soil organic matter quality, quantity and distribution to carbon dioxide respiration.

Approach: Field study sites were established for the major arctic ecosystems from the coastal plain in the north to the transition to boreal forest in the south. We characterized the soils of these sites chemically and morphologically, with special attention to the quantity and distribution of soil organic matter. Laboratory studies are being conducted to determine properties of the soil organic matter and the character of soil carbon dioxide respiration under different temperature conditions.

Progress: We assessed carbon stocks of the north-south transect of study sites and found that the arctic coastal plain and foothills sites were highest. For the arctic coastal plain and foothills sites, significant portions of soil organic matter stores are contained in the lower part of the seasonally thawed active layer. The position of this organic matter makes it potentially susceptible to cold-season biological activity. Forest transitions sites

contain low amounts of carbon in subsurface layers.

Preliminary results of laboratory incubations of transect study site soils show two interesting trends. First, near 0 °C the activity of soil organic matter is greatest and nearly equal for both the highly organic surface soil layers and for the deeper, minimal carbon mineral layers. Second, soils in the active layer between the surface organic and lower mineral layers are of intermediate carbon percentage and bioactivity level around 0 °C.

However, field morphology of arctic soils show that many soils contain very large amounts of organic matter in these layers due to frost mixing of soils. These soils with significant stores of carbon in this profile position apparently hold high potential for release of carbon dioxide during the cold-season.

Impact: We provide real soils data as a basis for models of winter carbon flux to the atmosphere for the arctic system. Ultimately, the arctic model will be an essential part of an improved global climate model for predicting the impacts of climate change.

• *Chien-Lu Ping and Gary Michaelson*

Wet soils monitoring in Alaska

Objective: The objectives of this project are to establish a database for hydric soils criteria in permafrost-affected areas, and to field-test the newly-adapted Gelisol order in Soil Taxonomy.

Approach: It has long been accepted that 40 °F is the biological zero at which biological activity stops. However, based on several years of field study in permafrost-affected regions, it has been discovered that soils with ice-cemented permafrost within 60 cm have redoximorphic features in the upper 25 cm, characteristic of hydric soils. Yet these soils have soil temperatures during the growing season barely above the freezing point.

Field monitoring was accompanied by manual measurement from mid-June to late-August, to verify monitoring results. During the spring-summer thaw of the active soil layer, seasonal frost melting creates a saturated zone above the frost layer. Field measurement indicated that the redox potential was below the Fe-reducing threshold. The reduced condition is supported by morphological properties and field measurement. Thus, soils with ice-cemented permafrost and with the permafrost table within 60 cm of the mineral soil surface are hydric soils.

Impact: This project allows connections to be made between actual observed conditions in the northern regions and soil properties that are used in determination of both hydric soils and wetlands. The morphological features can be reliably used as hydric soil indicators in the permafrost-affected soils.

• *C.L. Ping, V.E. Romanovsky, G.J. Michaelson and F.R. Paetzold*

Soil organic matter in tundra soils

Objective: The objective of this study is to chemically characterize soil organic matter from arctic systems.

Approach: The soil organic matter of selected arctic soils was chemically characterized. The soils and soil organic matter from the soils were incubated in the laboratory and the release of carbon dioxide monitored. Chemical characteristics were compared with carbon dioxide release.

Progress: We found the soil organic matter from arctic soils to be chemically distinct. A large portion of the organic matter is in the humin fraction, comprised largely of lipid and paraffin-like compounds that are a likely result of microbial activity and are slow to degrade in the cold environment.

We found that surface organic soil horizons and mineral soil horizons released carbon dioxide in similar amounts relative to their organic matter contents, but it is apparent that different soil characteristics control microbial activity and carbon dioxide respiration for the two soil horizon types.

Results thus far indicate that soils of different genetic horizons, as found with depth in the soil profile of arctic soils, will have to be considered differently with regard to assessment of their quality and potential for respiration of carbon dioxide.

Impact: This study provides a chemical basis for assessing soil organic matter quality and reactivity, in order to better predict the effects of climate change on soil carbon dynamics in arctic tundra ecosystems.

• *Chien-Lu Ping, Xiaoyan Dai, and Gary Michaelson*

Investigating soils in China

Objective: The objectives of this project are to establish a database for cryogenic soils in the plateau permafrost region, to relate the vegetation community with soil geography and to explore the possibility of finding a modern analog of the Beringia environment.

Approach: Soil pits were excavated at eight sites representing the major ecosystems along the Qinghai-Xizang Highway. The elevation of the sites ranged from 14,000 to 16,500 feet. Soil morphological properties were studied including soil horizon and thickness, color, field texture, structure, consistency, carbonates and abundance, root distribution and rock fragment. Dr. Frank Paetzold of the USDA-NRCS National Soil Survey Center assisted with the installation of 5 soil monitoring sites for long-term soil climate study.

Progress: Based on cryogenic features noted in the field, these soils experience strong seasonal freeze-thaw cycles. Although the area has widespread permafrost, the soils team found that in most soils the permafrost table is generally deeper than 2 m (6 ft) due to strong solar radiation and arid

climatic conditions. The arid conditions are further indicated by the presence of segregated carbonates in soil profiles due to net upward evaporation. Salts, particularly gypsum, were noted in the upper part of some soils. These soils, formed under cold and arid conditions with strong diurnal and seasonal freeze-thaw cycles, are not widely known to the scientific community in North America. This cooperative study contributes to our understanding of the soil processes on the Plateau.

The alpine steppe occurs in several distinct types; one extensive type was characterized by *Stipa* species. The drier faces of this steppe, in which *Carex moorcroftii* was prominent, approached what many would call steppe-desert. Whereas in North America and eastern Asia the genus *Artemisia* is a prominent steppe component, alpine steppe occurred where *Artemisia* was insignificant in the vegetation.

As the team crossed the crest of the Tangel-La Range from an arid region to one with more precipitation, the vegetation changed from steppe to alpine meadows. Dry slopes and summits in the same areas supported alpine steppe, and the transition between meadow and steppe could be remarkably abrupt. In the valley bottoms, stream courses were outlined by tufted species of *Kobresia*, but the principal component of the alpine meadow is *K. pygmaea*, which forms a turf with the resistance of pavement. Nevertheless, the combination of frost action and erosion by wind and water formed cracks in the turf which became occupied by a variety of forbs. These cracks account for significant floristic diversity.

Impact: This is the first approach to join soil scientists and botanists to establish soil-vegetation relationships in the Qinghai-Tibet Plateau and to provide a database for comparison with the Beringia environment.

•Chien-Lu Ping and D. F. Murray

Silent ovulation identified

Objective: The occurrence of silent ovulation (ovulation without the expression of estrous behavior) during the postpartum period is common among high-producing dairy cows. The objective of this study was to identify ovulations that were silent by using radiotelemetry and visual estrus detection to collect estrous behavior data, verifying the occurrence of ovulation using progesterone assay.

Approach: Nineteen cows received transmitters for radiotelemetry and we began the visual estrous detection routine on day 10 after calving. Blood samples were obtained every other day from day 10 until first service artificial insemination, for radioimmunoassay of progesterone. Following progesterone assay, radiotelemetry and visual estrus detection data were evaluated at time periods coinciding with ovulation to determine whether standing estrus had occurred.

Progress: Visual estrus detection indicated 94.7% of first ovulations were silent ovulations while the inclusion of radiotelemetry information indicated that only 42.1% of first postpartum ovulations were true silent ovulation. During second postpartum ovulations, visual estrus detection indicated 50% were silent ovulations while the inclusion of radiotelemetry information indicated only 12.5% were true silent ovulations. During third and fourth postpartum ovulations, visual estrus detection indicated 33.3% were silent ovulations while the inclusion of radiotelemetry information indicated only 6.7% were true silent ovulations.

Impact: Identification of estrous activity during the early postpartum period, a period associated with a high percent of silent ovulation, is important because it helps producers identify cows that have returned to estrus cyclicity. Using radiotelemetry, very low intensity estrus bouts were identified which would have been labeled silent ovulation using only visual estrus detection management.

•Milan Shipka

Ovulation in dairy cows

Objective: The objectives of this study were to determine whether a precise correlation exists between behavioral and biological estrus, and to determine the efficacy of measuring milk estradiol-17b concentrations during milking as a potential indicator of estrus in dairy cows.

Approach: Twenty-three cows received radiotelemetric transmitters on day 16 of the estrous cycle for continuous monitoring of behavioral estrus. Cows also underwent twice daily visual estrous detection. Milk and blood samples were collected at each milking, from day 18 until the fourth milking after estrus, for radioimmunoassay of E2. Ultrasound examination of ovaries was conducted daily in a subset of cows from day 18 until ovulation was confirmed.

Progress: Plasma and milk E2 concentrations were not highly correlated. Intervals from peak plasma and peak milk E2 until onset of estrous standing behavior and until ovulation were different. Peak milk E2 concentrations were related to standing behavior. Mean duration from peak milk E2 until onset of standing behavior was 21 hours and until ovulation was 46.7 hours. Mean duration from onset of estrous standing behavior until ovulation was 26.4 hours. Interval from peak milk E2 until ovulation was different than interval from the onset of estrous standing behavior until ovulation. These two intervals were correlated and had equal variance, indicating that knowledge of milk E2 concentration may be a useful tool for dairy cow insemination management if on-farm tests for milk E2 were developed.

Impact: Results of the current study suggest that milk estradiol-17b concentrations may be a

useful tool for dairy cow insemination management. Knowing the concentration of this steroid hormone in milk and establishing a fixed time for artificial insemination may decrease the need for visual estrous detection, thereby greatly reducing the labor required for a successful artificial insemination program.

•Milan Shipka

Reindeer cow estrous activity

Objective: This study examines factors associated with the presence or absence of a male reindeer on the reproductive physiology of reindeer cows. Research of this type has not been done in reindeer.

Approach: Blood samples were collected weekly from reindeer cows at the Fairbanks Experimental farm from mid-July through September, 1999. Reindeer cows were housed separately from any reindeer bull during the sample period. The physiologic onset of ovarian activity in the reindeer cows was determined by identifying the first significant rise in systemic progesterone concentrations. Following the sample collection period, in preparation for studies during 2000, half of the reindeer cows were penned with the reindeer bull and bred. The other half of the reindeer cows experienced no contact with the reindeer bull.

Progress: Based on progesterone concentration analysis, which indicates ovarian activity, the reindeer breeding season began on or about September 15, 1999. All cows penned with the reindeer bull were bred within a two-week period and produced calves during spring 2000.

Managing reindeer in this manner allows for two experimental groups of cows during year 2000. Group one will consist of cows that produce calves and lactate during the spring and summer of 2000, and group two will consist of cows that have not experienced pregnancy and, therefore will not be lactating during 2000. Furthermore, cows in group two will not have experienced contact with a reindeer bull during the breeding season.

Impact: Reindeer producers have the potential to improve the profitability by improving management of reproduction in reindeer. This research will provide important information that will assist reindeer producers in manipulating animal management routines, benefiting reproductive success in their herds.

•Milan Shipka

Fertilizer applications on forage

Objective: The objective of this study is to determine optimum time and rate for nitrogen fertilizer applications, in order to produce high yields of forage from cool season grasses in interior and southcentral Alaska.

Approach: Four established stands of smooth brome grass (*Bromus inermis*) and one established stand of timothy (*Phleum pratense*) were selected in

1999 for this two year study. Three sites were chosen near Delta Junction, one site near Fairbanks and one in Palmer. Ten urea nitrogen fertilizer treatments unique in amount and application time were applied at each site. Phosphorus and potassium were uniform across treatments. The treatments were designed to best aid forage growth as well as the producer in practicality of application and cost. Two harvests are made each season at early heading. Dry matter yields are being determined and plant samples are being analyzed for forage quality.

Progress: Treatments were established and harvests done for the 1999 field season and are continuing during the 2000 field season. Samples were processed in Fairbanks for total yield and quality measurements. Samples were analyzed for neutral detergent fiber, acid detergent fiber, acid detergent lignin, crude protein, Ash, *in vitro* digestible dry matter and crude fat.

Impact: Due to its unique northern environment, agricultural land in Alaska is capable of producing high yielding, quality cool season grasses for forage. However, management information is limited. This study provides Alaskan producers with important information to increase their forage production and improve forage quality.

•Natalie Howard and Stephen Sparrow

No-till forage establishment

Objective: The objectives of this project are to assess the effectiveness of no-till forage establishment as a means to reduce forage production costs and improve soil and water conservation in Alaska.

Approach: Experimental plots were established on farmers' fields at two location in interior Alaska and four locations in southcentral Alaska.

Manchar smooth brome grass (interior Alaska locations) or Engmo timothy (southcentral Alaska locations) were no-till seeded or seeded into tilled soil. Nitrogen fertilizer was applied with the seeds at several rates.

Oats, annual ryegrass and fodder rape were planted as companion crops with smooth brome grass or timothy. Crops were seeded into tilled soil or untilled sod.

Smooth brome grass or timothy and red clover were seeded into untilled sod at 0.5X, 1X and 2X the recommended seeding rates. Plots were planted in 1997, 1998 and 1999. Above-ground plant material is harvested each year and weeds and crops are separated, and dry matter yields determined.

Progress: No-till seeding resulted in poor germination and lower dry matter production than conventional seeding in interior Alaska. In southcentral Alaska, no-till seeding resulted in yields equal to or higher than conventional seeding. Including companion crops resulted in higher total yields than seeding grass alone, but greatly reduced

yields of brome grass and timothy. Increasing seeding rates to 2X the normal rate for grass or red clover under no till seeding increased yields slightly.

Impact: This research will help farmers reduce costs and improve soil and water conservation in establishing perennial forage crops.

•*Stephen Sparrow, Ray Gavlac, and Beth Hall*

Forage crop variety trials

Objective: The objective of this study is to screen forage species and varieties for adaptation, yield and quality potential under various climatic and soil conditions in interior Alaska.

Approach: Forage legume and grass species and varieties were planted at four locations in interior Alaska. Plants were harvested at early flowering and dry matter yields were determined. Promising varieties of annual crops will be replanted in future years. Plots of perennial species will be maintained and evaluated for long-term yields. Plant samples will be analyzed for various forage quality characteristics.

Progress: Among the grasses, perennial ryegrass varieties produced the highest yields (occasionally exceeding 3 tons dry matter per acre). Annual ryegrasses headed very early in the season, prior to heavy vegetative growth. This is likely to result in poor quality. Brome grass and timothy varieties generally yielded less than ryegrasses, but at some locations, some of the varieties produced dry matter yields in excess of 2 tons/acre. Forage legume yields were generally considerably less than grass yields. Alfalfa and red clover produced the highest yields, with some varieties exceeding 1 ton dry matter per acre. Plant chemical analyses have not yet been completed so there is no data on the forage quality of plants in these trials.

Impact: This research will provide farmers with recommendations for forage crop varieties adapted to their area, and should ultimately result in increased forage yields and/or improved forage quality for farmers in interior Alaska.

•*Stephen Sparrow*

Tillage practices effects on soil

Objective: The objective of this study is to determine the effects of long-term tillage and small grain crop residue management practices on various soil chemical, physical and biological properties in a subarctic environment.

Approach: This study is part of a long-term tillage and crop residue management study in its 18th year in central Alaska. Cropping consists of continuous barley with occasional years of chemical fallow (to control perennial weeds). Tillage treatments consist of disking twice, disking once, chisel plowing or no-tillage. 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. For this study, we sampled only the disked-twice, the disked-once, the no-till and treatments with all crop residues removed or all crop left on the plots. Soil samples were collected in 1998 and 1999 prior to tillage operations and also following harvest. Soils were analyzed for 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).

Progress: In general, total C and N and mineralizable C were lowest in the disked-twice treatment and were similar in the disked-once and no-till treatments. Microbial biomass C was highest in the no-till and lowest in disked-twice treatment; microbial biomass N was little affected by tillage. Soil pH was not affected by tillage treatments. Soil aggregate stability was highest in no-till and lowest in the disked-twice treatment. Crop residue management had little effect on any of the soil properties measured.

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.

•*Stephen Sparrow and Charles Knight*

Computerized data collection

Objective: The Reindeer Research Program's (RRP) computerized data collection system is designed to provide reindeer herders with a complete and accurate life history record of their herds.

Approach: In 1999 individual reindeer herds on the Seward Peninsula-Alaska were rounded up for censusing, antler harvest, vaccinations and tagging. Staff from the RRP recorded demographic data for herd evaluation and support of research projects. Each reindeer was given a uniquely numbered six-digit ear tag when first handled, making possible a life history record. Data collected from some herds extends back to 1984. We used laptop computers to improve the quality and quantity of data collected. The data was entered into a customized database program, making it available to herders for management decisions.

Progress: At the end of the handling season a herd report was sent to each herder describing how many animals were handled, reproductive status of the herd, average weights and numbers vaccinated.

Impact: This information allows herders to make management decisions such as the culling of non-productive females, establishing appropriate sex ratios within the herd, and monitoring calving success and survival rate.

•*Pete Terzi and Greg Finstad*



Harvest effects on stream temperature

Objective: This project deals with the effects of timber harvest activities on stream temperature regime. The focus is on answering questions pertinent to interior Alaska streams. Can ice-bridges increase ice thickness such that fish or fish habitat might be negatively affected? Can we predict how ice thickness will respond to alteration in construction techniques and weather? How does summer water temperature change with downstream distance, regardless of buffering by riparian vegetation? Finally, is stream temperature affected by broad-scale changes in watershed vegetative cover, independent of riparian buffers?

Approach: We address these questions through literature reviews, simulation experiments, and field measurements. We have completed reviews of historic ice-thickness measurements for Alaska streams and rivers, and the literature related to ice-bridge construction and the possible effects of river ice on fish habitat. This information will be supplemented with photos and measurements made on actual ice-bridges constructed in the interior, and models of ice growth as a function of freezing-degree-days will be tested. We anticipate using a layered model to account for ice thickness changes associated with build-up of ice bridge surfaces, or with the removal or compaction of snow. We will make stream temperature measurements on selected streams, and will also use computer models to explore the dynamics of water temperature and sensitivity to riparian shade.

Progress: This project is in its early stages. A draft annotated bibliography on ice thickness data and ice-bridge construction has been completed. Several candidate models of ice growth and water temperature dynamics have been identified. In addition, a multi-layered model of river freezing with snow cover is being modified for use in this project.

Impact: The annotated bibliography and literature review has been incorporated into a report by the Science and Technology Committee, appointed to help review riparian standards under the Alaska Forest Practices Act for interior Alaska. We anticipate additional useful results as the project advances.

•John Fox

Duff moisture dynamics

Objective: Fire severity in interior Alaska fuel types is determined by the depth and dryness of the organic mat constituting the forest floor. The objective of this project was to obtain some basic information on the physical and hydrologic characteristics of this organic mat.

Approach: We designed and implemented a sampling scheme to take bulk volume samples of the organic layer. The samples are inspected for homogeneous layer structure, weighed, oven-dried and then weighed again to determine water contents and bulk densities. New field probes for measuring duff water contents were installed and monitored. The time tracking of this duff fuel moisture content will be compared to the time tracking of the fire danger rating index.

Progress: We have made considerable progress in identifying the bulk density characteristics of the organic layer and its variation with depth and horizon. The moisture content of the duff layer corresponds well with the fire danger rating index, however, questions remain about initiating the index and its absolute meaning in terms of fire danger. The new moisture probes appear to be working well. Some work remains in determining the most appropriate calibration.

Impact: The Alaska Fire Service (AFS) is continuing to monitor and test the moisture probes, which may allow an automated method of monitoring fuel moisture, and thus fire danger, through the current network of remote automated weather stations. The information on bulk density and duff drying rates may lead to new fuel models for Alaska. Several presentations have been made and reports for the AFS and the U.S. Forest Service are being prepared.

•John Fox

Recent climate and forest history

Objective: This study investigates long-term climate trends, the relationship of temperature and precipitation to the growth of white spruce and the age structure of white spruce in the headquarters area of Denali National Park.

Approach: I measured tree-rings from the Rock Creek Watershed above the headquarters area and compared their growth with the headquarters climate record begun in 1923. I correlated tree ring-width with monthly temperature and precipitation to determine which climate parameters affect radial growth, if any. Some values had to be reconstructed based on a predictive relationship with the Fairbanks climate station.

Progress: The oldest trees collected were at the lowest site, and the youngest at treeline. Ring-width was highly negatively correlated with summer

temperature at the lower sites. This means that the trees grow more in cool summers and less in warm summers. At treeline, some trees showed the same negative relationship, while other trees showed a positive relationship (more growth in warm years). There was a weak but generally positive relationship between growth-year precipitation and ring-width.

Major growth events indicated by tree-rings include stem breakage from heavy snowfall, frost rings from hard freezes, narrow rings from dry summers, a major change in rate of growth starting in 1977 and subsequent spruce beetle attacks.

Impact: The adjusted temperature at headquarters shows a sustained warming since 1976. If correct, summer and mean annual temperature increased about 1.3 °C after 1976, a substantial increase consistent with other locations in central Alaska during that time. The ring-width results strongly suggest that the growth of most trees in the watershed is limited by drought stress, with hot summers being particularly stressful.

If climate warming continues, trees in most of the Rock Creek Watershed could become severely drought stressed except near treeline, where frequent cone crops and warmer, longer summers would lead to increased white spruce seedling establishment and more rapid growth of white spruce.

• Glenn Juday

Climate and rapid climate change

Objective: This study reconstructs climate from the 1800s based on the relationship between tree-rings and climate at Fairbanks since 1906, when instrument-based records began. Interior Alaska experienced rapid climate warming in the 1970s—another goal was to look at the rate of temperature change over a nearly 200-year period.

Approach: We compared the ^{13}C isotope content and latewood density of white spruce tree-rings collected at sites across interior Alaska to long-term climate records at Fairbanks. We identified significant relationships between the tree-ring properties and monthly temperature and precipitation. We then used tree-ring properties alone to reconstruct climate in the 1800s.

Progress: Latewood density and ^{13}C successfully predicted April through August mean temperature during the 1900s. We used this relationship to reconstruct summer temperatures in the 1800s. Ring-width was influenced by two years of weather (year of ring formation and the 1 prior year), so it was not as useful for reconstruction.

We identified four climate regimes from the early 19th to the early 20th century and two regimes in the 20th century. These regimes were characterized by cool, warm, hot, warm, cool, and hot summers respectively. Change between regimes was abrupt,

usually over one or two years. Nineteenth century regimes exhibited generally high levels of moisture stress and low radial growth consistent with a dry continental climate influence. The first regime of the 20th century was a uniquely favorable period of low moisture stress, moderate summer temperatures, relatively high precipitation and high radial growth for white spruce, consistent with a stronger maritime influence.

Impact: The highest sustained summer temperatures occur in the most recent climate regime since the 1970s, but a nearly equally warm period of reconstructed summer temperature occurred in the 1820s and the 1860s and 70s.

• Glenn Juday, Valerie Barber, and Bruce Finney

Seedling and sapling tree growth

Objective: This study is a long-term monitoring project that measures survival and height growth of seedlings and saplings in an area burned in the 1983 Rosie Creek Fire.

Approach: White spruce seedlings in a 100m² hectare (2.47 acres) have been mapped and measured since 1988. In 1999 hardwoods stems greater than 2 cm in diameter were mapped and measured in one fourth of the plot.

Progress: A spring 1999 survey measured height elongation of all spruce and a fall survey measured 1999 height growth. A total of 2,389 spruce are in the data base. Spruce seedlings nearly all originated from the 1983, 1987 or 1990 seed crop. The best-performing seedlings are the 1983 seed crop. Height growth was significantly below predictions from the 1997 trend line, probably because of drought in 1997 and 1998.

Impact: Natural regeneration of white spruce is often less than desired, and hardwood competition is an important factor. This project reveals the details of the process of spruce seedling establishment, survival and early growth. Most 1983 seed crop white spruce seedlings have excellent position and many will become new canopy trees. Only some 1987 seed crop seedlings are well positioned to emerge into the canopy. Few 1990 seed crop seedlings will emerge until the death of overtopping vegetation, which may take a century. Data from this stand are being used in large computer models of forest regeneration.

• Glenn Juday

Historical land surface uplift

Objective: The northern part of southeast Alaska is experiencing some of the highest rates of land uplift in the world. This study uses tree establishment on the newly uplifted surfaces to determine the historical rate and amount of uplift and to determine the cause.

Approach: As the land rises former seabed is exposed and emerges above the tide level. Sitka spruce trees colonize the new land surfaces almost immediately. We are coring spruce from the outer beach position, and inland to old-growth forests that have not been submerged for thousands of years. Ring-counts give the date of establishment of the trees; we then measure elevation above sea level of each tree. A plot of date of establishment versus elevation gives a land uplift curve for each sample transect.

Progress: The 1999 field season was the second on this project. Transects were completed at several sites, with some trees with dates of establishment in the late 1500s to early 1700s. Land uplift rates are among the highest in southeast Alaska, generally in the range of 2.5–3.5 cm per year. Uplift appears to have been occurring since the mid-1700s. The latest portions of the curves suggest that uplift rates are less in recent decades than in the 19th and early 20th centuries.

• *Glenn Juday and Roman Motyka*

Forest productivity

Objective: Productivity of northern forest lands is commonly estimated graphically by using height over age curves called site index curves. Curves are not available for all species, and existing 30-year-old curves are suspect because they are based on a single average guide curve.

New curves for balsam poplar have been published, while curves for tamarack and black spruce do not exist for Alaska. The objective of this study is to develop new site index curves for Alaska northern forest species.

Approach: Four healthy, vigorously growing trees are selected for sampling from pure, single age stands of various productivities. Stands must be at least 50 years old and contain no decay or environmental damage. Trees are felled, measured for height and cut into sections. Sections are measured for diameter, rings are counted and ring width is measured. Height-over-age curves are plotted for each tree and regression analysis is used to develop site index curves.

Progress: In 1999, stem analyses were completed for remaining aspen. The data were entered and verified for 248 aspen and curve fitting begun; the final report is anticipated for late 2000 or early 2001. The remaining 24 black spruce were sampled, bringing the total to 184 trees. A paper on poplar/cottonwood growth in relation to landform and soils is being finalized.

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

between species is not possible because both permanent and temporary sample plots must be established and their yield characteristics correlated with the site index.

• *Edmond C. Packee, Sr.*

Reforestation stocking standards

Objective: Espacement, the distance between trees, impacts forest tree characteristics, which in turn affects stand structure, wood quality and wood volume per acre.

The objective of this study is to determine for Alaska's northern forest species the effect of planting espacement on stem size, yield per acre, stand structure characteristics and wood quality. A second objective is to recommend espacement guidelines for both Alaska's northern forest and coastal forest species.

Approach: Levels-of-Growing-Stock (LOGS) plantations were established to determine the effects of espacement on tree characteristics. Survival and seedling/sapling condition and height growth are measured annually. Once the majority of trees reach a breast high diameter of one inch diameter, diameter is also measured, with measurements done at five-year intervals. An ongoing literature review addresses the impact of espacement on tree characteristics. Review of operational practices and literature provided espacement guidelines for both northern forest and coastal forest species. 25

Progress: First 10-year height growth data for white spruce LOGS plantations near Fairbanks were analyzed and presented at the Society of American Foresters Annual National Meeting. Height at 10 years of age is less at both the narrowest and widest espacement; this relationship holds for the two sites. Two papers were published addressing the impacts of espacement on wood quality and providing espacement guidelines.

Impacts: The literature review and the LOGS plantations demonstrate that optimum management of northern forest conifer species depends on initial espacement. Although preliminary, tools now exist to assist forest managers in making sound management and financial decisions regarding silvicultural prescriptions to obtain adequate regeneration.

• *Edmond C. Packee, Sr.*

Permanent sample plots (PSPs)

Objective: Permanent Sample Plots provide a long-term continuous inventory of forest stand conditions and the basis for yield equations. The objectives of this study are to establish a network of Permanent Sample Plots (PSPs) throughout the northern forest of Alaska for the development of growth and yield models, continuous forest inventory, continuous wildlife habitat inventory, and monitoring of forest health, change and biodiversity.

Approach: A network of one-tenth acre plots are established in representative forest stands throughout the northern forest of Alaska. Within each stand, three square plots are established and described in terms of geology, topography and general soil characteristics. Tree characteristics are measured and presence and cover-class of each understory is determined. Five regeneration plots are located systematically within the plot and regeneration by species is tallied and measured.

Progress: During 1999, 48 plots at 14 sites were established in the Copper River Basin. Tanana Basin plots were remeasured (first 5-year remeasurement). To date 231 PSPs have been established plus an additional 196 Sustained Yield Plots (SYPs) as treatment plots. For all plots site data have been entered for future analyses. Permit applications were started for potential Susitna and Matanuska valley sites.

Impact: For mixed stands and spruce stands originating as mixed stands, there is no evidence that stands fill-in with spruce seedlings at a rate sufficient to become fully stocked—this may explain the openness of many mature stands of spruce. Data suggest that many forest sites are capable of producing significantly greater amounts of fiber and that early models inadequately describe succession. PSP and SYP data will support improved yield equations, better prescriptions for fiber and wildlife habitat production and a better understanding of forest stand conditions and biodiversity.

•Edmond C. Packee, Sr.

Early height growth

Objective: Early height growth of white spruce has not been quantified in Alaska except for experimental sites; early height growth of other species has not been quantified.

The objective of this study is to develop models of early height growth patterns of northern forest tree species with early emphasis on white spruce and then, other species.

Approach: This study uses methodology developed and tested on Levels-of-Growing-Stock white spruce plantations. Nineteen operational plantations were selected, based on age and free-to-grow status, west of Fairbanks in the Tanana Valley. The plots consisted of 25 trees. Regression analyses are being used to develop the initial model. The model will be compared with models or data from elsewhere.

Progress: A literature review was completed; data for the study are being obtained from elsewhere. Statistical procedures were tested, and a master's thesis addressing free-to-grow white spruce height growth is expected to be completed in late 2000.

Impact: The models developed for this study will predict age range at which free-to-grow status is reached for white spruce in Alaska, the time for trees to reach breast height and help better predict early growth pattern or trajectory for yield forecasts.

•Edmond C. Packee, Sr. and Jamie Hollingsworth

Tree volume equations and tables

Objective: Accurate tree volume equations and tables are essential as forest-products markets and opportunities become more competitive and utilization standards improve. This study addresses concerns with current equations including: differences among tables for given species, small trees with negative volumes and which tables should be standard (buyer versus seller).

The initial emphasis is on white spruce; ultimately the effort will expand to cover other northern forest species. The objectives are to develop new individual tree cubic volume tables for northern forest species, and test the suitability of statewide equations versus regional tables.

Approach: Only cubic volume equations and tables will be developed; these can be readily converted to weight. Measures such as cords and board feet do not address solid fiber content and are influenced by operator equipment and skill.

We developed a standard procedure for all species. We measure total tree height and then diameters at four-foot intervals beginning with a six-inch stump. Commercially harvested trees or trees cut for land clearing are used. Cubic volume of each section of a sample tree is calculated and then the section volumes are added together. Regression analysis of all sample tree volumes for a species are used to make user-friendly equations or tables based on tree height and diameter breast high (4.5 feet). Equations permit obtaining volumes for total tree and for various top diameters.

Progress: Analysis of Tanana Valley white spruce indicates that tree volume equations for the Tok and Fairbanks areas are similar to equations for Delta Junction, despite differences of area trees. We believe this is related to the much smaller sample of trees from the Delta Junction area and plan to sample additional trees in year 2000 before finalizing white spruce volume equations for the Tanana Valley. During 1999, we sampled an additional 29 white spruce trees.

Impacts: New equations and tables based will replace existing ones in the Tanana Valley and are part of a much larger statewide sample. Once equations have been tested and accepted, equations will be developed for other regions and for the entire state. Improved equations and tables will improve timber sale cruise efforts, flexibility in marketing trees, forest management growth and yield forecasts.

•Edmond C. Packee, Sr. and Tom Malone

Disturbance history in the Tanana Valley

Objective: Man has impacted ecosystems and biodiversity through time—both unknowingly and deliberately. Intervention in natural processes, especially fire control, impacts long-term forest health and ultimately the local economy.

This study documents historical information concerning man-caused disturbance of northern forest ecosystems in Alaska, and addresses the implications for forest resource planning and ecosystem management.

Approach: The study uses a combination of literature reviews, archival searches, personal interviews and site searches to determine locations and types of human-caused disturbance.

Progress: In 1999, results to date were published as two abstracts, a poster was presented at the Tanana Valley State Fair and a paper was accepted for publication. Efforts have been initiated to determine locations of pre-statehood sawmills in the Tanana Valley. A paper is being developed describing suitability of harvest methods and silvicultural systems for Alaska northern forest stands.

Impacts: This study promotes the concepts that timber harvest, human-caused fire and human-conducted fire control efforts must be considered for the Tanana Valley forest ecosystem. Questions concerning forest stand history are becoming more prevalent, including the viability of management options based on “nature knows best.”

•*Edmond C. Packee, Sr. and James Roessler*

Ethanol production

Objective: Extensive areas of Alaska’s northern forest consist of unmerchantable fiber for traditional forest products; additionally, a considerable portion of every merchantable tree contains unmerchantable material such as bark, tops and branches. Unmerchantable forest biomass could be used as alternatives to fossil fuel and to meet human needs.

Ethanol production is typically associated with standard agricultural crops such as corn and barley. Use of tree biomass for ethanol production greatly reduces fossil hydrocarbon requirements since disturbance occurs only two or three times during a rotation and natural soil processes maintain or restore soil fertility.

Ethanol production efficiency depends upon the process. The Paszner process utilizes any vegetation biomass so that there is no waste: conifer and hardwood wood and foliage produce ethanol, lignosulfonates, vanillin (industrial and edible), xylitol and pharmaceuticals and is an energy source for power co-generation. The Paszner process has been demonstrated to be feasible and cost effective; per gallon production cost is less than one-half that of

other ethanol processes and below 1999 wholesale gasoline prices.

The objectives of this study are to determine fiber need and availability for a 300-350 ton per day plant, identify fiber supply sources and identify additional fiber supply information requirements.

Approach: Alaska Forest Refinery, Inc. inquired about fiber supply in the upper Tanana Basin and adjoining areas. A review and analysis will be done of all published forest fiber inventories for the upper Tanana Valley (east of Delta Junction) and adjacent areas. Estimates will be developed of fiber quantity (cubic feet and tons) available from private lands and annual allowable cut capabilities, and additional information needs will be identified.

Progress: Fiber quantities and annual allowable cuts were estimated from published inventory reports for each private holding entity using three methods (Von Mantel, adjusted Von Mantel and Hanzlik) and reports were provided to Alaska Forest Refinery, Inc. and private landowners. There is a need for additional information concerning small tree volume and per acre volumes for dwarf forest stands. The Paszner process was verified as feasible and superior to others currently known.

Impacts: Based on progress to date, the Alaska Forest Refinery is pursuing venture capital for a facility near Tok. Once on-line, the plant will employ approximately 125 persons year-round plus woods workers and truckers. Creating a market for otherwise unmerchantable-sized material should improve profitability for small forest product firms and operators. Improved utilization standards will increase fiber value, and using forest fiber for ethanol may help reduce fossil fuel use and the associated production of greenhouse gases.

•*Edmond C. Packee, Sr.*

Frostfire

Objective: The broad objectives of Frostfire are to gain insight into wildfire behavior and consequences in boreal forests. We will use that information to improve models simulating carbon balance, hydrology, nutrient cycling and other aspects of boreal forest dynamics. My component, shared with Dr. Rich Boone in the Institute of Arctic Biology, has focused on how fire effects soil processes governing carbon balance and nutrient availability.

Approach: An 11 km² forested watershed within the Caribou-Poker Creeks Research Watershed was experimentally burned starting July 8, 1999. Our strategy was to compare patterns of soil temperature, respiration and decomposition in burned stands following the fire with those before the fire and in nearby unburned control stands.

Progress: Our pre- and post-fire data have revealed several patterns in soil respiration dynamics. Our pre-fire data indicated that soil respiration was half again as high in mixed hardwoods as in black spruce sites, and in control and to-be-burned sites was comparable within forest stand type. Following the fire, soil respiration declined 10-20% in burned closed-canopy black spruce and mixed hardwood forest stands relative to controls, and this difference has persisted well into summer, 2000.

Our results suggest that the loss of root respiration is not completely compensated for by increases in decomposition resulting from the large input of newly dead plant parts combined with warmer, moister conditions. To learn more about this project and its progress, you can access project information over the world wide web at http://www.lter.uaf.edu/~jirons/cpcrw_www/frostfire/frostfire.htm.

Impact: The importance of this research is two-fold. First, the boreal forests of the circumpolar north contain as much carbon as the Earth's entire atmosphere. Variations in climate interact in complex ways with disturbance dynamics, and gaining insight into these interactions is essential if we are to predict the future role of boreal forests as net carbon sink or source to the atmosphere. Second, fire disturbance is often cited as the natural analog to clear-cutting forest stands. There are important differences between them, however, and understanding those differences is key to tailoring forest management prescriptions to long-term sustainable use of the resource. This will be the objective of future research comparing these results with the dynamics of soil processes following harvest in interior Alaska forests.

•David Valentine

Net nitrogen mineralization

Objective: Low nitrogen availability is a major limitation to plant growth in Alaska's boreal forests. This is partly a result of the very cold soil temperatures slowing rates of decomposition that supply mineral nitrogen for plant use, but may also result from variation in chemistry of decomposing plant tissues. One mechanism by which plant species may influence soil N dynamics is through releasing soluble carbon compounds, such as simple phenolics, from foliage and decomposing litter. We investigated whether leached phenolic compounds affect nitrogen cycling in field conditions, and what processes of N cycling phenolic compounds are modifying.

Approach: *Ledum palustre* (Labrador tea) is a good candidate to have such an influence in boreal forests because it is widely distributed, has high shoot concentrations of phenolic compounds, and readily leaches organic compounds into water.

We used two complimentary approaches to

evaluate patterns and mechanisms by which *Ledum* might influence soil nitrogen dynamics. We compared net rates of carbon and nitrogen mineralization in both organic and mineral horizons from underneath *Ledum* patches (Ledum soils) and from nearby areas without *Ledum* (non-Ledum soils). In order to clarify the possible role of the plant soluble phenolics in affecting these processes we incubated Ledum and non-Ledum soils with Ledum litter leachates containing phenolic compounds, and then estimated gross nitrogen transformation rates.

Progress: Mineral soils associated with *Ledum* had lower net nitrogen mineralization and higher CO₂ production compared to the non-Ledum controls, indicating a higher nitrogen immobilization rate. Comparable effects were not found in the organic horizon. Leachates increased net nitrogen immobilization rates in both cases. Ledum presence and leachate addition increased gross mineralization rates as well as ammonium consumption in mineral soils. Because leached phenolic compounds and Ledum presence had parallel effects and only a small portion of the dissolved organic carbon in the added leachates was actually respired, we hypothesize that leachates from throughfall could explain the differences between soils associated and not associated with Ledum in nitrogen cycling. Results showed that phenolic compounds not only stimulated gross and net immobilization when microorganisms used them as carbon source, but in so doing also accelerated gross (but not net) nitrogen mineralization rates. Our future research will focus on other pathways of phenolic release from Ledum—for example, leaching from Ledum litter in the forest floor—and their impacts on soil N dynamics and availability.

•Eva Castells and David Valentine

Carbon balance in black spruce forests

Objective: Black spruce forests are ubiquitous throughout North American taiga and often overlay large stores of carbon. The annual carbon balance (balance = plant production – decomposition) of these forests is seemingly sensitive to the warming of deeper soil carbon, that is, carbon that is beyond the rooting zone. This suggests plant production and decomposition can operate independently, making black forests potential net sources of carbon dioxide to the atmosphere in a warming climate.

Another aspect of black spruce forests is their tendency to burn, which results in immediate soil carbon loss. The question remains as to how soil carbon is connected to either past or present plant productivity and what effect fire has on carbon balance. Answering these questions is the focus of this study, where we are attempting to better understand the link between decomposition, plant production, climate warming and fire.

Approach: Near Fairbanks, Alaska, topography results in yearly average temperature differences that mimic latitudinal gradients. We located three mature black spruce forests that vary in elevation, and as a result, yearly thaw depth. This variability allows us to examine how soil temperature affects the accumulation or loss of carbon from this ecosystem type. An experimental burn at the Caribou Poker Creek Experimental will provide data on the effect of fire on soil carbon. The measurements being made at the mature sites include the rate of carbon dioxide evolution from the soil surface (decomposition), soil temperature and plant production.

Progress: The initial data suggests that the soil temperature gradient has resulted in differences in soil carbon accumulation. Soil carbon dioxide evolution is heavily affected by understory plants, which can remove nearly one-quarter of the carbon that would otherwise be lost to the atmosphere. Soil carbon budgets from the mature sites will be compared to data collected by Dr. David Valentine at the Caribou-Poker Creek watershed.

Impact: The information collected for this study will help clarify the role of these widespread forests in the global carbon cycle. Identifying how these forests are sensitive to either warming or fire will provide crucial data for predictions on their role and fate in a changing environment.

• Jason Vogel and David Valentine

White spruce resistance to beetle

Objective: Over the last ten years, more than three million acres of Alaska forests have been infested with spruce beetles. This has been called the largest insect infestation in recorded history. In some areas, such as around Homer, mortality of spruce trees ranges from 90% to 100%. In other areas, mortality is much lower, and the reasons for these differences in mortality are the subject of much speculation. Though a variety of factors are likely involved, researchers believe that genetically-based differences in the ability of individual trees to resist attack play a critical role.

To date, the majority of research on the spruce beetle infestation has focused on the use of insecticides, selective thinning regimes and insect pheromones. No one has attempted to document or exploit the natural resistance that occurs, to varying degrees, in the white spruce trees themselves.

Approach: Our work makes use of seed collected by John Alden on the Kenai in the 1980s. The stands of trees where Dr. Alden worked were not yet infested with spruce beetles. Alden kept detailed records of the locations of the parent trees, and in September, 1998, revisited the precise locations of his 1980s collecting trips. He found that although virtually all of the original parent trees had been

killed in the intervening years, he was nevertheless able to collect new seed from uninfested or lightly-infested trees growing close to 27 of his original 1980s collection sites. The result was two samples of seed from 27 different stands of Kenai Peninsula white spruce: one collected before the stand was infested, the other collected from a rare surviving individual after the infestation had run its course.

In our planned experiment, the 1980s collection will function as the “control” group. The level of resistance to beetle attack inherent in this group should be no different than the overall pre-infestation population. Conversely, the seeds collected in 1998 will function as the “presumed resistant” group. By simple virtue of their survival to 1998, we hypothesize that this group has some genetically-based ability to resist beetle attack.

Progress: In 1999 we contracted with a Canadian nursery to produce seedlings from the two groups of seeds. We chose a study site and had it scarified to prepare the ground for planting. We received funding from the UAF Natural Resources Fund to cover the installation of these plantations in June, 2000.

Impact: The resulting research plantation will provide a number of opportunities. The plantation will preserve the two genomes for future experimentation, provide the chance to test the seedlings’ resistance to other types of insects (which can act as proxies for spruce beetles), increase the amount of tissue of each genotype for the purpose of examining resistance in the laboratory and set the stage for a long-term test of resistance.

• Tricia Wurtz, J. Alden, J. Graham, M. Kromrey, and J. Fox

Socio-economic profile

Objective: This document is designed to acquaint the reader with the salient social, legal and economic characteristics concerning the people and institutions of Kachemak Bay Watershed, and to predict landscape level change in the region.

Approach: The report involved the integration of IMPLAN regional economic modeling, GIS-based landscape level modeling and traditional legal analysis.

Progress: The project is completed and the results are being published. In summary, the document makes five general observations concerning dominant socio-economic conditions and trends:

1. The land ownership pattern of the Kachemak Bay watershed is unique when compared to that of the rest of Alaska. Nearly 10% of land in the KBW is privately held. This compares to only 0.3% of land in private hands throughout the rest of the state. The amount of private land, in total acres, in KBW accounts for almost 8% of all private lands in Alaska, even though the land base for KBW constitutes just 1% of land in Alaska.

2. The most aggressive logging activity is, and will continue to be, on Native Corporation lands. Timber harvest on state-owned public land has lagged behind the expansion of the beetle infestation perimeter. Consequently, timber values for harvested trees are considerably less on state land than on corporation land.

3. Areas outside of, but within the vicinity of, Homer are undergoing rapid population growth. This population trend is accompanied by an expansion of housing starts in the area. Areas of particularly fast growth include the Diamond Ridge and Fritz Creek regions. Continued subdivision is expected due to the ready supply of available private land for development.

4. Data from the Alaska State Department of Labor *understates* the number of jobs in the Kachemak Bay watershed and the potential for economic expansion. The IMPLAN model employed in this profile indicates 1996 employment within Kachemak Bay to be nearly twice that suggested by state records for the same period.

5. Several industries within the Kachemak Bay watershed are undergoing dramatic change. Cattle

grazing is most likely to undergo the greatest decline due to changes in state, Native Corporation and private lease policy. Mariculture is expected to increase substantially. Finally, changes in the allocation of fish catch are expected. The proportional share of catch landed by commercial fishers will decline as the proportion of harvest taken by recreation operators and subsistence fishers increases.

Impact: With this information natural resource managers, as well as members of the general public, may achieve a better understanding of the complex interactions between natural ecosystems and socio-economic institutions within the watershed.

•Harry Bader

Regulating private lands near parks

Objective: Throughout the western United States the federal government owns more than half of all land. As development pressure increases on remaining private land due to expanding populations, conflict is bound to ensue along the park-urban interface. This project is designed to develop identifiable standards for predicting the appropriate reach of federal regulatory authority.

Approach: This report employed a traditional legal analysis of case law research.

Progress: The report has been completed and published.

Impact: The publication serves as a rudimentary primer for the private land owner to guide decisions concerning capital investment, loans and title transfers. It should lead to more informed decision making and efficient private investment allocations.

•Harry Bader

Kachemak Bay watershed model

Objective: This model is designed to predict landscape level anthropogenic disturbances in the watershed based upon changing economic variables. The purpose to be achieved is the prediction of the location, size and timing of land conversions in forestry, agriculture and aquaculture associated with changing economic conditions in the timber, fish, real estate and tourism industries.

Impact: Benefits of this research will be to improve local city, borough and state resource planning on the Kenai Peninsula. This research project is funded by the National Oceanic and Atmospheric Administration.

•Harry Bader

Bosnia forest damage assessment

Objective and Impact: This research project is funded by the World Bank. It is designed to detect changes in forest health, value and productivity due to damage associated with the recent conflict. The

purpose of the project is to improve international resource planning. Benefits to Alaska involve the assessment of resolution size on remote sensing data accuracy.

•Harry Bader

Standards in ecological litigation

Objective: This project is designed to produce a manual for scientists on study design and implementation protocols for scientific evidence admissibility in courts.

Impact: The protocols will improve scientific efforts in highly contentious research such as the effects of the Exxon Valdez oil spill, mining and timber harvesting. The project is funded by the Alaska Sea Grant Program.

•Harry Bader

Global change education in Alaska

Objective: The Global Learning and Observations to Benefit the Environment (GLOBE) Program (<http://www.globe.gov>) was used to sustain global environmental change education curricula in Alaska for pre-college students. The goals of the GLOBE program are to: increase environmental awareness; enhance student achievement in science, math and technology; and increase scientific understanding of the earth.

Approach: A GLOBE Training Workshop for teachers was conducted and offered as a natural resources management course as well as an education course.

Progress: The Alaska GLOBE program has grown to include 88 classroom teachers in 62 schools, three education specialists, four environmental specialists, two administrators and 7 scientists, in locations across the state. GLOBE implementation activities in K-12 schools included setting up study sites, environmental data gathering in the areas of atmosphere, hydrology, land cover biology, soils and plant phenology, and data entry on the GLOBE data server. GLOBE was also used to teach an environmental science course for middle and high school students in Shageluk. GLOBE protocols and learning activities were used to support science concept development, technology use and student inquiry in classrooms.

Impact: Global change education will help individuals make well-informed choices regarding global environmental change issues, prepare for consequences of global environmental alterations and take mitigating steps when needed.

•Elena B. Sparrow

Seasons: the global plant waves

Objective: A K-12 school based research project on plant phenology initiated in 1998 was continued in 1999. The objective of the study is to obtain on-the-ground observations to validate satellite-based

estimates of the start (greenup) and end (senescence) of natural plant growing seasons.

Approach and Progress: We trained teachers of participating schools in the plant phenology protocols and learning activities we developed (posted at <http://www.lter.uaf.edu/~dverbyla/globe>) as part of the Global Learning and Observations to Benefit the Environment (GLOBE) Program Workshop. These teachers subsequently trained their students to gather data on timing of greenup and growth rate of leaves of dominant deciduous trees and shrubs in the spring, and timing of greendown in the fall at study sites close to their schools.

Impact: Greenup and senescence can be used to examine regional and global vegetation patterns, year-to-year trends and vegetation responses to climate change. Student data would be useful in determining the appropriate satellite remote sensing greenness values that truly represent the growing season. Monitoring the length of the growing season is very important for detecting climate change. The information gathered from this project would also be useful to climate modelers and to stakeholders in Alaska.

•Elena B. Sparrow, David Verbyla, and Leslie Gordon

Irrigation feasibility study

Objective: The objective of this study is to determine the feasible operation of irrigation systems for feed barley in Alaska.

Approach: Cash Flow analysis was used to determine the profitability of 3 irrigation systems for a 160 acre field. A 15 year payoff period was used.

Progress: The final report has been reviewed and revisions are being made for final publication as an AFES Circular. In general, the initial purchase price impacts the decision to purchase an irrigation system and ultimately, its positive cash flow over the 15 year period. The area of land irrigated by a system also determines its feasibility. For example, a center pivot system is the most expensive and least efficient in covering a 160 acre field (only 133 out of 160) vs. 154 out of 160 for the other systems (wheelline and handline). Thus, in order of profitability over a 15 year period, the most profitable is the handline, next is the wheelline and the least profitable is the center pivot.

A major consideration in deciding the profitability of the systems was that feed barley is a very low value crop, so that irrigation is a very marginal operation for all of the systems. Also, irrigation in Alaska is a very low volume activity. Thus, labor and other variable costs do not become a limiting factor as they do in areas of high water usage.

Impact: Application of the results of this research may help farmers to determine which irrigation system might be appropriate for their operations.

•Hans Geier

Marine sport fisheries assesment

Objective: 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. This study documents the monetary and non-monetary benefits to tourism-related businesses.

Approach: The study developed a predictive model of participation rate changes that can be used with a regional input-output model to measure the impact of marine sport fisheries on the Kenai Peninsula economy. The model also predicts how impacts will vary as variations in trip characteristics influence participation.

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Progress: The project was presented at the annual Coastal Marine Institute meetings in 1998 and 1999, at a seminar in Anchorage and at the information transfer meeting in Anchorage.

We are ready to begin using the models to explore the effects of changes in sportfishing opportunity on angler net benefits, and the ultimate impact of those changes on the regional economy, through the evaluation of various scenarios. It would be premature to draw conclusions from the data or simulations at this time.

•Hans Geier, C.E. Lewis, J. Greenberg, M. Herrmann, C. Hamel, K. Criddle, S. Todd Lee

Feasibility of canola oilseed market

Objective: The objective of this study is to gather data related to the production and pricing of canola and its manufactured products, and determine the likelihood of operating a canola industry in Alaska, including predicted economic impact on the Alaska economy.

Approach: A significant effort to gather data is needed before any analysis can take place. Data are being gathered from a variety of sources including manufacturers and importers, other universities and other states and provinces, concerning yield data for canola. A breakeven analysis will be used to determine profitable operation of a plant and also for growing canola. The budgets from this analysis will be used to predict the impact of an oilseed business on the Alaska economy using the IMPLAN input/output regional economic modeling software.

Progress: The project is in the initial stages and is still in the data acquisition process.

Impact: This project is designed to answer questions concerning the operation of a canola oilseed industry in Alaska and to assist those with an interest in the industry to make appropriate investment and production decisions.

•Hans Geier

Economic analysis of subsistence whaling

Objective: This project is intended to provide an important baseline assessment for future comparisons of Bowhead whaling off the north coast of Alaska, and will depict the unique features of this cash/non-cash economy. Working in partnership with the North Slope Borough Department of Wildlife Management and the Barrow, Kaktovik and Nuiqsut communities will assure accurate and reliable information and ownership of the model by community members.

There are three primary objectives to the whale valuation study. First, to derive the food value of the bowhead whale on a caloric and protein content basis and determine the replacement costs using commercially available products. Second, to depict whaling as an industry and determine the benefit to the community from the money spent by those involved in whaling activity. And third, to determine the economic value of whaling to the residents of the North Slope Borough, based on their expressed preferences for trade-offs (such as oil and gas development and revenue) they may make in exchange for an increase or decrease in the number of whale strikes.

Approach: Two economic techniques, non-market valuation and regional input-output modeling (IMPLAN), are appropriate for policy and resource development analysis in Alaska. This will address the absence of the use of comprehensive economic methodologies depicting non-formal, subsistence sectors prevalent in rural Alaska economies. Prior to developing the necessary economic models, extensive information gathering tasks are required in partnership with the residents of the North Slope Communities.

Progress: To date, we have been involved in the first stage of this project—information/data collection and collaboration with community leaders in how to best structure the economic models. We have met with community leaders to develop the strategy for presentation of the project. Collection of secondary data is continuing.

We have also been involved in organizing a session on subsistence whaling at the International Institute of Fisheries Economics and Trade Conference held in Oregon in July, 2000. This session is part of efforts toward developing additional background information on subsistence whaling, current socioeconomic issues with respect to indigenous whale harvests and resource use perspectives. A panel discussion of culture, value and perspectives on indigenous whale harvests will follow. The session will be filmed for subsequent educational use (Taped copies of the session are available from AFES).

•J. Greenberg, C.E. Lewis, H. Geier, M. Herrmann, and K. Giraud

Land-use patterns of reindeer herders

Objective: The overall project goal is to increase our understanding of the feedbacks between climate, environment and human land-use in the Arctic. The goals for the economic component of the project are to estimate the contributions of the reindeer industry to local and regional communities and to identify economic consequences of reindeer-caribou interaction.

Objectives of the economic impact analysis include the following: modeling the economic components of the reindeer industry, providing an economic description of the interlinkages between the reindeer industry and the broader regional economy, describing the economic contribution of the reindeer industry to the regional economy, evaluating the costs of recent reindeer-caribou interaction, and projecting future performance of the reindeer industry.

Approach: A Seward Peninsula regional economic model is being developed to evaluate the socioeconomic impact of reindeer-caribou interaction on the Seward Peninsula. The evaluation will focus on estimating the contribution of the Alaska reindeer industry to the regional economy. The modeling efforts will focus on the Seward Peninsula communities in which reindeer operations are based.

The methodology chosen for investigation is input-output analysis (IO) and the IMPLAN input-output system. Input-output models are applied economic tools used to analyze the interdependence of economic factors in a regional economy. The IO framework is based on identifying sectors of regional economies as defined by a sector's usage of inputs in the production process and the subsequent distribution of a sector's output throughout the economy. The reindeer industry represents a local independent owner-operator industry in a region where few alternative locally based industries exist.

Progress: The first step in constructing the regional economic model is developing an accurate description of the regional economy. We are currently engaged in this information gathering stage. Various community research methods are being employed to collect primary data for the regional economic description and the IMPLAN model. Information must be collected on both the economy of the Seward Peninsula and the reindeer industry.

•Joshua Greenberg and Stephanie Moreland

Property Rights Based Management

Objective: This project investigates potential economic and management consequences of use privileges for the Aleutian Islands golden king crab fishery.

Approach: A discrete time deterministic model was constructed to characterize the bioeconomic system of privately owned Territorial Use Rights in

Fisheries (TURFS). The model was adjusted to represent various other property rights systems and assess economic and management implications of their employment.

Progress: Management programs reviewed include individual fishery pot quotas (ITPQs), Individual Fishery Quotas (IFQs), Fishery Cooperatives, and Territorial Use Rights in Fisheries (TURF)s. ITPQs define property rights to units of gear and as such, indirectly control fishery harvests. However, ITPQs were identified as failing to address the externalities associated with gear conflicts or stock depletion. Also, ITPQs, while limiting fleet capitalization in one harvest input, do not address overcapitalization in other harvest inputs.

IFQs assign property rights to fishery harvests. While IFQs may reduce the incentive to race-for-fish, there is still competition for preferred fishery locations in the spatial-time commons.

TURFs assign spatial property rights to the fishing grounds. Under a secure TURF management structure with durable and transferable rights, harvesters will select efficient levels of capital investments, and if migration rates are low, they will internalize the benefits of stock conservation.

Finally, Fishery Cooperatives assign joint property rights to a common group of vessels.

•Joshua Greenberg, Keith Criddle and Mark Herrmann

Alaska Grown products

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

Approach: The classroom is used to test consumer acceptance of Alaska Grown products. In the course *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. We also try to bring our sensory work to as many of the Agricultural and Forestry Experiment Station events as possible.

To date our students, with help from the University of Alaska community and residents of Fairbanks, Anchorage and Palmer, have helped us bring producers and consumers information about the appearance, texture, flavor and overall acceptability of Alaska honey, carrots, barley pancake mix, salsa and tomatoes. We added seafood products to our agenda in 1996. This year we added hotdogs.

Progress: Sausages are one of the oldest forms of processed food. The hot dog is a specialized form of sausage. Today, the hot dog enjoys popularity throughout the world. For our taste test, we selected three major brands of all-beef hot dog to compare to the Palmer Pride all-beef frank.

Our 144 tasters ideal hot dog was 'hot-dog pink', not stale and plump. The skin was a bit more soft than chewy though somewhat snappy. The ideal meat was firm. The tasters favored a beefy flavor, somewhat smoky, that was not necessarily salty or sweet. The Palmer Pride frank was preferred by all participants. The 5-12 year age group strongly preferred the traditional hot dog at the high end of the price scale. The teenagers preferred the higher-priced traditional dog, but their preference for the Palmer Pride frank was stronger than that of our younger panelists.

Impact: We continued to expand the series of publications begun in 1998 through the Agricultural and Forestry Experiment Station. This series highlights the products we have tested. Brochures telling our audience about barley trailcakes, salsa, tomatoes, russet potatoes and spinach, as well as hot dogs, were completed in 1999. Publication numbers are available in the publications section of this issue.

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*

Federal-state marketing improvement

Objective: Approximately 90% of the food for the 650,000 people in the state of Alaska is imported. However, receipts from Alaska's agricultural industry have increased substantially since the mid 1970s. Farmers are producing high quality products. Their products are in demand by the state's consumers. Markets are not the problem. Marketing is the problem.

Approach: The project will assist farmers in overcoming barriers in the Alaskan marketing infrastructure and provide a plan of action. A cornerstone of the project is to quantify the demand for vegetables and potatoes in Alaska by value-added processors and food retail outlets. Farmers will also be asked to provide information on their current product sales and to identify market barriers.

Progress: A survey was prepared and sent to retailers, wholesalers and vegetable processors in Anchorage and Fairbanks. There are six major wholesalers, three retail chains, two major discount outlets, two processors and the military complex that form the retail/wholesale distribution chain for vegetables and potatoes in Alaska. Most carry Alaskan products; several who don't would like to do so. Only one had apparently no interest. We are in the process of tabulating results from the surveys we have received and following up on those we have not

received. The major crops that are purchased from Alaskan producers are potatoes, lettuce, cabbage and carrots. During the coming year, we will also survey producers in Alaska. We will be asking for information on the crops they produce and sell and asking them to identify market barriers and any successes they have had in entering the retail/wholesale marketing chain in Alaska.

Impact: A much clearer picture of the markets available to Alaska farmers will be gained by our work with the USDA and the Alaska Division of Agriculture. Farmers will be made aware of the product that buyers are looking for, the prices they are willing to pay, where the products are in demand and how to effectively promote their products to buyers. Buyers will be more aware of the availability and ability of Alaska producers to provide vegetables and potatoes for their needs, what price the farmers need for economically viable operation, where they may obtain vegetables and potatoes and effective promotion methods of Alaska products to consumers.

• *Carol E. Lewis and Hans Geier*

Muskox: looking toward the future

Objective: Despite increasing demand for knitted products from qiviut and an emerging market for meat products, the muskox industry in Alaska is not growing. The Alaska Science and Technology Foundation (ASTF) has provided funding for investigations of new feed rations. A component of the study is to prepare a plan for revitalizing the industry.

Approach: The Agricultural and Forestry Experiment Station is cooperating with the Institute of Arctic Biology, University of Alaska Fairbanks and individuals from the private sector to develop a footprint for industry growth. A part of this plan is to form a working task force and resource group that can address major components needed if the muskox industry in Alaska is to expand. These components are: availability of animals; producer awareness of muskox husbandry, products, markets, and marketing; and capital requirements and operating costs.

Progress: A Muskox Task Force was formed in late December, 1999. Members of the task force were selected because of their broad knowledge and experience with exotic breeds and their specific interest in muskoxen. They represent expertise in feed production and marketing; exotic animal breeding and sales; production of exotic breeds; qiviut production, fibers, knitting, and product marketing; and meat processing and sales. The task force and resource group are to meet in 2000 at a work shop being planned around the theme "The Private Sector Must Take Control of the Muskox Industry if it is to Succeed". A challenge to the task force is to provide an outline of an action plan for the

industry's future, and action items that will promote the industry.

Impact: An industry cannot survive without infrastructure. The animals, of course, form the backbone for the muskox industry in Alaska. Research is a critical element, particularly with a breed as little understood as the muskox. Finally, product diversity, product processing and an aggressive marketing strategy are necessary if the industry is to succeed and grow. Should the private sector 'buy into' the action plan developed by the Muskox Taskforce and Resource Group, the industry can expand. The financial viability of the industry as a whole will depend on the viability of industry producers and the successful entrance into markets for muskox products.

•Carol E. Lewis, Perry Barboza, John Blake

The internet as a tool

Objective: This research looks at the pros and cons of using electronic communication (such as web surveys and listservs) for involving the public. The exponential growth in the popularity of the internet makes it possible to communicate frequently and inexpensively with the stakeholders in a planning process. Indications are that this technology will soon be as ubiquitous in American homes as telephones and televisions are now. Public involvement experts have always recommended using a wide variety of tools to communicate with the public. Now they have one more that may become the biggest boon to democratic planning since the introduction of public involvement efforts.

Approach: The basic approach is to develop several internet tools (listservs, surveys and so forth) and apply them in actual planning cases, to explore both their advantages and their limitations for enhancing citizen participation. We then determine how different agencies are currently using the internet to involve the public. Finally, we evaluate the pros and cons of each of the primary tools available on the internet (such as email, listservs, web pages and so on) that could be used in public involvement.

Progress: Work on the first objective is complete: internet tools were used for obtaining public comment on two planning cases. In the first case, a public web survey was prepared and analyzed for the SALRM Board of Advisors' Strategic Plan. In the second case—a plan for the UAF Trail System—a web survey, an email distribution list, a listserv and a website posting of the Draft Plan were used to solicit public input. Manuscripts on how different agencies are currently using the internet and on the pros and cons of the primary internet tools are now in progress.

Impact: With the rise of interactive electronic communication, we can create a virtual town hall in which citizens will have greater power over the future of their communities and public lands than ever before. What's more, they will be able to participate at their own convenience and from the comfort of their homes.

The biggest drawback to the use of the internet is that 50% of American households are not currently online. The two groups most under-represented include the poor and the elderly, so other approaches must be used in conjunction with the internet to reach these people as well as those who prefer traditional methods such as public meetings.

Research such as this will help us design public involvement programs with both traditional and modern tools so that we can take advantage of the internet's strengths while also compensating for its weaknesses. Today, most agencies have a web site that provides considerable information about their mission and activities, but at this point few agencies take advantage of the interactive capabilities of the internet.

Providing information is certainly valuable, but to realize the internet's full potential to involve people in open discussions of the issues, agencies must incorporate interactive tools into their websites. In doing so, they can make public involvement a more integral part of everything they do.

•Susan Todd

Faculty Publications

January 1999—December 1999

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- Lewis CE. Alaska tomatoes: tempting, tantalizing, tundra treats. AFES Misc. Pub. 99-2.
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FY 00 research funding

Grants and Special Funds; July 1, 1999– June 30, 2000

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
Fredric Husby, Greg Finstad	Reindeer herding
Elena Sparrow	Global change education
Marilyn Walker	ITEX

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

United States Department of Agriculture; ARS

Dennis Fielding	ARS research support
Stephen Sparrow	Control of AK grasshoppers
Fredric Husby	Feed supplements from fish wastes

United States Department of Agriculture; CREES

Donald Carling	Screening accession of <i>Solanum ssp.</i>
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

University of Alaska Natural Resources Fund

Don Carling	Late blight disease of potato
Greg Finstad	Heavy metal concentrations in reindeer and caribou tissue
Patricia Holloway	A plant propagation system for horticulture, forestry and phytoremediation in Alaska
Glenn Juday	Development and calibration of SKOG
Meriam Karlsson	Light quality for off-season raspberry production
Meriam Karlsson, Jenifer McBeath	Evaluating ginsenosides in ginseng produced in AK
Carol E. Lewis, Robert Trent	UA–MIT partnership
Jenifer McBeath	Support of potato industry in AK
Jenifer McBeath, Meriam Karlsson	Cultivation of ginseng in AK
Jenifer McBeath, Meriam Karlsson	Cultivation of ginseng, chavanbeimu, and huanggi in Alaska
Edmond Packee	Continuous forest inventory
Stephen Sparrow	Agronomic and economic evaluation of forage crops for AK
Charles Knight	Forage management
Meriam Karlsson	Resource ambassador program
Meriam Karlsson	Leadership continuum program for K-12 students
Tricia Wurtz	Assessing white spruce resistance to beetle attack
Cary de Wit	Development of a circumpolar regional database
Fredric Husby	Development of a UA and federal initiative

AK Department of Natural Resources

Patricia Holloway	Mulches for tree planting in AK landscapes
Jenifer McBeath	Virus free seed potatoes
Jenifer McBeath	Produce certification
Dot Helm	Abandoned mines land reclamation

UA International Arctic Research Center (IARC)

Elena Sparrow	GLOBE: Global change education for K-12 students
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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

AK Science and Technology Foundation

Jenifer McBeath Seed potato
Don Carling Potato chipping

University of Alaska Foundation

Patricia Holloway Georgeson Botanical Garden
Larry Burke Experiment farm

U.S. Fish and Wildlife

David Verbyla Radar remote sensing of alluvial habitat
David Verbyla Synthetic aperture radar

National Biological Survey

Chien-Lu Ping Rock Creek water quality

USDA Forest Service

John Yarie Forestry research

University of Nebraska Lincoln

David Valentine Modeling of methane

Sea Grant

Harry Bader Study design and filed implementation protocols for the development of scientific evidence

World Bank

Harry Bader Bosnia forest damage

NOAA/Technology Planning and Management Corp.

Harry Bader Analysis and synthesis support; socio economic characterization of Kachemak Bay, AK

Kawerak, BIA

Harry Bader, Greg Finstad Legal restraints in response to reindeer-caribou competition and co-mingling on the Seward Peninsula

Cornell University

Meriam Karlsson Raspberry production

U.S. Geological Survey

Glenn Juday Dendrochronological studies in national parks in AK

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. Department of Education

Fredric Husby Star Schools

Department of Commerce and Economic Development

Jenifer McBeath Export certification process

Fred Gloeckner Foundation, Inc.

Meriam Karlsson Production requirements of Forget-me-nots

Phillip Morris Co.

Charles Knight, Dave Maddux Constructed wetlands

University of Arizona (EPA)

Elena Sparrow Environmental outreach

U.S. Department of the Interior

Carol Lewis, Kelly Giraud Bowhead whaling

National Geographic Society

Chien–Lu Ping..... Soil and vegetation in China

Formula Funds

Hatch General; USDA

Harry Bader	Comparative legal analysis of private property use and regulation in the rural U.S.
Stephen Sparrow	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	Agricultural and Forestry Experiment Station
Meriam Karlsson	Environmental plant physiology of greenhouse produced crops
Carol E. Lewis	Marketing Alaska’s agricultural and processed seafood products
Charles Knight	Alternative crops for the subarctic
Don Carling	Evaluation of production practices, cultivars, and some diseases of potato and vegetables
Patricia Holloway	Horticulture crop production for AK
Joshua Greenberg	Regional economic modeling for rural AK
Fredric Husby, Greg Finstad	Raised reindeer
Susan Todd	Resource planning
Milan Shipka	Reproductive performance in domestic ruminants

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Hatch Multistate; 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 soil–borne plant pathogens
Milan Shipka	Reproductive performance in domestic ruminants

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	Ectomycorrhizae in disturbed lands
David Verbyla	Development of an Alaska 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

Financial Statement

Expenditures — July 1999 through June 2000

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1999 and ending June 30, 2000 (FY 00). NOTE: This is not an accounting document.

FEDERAL		(percent of total)
Hatch General Formula Funds	\$735,536	11.8
Hatch Multistate Formula Funds	\$190,171	3.0
McIntire–Stennis Formula Funds	\$565,076	9.1
OTHER GRANTS AND CONTRACTS	\$1,691,958	27.1
STATE APPROPRIATION/PROGRAM RECEIPTS	\$3,053,969	49.0
TOTAL	\$6,236,710	100.0 percent

Dean Husby Retires

Dr. Fred Husby has filled many shoes since his arrival at UAF in 1975. He was hired as a young assistant professor of animal science straight out of Washington State University.

Finding housing was a bit interesting back then. This was during the pipeline days and rental units were expensive—if you could find one. The UAF farm had some old, rundown housing units located across the road from where the reindeer pens are today and that's where Dr. Husby and his young family first took up residence.

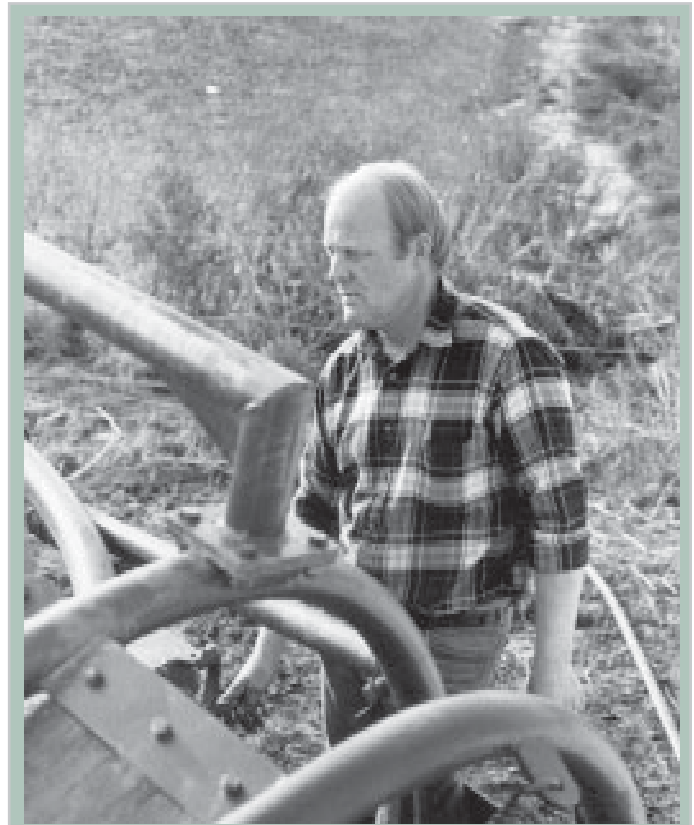
Husby was the only animal science professor in the School of Agriculture and Land Resources Management (SALRM) for many years. He spent numerous hours above and beyond the call of duty traveling to maintain research facilities across the state.

Fred made time to be with his children even while on the road. He tells this story of transferring some cattle from Kodiak to Homer one year very close to Christmas. Knowing he might return late on Christmas Eve, he asked his then-young son, Martin, to come along with him. They drove to Homer and got on the ferry. As is often the case, the weather turned bad on the way over to Kodiak and before Fred could take precautions, Martin was looking very green.

After loading the cattle it was time to re-board the ferry for the return trip. Martin stood on the dock and adamantly said, "No more boats, Dad," and refused to get on. After that trip, Martin was careful about which trips he agreed to accompany his dad on!

During the mid-1980s, faculty positions were added in Palmer and Fairbanks that allowed Dr. Husby to concentrate on his greatest interests, teaching and swine nutrition research. Husby's dedication to the agricultural producers of Alaska is evident in his research accomplishments, all directly applicable to Alaska agribusiness. He has:

- determined supplementation levels of salmon, herring, black and grey cod meals, and fish hydrolysates and powders in early-weaned pig diets;
- determined supplementation levels of Alaska shellfish processing wastes in swine, dairy and beef cattle diets;
- determined that rumen microorganisms could adapt to and utilize shellfish chitin;
- determined winter feeding requirements and summer grazing limitations of weanling and yearling cattle on the Kenai Peninsula, Alaska;
- determined the feeding value of a new mutant Alaska hulless barley, *Thual*, for sheep, beef cattle, swine and sled dog diets;



Husby demonstrating how to use the cow chute to students in a livestock management class he taught in the early 1980s. AFES file photo.

• formulated, tested and developed Alaska sled dog diets containing greater than 50% Alaska barley plus herring meal;

• published the first comprehensive bulletin on nutritional components of Alaska's feedstuffs; and he was a participant and past chairman of the Hatch Regional Project, "Characteristic and Feed Value of Barley and Western Protein Supplements for Swine" (1983-1988) and (1989-1993).

Dr. Husby may have been happiest in the classroom and the barn, but he became the head of the Plant, Animal and Soil Science Department in 1993. He again came forward in 1995 to take leadership as the interim Director of SALRM until 1997, when he added the duties of Dean of the new College of Natural Resources Development and Management to his already busy schedule. He filled both of those demanding roles for the last three years while still teaching courses in animal science.

Dr. Husby retired in July and we hope he will enjoy many years of hunting trips, and perhaps also use his farming and teaching expertise in other capacities that will continue to benefit Alaska.

news & notes

Congratulations to the SALRM graduates of 2000

B.S. in Natural Resources Management:

Courtney Berens
Kelly Bushong
Joshua Buzy
Amy Davis
Timothy Lauder
Jennifer Trudeau
Marylou Weber-Richard

B.S. in Geography:

Matthew Barlow
JoAnn Cooper
Brian Harshburger
Andrew Orthmann
Sam Shea
Jared Storm
Michael Walker

M.S. in Natural Resources Management:

Peter Christian
Heather Goldman
Lisa Popovics
Michelle Weston-York

SALRM students win scholarships

Stephen Winslow—\$1,000 from the John B. and Mae M. Hakala Scholarship Fund

Jennifer Arseneau—\$1000 from the John B. and Mae M. Hakala Scholarship Fund

Nick True—\$1000 from the Society of American Foresters—Dixon Entrance Chapter Scholarship Fund

Jeff McArthur—\$500 from the Society of American Foresters—Richard W. Tindall Scholarship Fund

Stephen Winslow—\$250 from the Eugene Evancoe Scholarship Fund

SALRM's Outstanding Advisor Award

Dr. Meriam Karlsson received an Outstanding Advisor Award in 1999-2000 for her work with the advising center for Plant, Animal and Soil Sciences. Dr. Karlsson was a previous recipient of the award in 1992 and 1995.

Usibelli Award

Dr. Jenifer McBeath received the Emil Usibelli Distinguished Service Award for 2000. Dr. McBeath was recognized for her work in plant pathology and entomology pertaining to Alaska seed potatoes.

The awards are given annually in the areas of teaching, research and service, and are named in honor of Alaska pioneer Emil Usibelli, who established the Usibelli Coal Mine.

Honorary American FFA Degree 43

Dr. Fred Husby is being presented with the highest FFA award, which will be given this October. The Honorary American FFA degree is awarded to nominated teachers and individuals who have made outstanding contributions to Agricultural Education/FFA. The other Alaskan to share this year's award with Husby will be Senator Ted Stevens.



After hearing the greeting, "Dean and Directors Office" in a smiling southern accent for the last 20 years, we are all going to miss Carolayne Wallace.

Wallace retires

"I remember when I first started working here. They were paying me \$5.42 an hour. I thought I'd died and gone to heaven. And then to make it even more unbelievable, they told me I'd get benefits including retirement," says Carolayne Wallace.

So finally it is here and the veteran administrative assistant for the Dean of the School of Agriculture and Land Resources Management has indeed retired. "I've enjoyed working on the various committees and boards," Wallace said in a 1995 interview. "But most of all I've enjoyed working with the students. They make it all worthwhile. It's important that we never forget their education is the reason for this place."

Carolayne was the mediator of many squabbles among faculty, staff and students. If ever there was a question of how a situation should be handled, someone inevitably would suggest that you go tell your story to Carolayne. She could always be counted on for good impartial advice. Her smile and cheerful voice will be missed by everyone who stops by the Dean's office.

She has worked with Dr. Bonita Neiland, Dr. James Drew and lastly Dr. Fredric Husby before moving on to this exciting new phase of her life.

