School of Agriculture and Land Resources Management
Agricultural and Forestry Experiment Station
Vol. 30, No. 2: The Annual Report *Fall 1998*

AgroBorealis

AFES Acting Director | Palmer Research Center | 533 E. Fireweed | Palmer, AK 99645

June 30, 1998

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

Dear Sir:

I submit herewith the annual report from the Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks, for the period ending December 31, 1997. 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

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.

AgroBorealis

EDITORIAL STAFF

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For more information on the centennial celebrations of the Agricultural and Forestry Experiment Station, see page 10–11.

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About the cover: Fall at the Fairbanks Station sees the farm crew out in the fields harvesting. Alan Tonne is swathing the barley to get it dry enough to combine.

Photo by Cal White

Back cover: The animal pens at the Fairbanks Station are a favorite visiting place for children of all ages. The pigs were busy this fall. With all the extra rain, their pen was perfect for digging wallowing holes.

photo by Jan Hanssinn

Honeybees tested as pollinators for arctic legumes

Jay D. McKendrick,
Harold R. Engel,
and Amanda A. Dreyer

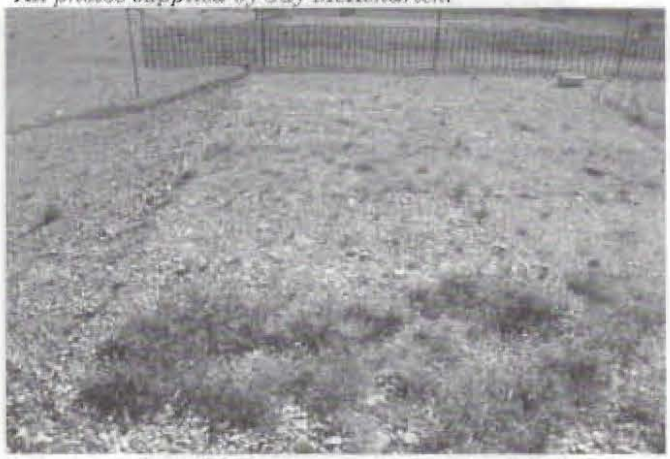
Installing beehives for pollinator study along Sagavanirktok River, south of Prudhoe Bay, Alaska.

Introduction

Pollination of flowers is essential for fruit and seed production. For cross–pollinated species the process occurs with wind and insects carrying pollen from one flower to another. For self–pollinated flowers, pollen may fall onto the stigma from nearby anthers. Mosquitoes, wasps, flies, and bees are some of the important insect pollinators in the Arctic. Bumblebees are important for cross pollination of *Pedicularis* species. Cross pollination of the legume flower requires an insect large enough to trip open the keel, which encloses the anthers and stigma. Without such insect pollinators, seed production for important forages, such as clover and alfalfa, would be greatly hampered.

We have discovered that in the arctic oil fields certain indigenous legumes are valuable for developing plant cover on barren gravel. Thousands of acres of barren gravel will likely require revegetation after Alaska's oil fields are closed out. A reliable supply of seed from these useful legumes could be used to establish plant cover on abandoned gravel pads and roads in arctic Alaska. Legume seed for revegetation experiments thus far have been hand–collected from natural stands. There are no commercial sources, and prospects for producing such seed outside the Arctic are not encouraging. For the most promising legume species, producing seed from local, naturally–adapted ecotypes may be most easily accomplished right in the Arctic, where we know the environmental conditions are suited to those plants.

All photos supplied by Jay McKendrick.



Long–term Gravel Vegetation Project test plot (28 July 1997). Foreground seven growing seasons after native legume species were seeded into restructured gravel fill. Middle plot, eight growing seasons after seeding primarily to grasses.

One seed production approach could be to create stands of the most promising and desired legumes on a few abandoned gravel pads in the Prudhoe Bay vicinity. Seed could be mechanically harvested from these stands for revegetation projects. Establishing the production stands would require hand–collecting from natural communities. Once established, these perennial communities should produce seed year after year to supply revegetation needs of the oil field complex. We have learned these legume species establish most successfully on bare gravel. The slow–growing legume seedlings establish best without competition from grasses, whose seedlings develop relatively quickly. Legume seedlings require five to seven growing seasons to reach maturity. We also know that altering the gravel substrate for revegetation by adding soil encouraged grasses at the expense of legumes.

There are feasibility questions to be answered before launching into a seed production venture in the Alaska Arctic. We should know about the seed production potentials of these plants and which cultural practices are needed to maintain stands and promote seed production in the Prudhoe Bay region.

One key question is, are there adequate cross–pollination insects for large stands of legumes in the Prudhoe Bay vicinity? Seed production stands established on gravel fill could eventually be tens of acres in size, far larger than the natural communities along rivers. This could mean there would be

more flowers to pollinate than natural insects to do the pollinating. Oil field gravel pads are most often located in wet–sedge tundra, a habitat unsuited to bees. The indigenous bees do not nest in either the wet–sedge soils or the gravel that best supports the legumes. Instead they nest in the well–drained sandy and loamy soils along the margins of streams. Thus, a production stand on a gravel pad in the midst of wet–sedge tundra could be far from nests of natural pollinators. This condition, coupled with potentially large stands of legumes needed for producing adequate seed supplies could mean that insect cross–pollination would be a limiting factor for seed production. Honeybees are often used for legume crop pollination in the temperate latitudes. We wondered if insect pollination was a limiting factor in arctic Alaska, could honeybees be used to overcome that deficiency?

Experiment

We decided to test effectiveness of using honeybees to pollinate legumes in the Alaska Arctic during the summer of 1997. A local expert on bee keeping, Mr. John Liska, from Eagle River, Alaska was enlisted to assist the project. Two hives of bees, colonized during April at Eagle River, were transported to the Arctic and located on July 8th about 20 miles south of Deadhorse, Alaska, along the Sagavanirktok River. The location was adjacent to naturally established stands of legumes and other flowering plants, which had colonized within the Trans–Alaska Pipeline right–of–way. Beehives were left on site for 36 days, and transported back to Eagle River on August 14th.

Instruments were installed on one hive to record honeybee activity. Because insect (including bee) activity is dependent on temperature, and heat is limiting in the Arctic, temperature coincidental with honeybee activity was considered valuable information. We used a data recorder with two sensors, one for temperature and one to record bees exiting and entering the hive. Temperature was measured every 5 minutes, and averaged to provide a mean hourly estimate. The bee sensor was constructed by James Dryden of Dryden Instrumentation, Anchorage, Alaska. The bee counter consisted of an opening, which all bees exiting and entering the hive were forced to use, with an infrared light beam aimed at a sensor on the opposite side of the opening. When the beam was broken and subsequently restored, it created a count, which was recorded. The beam breaks during a one–hour period were automatically summed and recorded as counts per hour.

This is possibly the first time honeybees had been taken to the Alaska Arctic, and little was known about their reaction to that environment. Pollen traps were installed to strip pollen from the bees as they entered the hives. The pollen collected was compared with that from reference plants in the vicinity of the hives to identify which plant species the bees visited. Because stresses on honeybees were unknown, mortality of the two colonies was monitored by counting dead bees ejected from the hives.

The experimental design to measure seed set (pollination success) included two legumes in the vicinity, *Oxytropis borealis* (viscid oxytrope), and *Hedysarum mackenzii* (wild sweet pea). Both species have been successfully established in gravel vegetation tests and grow upright, offering the possibility for mechanically harvesting seed. The plan was to have one group of plants exposed to natural and honeybee pollinators, one group exposed only to natural pollinators, and a third group exposed to no insect pollinators. To exclude all insect pollinators, near the beehives ten immature inflorescences of each of the two plant species targeted were covered with nylon stockings. A site four miles up river was selected as a control (exposed to only indigenous pollinators), since it was beyond the flight limits (about 3 miles) of honeybees.

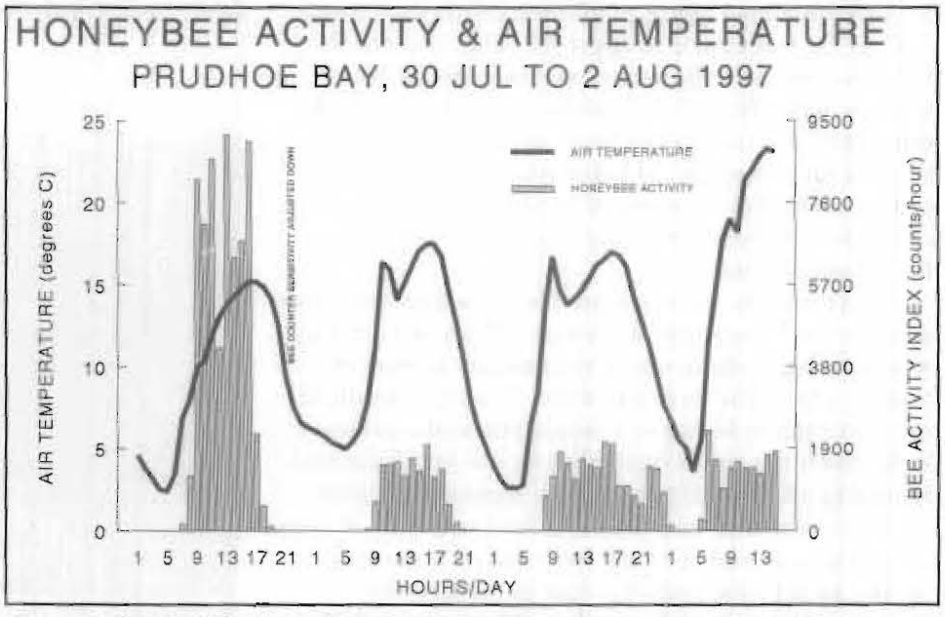


Figure 1. Graph of air temperatures and honeybee activity at test site south of Deadhorse, Alaska, over a three–day period during the summer of 1997.

Results and Discussion

Honeybee Activity & Air Temperature

Data for honeybee activity and air temperatures during one three and a half day period are shown in Figure 1. It is clear that honeybees were active only during the warmest periods of the day. Table 1 contains a listing of the temperature averages for the hours that bees began and ceased their out–of–hive activities. These temperature means ranged between 5.0 and 7.9°C (about 41 and 46°F, respectively). If the four beginning temperatures and three ending temperatures are considered separately and respectively averaged, the bees appeared to begin exiting the hives at a slightly warmer temperature (6.7°C/44°F), than when they ended flights (6.0°C/43°F). If true, it may mean that sudden weather changes, might be obstacles for honeybees used as pollinators in the Arctic. Research conducted in Montana indicated the critical threshold for honeybees is 40°F. It is not known what the temperatures were inside the beehives when our bees began and ended their flying activities. It is likely that the interior of the beehives warmed more slowly in the mornings, relative to the outside air.

Table 1. Beginning and ending of honeybee activity and corresponding hourly mean air temperatures for a three–day period in the summer of 1997, south of Prudhoe Bay, Alaska.

Date	Hour	Activity	Mean Hourly Air Temperature °C, (°F)
30 July	0700	Began	6.9 (44.4)
30 July	2300	Ended	7.6 (45.7)
31 July	0900	Began	7.9 (46.2)
1 August	0100	Ended	5.0 (41.0)
1 August	0700	Began	6.4 (43.5)
2 August	0300	Ended	5.5 (41.8)
2 August	0600	Began	5.5 (41.8)

It is also interesting to notice that bees were inactive for only three hours during the 1st–2nd of August. Bees commenced exiting at 7AM on August 1st and continued going in and out of the hive until 3AM in the morning of August 2nd. They did not fly for three hours, only to resume their out–of hive work at 6am. How this extended activity schedule, due mainly to influences from continuous daylight in the arctic summer, affected honeybee longevity and productivity in terms of honey, pollination, etc. could provide an interesting topic of investigation for entomologists.

Unfortunately, we were unable to gather extensive data on the honeybees' activities. When bee activity was very high, there was a continuous stream of insects across the hive entrance. The counter could not distinguish between a single bee and a group of bees, since the count depended on the breaking and resuming of the light beam. The sensor sensitivity could be adjusted, however absolute numbers of bees going through the opening were not as important as recording relative activity. Just as we had the instrument sensitivity set, the battery expired. We were unable to get a replacement until well after the experiment ended.

Honeybee Mortality Data

Bee mortality data have not been summarized. These data were compromised during the beginning of the project, when it was discovered that Arctic ground squirrels were eating the dead bees discarded from the hive. Special collection baskets were made from window screens to protect the discarded bees until they were counted.

Pollen Trap Data

Pollen was removed from the pollen traps on four dates: July 19th and 25th, and August 6th and 13th. Subsamples of the pollen were prepared and passed through a Hemacytometer to measure the relative numbers of pollen grains from various plant species. According to data from the pollen traps, honeybees are

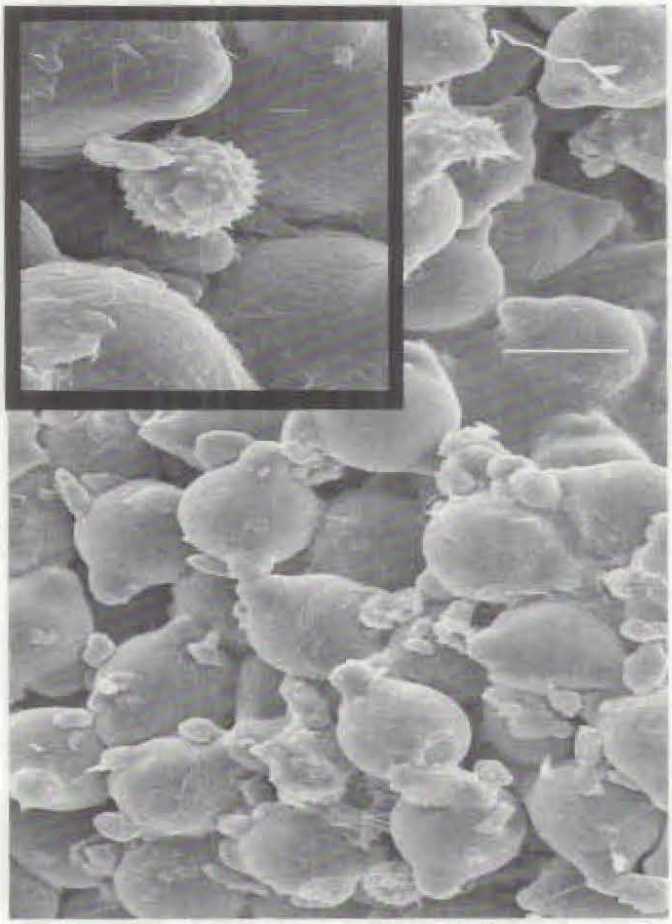
Joe Hanover and Amanda Dreyer covering Oxytropis borealis *inflorescences with nylon stockings near beehives.*

known to have visited the following plant species: *Achillea lanulosa*, *Epilobium latifolium*, *Hedysarum mackenzii*, *Oxytropis borealis*, *Polygonum viviparum*, and *Senecio congestus*, plus two unidentified plant species.

Between July 8th and 19th the dominant pollen was from *O. borealis*, *H. mackenzii*, and *P. viviparum*, in descending order. Between July 19th and 25th, the predominant pollen came from *H. mackenzii*, an unknown species, and *O. borealis*. Between July 25th and August 6th, the dominant pollen was from *H. mackenzii*, an unknown species, followed by *S. congestus*. Plant species still flowering in the vicinity of the beehives on August 6th included: *Castilleja elegans*, *H. mackenzii*, *E. latifolium*, and *Astragalus nutzotinensis*. Between August 6th and 13th, the dominant pollen came from *A. lanulosa*, followed by *S. congestus* and *E. latifolium*, respectively.

Seed Production from Legumes

The treatment which excluded insect pollinators was lost. On July 18th two grizzly bear removed all the nylon stockings from plants near the hives. This



SEM image of pollen from UAF SEM lab. Background image scale bar is 50 microns and the insert scale bar is 5 microns.

View of beehive entrance equipped with sensor to count bees passing in and out of the hive. The screen basket beneath the opening is to prevent Arctic ground squirrels from eating the dead bees discarded from the hive before they can be counted.

was serendipitously observed when Harold Engel and an assistant visited the hives that evening. They were also were able to verify the effectiveness of the electric fence in repelling bears from our beehives. After three approaches to the fence and three electrical shocks, the bear left the vicinity.

We collected seed from plants exposed to honeybees and native pollinators and from plants exposed to only native pollinators on August 29th. The average number of *O. borealis* seed per stalk near the beehives was about 11. Plants beyond the influence of the bees produced 31 seed per stalk, nearly three times more seed. The t–test indicated there was a high probably of that difference being real. The seed weights were lighter in the vicinity of the beehives (895 seeds per gram), in contrast with 789 seeds per gram beyond the influence of the bees. A t–test indicated no significant difference in those means.

It is not known if the difference in seed set for *O. borealis* was due to lack of pollination or if it was simply a factor of habitat conditions. Both collections were obtained from plants that had colonized naturally along margins of gravel fill created when the Trans–Alaska Pipeline was constructed in the mid–1970s, and were presumably of similar age. Both habitats were adjacent to undisturbed tundra of the Sagavanirktok River valley, as opposed to gravel bars in the channel itself. River bars were not considered suitable for sampling, because periodic high water floods some communities during the growing season. Neither of the stands sampled showed any signs of animal grazing.

It is possible that indigenous insects were repelled from the vicinity of the hives by the large population of honeybees. If that is true, it may have reduce effectiveness of indigenous pollination on the *O. borealis*. That would suggest honeybees may not

Table 2. Mean *Oxytropis borealis* seed harvested per stalk, mean seed number per gram, and respective t–test results for plants exposed to honeybees and without exposure to honeybees, Prudhoe Bay, Alaska. Seed harvested 29 August 1997.

Treatment Group	N	Mean	Standard Deviation	t–value	t–test Probability
Mean seed number harvested per stalk (10 stalks/sample)					
Honeybee	10	10.8	8.465	11.3	0.026
No Honeybee	10	31.0	23.473	18.0	
Mean seed number per gram					
Honeybee	10	895	142.891	17.7	0.138
No Honeybee	10	789	161.709	18.0	

only be less efficient pollinators than natural insects, but also perhaps out compete some of those indigenous insects for territory. Mr. Liska told us that he had not observed honeybees repelling other native pollinators. Therefore, competition among pollinator species may not have been a factor in this instance.

We were unable to collect seed from *H. mackenzii*, because all the pods had been stripped by Arctic ground squirrels between August 13th and 29th. Arctic ground squirrels have been observed collecting and storing seed from several species from our revegetation test plots at Prudhoe Bay, including: *Descurainia sophioides, Braya purpurascens*, and *Puccinellia laneana*. These animals appeared to gather whatever forb or grass seed was abundant in the vicinity of their burrows. The population of the Arctic ground squirrel in the Prudhoe Bay vicinity appeared to be markedly elevated in 1997, possibly because numbers of the main predator on these rodents, the Arctic fox, were down. Early in the 1997 growing season, long before seed matured for this pollinator study, we observed increased squirrel activity at our long–term gravel vegetation plots at Prudhoe Bay. In those plots, burrowing was disturbing plot marker stakes, and squirrels were stripping flowers from *A. nutzotinensis*. The degree of these activities from Arctic ground squirrels was considerably more conspicuous than exhibited in previous years.

Conclusions and Recommendations

As a first attempt to move honeybees to the Alaska Arctic, we learned much from the experiment. We did not obtain honey from these bees, because they consumed what they made before we removed them. The flowering period in the Prudhoe Bay environment is very short, perhaps only two to three weeks, depending on the weather conditions in a given year. Two to three weeks flowering is certainly not a long enough period to support a honey production industry. But the value of honeybees as pollinators could prove worth the effort of bringing bee colonies to the region for brief periods to ensure seed production by legumes valuable for gravel fill revegetation. The feasibility of the honeybees as pollinators of indigenous legumes is not yet answered. Our current data suggest pollination by honeybees may be less efficient than indigenous bees. If that is true at Prudhoe Bay, it is not unprecedented. It is known that indigenous solitary bees can be far more efficient at pollination than the honeybee.

Acknowledgments

The authors express gratitude to ARCO Alaska, Inc. for financial and logistical support. BP Exploration (Alaska), Inc. has funded the long–term research on gravel revegetation for nine years. The State of Alaska through its Legislative appropriation for organized research to the University of Alaska Fairbanks provided salary support on the Long–term Gravel Vegetation Project for Jay McKendrick. Salary and supply support for the Long–term Gravel Vegetation Project also came from the U.S. Department of Agriculture Cooperative State Research, Education, and Extension Service funding to the Alaska Agricultural & Forestry Experiment Station. Appreciation is expressed to Dr. James H. Anderson, UAF Library Assistant, who conducted a literature search on pollinators of the Arctic. Pete Nagel and Joe Dwyer of Alyeska Pipeline Service Company granted access to the pipeline right–of–way. Dick Schidler, Alaska Department of Fish and Game provide information on fences to keep bears from the beehives. John Liska and Ron Rebarchek provided honeybees and information on honeybee keeping in Alaska. Louie Miller and Stephanie Leman, ARCO Materials, and Joe Hanover, ARCO Spill Response Team assisted with cargo logistics and supplies. Beehives were transported as air cargo between Anchorage and Prudhoe Bay on Alaska Airlines. The scanning electron microscope image of pollen for this article was prepared by Kim DeRuyter, lab technician, and Kenneth Severin, Director of Advanced Instrument Laboratory, Geology and Geophysics Department, University of Alaska Fairbanks.

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AFES– celebrating 100 years of agricultural research in Alaska

The AFES Golden Days float (left) was driven by Bob VanVeldhuizen and manned by 4-H'ers and their animals. Haleigh Fowler, Jacob VanVeldhuizen, and Bo Dinstel (bottom left) take a short break from handing out candy and AFES centennial flyers, and letting kids pet the rabbit during the Golden Days parade. Samantha Carpenter, Carolyne Wallace, Dean Fred Husby, Kenton Hanscom, and Callie Jo Dinstel (bottom right) admire the Dean's new sheep acquired from 'Ship-a-Sheep'. The Dean had to pay to get the 4-H'ers to take the sheep away.

It may have all started in Sitka in 1898 but celebrations for the centennial of agricultural research in Alaska were centered in Fairbanks and Palmer this summer of 1998. With banners proclaiming our milestone to the public on display every where from downtown Fairbanks streets to the side of the Matanuska Stations' barn, it was shouted out to all this summer, "Come learn about our history and share in our future."

At Fairbanks, the celebration started with a 4-H sheep being shipped to Dean Husby's office. The 4-H teens of the Tanana District also provided a petting zoo and lead environmental education activities on July 18 to help mark the Experiment Station's birthday along with AFES faculty presentations on topics ranging from animal diets to the history of the Fairbanks Station's fields and a bus tour of the Bonanza Creek Experimental Forest. Over 1,000 Fairbanks residents visited the Farm, participated in the many activities, and ate birthday cake. UAF Chancellor Joan Wadlow and retired UA president William R. Wood spoke of the contributions of the Experiment Station and it's future.

photos by Jan Hanscom

The 4-H'ers and AFES research technician, Bob Van Veldhuizen teamed up to present a float in the Fairbanks Golden Days Parade. While it meant being at the very end, it seemed fortuitous that our float was **number 100!**

Palmer Station hosts 2nd Agriculture Appreciation Day as part of the Agricultural and Forestry Experiment Station's Centennial Celebration

photos by Allen Mitchell

photos by Allen Mitchell

Gail Phillips, Speaker of the Alaska House of Representatives (above) and Wendy Redman, interim UA president, (bottom) welcome visitors to the Agriculture Appreciation Celebration.

Roger VanderWeele (above left) hangs out at the display of vegetables put together from the VanderWeele Farm while Cindy Gallager's team and wagon (above right) takes celebration participants for rides. Participation by local farmers and organizations made the Ag Appreciation Day in Palmer very special. All the food was Alaska Grown and activities insured that everyone learned something about agriculture in Alaska.

photos by Carol Lewis

At this year's competition, the School of Agriculture and Land Resources Management's Dean Fred Husby (above left) was pitted against AFES Director Allen Mitchell (bottom right) in a goat milking contest. Dr. Mitchell, a plant scientist, beat Dr. Husby, an animal scientist, hands down to win the coveted Alaska Dairy Goat Association Milking Pail Trophy (above middle). It may take Dr. Husby a while to live that one down!

Research Achievements

Plant, Animal and Soil Sciences

Molecular evaluations of *Rhizoctonia solani*

More than 500 potential homokaryons of isolate of *R. solani* AG–3 were produced through production of protoplasts from parent mycelium. At this time fewer than 20 of these appear to be genuine homokaryons based on colony morphology and macroscopic mating behavior. However, characterization of potentially homokaryotic isolates is not yet complete and may require methodologies other than those used on homokaryons of *R. solani* in the past. It seems probable that mating systems in *R. solani* AG–3 are different enough from systems associated with other AG that existing methods will not work.

•*Donald E. Carling*

Potato germplasm evaluation

Approximately 160 genetic lines of potato provided by the Potato Germplasm Bank in Sturgeon Bay, Wisconsin were screened for resistance to Black Scurf disease of potato caused by *Rhizoctonia solani*. The screening was conducted in the field and consisted of determining the relative tolerance of the potatoes. Although most lines are highly sensitive to *R. solani*, some appear to possess at least a moderate level of resistance. This is the first year of a multi–year study. The objective of this study is to identify sources of resistance that may be used in future traditional and molecular breeding programs.

•*Donald E. Carling*

Weed control with soil fumigants

Data was collected on a system of general weed control in field grown green vegetables. These crops, especially head lettuce, are difficult to grow profitably because effective selective herbicides are not available. As an alternative to herbicides, two soil fumigants (metam sodium and dazomet) are being evaluated. Of these, metam sodium is currently labeled for use on this type of crop. Applications of each chemical were made at a range of rates from 0 to 100 gallons per acre (32.7% metam sodium equivalents). Weed populations were monitored, phytotoxicity symptoms were sought, and crop performance was monitored. Both chemicals were effective and neither showed any sign of phytotoxicity symptoms or qualitative and quantitative yield reduction. Results of these studies were summarized and presented to commercial vegetable growers.

•*Donald E. Carling*

Potato variety evaluation

Forty–five potato varieties were evaluated under irrigated and nonirrigated conditions. The 1997 growing season in southcentral Alaska was warmer and wetter than in recent years resulting in above average yields. Potato varieties yielded well in both irrigated and nonirrigated trials. Average total yield in irrigated trials was 17.9 tons/acre whereas average US#1 yield was 15.3 tons/acre. In nonirrigated trials, average total yield was 15.2 tons/acre and US#1 yield was 12.5 tons/acre. The highest yielding cultivar was Green Mountain with a total yield of 24.4 tons/acre and 20.1 tons/acre in the irrigated and nonirrigated trials, respectively. Other varieties that yielded well in the irrigated trial included Norland, Red LaSoda and Allagash Russet. Other top yielding varieties in the nonirrigated trial included Kennebec, Red LaSoda and Atlantic. Russet Burbank was the top yielding russet variety in the nonirrigated trial and was above average in the irrigated trial.

•*Donald E. Carling*

Lettuce variety evaluation

Fifteen head lettuce varieties were evaluated at Matanuska Farm for general horticultural characteristics and for resistance to tipburn disease. This is a continuation of a study initiated in 1995. Early, mid and late season plantings were evaluated. The early season planting produced heads that were less than optimal size and weight and tipburn pressure was moderate. Incidence of tipburn was similar in the mid season planting, but head size and weight was much closer to the optimal range. Tipburn pressure was very light in the late season planting, and head size and weight was somewhat reduced. There was a high incidence of bacterial soft rot on the outer leaves in the late season harvest. When combined with data from the previous two seasons, the cultivars showing the best resistance to tipburn included 87–714–5, Top Gun, Tiber, and Patriot. Below average tipburn resistance was observed in Coolgreen, Target, Salinas, 87–716–1, Bullseye, and Premier. The numbered selections referred to above, are from the breeding program of Edward Ryder.

•*Donald E. Carling and Steven M. Dofing*

Barley breeding program

We advanced several breeding populations derived from crosses made in 1991. Progeny from two crosses between Alaska and Nordic germplasm appear particularly promising. We will advance these populations one more year, after which we will select several thousand heads from each for subsequent testing. After an exhaustive evaluation to identify lines for use as parents in the breeding program, two lines have been identified that show continued superior performance in our conditions. These lines are Arve, developed in Norway, and Jo 1632, developed in Finland. Both are currently in use as parents in the breeding program.

Two years of replicated testing have been completed on a set of experimental lines obtained from the Boreal Plant Breeding Institute in Finland in 1993. Several of these lines show higher yield and maturity equal to or earlier than Otal.

•*Stephen Dofing*

Reduced tillering barley populations

Alaska barley growers are frequently faced with the situation of uneven ripening of heads at harvest caused in part by late–developing tillers. One potential means to reduce this problem is through the use of limited–tillering varieties. In 1989 Otal was crossed with a winter dwarf barley line having a gene that promotes reduced tillering, and for the past eight years back–crosses to Otal have been made. This year, we evaluated 1,000 F2 plants from two of those populations. The average number of tillers/plant was about 12, but approximately one–fourth of the thousand plants had only 1–4 tillers. Many plants in this group produced no infertile tillers (tillers without heads), and all stopped producing tillers early in the season. Within this group, we identified plants that were free of obvious defects and had the largest heads, and will advance them with the objective of developing an adapted limited–tillering barley variety.

•*Stephen Dofing*

Genetic diversity of short–season barleys

In order to achieve gains in plant breeding programs, plant breeders attempt to use parental germplasm that is both high–performing and genetically diverse. Varieties that are consistently ranked near each other when grown in different environments are genetically similar, whereas varieties that show large changes in rank in different environments are genetically diverse. We evaluated 28 short–season barley varieties developed in Alaska, Canada, and the Nordic countries for agronomic performance with the objective of identifying varieties that are both high performing and genetically diverse.

•*Stephen Dofing and Charles Knight*

Reindeer forage plants on the Seward Peninsula, Alaska

Reindeer herders and land owners/managers need range evaluations to maximize herd production and to maintain the integrity of range resources. The nutritional value of reindeer/wildlife forage plants on the Seward Peninsula, Alaska, is not known. Evaluation of the nutritional value of range resources for reindeer/wildlife would allow for more effective range resource management.

The Reindeer Research Program personnel determined the nitrogen, fiber, and mineral profile of reindeer forage plants located on the Leonard Olanna (Brevig Mission), Tom Gray (White Mountain), and Larry Davis (Nome) reindeer ranges. Samples were collected biweekly from leaf emergence in spring to senescence in September. All samples were analyzed for nitrogen concentration, macro and trace mineral levels, and neutral detergent fiber (NDF) and acid detergent fiber (ADF) content.

Plant growth forms exhibited various nitrogen depletion and NDF and ADF repletion curves. Graminoids exhibited nitrogen concentration increases during leaf expansion, then progressively decreased through senescence. Initial fiber levels were high, but began dropping through midseason as fiber and nitrogen pools were diluted by total non–structural carbohydrates (TNC). Fiber levels increased again during the fall as plants began to translocate and assimilate nutrients to storage organs.

Deciduous shrubs exhibited high nitrogen levels in the spring. These levels dropped dramatically to midseason, where concentrations stabilized until fall, when they again decreased significantly. Fiber levels increased gradually from leaf emergence to full leaf expansion to senescence.

Forbs exhibited no consistent pattern of nitrogen depletion or fiber repletion among species. However, forbs generally had higher nitrogen and mineral concentrations and lower fiber levels than shrubs or graminoids.

•*Greg Finstad*

Diet and habitat selection of free–ranging reindeer

A study was undertaken to determine seasonally used reindeer habitats and vascular forage plants on the Seward Peninsula. This study provides the reindeer herder with information to more efficiently use range resources. Reindeer can be moved to habitats optimizing the seasonal emergence of preferred forage plants. Weight gain of reindeer will

be improved, the potential for overgrazing will be reduced, and errant migration patterns of foraging reindeer will be minimized.

Radio–collared reindeer were located at 7–10 day intervals from April to September. Observations of habitat use and plant species consumed were recorded. Fecal pellets were collected for microhistological diet composition analysis. Samples of preferred forage species were collected for nutrient and mineral content analysis.

Reindeer moved to south–facing, tussock tundra slopes in early to mid April to forage on emerging *Eriophum vaginatum* floral heads. Wintergreen stems of *Carex aquatilus* were consumed in late April to early May. Rhizomes of *Hedysarum alpinum*, *Artesimia tilesii*, and *Petasites frigidus* were dug from exposed slopes and hummocks soon after snowmelt. Small lakes became preferred habitats as lake edges began to thaw. Stems of *Eriophorum angustifolium* were eaten as they became exposed from receding shore ice. Reindeer foraged heavily on aquatic plants where they were available, such as *Hippuris vulgaris* and *Caltha palustris*. Many graminoids and forbs, flowers of *Petasites frigidus* and *Pedicularis spp.*, were consumed by reindeer in early June. Leaves of *Salix spp.*, especially *S. pulchra*, were avidly sought as they became available. Reindeer diets became catholic during late June and early July when a large array of graminoids, shrubs, and forbs were available. Reindeer migrated to upland or coastal areas during July for relief of insect harassment. *Honckenya peploides* and *Salix fuscescens* were selectively grazed in coastal areas while *S. pulchra, Carex spp.*, and forbs were grazed in upland areas. Reindeer migrated to wet sedge meadows on upper slopes during August and September to graze on *C. aquatilis*.

•Greg Finstad, Maria Berger, and Lara Savage

Computerized data collection

Reindeer in western Alaska are rounded–up either once or twice a year for antler harvest, vaccinations, etc. The Reindeer Research Program personnel attend handlings and record data for herd monitoring and a variety of research projects. Reindeer are given a uniquely numbered six digit ear tag when they are first handled, allowing us to keep records for each individual animal throughout their life. Data for some herds extends back to 1984 providing a valuable long–term database.

We are using laptop computers to improve the quality and quantity of data collected, and to make the data instantly available to herders for making management decisions during a handling. During the 1998 winter handlings, data were directly entered into a customized Lotus Approach database program as animals were handled. Two herders were given copies of their herd records, and taught to use the computer program. The computer entry worked well even under adverse weather conditions.

•Greg Finstad, Alex Prichard, and Drew Shain

First reproduction in Alaska reindeer

Free range reindeer on the Seward Peninsula, Alaska, have unusually high rates of growth and as a consequence high pregnancy rates early in life. Up to 50% of female reindeer in some herds in western Alaska may breed in their first fall (~5 months of age) and give birth the following summer. The effect of climatic conditions on the quality (protein and fiber levels) of common forage plants and the effect of climatic conditions on yearling reproductive rates the following year were examined.

Data collected on the Seward Peninsula from 1987–1997 was used to test a model relating prior spring temperatures, summer temperatures, and winter snow depth on the proportion of lactating yearlings. The model predicted that warm spring temperatures increased pregnancy rates in yearlings and snow depth and warm summer temperatures decreased pregnancy rates the following year.

Age of first reproduction in reindeer may be a good indicator of general range conditions and the effects of environmental conditions on herd health. Continued tracking of female reproduction and body weight, as well as determining factors influencing age of first reproduction may allow us to quantify effects of density dependent factors such as herd size increases and density independent factors such as global climate change on range quality.

•Greg Finstad, Alex Prichard, and Drew Shain

Evolution and improvement of barley for food and feed for swine

Previous research conducted at the Fairbanks Station had determined the utilization of covered and hulless barley in diets for growing–finishing and 21– versus 28–day old early weaned pig diets. With the exception of low test weight, both types of barley provided satisfactory growth and feed performance for all classes of swine. Historically, barley has not been recommended as the sole source of carbohydrate in pig starter diets. However, research conducted by cooperators in the W–166 Western Region Swine Nutrition Project and at the University of Alaska has indicated that barley can be utilized effectively as the sole grain in starter diets. Although the hulless mutant Thual would appear to have more available energy than covered cultivars, it has never improved growth or feed performance when compared to covered barley cultivars.

Therefore, a study was conducted to determine the feeding value of naked oats, Cascade and Freedom in replacement of covered Datal and hulless Thual

barley in early weaned pig diets. Pigs were allotted to test diets at 21 days of age to compare growth and feed performance with the four cereals as the sole grain source in the diets. All diets were formulated to contain 20% dried whey, 21% crude protein, 1.2% lysine, and 4% corn oil.

Preliminary results of the first four replications would indicate that diets containing naked oats are equal to and may provide slightly improved feed conversion when compared to the barley–based diets.

•Fredric Husby

Usibelli vegetation studies

A study was initiated in 1991 to evaluate growth of grass species on different growth media on windy, south–facing slopes for cover, nutrient absorption, and decomposition. An additional study was implemented in 1995 to assess the effects of fertilization for varying numbers of years. The seventh and third year of plant cover and soil nutrient data were obtained for those two studies in 1997.

Norcoast Bering hairgrass (*Deschampsia beringensis*), a cultivar developed at the Agricultural and Forestry Experiment Station, has maintained better cover than most other species on the once–fertilized plots. Cover of many other species has declined substantially on these plots. Native colonization was greatest on plots seeded with legumes and consisted mostly of herbaceous species that follow disturbances, such as fireweed (*Epilobium angustifolium*) and bluejoint reedgrass (*Calamagrostis canadensis*) although Bebb willow (*Salix bebbiana*) and paper birch (*Betula papyrifera*) also colonized these plots. Aspen (*Populus tremuloides*) sprouted from root fragments where an organic mat was used.

These studies are funded by Usibelli Coal Mine, Inc.

•Dot Helm

Revegetating Silverado Mines

Although natural colonization may provide adequate cover in the intermediate and longer term, seeded grasses are frequently needed to stabilize reclaimed mining sites in the first few years. Silverado Mines initiated revegetation trials in fall 1995 to assess suitable plant species and fertilizers. Plant species tested included Norcoast Bering hairgrass (*Deschampsia beringensis*), Nortran tufted hairgrass (*Deschampsia caespitosa*), Alyeska polargrass (*Arctagrostis latifolia*), Gruening alpine bluegrass (*Poa alpina*), Arctared red fescue (*Festuca rubra*), Tundra bluegrass (*Poa glauca*), and Alsike clover (*Trifolium hybridum*). Four seed mixes were also tested in plots as well as in the actual revegetation of the site.

These plots were monitored in 1997. Natural colonization is also being documented on reclaimed exploration trails as well as in the main mine area.

Funding is provided by Tri–Con Mining, Inc., a subsidiary of Silverado Mines (U.S.).

•Dot Helm

Establishing woody plants on disturbed lands

The objectives of this study include evaluating longer–term (5–10 years) effects of growth media or mycorrhizal inoculum on woody plant growth and natural colonization on three mined sites. The southernmost site, a proposed coal mine near Palmer, contains woody cuttings and seedlings planted in 1989 on four growth media: three soil materials and glacial till (overburden) material. Plant growth has been substantially better on the three soil–material sites compared with the glacial till site for the first 9 yr.

Plants grown at an active coal mine in soil inoculated with native mycorrhizal have been monitored for height since 1990. Seedling colonization is being monitored on an abandoned placer mine that was reclaimed in 1993.

Project funding has been received from McIntire–Stennis funds, Usibelli Coal Mine, Inc., Idemitsu Alaska, Inc., Alaska Department of Environmental Conservation (grant from U.S. Environmental Protection Agency), Alaska Department of Natural Resources (Division of Agriculture), and Alaska Science and Technology Foundation.

•Dot Helm

Amisorb effects yield of cabbage and tomatoes

Amisorb, is a polyaspartate soil drench that makes mineral nutrients more available to plants when applied with fertilizer. It is sold as a nutrient absorption enhancer for crops such as corn, wheat, and vegetables. Amisorb (0.003%) was applied as a drench during greenhouse transplanting of marigolds, pansy, nicotiana, pepper, tomato and cabbage. No differences in total biomass were recorded between treated and untreated seedlings for all species. Seedlings were harvested four to eight weeks after transplanting. In field trials, Amisorb was applied with soluble fertilizer at planting and in mid–season to O–S Cross cabbages and Subarctic 25 tomatoes. The Amisorb treatment did not influence cabbage yields, but increased tomato yields (weight per plant) by 25 percent.

•Patricia S. Holloway and Grant E.M. Matheke

Ranunculus plant quality

Ranunculus asiaticus (Persian buttercup) has primarily been grown as a cut flower although cultivars suitable as bedding plants are now available. Plant height is critical in marketing ranunculus as a

bedding plant or cut flower. Flower initiation occurred faster at long days (16 hours) and 68°F than at 8 hours day length and 54°F. Plant height and flower stem length increased at growing conditions with longer days or higher temperatures. The relationship between day and night temperatures has been found to control height in many plants. The effects of day and night temperatures on the growth and development of ranunculus are studied for the development of production guidelines.

• Meriam Karlsson and Jeffrey Werner

Media for plug production

Due to high temperatures, maintaining a consistent and high quality production of lettuce and vegetable transplants may pose problems during the summer months. A proper balance between root and above ground growth during early development is essential for good field performance. Various types of medium were tested for optimum transplant plug production. Seeds of head lettuce sown on a peatlite medium and covered with perlite germinated faster and more uniformly than seeds covered with a layer of peatlite medium, coconut coir dust or vermiculite.

• Meriam Karlsson and Jeffrey Werner

Cyclamen leaf development

The initiation and appearance of leaves were determined for cyclamen (Florists' cyclamen or Alpine violet). Plants were grown during the leaf unfolding stage at 46, 54, 60, 68 or 75°F. Leaves appeared faster with increasing temperature up to 68°F. Fastest average leaf appearance was 0.3 leaves per day. Flower buds were visible at the same time for plants grown at 54, 60 or 68°F. At 75°F, flowers appeared on average 5 days later and at 54°F, 40 days later compared to plants grown at 60 or 68°F. The number of leaves at flowering increased from 38 at 54°F to 77 for plants grown at 75°F.

• Meriam Karlsson and Jeffrey Werner

Cyclamen flower development

The effect of temperature on rate of flowering was determined for cyclamen. As flower buds were first visible, plants were placed at 46, 54, 60, 68 or 75°F. Plants at 68°F had open flowers first, although the rate of flower appearance was not significantly different from the plants grown at 60 or 75°F. Cyclamen grown at 54°F required 28 more days and cyclamens grown at 46°F, 45 more days to first open flower compared to plants grown at 68°F.

• Meriam Karlsson and Jeffrey Werner

Flower shop to garden crops

The floral industry is requesting locally produced crops that can be marketed as flowering potted plants and later planted outdoors for continued flowering throughout the summer. Several plants including tick flower (*Coreopsis*), primrose (*Primula*), Persian buttercup (*Ranunculus*), poppy anemone (*Anemone*), carnation (*Dianthus*), columbine (*Aquilegia*) and cyclamen were evaluated for this type of marketing.

• Meriam Karlsson and Jeffrey Werner

Comparing tillage methods

A study comparing tillage methods, straw removal treatments, and N fertilization rates has been conducted on continuous barley near Delta Junction, Alaska since 1983. Four tillage treatments are compared: no–till, disk once, disk twice, or chisel plow plus disk once. Three straw management treatments are superimposed on each tillage treatment: all standing stubble plus loose straw removed, all loose straw removed, or no straw removed. Four N fertilization rates are superimposed on each straw treatment: 11, 51, 91, or 131 lbs. N/acre.

Soil moisture is often limiting in the Delta Junction area and precipitation in the 1997 growing season was below normal. Over the long–term, barley yields have been highest in plots which have been disked once. However, in very dry years, the no–till plots yield higher. 1997 yields were highest under no–till conditions. Straw management practices have had little effect on barley yields, with slightly higher yields where both loose straw and standing stubble have been removed. 1997 yields were not affected by straw treatments. Long–term average yields have been greatest in plots fertilized at 91 lb. N/acre. However, in 1997, yields were greatest in plots which received 51 lb. N/acre.

Current recommendations for dryland continuous barley cropping are to use no–tillage unless perennial weeds are a problem, then disk once prior to planting; fertilize with between 51–91 lbs. N/acre depending on precipitation (65–70 lbs. N is usually recommended). Stubble management has shown little effect on yield, but removal of all straw and stubble will likely deplete soil quality over time.

• Charles Knight

Canola varieties compared

Eight varieties of Polish canola (*Brassica rapa*) were compared in a replicated study near Delta Junction, Alaska in 1997. The season was dry and yields ranged from 1597–1151 lbs/acre. Highest yields were obtained from the variety Goldrush, followed consecutively by Horizon, Reward, Maverick, Eldorado, Sunshine, Colt, and Tobin. Approximately 200 acres of canola were grown by farmers in interior Alaska this year. No crushing facilities are

available in Alaska, so all canola is being used as a protein and energy supplement in animal rations, primarily for dairy cattle.

•*Charles Knight*

Small grain variety trials

Early maturing varieties of spring planted small grains from Alaska, Canada, Norway, and Finland were evaluated at three locations in interior Alaska. Seed yield and date of maturity were the primary evaluation criteria. Dry weather during early summer, followed by wet weather during late summer and a late frost favored late maturing varieties. Cascade was the highest yielding oat variety at all locations. Arra was the highest yielding feed barley variety. Among malting barley varieties, Duel had the highest average yield, but it had a low test weight and poor germination. Harrington yielded slightly less, but reached full maturity and had a normal test weight and good germination. Several feed barley varieties were tested for the first time at Fairbanks. Six of those varieties produced average yields of greater than three tons of grain per acre and will be included in variety tests throughout the Interior in 1998.

•*Charles Knight*

North Slope waste products revegetate gravel pads

An experiment was conducted in the greenhouse to test additions of food waste, wood fiber, sewage sludge, and used drilling mud and cuttings on the growth of an indigenous grass. The native red fescue (*Festuca rubra*) was used in the experiment. Gravel from the Prudhoe Bay Oil Field was mixed with the waste products to produce an array of growing media concentrations.

The sewage sludge improved plant growth when added to North Slope gravel at concentrations not greater than 1% by volume. At sludge concentrations greater than 1%, plants died. However, when combined with an equal amount of drilling mud, as much as 2.5% sewage sludge could be added without substantially reducing plant survival. Food waste also improved the vigor of plants at the lowest concentrations. As with sewage sludge, plants died as the concentration of food waste increased. Fescue plants survived throughout the experiment in gravel to which either wood fiber or drilling mud was added up to 20% by volume and pure gravel. Based on greenhouse tests at UAF, a pilot compost experiment was undertaken at Prudhoe Bay . Compost produced will be tested on gravel fill beginning in the summer of 1998.

Financial support for this project came from ARCO Alaska, Inc. and the Agricultural & Forestry Experiment Station (State of Alaska Legislature and USDA Hatch).

•*Jay D. McKendrick*

Long-term responses to tundra revegetation experiments

This project was to document the treatments imposed and permanently mark plots to allow continued monitoring. The first year, early establishment of grass seedlings required phosphorus fertilizer. No plant response to nitrogen occurred without phosphorus. The measurable effects of nitrogen application to the availability of soil nitrogen disappeared within 5 years, but the effects of phosphorus have persisted for 26 growing seasons. The long-term potassium influence on available soil potassium was not consistently apparent over the years.

Puccinellia arctica grew quite well and was not eaten by the geese and caribou. In 1985, we noticed *P. arctica* was being replaced by other tundra plant species. By the 15th year, the dense stand of *P. arctica* was gone, and other tundra plants were in its place. During the same period at other locations, grasses currently recommended for tundra revegetation established, persisted, and blocked tundra plant succession for a full quarter century. Thus, if natural tundra is the ultimate revegetation goal, it appears that seeding *P. arctica* may be a superior choice.

In 1997, we decided to examine the soil organic carbon accumulation. Unexpectedly there was a negative relationship between total organic soil carbon and nitrogen with phosphorus applications. It appears that the overwhelming positive influence phosphorus has on vascular plant growth also affects the decomposition of soil organic matter.

Support for this research has come from ARCO Alaska, Inc., BP Exploration (Alaska), Inc., Husky Oil NPRA Operations, Inc., the Agricultural & Forestry Experiment Station (State of Alaska Legislature and USDA Hatch).

•*Jay D. McKendrick*

Recording tundra recovery, National Petroleum Reserve–Alaska (NPR–A)

In the course of measuring vegetation recovery in 1996 on gravel fill at some exploration sites in the NPR–A, we noted the relatively rapid accumulation in recent years of mosses in portions of the gravel fill where thermokarst had occurred and moisture was accumulating. We returned to these locations in 1997 to sample and measure the organic carbon buildup since the sites were abandoned in the late 1970s. Three exploration sites were sampled: Inigok, Tunalik, and Lisburne. Organic carbon accumulated on the surface of abandoned gravel fill was measured.

Moss accumulation has not been linear over time at

these locations. Mosses did not significantly colonize until sufficient thermokarst developed to create basins that collected water. Also mosses produce a positive feed to the soil surface environment by increasing moisture retention as moss biomass accumulates. It is quite likely that most of the carbon accumulated on the gravel fill has occurred during that past 5–7 years. These accumulations represent the maximum accumulation in favorable habitats. Much of the gravel fill has little or no moss accumulation at this point in time. However, these data do show the potential for organic carbon to accumulate in these cold environments, because photosynthetic production substantially exceeds decomposition.

Support for this research came from the University of Alaska Natural Resources Fund (UA President's Office), U.S. Department of the Interior, Bureau of Land Management, BP Exploration (Alaska), Inc., and the Agricultural & Forestry Experiment Station (State of Alaska Legislature and USDA Hatch Funds).

•Jay D. McKendrick

Long-term gravel vegetation

Gravel fill has been used extensively in the production of oil from fields in arctic Alaska. An experiment was begun in 1989 at the BP Put River №1 (BP Discovery Well). The pad was restructured to create conditions for experimental plots to test various treatments and natural tundra plants for creating vegetation and wildlife habitat on these gravel pads. The experiment is still being monitored.

BP Exploration (Alaska), Inc. has financed this research in addition to the Agricultural & Forestry Experiment Station through State of Alaska Legislative appropriations and USDA Hatch Funds.

•Jay D. McKendrick.

Rate of moisture loss from cut forage

Timing decisions can have important effects on the yield and quality of the hay crop. A better understanding of the hay drying process is needed for Alaska conditions. First cutting (mid to late June) grass dried to 20% moisture in 2–5 days due to low humidity, high temperatures and a lack of clouds. Second cutting grass did not reach 20% moisture over an 8–day drying period.

Rainfall was lower than normal during the second cutting, but high humidity, lowering temperatures, and cloudy weather prevailed. In several cases, moisture contents were low enough to use preservatives, but slow rates of moisture loss greatly increase the risk of rain damage to the hay crop. Where possible, the second crop should be stored as silage.

•Michael T. Panciera

Forage variety trials

Many new forage varieties have been developed in recent years. Of particular interest are grass and legume varieties developed at similar latitudes to Alaska. A grass trial was established in 1993 to compare several grass species and varieties. Timothy and reed canarygrass continued to perform well with yields in the 3.5 to 4.0 tons/acre range, but smooth bromegrass produced 4.0 to 5.5 tons/acre. In a study planted in 1996 at Point MacKenzie, several Scandinavian varieties of creeping bentgrass, orchardgrass, red fescue, reed canarygrass, timothy, and Kentucky bluegrass continue to show promise. Three new variety trials were planted in 1997: a comparison of Scandinavian varieties red and alsike clovers; a grass species study; and a comparison of North American and Scandinavian varieties of timothy and reed canarygrass. As promising varieties are found, they will be tested more extensively around the state.

•Michael T. Panciera

Establishing minimum tillage forage

Preliminary studies suggested that minimum tillage would be effective for small–seeded forage crops. Annual and perennial forage crops were planted with a minimum tillage drill in 1997. Red and alsike clover populations were high, but seeding year growth was limited due to low rainfall. Except for Lana vetch, annuals did not do well due to a combination of low rainfall and no fertilizer placed in the row. Fertilizer attachments have been added to the drill and more extensive testing will be done. Minimum tillage establishment of forage crops will be evaluated at Delta, Fairbanks, Palmer, Point MacKenzie, Sterling, and Anchor Point over the next three years. Seeding rates, fertilizer rates, and different crop species will be studied in cooperation with Alaska Cooperative Extension and the Natural Resource Conservation Service.

•Michael T. Panciera and Stephen D. Sparrow

Carbon stores in tundra soils of Alaska

The tundra soils of Alaska measured much higher C stores than that of the temperate regions and nearly half of the total pedon C store is sequestered in the upper permafrost layers. Carbon measured is 30–100% higher than previously reported. The carbon stores on the arctic tundra landscape generally increase northward, due to the impeded drainage. Carbon distribution in the tundra soils profiles does not follow the depth function due to cryoturbation which often caused a second concentration zone of carbon in the upper permafrost. The C/N ratios of

arctic tundra soils favor N mineralization and more trace gas flux is expected with increased plant residue input due to climate warming. The C/N ratios are generally lower than that of the boreal and coastal regions because of the higher contents of microbiomass in the tundra soils. This is also reflected in the low carbon content of SOM.

•*C.L. Ping and G.J. Michaelson*

Characteristics of cryogenic soils

The dominant soil forming process in permafrost–affected soils is cryopedogenesis in which the freeze–thaw cycle results in patterned ground microrelief and cryoturbated soils. Common cryopedogenic structures are granular in A, platy in B, lanticular in BC, massive in Bg, blocky in Bcf horizons, and ice–rich layers or ground ice in upper permafrost. A Gelisol order was introduced to replace the Pergelic Cryochrept subgroups in Soil Taxonomy to accommodate the cryogenic nature of these soils. There are three suborders introduced: the Histic (organic), Turbic (warped or broken soil horizons due to frost heave), and Static (the remaining). The depths of active layer, which freeze and thaw annually, fluctuate between 35–60 cm (14–24") in the arctic tundra and between 50 to over 100 cm (20–40") in the boreal forest. The permafrost table perches water which results in a saturated zone. Mottles or gleyed features are common in the zones above the upper permafrost due to the reducing conditions. Thus, these soils are hydric; one of the three criteria for wetlands. Water content in the upper permafrost is more than 50% by volume. Following climatic warming or a forest fire, the permafrost would thaw and release excess water. This would result in the subsidence of the ground or the formation of thermokarst. Carbon stores in the permafrost–affected soils are found to be double of previously estimated when the carbon sequestered in the upper permafrost is taken into consideration. Following the thawing of permafrost, this frozen fraction of carbon would be released into the biogeochemical cycles of the arctic and subarctic ecosystems.

•*C.L. Ping, G.J. Michaelson, and J.M. Kimble*

Monitoring Rock Creek soil environment and water quality

Rock Creek was selected for soil monitoring protocol development because it is close to the Meteorological Station at Park Headquarters in Denali National Park. The climatic data can be calibrated against the long–term record. All temperature, humidity, wind, solar radiation, and sensors are hooked to a datalogger for automated recording. Soil redox potential, soil water potential and water content were measured manually. Currently, the UAF–AFES cooperates with the USDA–NRCS and Forest Service to test automated systems for these items.

Although Rock Creek watershed is a small watershed, the vegetative communities and soil environmental parameters have proven to be complex. The annual temperature of the permafrost is only a fraction of a degree below the freezing point. A prolonged warming trend would lead to melting of the permafrost, alteration of the hydrological cycle, and an increase in nutrient flux to the stream. Changes in the vegetative community would follow.

Preliminary results from the soil water quality monitoring in Rock Creek indicate that each map unit has characteristic soil water quality parameters. These parameters are closely related to the vegetative communities and soil environmental parameters.

Soil monitoring in the Denali Park is a linchpin in a statewide soil monitoring network. The UAF–AFES cooperates with the USDA–NRCS and the Forest Service to monitor soil environments in the southeast, southcentral, and interior of Alaska. The UAF, USDA–NRCS, and NSF (LTER) have separate or cooperative soil monitoring projects in the boreal forest and arctic Alaska. The data from this network is vital for the assessment of the effects of global change on the different ecosystems and land use decisions in Alaska.

•*C.L. Ping and L.M. Popovics*

Hydric soils in boreal regions of Alaska

A series of monitoring sites were set up to correlate the morphological properties with the hydrology and redox measurements of hydric soils.

The boreal forest of interior Alaska lies within the zone of discontinuous permafrost. Soils formed in the bottom land and north facing toeslopes are usually underlaid by permafrost which perches water. These soils generally have an Oa horizon (muck) and experience long periods of saturation within 25 cm (10") from the surface. Reducing conditions also develop through the growing season. These soils fit the hydric soil criteria. Soils on the south facing toeslopes often lack the clear morphology of hydric soils. Most of these soils form in deep loess and lack the Oa horizons. Morphological features suggest the upper part of the profiles are well drained. The presence of ferrous iron, an indicator of hydric soils, was detected during the early growing season. In addition, soils affected by permafrost have active layers that fluctuate annually due to meteorological conditions. The lowering of permafrost may also be induced by the fire cycle in the interior boreal forest. Thus, the permafrost table may be at 50 cm to more than 100 cm (20–40") in depth. The reducing condition may disappear following a warming due to lowering of the permafrost and saturation zones. This would create a problem in the delineation of hydric soils.

•*C.L. Ping and V.L. Romanovsky*

Modeling production and income of reindeer herds

Free–range reindeer in western Alaska are managed for both antler and meat production. Optimum management should maximize the income generated from both meat and antler production while managing the herd at levels near the carrying capacity of the range. Meat production precludes future antler production from slaughtered animals, therefore slaughter decisions should reflect antler and body growth rates, current antler and meat prices, natural survival rates, and population demographics.

A user–friendly computer model was created to generate estimates of production and gross income under different slaughtering levels and market conditions. Input variables include sex and age specific survival rates, harvest levels, antler weights, body weights, and recapture rates, as well as reproductive rates, antler price, and meat price.

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

•Alex Prichard, Drew Shain, and Greg Finstad

Implants for reindeer steers

Trials were conducted during the summer to determine the effect of growth promoting implants in reindeer steers. Twenty–six yearling steers from the Jim Noyakuk herd (Seward Peninsula) were implanted during the summer handling with Synovex C. Implanted and non–implanted steers were subsequently weighed during the winter handling in January 1998.

Preliminary data indicates that implanted animals improved weight gain by 4.25% which equates to approximately 8 lbs. of body weight or 4 lbs. of carcass weight. At a cost of $.60 per implant the net increase in return per carcass (at $2.25/lb. carcass weight) would be $9.00. These implants provide synthetic derivatives of the naturally occurring hormones found in the animals body. Implanting the animal only adds additional hormone. If concern exists about antler quality in implanted animals, the animals are implanted after antler harvest and are slaughtered before the next years antler harvest. If an animal is not slaughtered during the winter the effect of the implant has worn off by the time the antler starts to grow. However, the increase in carcass weight of an animal can only be obtained if the animal is slaughtered within the same year it is implanted.

•Drew Shain

Body measurements to predict weight

Body weight is probably the best indicator to evaluate the plane of nutrition that free–ranging reindeer experience. This assessment is very important for reindeer producers to use in evaluating range conditions and the general health of their herd. We are attempting to establish body measurements which can determine an accurate estimate of body weight.

Body measurements from 41, ten month old female reindeer fawns were collected in February and correlated with body weight. Correlation estimates indicate that chest girth or body length may be used as indicators of body weight.

If strong correlations between body measurements and body weight can be determined this will provide a valuable tool for estimating reindeer body weight and comparing differences between herds in situations where weight cannot be measured directly.

•Drew Shain, Greg Finstad, Todd Nichols, and Alex Prichard

Reindeer fawn growth

The growth of reindeer fawns during their first summer is critical for survival during the winter period and may be an important factor influencing subsequent productivity.

The growth of fawns raised under captive and free–ranging conditions were compared. In June 1997, 65 female fawns from a reindeer herd on the Seward Peninsula (Larry Davis) were transported to Nenana, Alaska. Weights were obtained prior to transporting and again in February 1998. Captive fawns were fed a corn/ barley based commercial diet ad libitum. In addition, weights for 22 female fawns were obtained from a free–ranging operation on the Seward Peninsula (Clifford Weyiouanna) in June 1997 and February 1998. Fawn weights recorded in June were slightly higher for free–ranging fawns compared with fawns transported to the captive operation. However, by February weights were similar for captive and free–ranging fawns indicating that growth in captive conditions was equal to growth obtained in free–ranging fawns.

These data indicate that the captive fawn management practices used in this situation were sufficient for raising fawns when compared with free–ranging situations.

•Drew Shain, Todd Nichols, Alex Prichard, and Greg Finstad

Perennial legumes

The objectives of this project were to determine herbage yields, N yields, N fixation, long–term persistence of perennial legumes, and the effects of various legume and non–legume crops on soil properties under different soil and climate conditions in Alaska. Plots were established at Point MacKenzie in southcentral Alaska in 1992 and at Fairbanks and Delta Junction in interior Alaska in 1993. Seven legume species and three non–N–fixing crops were planted. In addition, a fallow treatment was included. For each crop, a N–fertilized and non–N–fertilized treatment was included. At the end of the 1996 growing season, the perennial crops were killed with herbicides and all plots were planted to cereal crops in 1997 to determine the residual effects of the different cropping systems. At Delta Junction, none of the legumes persisted enough to produce harvestable yields for more than two years. At Point MacKenzie, all legumes were severely damaged during the winter of 1995–96. At Fairbanks, alfalfa and red clover persisted throughout the study.

Total forage yields for the legume crops were less than 1.5 T/A at Delta Junction, but were higher than 15 T/A for some legume crops at Fairbanks and Point MacKenzie. Total amounts of N fixed ranged from near 0 to over 700 lb./A. Cereals following fallow generally produced the highest dry matter yields. Cereals following legumes produced yields similar to those following barley which had been fertilized annually with N. Soil microbial biomass was highly variable throughout the study, with no apparent effect of crop type. Soil aggregate stability was generally higher for perennial crops than for annual barley or fallow.

• *Stephen D. Sparrow and Michael T. Panciera*

Managing bluejoint

Bluejoint grass (*Calamagrostis canadensis*), a native Alaska grass, can be a serious weed on pasture/range land in Alaska because it often out competes introduced forage grasses. Bluejoint produces fairly good quality forage early in the growing season, but the quality decreases rapidly as the season progresses. Often, using herbicides is not an option for controlling bluejoint. The purpose of this study was to determine if various mowing treatments, combined with various nitrogen (N) fertilizer treatments, would improve the late season forage quality of bluejoint or control its growth, thus allowing more desirable species to grow.

Fertilizer treatments included no N fertilizer, N fertilizer applied once at the beginning of the growing season, or split applications where N fertilizer was applied once early in the season and again at time of the first mowing. Mowing treatments included none, single or triple cuttings done at different times during the growing season. The treatments were applied in 1995 at one site and in 1996 at another site. Harvests were done in the year the treatments were applied and for two years following treatment. The study was done near Delta Junction in interior Alaska.

In both 1995 and 1996, addition of N fertilizer resulted in substantial yield increases but only small increases in late season forage quality indices. Mowing in June resulted in a fair amount of regrowth; mowing in mid–July or later resulted in little regrowth of bluejoint. In 1997, residual treatment effects of mowing were small; N fertilization resulted in measurable increases in yield in the year following application.

• *Stephen D. Sparrow and Michael T. Panciera*

Forage variety trials

Perennial and annual forage grasses and legumes varieties were evaluated in replicated trials at four sites in interior Alaska and one site in southcentral Alaska. Twelve alfalfa, one red clover, two berseem clover, one vetch, one annual ryegrass, two bromegrass, and two timothy varieties were tested; although not all varieties were included at all sites. Sites included the Eielson farm area, Fairbanks, Tanana Loop, and Nenana in interior Alaska and Point MacKenzie in southcentral Alaska. At some sites, visual observations were made, but plants were not harvested. Overall, highest yields were at Fairbanks, with Altaswede red clover producing the highest yield at 2.8 tons of dry matter per acre. By late May 1998, Eielson, Fairbanks, and Tanana Loop had been evaluated for winter survival as indicated by the amount of material greening up in the plots. All of the perennial grasses showed excellent survival and spring regrowth at all three sites. Altaswede red clover showed good survival at all three sites. There was a large amount of variability in survival or spring green–up rate among the alfalfa varieties, with Peace and Rambler showing high rates of survival and spring green–up, and Nitro showing very little green–up by late May of 1998.

• *Stephen D. Sparrow and Michael T. Panciera*

Nitrogen fertilizer in bioremediation systems.

Microbial use of inorganic nitrogen fertilizer by microorganisms used for bioremediating petroleum–contaminated soils was studied to learn how long this nitrogen provides nutritional support for soil microorganisms. Small amounts of nitrogen fertilizer (about 30 mg N/kg soil) were added to contaminated soil, resulting in accelerated microbial

activity. By observing how long the increased activity persisted, we are able to determine how long fertilizer nitrogen remains biologically available. Early data suggest that small doses of nitrogen fertilizer may only remain available for a period of approximately one month.

•J.L. Walworth and C.R. Woolard

Moose impacts on hardwood growth

Analysis of plot data in the lower Mat–Su area addressing the impact of moose browsing on growth of aspen and poplar in southcentral Alaska was completed. Results indicate major impacts of moose on rotation length for hardwoods are likely in many areas with winter concentrations of moose. Data collected suggests that a free–to–grow status for hardwoods can exceed 25 years. Observations suggest that butt log of many trees will be of low value due to poor form and decay related to moose browsing. Data also suggest that changes in community dynamics is occurring: Succession to conifers (where present) can be advanced; succession where conifers are not present may be retarded with the perpetuation of "shrub stage"; a loss of the hardwood–dominated overstory stage may occur on many sites; and biodiversity may be impacted with the loss of the classical mixed species stand and associated structure.

•Jonathan Andrews and Edmond C. Packee

Climate change benefits and vulnerabilities for Alaska wildlife

The probable effects of potential climate change on Alaska wildlife was synthesized from existing information sources. Temperature increases would generally increase survival of birds through reduced exposure for adults and young during the nesting season, milder winter temperatures increase survival of overwintering species, and lengthening of the growing season lead to increased production of young. Most Alaska small mammals are active throughout the winter, consuming frozen green plant material in the space between the snow and ground surface. One of the crucial factors for the survival of small mammals then is sufficient snow depth to adequately insulate the ground, which prevents the loss of more energy than the mammals can replace. Caribou, the dominant large herbivore of tundra ecosystems, on occasion have experienced mass starvation when their winter forage becomes unavailable because plants become coated with ice from fall or winter freezing rain, which usually happens in particularly warm years. Moderately mild winters and early springs can improve caribou survival, but abnormally early spring weather can start spring plant growth so early that the forage plants become fibrous and low in nutrition before the caribou traditionally arrive to forage.

•Christopher Babcock and Glenn Juday

Confirmed moisture stress

Our previous research had found that a measurable indicator of moisture stress, the amount of the ^{13}C isotope in plant tissues, had increased in annual layers of wood collected from trees on timber sites near Fairbanks since the late 1970s. ^{13}C is a useful measure of overall moisture stress because it is internal to the plant. The earlier results were confirmed only through 1983 when the sample trees were killed by the Rosie Creek Fire. In this update study, surviving trees around the edge of the 1983 burned area were cored and the ^{13}C content of wood was measured for the years 1983–1996. ^{13}C content (and thus moisture stress) in the most recent years has increased to the highest levels of the 20th century, indicating unprecedented moisture stress in these trees. One possible confounding factor is that fossil fuel combustion has increased the amount of ^{13}C in carbon dioxide in the atmosphere, leading to a steady background increase in ^{13}C content of all plants. Even correcting for the fossil fuel combustion factor, unprecedented ^{13}C enrichment still is found in recent years.

•Valerie Barber and Glenn Juday

Detection of Alaska wildfires

Satellite remote sensing can provide a timely and cost–effective alternative to the traditional wildfire detection methods of aircraft reconnaissance and tower observations. A vital component of effective fire monitoring systems is frequent observations and the Advanced Very High Resolution Radiometer (AVHRR) sensor provides that.

Three different strategies are being compared. Algorithms with parameters suitable for interior Alaska ecosystems have been developed. One method uses predefined temperature and reflectance thresholds. A second method, called the contextual method, compares each image pixel with its surrounding pixels. If temperatures from the candidate pixel are sufficiently different, it is considered a fire. The third method is intended to remove false alarms resulting from nonvegetated surfaces such as braided river channels. Each

algorithm will be tested against 31 AVHRR images from the 1994–1996 fire seasons. Fire locations from the Alaska Fire Service will be used as reference data.

•*Steve Boles and Dave Verbyla*

Landscape interactions with convective thunderstorms

How does Alaska landscape and vegetation influence the development of thunderstorms and lightning strikes? Earlier studies have suggested a positive correlation between the number of lightning strikes recorded per unit area and terrain elevation below ~ 700 meters (2520') above sea level and a negative correlation above this elevation. A smaller grained digital elevation model is used to examine data trends and their correlation with the dominant underlying surface. Models used to predict lightning strike frequencies are typically based solely on meteorological parameters, thus not directly incorporating the effects of the surface. Digital terrain and vegetation data are incorporated in the analysis of thousands of lightning strikes in Alaska. The potential influence of low albedo/high temperature wildfire scars on mesoscale convection patterns in a test of a positive feedback hypothesis relating convective thunderstorms to wildfire scars is being studied.

•*Dorte Dissing and Dave Verbyla*

Modeling landscape level management

Work continued with emphasis on re–writing the HYFORFT water–balance model for more wide spread use via a cross–platform web browser based language with a user–friendly graphical user interface (GUI). Studies with a more detailed soil surface energy balance model indicated a close association between surface temperature and solar radiation for cloudless days, and with air temperature for windy and cloudy days. Analysis to date indicates a finer time increment may be needed in the water–balance model to adequately capture surface temperature dynamics. Attempts are being made to build a spatial display capability into the water–balance model itself, as well as generate output files directly readable by the ARC/INFO GIS software. In addition, a simpler "spreadsheet" model of the local water balance has been developed that should be useful for a "first look" at local and regional water balance characteristics.

•*John Fox*

Risk analysis for forest management

Simple models of forest growth and yield were combined with statistical distributions of stumpage price and regeneration success to explore the concepts of uncertainty and risk in silvicultural and financial investments in wood fiber production in interior Alaska's forests. The technique offers promise for more realistic forecasts of financial feasibility without rendering a false sense of certainty characteristic of many modelling results.

•*John Fox*

Impact of campgrounds on tree growth

The effect of campground establishment and use on white spruce tree ring–width was measured at seven campgrounds along the interior Alaska highway system. Measurements were made at 77 impacted campsites and 40 control sites, with radial growth measurements collected from 79 impacted trees and 46 control trees. Mean radial growth (since 1910) was highly correlated from campsite to campsite and among control trees compared to impacted trees, indicating that nearly all trees were responding to the environment in the same way at roughly the same time. Differences between control and campground–impacted trees were less than 10% of the total variability. The radial growth of these trees was strongly correlated with annual precipitation (tree growth highest in wettest years) and negatively related to summer temperature (growth lowest in warm years). At the Quartz Lake site radial growth of trees appears to have increased in impacted trees, probably because campground construction there occurred on cold or permafrost soils and disturbance warmed the soil sufficiently to increase site productivity. Relative growth rate of basal area was compared between control and impacted trees to identify small levels of growth reduction that might be due to campground effects.

•*Brian Glaspell, Glenn Juday, Alan Jubenville*

Mapping the growing season

Length of growing season is the dominant regional factor influencing natural resource systems in arctic and subarctic Alaska. Unfortunately, all climatic maps of this region are interpolations from relatively few weather stations. For example, there are 45 NOAA weather stations north of 63° latitude in Alaska to represent hundreds of millions of hectares. Furthermore, since most of these stations are either located along the coast or in valley bottoms, their locations poorly represent the Alaska landscape.

We have used the normalized difference vegetation index (NDVI) derived from bimonthly AVHRR (advanced very high resolution radiometer) from 1992–1997 to estimate the growing season. Satellite–derived growing season estimates for each year were compared to temperature data from NOAA weather stations. We found a positive relationship between growing season based on AVHRR data and growing season based on temperature data.

•*Heather Goldman and Dave Verbyla.*

Climate change is affecting the forests

High–quality daily weather data are available for a 48–year period at Fairbanks. Using a daily growing degree day (40°F threshold) measurement, the average summer day has been 11% warmer in the most recent 24 years (1973–96) compared to the previous 24 years (1948–72). Warm season (April through October) precipitation has been declining at Fairbanks since the mid–20th century. The growth of low–elevation forests in interior Alaska is directly limited by summer warmth and moisture deficit, as indicated by an analysis of the density and ^{13}C isotope content of tree–rings. Radial growth in these white spruce trees is highly correlated with an index of summer warmth and multi–year drought. The index has become highly unfavorable since the 1970s; growth of even young spruce has slowed in response to the less favorable climate. Growth of interior Alaska paper birch has slowed at the same time as a slightly differently weighted but similarly less favorable recent climate has developed in the last 20 years. Outbreaks of insects that reduce the growth of white spruce such as spruce budworm, generally increase during periods of high climate stress. During the last 40 years total area burned by forest fires in Alaska generally correlates with warm interior Alaska summer temperatures. As long as recent climate conditions persist: (1) the risk of outbreaks of insects that attack stressed trees is very high, (2) frequency, extent, and intensity of forest fires would likely increase, (3) tree growth rates will probably continue to decrease, (4) groundwater storage and summer water levels will decrease, and (5) the possibility is increased that forest regeneration responses to natural and management disturbances will not match current knowledge and predictions.

•Glenn Juday

Big Windy Hotsprings

The 160 acre (65 ha) Big Windy Hot Springs Research Natural Area (RNA) in the Steese National Conservation Area of central Alaska is managed by the Bureau of Land Management. Hot water (61°C/142°F) flows at about 3.6 gallons (8 liters) per minute from the largest of a system of small springs and seeps. The fracture of massive boulders from a cliff is one of the most distinctive features of the RNA. The main geothermal pools are lined with thermophytic algal and cyanobacteria mats. Geothermal heat in the vicinity of the main vents promotes a lush growth of vegetation including *Phalaris arundinacea* and *Ranunculus cymbalaria*, two species that occur here north of their previously reported distribution in Alaska. Diffuse geothermal heating of soil around the vents is associated with a large and productive mature white spruce forest on the south–facing slope. A paper birch forest with a minor white spruce component covers most of the south–facing slope. The north–facing slope is underlain with permafrost; areas of boulder talus are subjected to periglacial weathering processes. The lowland east–central Alaska region has experienced a strong climate warming trend since the late 1970s. Tree–ring growth of white spruce at Big Windy Hot Springs is generally negatively related to summer temperature. The Big Windy Hot Spring site is a mineral lick heavily used by a local population of Dall sheep that roam from nearby alpine habitats into the RNA. A collection of the water shrew (*Sorex palustris*) in the RNA is several hundred kilometers from the nearest known population and is the new northern limit for the species in North America.

•Glenn Juday and Jim Herriges

Backcasting white spruce natural regeneration

Previous analysis of a 40–year record of white spruce cone and seed production found that white spruce cone crops are infrequent, and crops large enough to effectively regenerate a predominately white spruce forest type occur about 12 years apart. In this study, the ratio of tree ring–width in the large cone crop years to the previous year showed a distinct pattern. The search for the ring–width signal of large cone crop years was extended back to the 1830s using long–term tree–ring series collected from commercial forest sites. The most likely large white spruce cone crop years were 1941, 1924, 1912, 1910, 1892, 1889, 1869, and 1856 with a mean interval between crops of 12.7 years.

•Glenn Juday, Scott Rupp and John Zasada

Hidden decay in white spruce

This study, a cooperative project with Tanana Chiefs Conference forestry program, was to evaluate and predict wood decay in standing white spruce. Root and lower trunk rots are one of the major factors that reduce or eliminate the commercial value of white spruce wood in older stands. Some wood–decaying fungi can cause heart rot or other defects with few or no external indicators. This study explores possible relationships of decay with simple tree characteristics such as species causing the decay, diameter, age, and height. An old floodplain stand (135–425 years old) affected primarily by *Innonotus* rot, stand–opening disease, supported nearly 80% of trees with rot. A near–rotation age upland stand (100–183 years old) affected by *Innonotus* and *Phellinus pini*, red ring rot, supported 20% of trees with decay. Larger

diameter stumps in both stands had slightly higher percentages of decayed trees than smaller diameter stumps. A weak or no relationship was found between dbh (diameter at breast height) and height of decay in the trunk. A weak relationship was found between dbh and actual volume of decay (bigger trees had larger decayed areas). The actual volume of decay in infected trees was roughly proportional to total log volume.

• Shawn Osborn, Robert Ott and Glenn Juday

Tree species growth and yield and site productivity for the Alaska northern forest

Goals of the Forest Growth and Yield Program are to quantify timber productivity of Alaska Northern Forest lands and to provide resource managers with appropriate equations, tables, and graphs essential for basic, state–of–the–art timber management decision-making and stand prescriptions. Timber is not only looked upon as a commodity but also as the basis for stand structure which provides habitat and food for many organisms.

Project units and objectives include:

1. **Site Index**: Develop appropriate polymorphic site index curves for trembling aspen, tamarack, black spruce, and white spruce; standard index age will be 50 years at breast height.

2. **Volume Tables**: Develop individual tree volume tables for each species by biogeoclimatic regions or zones.

3. **Impact of Moose on Hardwood Height Growth**: Describe the potential impact of moose browsing on the early height growth of paper birch, aspen, balsam poplar (includes black cottonwood).

4. **Levels–of–Growing–Stock**: Continue Levels–of–Growing–Stock (LOGS) studies for yield analyses for each tree species through monitoring existing plots and a) additional plantation establishment, b) spacing (pre-commercial thinning at or near canopy closure), and c) thinning (commercial).

5. **Yield Tables**: Continue establishment of fixed area, permanent sample plots (PSP) for pure and mixed stands of appropriate tree species; the program will be a cooperative effort with the commitment of the land manager/owner. Data to include stand structure and other resource characteristics.

6. **Forest Inventory Directory**: Identify, document, and review available timber inventories for the Northern Forest in Alaska; complete summary of public inventories.

7. **Growth and Yield Models**: Assess growth and yield prediction equations (models) for use with Alaskan species and identify the most promising for adoption (with modification).

8. **Minor Studies**: Review, consolidate, and maintain (remeasure) various silvicultural studies that may provide significant impact growth and yield information.

A major emphasis of the Forest Growth and Yield program continues to be an effort to develop mutual cooperation or partnering with public and private land managers.

• Edmond C. Packee

Forest productivity

Sampling continued for aspen and black spruce site index; one located site for aspen and seven for black spruce remain to be sampled. To date, few tamarack stands over breast–height–age of 50 have been found. Data for aspen and black spruce were entered into spreadsheets and checked for analysis.

• Edmond C. Packee

Reforestation stocking standards

Reforestation stocking standards must consider planting costs and future stand conditions. What affect does the number of trees planted per acre have on individual tree size and volume, and what affect is there on individual tree value? This is a major concern in modern forest stand management. Levels–of–Growing stock plantations are designed to assess the impacts of initial espacement (distance between trees) on tree growth including per acre characteristics such as number of trees per acre and volume per acre and individual tree characteristics such as diameter, height, height to live crown, limb characteristics, and taper.

Levels–of–Growing stock plantations exist at two locations: Bonanza Creek (white spruce and tamarack) planted in 1986 and Tok (white spruce, black spruce, tamarack, and lodgepole pine) planted in 1992. During the year plantations at both locations were remeasured and cleaned of competing vegetation to minimize above ground competition for light. Preliminary assessment of height growth data resulted in annual height growth measurement being changed from every five years after the fifth year to annually for the first 15 years. At Bonanza Creek, internodal height growth was measured for years 6 through 11 to obtain the required data. All data have been entered into spreadsheets for 5–year and 10–year analysis. Survival at Tok continues to be high except for lodgepole pine where foliage on many seedlings appears "burned" and dead due to winter climatic conditions.

A review of the literature addressing the potential impacts of early stocking (includes espacement and precommercial thinning) on wood quality of Alaska species was initiated. Preliminary results suggest the following wood characteristics are commonly associated with stocking: juvenile wood production

which is associated with specific gravity (strength characteristic), tree taper, reaction wood, and branch characteristics (knots). These characteristics affect wood quality and hence value. In Alaska species, concerns about juvenile wood varies among species; e.g., it is a serious problem in some species and no problem in others.

•*Edmond C. Packee*

Permanent sample plots

Sample Plots (PSP) at 15 sites were established in the Tanana and Copper River drainages; an additional 30 potential sites have been located. These plots can be used for Continuous Forest Inventory (CFI), for Continuous Habitat Inventory (CHI), and for monitoring forest health and basic succession. Based on five–year remeasurements, growth, regeneration, and mortality can be quantified as well as changes in stand structure. Response to treatments including harvest can be measured as well. Preliminary analysis of mixed–stand PSP indicates high within stand variability; stems per acre can exceed 2,000 in mixed spruce–hardwood stands over 100 years of age. All PSP data were checked, cleaned and entered for future analysis. Of 157 cores from PSPs, radial measurements were completed for 92. Sites sampled or measured in 1997 and older study sites are being located using GPS. GPS data were provided to State of Alaska Department of Natural Resources Division of Forestry and have been used to check or refine Department of Natural Resources' maps.

•*Edmond C. Packee, Susan Frick, and Tom Malone*

Individual tree volume tables

Individual tree volume data collection continues. The field data collection effort is complete for white spruce; limited data are available for black spruce, paper birch, aspen, and balsam poplar. Kenai white spruce tables are in draft form; analysis of data was initiated for Tanana Valley trees. Final equations and tables will provide three sets of data based on total tree height in feet and breast height diameter in inches: cubic foot volume, cubic meter volume, and finer weight per tree.

•*Edmond C. Packee and Tom Malone*

Forest health

Impact of spruce beetle (*Dendroctonus*) on forest stand structure, processes, functions, and biodiversity was investigated. Obvious impacts are sudden defoliation and mortality of a large percentage of the spruce trees in the stand. Other agents–of–change have similar impacts. These impacts affect soil moisture and nutrient cycling, streamflow and water temperature, fish and wildlife habitat, fire risk, and recreation and especially liability for recreation providers. Silvicultural options ranging from do nothing to salvage timber followed by site preparation and planting were identified for ecosystem restoration efforts. In the Tanana Valley, a study continues on the ecology of engraver beetles (*Ips*) and forest harvest implications. Engraver beetles most commonly attack slash, but can attack damaged or weakened living trees. They kill trees or portions of trees by burrowing under the bark, similar to the spruce beetle, but from the top down. Preliminary results suggest that engraver beetles found in log decks and slash piles initially do not migrate far. When mature they drop to the ground before searching for new host material. Thus, the engraver beetle appears to be more controllable than the spruce beetle.

•*Edmond C. Packee and Vaughn Salisbury*

Disturbance history in the Tanana Valley

Historical information concerning disturbance in the northern forest of Alaska is largely lacking. The implications of man–caused and natural disturbances on planned management activities in the Tanana Valley was addressed. Through archival research, field site visitations, interviews with land and fire managers, and review of current planning documents, four major conclusions were reached: 1) lack of use of historical information regarding human–caused changes to the landscape; 2) past involvement of stakeholders in fire planning was inadequate; 3) Alaska Interagency Fire Management Plans need to identify scientific parameters that address specific land management objectives; and 4) prescribed fire must become a more common management prescription following harvest of white spruce. The idea of "pristine" lands "untrammeled" by man is no longer true. Such lands were found to have been logged and settled in the past but show little trace of such activity now.

•*James S. Roessler and Edmond C. Packee*

Frostfire project

The effects of an experimental wildfire on an 11 km^2 boreal forest watershed in the Caribou–Poker Creeks Research Watershed near Chatanika, Alaska is being studied. Changes in soil respiration, carbon balance, and nitrogen dynamics resulting from the fire will be monitored. Eighteen sites (9 burn + 9 control) were established and instruments to measure soil temperature, respiration, and decomposition rates were installed.

•*David W. Valentine*

A geographic forest ecosystem dynamics model integrated within a GIS

Theoretical and empirical approaches have been used to model the biology of forest ecosystems. These models have represented the function of a forest ecosystem generally within an undefined spatial context. Moving to a large spatial area will require the use of theoretical representations of critical ecosystem functions that can be represented on an individual cell basis. It should then be possible to vary the size of the smallest cell from 1 m^2 to 1000 ha.

A forest ecosystem dynamics model was developed that is based on the nitrogen productivity concept for forest growth; litterfall quality and microbial efficiency for forest floor decomposition. Climate and ecosystem level disturbances will be handled as restricted stochastic processes. The restriction will be based on known state factor relationships. The state factors are used to describe a broad scale classification of the landscape to define basic limitations for the randomly derived driving variables used in the model.

The model has been programed as an ARC/INFO AML within the GRID package. The current version of the model has been verified as functional from an individual tree basis (1 m^2 cell size) in a number of forest types found in interior Alaska. Verification on a landscape scale (1 ha. cell size) is difficult because of a lack of detailed data that can be used from a landscape perspective.

• *John Yarie*

Carbon balance of the taiga forest

Forest biomass, production rates and carbon dynamics are a function of climate, plant species present and the structure of the soil organic layer and mineral soil layers. The state of Alaska represents only a small fraction of the total world wide boreal forest. The estimated forest area is 17,244,098 hectares. The total above ground biomass within Alaska was estimated to be 815,330,000 metric tons. Based on the CENTURY model the maximum net ecosystem production (NEP) was 136.9, 88.4, 152.3, 64.5, and 98.5 g/m^2 per year for aspen, birch, balsam poplar, white spruce and black spruce ecosystems. These values were seen at the stand ages of 75, 60, 45, 100, and 75, respectively. As a result of a five degree increase in the mean annual temperature, we predicted a higher amount of production and decomposition in all ecosystems, resulting in a higher estimate of NEP. We estimate that the effect of the current vegetation on the carbon budget is to absorb approximately 9.65 x 10^9 kg of carbon per year within the boreal forest of the state. If there is a five degree increase in the mean annual temperature with no change in precipitation we estimated that NEP for the boreal forest in Alaska will increase to 27.5 x 10^9 kg of carbon per year.

• *John Yarie*

Resources Management

Developing recreational trails

A project designed to develop a reliable technique for detecting small scale anthropogenic disturbances in a recreational use context was completed. The study site, located on Porcupine Dome within the White Mountains of interior Alaska, assessed the impact of the Pinnell National Recreation Trail on a sub–arctic, alpine vegetation community. The project attempted to take into account topo–edaphic variables while assessing the impact of trail construction and use on vegetation composition and diversity.

• *Harry Bader*

Bosnia deforestation

Final data collection was completed this year for the Bosnia Forest Damage Assessment. This project, with the assistance of NATO and the United Nations, is designed to provide information on the type, severity and extent of forest damage as a result of the conflict in the former Yugoslavia. Data will be used to help plan for refugee repatriation, environmental reclamation, and economic reconstruction.

• *Harry Bader*

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

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. Sport fisheries produce non–monetary benefits to fishers and monetary benefits to tourism related businesses. Outer Continental Shelf exploration, development and production activities could affect the quality of recreation opportunities and the demand for tourism related services. Our research will quantify both types of benefits. We are using a set of surveys based on the contingent valuation methodology to estimate the consumer surplus that accrues to sport fishers. We are employing a regional input-output model to measure the impact of marine sport fisheries on the Kenai Peninsula economy.

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

Regional economic modeling and community development

Researchers are focusing on developing applications for the IMPLAN input–output modeling system for Alaska communities. Policy review for Alaska agricultural development is also taking place. Concurrent projects include the Economic Assessment of the Marine Sport Fisheries in Lower Cook Inlet, and work on agricultural policy with respect to community development as it relates to land disposal and settlement. This includes a review and analysis of past State land disposals with recommendations for improved retention of qualified operators through market mechanisms, as well as an analysis of governmental policies toward new communities.

• *Hans Geier, Carol E. Lewis and Josh Greenburg*

A public information system for the Big Khekhtsir Nature Reserve, Russia

A survey of public information systems in Alaska natural areas, including public parks, forests and refuges shows that a complex of methods and information is used to benefit both the natural area and the visiting public. In contrast, at the current time, Russian Nature Reserves have very little in the way of public information systems. This study reviews the different ways that public information is used in managing Alaska's natural areas and makes recommendations for systems that should be added, or could be adapted, for use in the Big Khekhtsir Nature Reserve outside the city of Khabarovsk in the Russian Far East.

• *Sergei Ivanov, Susan Todd, Alan Jubenville, Doug Schamel*

Wildfire management in Alaska

The objective of this research is to investigate various aspects of wildfire management in Alaska. This includes the history of fire management in Alaska, the fire management planning process, whether the objectives of fire management are being met (particularly in limited suppression areas), and the social and economic impacts of changes in fire policy on rural Alaska villages.

Managing wildfire is particularly difficult in Alaska, due to the great expanse of territory with few, if any, roads. Because Alaska is unique in this regard, the research and fire management policies of the Lower 48 often do not apply. Research is needed that is targeted specifically to our unique challenges. This research project will help fill this gap.

• *Holly Jewkes, Susan Todd, John Yarie, Claus Naske*

Territoriality in recreational settings

The data collection on territoriality along the Gulkana River was continued. The basic pattern of floating and camping on the known best fishing holes for an extended period of time has basically been abandoned. Taking a cue from the successful guides on the river, people tend to fish all holes because the fish can be holding anywhere—not just the few large well–known fishing holes. The fishing is done more intensively over the entire river not just the major holes. Even when people stop and fish a given hole, it is usually for a short period of time and then off to the next stop. For that short period others floating the Gulkana respect that territory. Some would simply put into shore and wait if they want to fish that particular hole.

The study was extended to the Chulitna, Klutina, and Chatanika Rivers. The old pattern of just fishing the few, well–known holes continues. None of the rivers lend itself to floating and fishing all the holes. Two of the three basically offer walk–in fishing. The third is extremely fast whitewater, which means only a few places are fishable.

Rivers are interesting because they have unidirectional and many options to fish. I suspect that land–based recreational opportunities will never undergo the radical change of use pattern experienced on the Gulkana River because there are fewer spots where people would want to stop and establish a territory, and people have many more transportation options to access those few locations.

• *Alan Jubenville*

Advancing extreme life systems

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

Both physical chemical and biological waste treatment technologies are under investigation by NASA. The most relevant from the suite of technologies have been selected for arctic applications. The emphasis is on full recovery and recycle of resources. Ideal for community applications is the Wiped–Film Rotating Disk (WRFD) distillation processor. The processing system can be operated using waste heat from any number of sources including village power generators. The effluent from the WRFD can be used as gray water or it can be polished using, for example, a hydroponics plant growth system. This combination is in operation at the South Pole Station in Antarctica.

While plants can play an important role in water purification systems, they are important for the food they produce. New, high–efficiency lighting systems

using recirculating water jackets, make the economics of production more feasible than with past lighting systems. Production per unit area allocated to production and efficiency of conversion for energy to operate lights to crop mass has been increased over conventional systems by a factor of three.

• *Carol E. Lewis and David L. Bubenheim*

Alaska grown products

We tested the acceptability of breaded arrowtooth flounder fillets targeted at the frozen, breaded fillet market. The Tanana Valley State Fair provided us with an excellent cross–section of Alaska consumers. Marketing the arrowtooth flounder could add significantly to income in groundfish fisheries in Alaska. The arrowtooth flounder bicatch exceeds the catch in the groundfish fisheries of southern and western Alaska. It is a very soft fish that presently has a low or zero market value. The product we tested was injected with both the whey and sodium additives in the same mix as used for pollock fillets. The injected product was tested against a control that was not injected. Both were breaded in a mix developed by Tyson Industries and deep–fried in canola oil before serving. Consumer acceptability of both samples was excellent. To refine these determinations, we tested our injected, breaded fillets against several branded fillet products and one generic frozen fillet product. The arrowtooth was again determined to be superior. We postulated that the breading might have been the deciding factor for our panels rather than the texture of the fillet itself. In any case, the injected arrowtooth flounder fillet should be an acceptable product in the frozen fillet market.

• *Carol E. Lewis and John S. French*

Marketing cooperatives in Alaska

The objective of this project has been to educate and develop services for producers and processors interested in forming marketing cooperatives. We began our work in Delta Junction with several dairy farmers. We worked with Wrangell residents interested in a boat haul–out and dry dock, and an artists' cooperative. Most recently, sponsored by the Alaska Economic Development Center, we worked with the Unalaska Fisherman's Association who established a cooperative to process seafood.

We have strongly emphasized throughout our work that cooperatives are a business. They are not a vehicle for obtaining grant funding nor are they non–profit service organizations. Cooperatives are formed to benefit the owners but owners must be committed to the cooperative to receive the benefits it can bring to them.

• *Carol E. Lewis and Hans Geier*

Advanced technology for remote complex regions: Mining and forestry

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

The objective of the UA/MIT partnership is to develop technologies to enhance the value– added timber industry in Alaska and to develop either 'smaller' or more remote mineral deposits that are not now feasible to mine. The focus this year was on two projects. The first is an acoustic imaging device to inspect the interior of live trees. A bench model has been developed and a patent disclosure has been filed. The second is potential mining of low–grade waste from mining operations in southcentral Alaska.

• *Carol E. Lewis and Robert Trent*

Designing effective planning teams

To deal with resource management controversies, agencies often form planning teams, advisory committees, and/or citizen groups to assist them in negotiating a resource plan. Success in such negotiations depends to a large extent on these teams—who is chosen, how they are chosen, and what they are expected to do will have a profound effect on the negotiations. While such teams are now common, there is no empirical research focused explicitly on how agencies should go about establishing such a team. Should participants represent just themselves or organizations? How much authority should a team have in setting policy? Such teams require considerable time, effort, and expense on the part of everyone involved. Therefore, it is vital to determine if some team design options are more successful than others.

We have completed case studies of the Creamer's Field planning team, the McNeil River Grizzly Bear Refuge planning team and five wolf management teams. In 1997, we completed a case study of the Governor–appointed Dalton Highway Advisory and Planning Board as well as a synopsis of the self–appointed, "grass–roots" planning team for the Chena River Watershed Plan.

• *Terri Lomax and Susan Todd*

Faculty Publications
January 1997—December 1997

Journal Articles

Title	Author(s)	Published in:
Enhancement and inhibition of microbial activity in hydrocarbon–contaminated arctic soils: Implications for nutrient–amended bioremediation	Braddock, J.F., M.L. Ruth, P.H. Catterall, J.L. Walworth, and K.A. McCarthy	*Environ. Sci. Tech.* 31:2078–2084
Moose (*Alces alces*) habitat relative to riparian succession in the boreal forest, Susitna River, Alaska	Collins, W.B. and D.J. Helm	*Canadian Field–Naturalist* 111:567–574
Northern Alaska oil fields and caribou: A commentary	Cronin, M.A., W.B. Ballard, J.D. Bryan, B.J. Pierson, and J.D. McKendrick	*Biological Conservation* 83(2):195–208
Ontogenetic evaluation of grain yield and time to maturity in barley	Dofing, S.M.	*Agron. J.* 89:685–690
Vegetation succession and disturbance on boreal forest floodplain, Susitna River, Alaska	Helm, D.J. and W.B. Collins	*Canadian Field–Naturalist* 111:553–566
Expression of an engineered cecropin gene cassette in transgenic tobacco plants confers disease resistance to *Pseudomonas syringae pv. tabaci*	Huang,Y., R.O. Nordeen, M. Di, L.D. Owens, and J.H. McBeath	*Phytopathology* 87:494–499
Interannual variation in global–scale net primary production: Testing model estimates	Malmstrom, C.M., M.V. Thompson, G.P. Juday, S.O. Los, J.T. Randerson, and C.B. Field	*Global Biogeochemical Cycles* 11(3):367–392
Comparison of 0.1M sodium hydroxide with 0.1M sodium pyrophosphate in the extraction of soil organic matter from various soil horizons	Michaelson, G.J. and C.L. Ping	*Commun in Soil Sci. and Plant Anal.* 28(13–14):1141–1150
Carbon content and distribution in tundra soils in arctic Alaska, USA	Michaelson, G.J., C.L. Ping, and J.M. Kimble	*Arctic & Alp. Res.* 28:414–424
Impact of agriculture on soil consumption of atmospheric CH_4 and a comparison of CH_4 and N_2O flux in subarctic, temperate and tropical grasslands	Mosier, A.R., J.A. Delgado, V.L. Cochran, D.W. Valentine, and W.J. Parton	*Nutrient Cycling in Agroecosystems* 49(1–3):71–83
CH_4 and N_2O fluxes in the Colorado shortgrass steppe: 2. Long–term impact of land use change	Mosier, A.R., W.J. Parton, D.W. Valentine, D.S. Ojima, D.S. Schimel, and O. Heinemeyer	*Global Biogeochemical Cycles* 11(1):29–42
Effects of chemical drying agents on the fine structure of alfalfa cuticles and epicuticular waxes	Panciera, M.T. and C.R. Krause	*Crop Science* 37:1292–1296
Carbon storage along a latitudinal transect in Alaska	Ping, C.L., G.J. Michaelson, and J.M. Kimble	*Nutrient Cycling in Agroecosystems* 49:235–242
Rhizosphere and nutrient effects on remediating subarctic soils	Reynolds, C.M., B.A. Koenen, J.B. Carnahan, J.L. Walworth, and P. Bhunia	*In Situ and On–Site Bioremediation* 4(1):297–302
Enhancement and inhibition of soil petroleum biodegradation through the use of fertilizer nitrogen: An approach to determining optimum levels	Walworth, J.L., C.R. Woolard, J.F. Braddock, and C.M. Reynolds	*J. Soil Contamination* 6(5):465–480

Title	Author(s)	Published in:
The role of soil nitrogen concentration in bioremediation	Walworth, J.L., C.R. Woolard, J.F. Braddock, and C.M. Reynolds	*In Situ and On–Site Bioremediation* 4(4):283–288
Nitrous oxide consumption in contaminated soil	Willson, E.H., E.V. Hogan, C.R. Woolard, and J.L. Walworth	*In Situ and On–Site Bioremediation* 4(1):397–401
Nitrogen productivity of Alaska tree species at an individual tree and landscape level	Yarie, J.	*Ecology* 78:2351–2358
Components of a geographic forest ecosystem model used for potential management of interior Alaska's forests	Yarie, J. and S. Rupp	*Forest Management for Bioenergy*. The Finnish Forest Research Institute. pp.182–192

Book or Book Chapter

Title	Author(s)	Published in:
Who has the legal right to fish?	Bader, H.R.	Marine Advisory Bulletin No. 49
Vegetation	Helm, D.	*Mining Environmental Handbook: Effects of Mining on the Environment and American Environmental Controls on Mining*, London, Imperial College Press. Book Section 5.3.1. pp.140–145
Hiking trails, canoe trails, and public use cabins in southcentral Alaska	Jubenville, A.	Hunter Publishing: Trenton NJ
Cultural procedures for cyclamen	Karlsson, M.G.	*Growing Specialty Potted Crops*. Ohio Florists' Association. pp.59–63
Cultural procedures for primula	Karlsson, M.G.	*Growing Specialty Potted Crops*, Ohio Florists' Association. pp.107–111
Long–term tundra recovery in northern Alaska	McKendrick, J.D.	*Disturbance and recovery in Arctic lands: An ecological perspective*, Kluwer Academic Publishers. pp.503–518
Characteristics of soil organic matter in arctic ecosystems of Alaska	Ping, C.L., G.J. Michaelson, W.M. Loya, R.J. Candler, and R.L. Malcolm	*Soil processes and the carbon cycle*, CRC Press. Chapter 12
Processing digital images in geographic information systems	Verbyla, D.L. and K. Chang	OnWord Press, Sante Fe NM. 295 pp

AFES Bulletins

Title	Author(s)	AFES Publication No.
Bromegrass in Alaska. VI. Effects of a broad array of harvest schedules and frequencies on forage yield and quality and on subsequent winter survival of cultivars Manchar and Polar	Klebesadel, L.J.	Bul. 104
Timothy in Alaska: Characteristics, history, adaptation, and management	Klebesadel, L.J.	Bul. 105

AFES Circulars

Title	Author(s)	AFES Publication No.
Potato variety performance, Alaska 1996	Carling, D.E., and M.A. Boyd	Cir. 110
Head lettuce variety performance, Matanuska Valley, Alaska 1997	Walworth, J.L., S.M. Doﬁng, and D.E. Carling	Cir. 111

AFES Newsletter

Title	Author(s)	AFES Publication No.
The Georgeson Botanical Garden Review	Holloway, P.S.	Vol 6, No. 1
The Georgeson Botanical Garden Review	Holloway, P.S.	Vol 6, No. 2
The Georgeson Botanical Garden Review	Holloway, P.S.	Vol 6, No. 3

Miscellaneous Publications

Title	Author(s)	Published in:
Hydrology, morphology, and redox potentials in four soils of southcentral Alaska	Clark, M.H. and C.L. Ping	Aquic conditions and hydric soils: The problem soils. *Soil Science Society of America (SSSA) special publication* no. 50. pp.113–131
Community and economic profile for the villages of Grayling, Anvik, Shageluk, and Holy Cross	Geier, H., C.E. Lewis, and J. Greenberg	AFES Misc. Publ. 97–1
Growing today's improved primula cultivars	Karlsson, M.G.	*Greenhouse Product News* 7(9):12–17
Primula	Karlsson, M.G.	*Ohio Florists' Association Bulletin* no. 817:3–5
Aquic conditions in andisols of the Northwest USA	McDaniel, P.A., J.H. Huddleston, C.L. Ping, and S.L. McGeehan	Aquic conditions and hydric soils: The problem soils. *SSSA special publication* no. 50. pp.99–111
Image processing workshop: A GIS perspective	Verbyla, D.L.	Workbook for workshop taught at the 1997 Alaska Surveying and Mapping Conference, Anchorage AK
Boreal forest clear–cutting	Yarie, J.	Alaska Forest Association, Inc. Newsletter, Ketchikan AK. p.9

Proceedings

Title	Author(s)	Published in Proceedings of:
Wildlife	Babcock, C. and G.P. Juday	Implications of global change in the western Arctic workshop, Fairbanks AK. June 3–6. pp.35–39
Optical and radar satellite classifications of wetlands within the Tanana Flats	Balser, A.W. and D.L. Verbyla	Alaska Surveying and Mapping Conference, Anchorage AK
Soil respiration in the boreal forest: Linking soil CO_2 to moisture availability	Billings, S., D. Richter, and J. Yarie	Soil Science Meetings
Gelisols: A newly proposed order in Soil Taxonomy	Bockheim, J.G., J.M. Kimble, C. Tarnocai, and C.L Ping	International conference on Advances on fundamentational research of the earth cryosphere in Arctic and subarctic, Novosibirsk, Russia. April 22–26, 1996
Application of NASA'a advanced life support systems in polar regions	Bubenheim, D.L., M.T. Flynn, and C.E. Lewis	Alaska Water and Wastewater Mgmt. Assoc. Fairbanks AK. April 23–25.
Arctic tundra	Douglas, D., G.P. Juday, and R. Meehan	Implications of global change in the western Arctic workshop, Fairbanks AK. June 3–6. pp.29–34
Facilitating natural succession for mined land reclamation by use of on–site resources and amendments in Alaska	Helm, D.J.	Fifth ISCORD, Anchorage AK. May 4–10. pp.505–508
Nitrous oxide as a nutrient source in bioventing	Hogan, E.V., E.H. Willson, C.R. Woolard, and J.L. Walworth	Fifth ISCORD, Anchorage AK. May 4–10. pp.167–170
Assessment of actual and potential global warming effects on forests of Alaska	Juday, G.P., R.A. Ott, D.W. Valentine, and V.A. Barber	New England Regional Climate Change Impacts Workshop, Durham NH. September 3–5. pp.121–126
Climate change and effects of tree growth as evidenced by tree–ring data from Alaska	Jacoby, G.C., R.D. D'Arrigo, and G.P. Juday	7th Conference of the International Boreal Forest Research Assoc. St. Petersburg, Russia. August 19–23
Forests, climate stress, insects, and fire	Juday, G.P., R.A. Ott, D.W. Valentine, and V.A. Barber	Implications of global change in the western Arctic workshop, Fairbanks AK. June 3–6. pp.15–28

Title	Author(s)	Published in Proceedings of:
Assessment of actual and potential global warming effects on forests of Alaska	Juday, G.P., R.A. Ott, D.W. Valentine, and V.A. Barber	New England Regional Climate Change Impacts Workshop, Durham NH. September 3–5. pp.121–126
Opportunities and challenges for greenhouse production in Alaska	Karlsson, M.G.	Fifth ISCORD, Anchorage AK. May 4–10. pp.13–16
Controlled environment agriculture: NASA technology can enhance community development	Lewis, C.E. and D.L. Bubenheim	27th Intnl. Conference on Environmental Systems (ICES) Lake Tahoe NA. July 14–17
Recovery and rehabilitation of disturbed wetland sites	McKendrick, J.D.	NPR–A Symposium Proceedings, Anchorage AK. April 16–18. pp.4–17 through 4–21
Survival of northern latitude plant species in petroleum–contaminated soils	Muniz, J.E., J.L. Walworth, and N. Moore	Fifth ISCORD, Anchorage AK. May 4–10. pp.513–516
Human land use and management	Rice, W., E. McDowell, S. Retheford, S. Hennig, G.P. Juday, S. Sparrow and V. Cochran	Implications of global change in the western Arctic workshop, Fairbanks AK. June 3–6. pp.40–45
The pedon as a basic soil unit	Tarnocai, C., J.M. Kimble, J. Bockheim, and C.L. Ping	International Conference on Advances on fundamentational research of the earth cryosphere in Arctic and subarctic, Novosibirsk, Russia. April 22–26, 1996
Topographic control of a spectral leaf area index	Verbyla, D.L.	Alaska Surveying and Mapping Conference, Anchorage AK
Bioremediation using fish bonemeal in cold climates	Woolard, C.R., J.L. Walworth, and K.C. Harris	Fifth ISCORD, Anchorage AK. May 4–10. pp.147–150
The role of flooding in ecosystem dynamics along the Tanana River, interior Alaska	Yarie, J.	ESA 82nd Annual Meeting, Albuquerque NM. August
A geographic forest ecosystem model for interior Alaska	Yarie, J.	17th ESRI user conference, San Diego, CA. July

Contract Reports

Title	Author(s)	Contracting Agency
Bioremediation of oil–contaminated soils, CRREL Farmer's Loop Field Station, Fairbanks, Alaska	Bhunia, P.K., C.M. Reynolds, M. Travis, and J.L. Walworth	Final Report for Alaska Science and Technology Foundation. Project No. 92–1–009
Abandoned placer mined land reclamation Birch Creek – Mile 101 Steese Highway vegetation – soils revegetation trials final report	Helm, D.	Prepared for Department of Environmental Conservation. 24 pp
Knob Creek revegetation monitoring: Oct 1996 – Jun 1997	Helm, D.	Prepared for Alaska Division of Mining and Water Management. 14 pp
Nolan Creek revegetation report: Establishment year 1996	Helm, D.	Prepared for Silverado Mines (US), Inc. 20 pp
Texture enhancement of bottom fish fillets	Lewis, C.E. and J.S. French	Fishery Industrial Tech. Center and AK Science and Tech. Foundation. 16 pp
Badami N°. 1 revegetation monitoring 1997 annual report	McKendrick, J.D.	BP Exploration (Alaska), Inc., Anchorage AK. 10 pp
X pad flare pit vegetation monitoring: 1996 data report	McKendrick, J.D.	BP Exploration (Alaska), Anchorage AK. 13 pp.+ Appendix XIV–LXVIII
Long–term gravel vegetation project quarterly report for January, February, March, 1997	McKendrick, J.D.	BP Exploration (Alaska), Inc., Anchorage AK. 5 pp + Appendix
Testing North Slope waste products for revegetation of gravel pads	McKendrick, J.D.	ARCO Alaska, Inc., Anchorage AK. 15 pp

Contract Reports

Title	Author(s)	Contracting Agency
An integrated investigation of methane and carbon dioxide fluxes in mid–latitude prairie wetlands: Micrometeorological measurements, process–level studies, and modeling	Verma, S.B., T.J. Arkebauer, F.G. Ullman, J. Kim, D.W. Valentine, D.S. Schimel, E.A. Holland, and W.M. Pulliam	Final Technical Report to the National Institute for Global Environmental Change

Abstracts

Title	Author(s)	Published in:
Growth rate responses of white spruce to river discharge patterns on a boreal forest floodplain	Adams, P.C. and G.P. Juday	*ESA Bulletin* (Supplement–Annual Meeting Abstracts) 78(4):43
Upland white spruce growth in Bonanza Creek LTER in central Alaska under unprecedented drought stress: Evidence from stable isotopes and wood density	Barber, V.A. and G.P. Juday	19th Annual Beringia meeting, Ft. Colins, CO
Stable isotope and wood density evidence of upland white spruce growth in Bonanza Creek LTER in central Alaska consistent with increased climatic stress	Barber, V.A., G.P. Juday, and B.P. Finney	*ESA Bulletin* (Supplement–Annual Meeting Abstracts) 78(4):50
Nutrient effects on microbial activity in hydrocarbon–contaminated Arctic soils: Implications for bioremediation	Braddock, J.F., J.L. Walworth, and K.A. McCarthy	International Symposium on Physics, Chemistry, and Ecology of Seasonally Frozen Soils. Fairbanks AK. June 10–12
Expression of the uniculm (UC_2) gene in near–isogenic backgrounds.	Doring, S.M.	*Agron. Abstracts*. ASA, Madison WI. p.73
Nitrous oxide as a nutrient source in bioventing	Hogan, E.V., E.H. Willson, C.R. Woolard, and J.L. Walworth	Fifth ISCORD, Anchorage AK. May 4–10
Indicators of recent environmental change in Alaska	Jacoby, G.C., R.D. D'Arrigo, and G.P. Juday	Eighth International Global Warming Conference and Exposition, Washington D.C.
Tree–ring evidence of climatic warming stress in Alaska: Variation and stand history context	Juday, G.P. and S.C. Marler	*ESA Bulletin* (Supplement – Annual Meeting Abstracts) 78(4):119
Flowering response of *Anemone coronaria* to photoperiod and temperature	Karlsson, M.G.	*HortScience* 32(3):466
Growth of cyclamen as affected by day and night temperatures	Karlsson, M.G.	*HortScience* 32(3):466
Herbivore effects on C and N cycling in riparian ecosystems in Rocky Mountain National Park	Menezes, R.C., E.T. Elliot, D.W. Valentine, and S.A. Williams	Oral presentation, SSSA
Survival of northern latitude plant species in petroleum–contaminated soils	Muniz, J.E., J.L. Walworth, and N. Moore	Fifth ISCORD, Anchorage AK. May 4–10
Wind flows and distribution of large–scale blowdowns on a landscape in the Tongass National Forest: Implications for management	Ott, R.A., T.E. Garvey, and G.P. Juday	*ESA Bulletin* (Supplement–Annual Meeting Abstracts) 78(4):157
Soil morphological clues to climate changes in the Beringia	Ping, C.L. and J.M. Kimble	Beringia Paleoenvironments Workshop, Florissant CO. Sept. 20–23. pp.124–125
Differences in plant species diversity and forest structure following natural fire versus historical logging in the boreal forest of Alaska	Rees, D.C. and G.P. Juday	*ESA Bulletin* (Supplement – Annual Meeting Abstracts) 78(4):168
Rhizosphere and nutrient effects on remediation subarctic soils	Reynolds, C.M., B.A. Koenen, J.B. Carnahan, J.L. Walworth, and P. Bhunia	Fourth International In Situ and On–Site Bioremediation Symposium, New Orleans LA. April 28–May 1

Title	Author(s)	Published in:
Have we missed something? Disturbance history of the Tanana River basin in Alaska	Roessler, J.S. and E.C. Packee	SAF National Convention, Memphis TN. October. p.359
Disturbance history of the Tanana River basin in Alaska: Have we missed something?	Roessler, J.S. and E.C. Packee	2nd International Wildland Fire Conference: Wildland Fire Management and Sustainable Development, Vancouver BC. May 25–30. Abstract 103
Observations and implications from a 40 year record of white spruce cone and seed production in interior Alaska	Rupp, S., G.P Juday, J. Zasada, L.A. Viereck, and P.A. Adams	Annual Meeting International Boreal Forest Research Association, Duluth MN. August 5–8
Ecosystem controls over methane emissions in the BOREAS southern study area fen	Valentine, D.W.	Oral presentation, Ecological Society of America (ESA) annual meeting
Do forests receive occult inputs of nitrogen?	Valentine, D.W., M. Christ, and D. Binkley	Soil Science Society of America symposium on big questions in forest soils
Biogeochemical constraints on CH_4 emissions from northern fens	Valentine, D.W., W.M. Pulliam, E.A. Holland, and D.S. Schimel	Oral presentation, International Symposium on Seasonally Frozen Soils. June 10–12
Nitrogen and bioremediation: Beneficial and harmful effects of nitrogen fertilization	Walworth, J.L.	Cold Regions Remediation Conference, Anchorage AK. April 3–5
The role of nitrogen concentration in bioremediation	Walworth, J.L., C.R. Woolard, J.F. Braddock, and C.M. Reynolds	Fourth International In Situ and On–Site Bioremediation Symposium, New Orleans LA. April 28–May 1
Nitrous oxide consumption in contaminated soils	Willson, E.H., E.V. Hogan, C.R. Woolard, and J.L. Walworth	Fourth International In Situ and On–Site Bioremediation Symposium, New Orleans LA. April 28–May 1
Bioremediation using fish bonemeal in cold climates	Woolard, C.R., J.L. Walworth, and K.C. Harris	Fifth ISCORD, Anchorage AK. May 4–10

Web Pages

Title	Author(s)	HTML address
Landscape interactions with convective thunderstorms in interior Alaska	Dissing, D.D. and D.L. Verbyla	http://www.lter.uaf.edu/~dverbyla/saving-tim.html
Observed climate changes in Alaska: The early consequences of global warming?	Juday, G.P.	http://www.usgcrp.gov/usgcrp/971202DD.html
The role of land-cover change in high latitude ecosystems: Implications for the global carbon cycle	McGuire, A.D., D.L. Verbyla, W.S. Armbruster, J. Melillo, D. Kicklighter and R. Meier	http://alces.sel.uaf.edu
Forage selection	Panciera, M.T.	National Forage Curriculum project http://www.forages.css.orst.edu/classes/NFC/Topics/ForageSelection/Crucial/body.html
ArcView GIS workshop	Verbyla, D.L.	http://www.lter.alaska.edu/~dverbyla/workshop3.html
Introduction to geographic information systems	Verbyla, D.L.	http://www.lter.alaska.edu/~dverbyla/workshop3.html
Remote sensing of natural resources	Verbyla, D.L.	http://www.lter.alaska.edu/~dverbyla/workshop3.html
GIS analysis	Verbyla, D.L.	http://www.lter.alaska.edu/~dverbyla/workshop3.html
Saving time in GIS work	Verbyla, D.L. and T.O. Hammond	http://www.lter.uaf.edu/~dverbyla/saving-tim.html

Theses/Student Professional Papers

Title	Author
Identifying rural development opportunities in the Denali Borough	Adams, L.
The impact of moose browsing on *Populus* species in Alaska	Andrews, J.H.
Recreation planning within the US Bureau of Land Management: An analysis considering the inclusion of viable management activities and specific management prescriptions	Fluetsch, D.
Transformation by microorganisms of nitrogen and phosphorus in salmon bonemeal into plant available forms	Follman, A.
A public information system for the Big Khekhtsir Nature Reserve, Russia	Ivanov, S.
A digital topographic atlas of Alaska	Plumley, G.
Patterns of species diversity following disturbance in upland white spruce forests of interior Alaska	Rees, D.
Disturbance history in the Tanana River basin of Alaska: Management implications.	Roessler, J.S.
Boreal forest regeneration dynamics: Modeling early forest establishment patterns in interior Alaska	Rupp, T.S.
Moss communities across successional gradients in the Bonanza Creek Experimental Forest, interior Alaska	Willstrud, S.A.

Financial Statement

Expenditures — July 1996 through June 1997

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1996 and ending June 30, 1997 (FY 97). NOTE: This is not an accounting document.

FEDERAL		(percent of total)
Hatch General Formula Funds	$ 660,946	10.4
Hatch Regional Formula Funds	131,517	2.1
McIntire–Stennis Formula Funds	454,197	7.2
OTHER GRANTS AND CONTRACTS	1,137,280	18.0
STATE APPROPRIATION/PROGRAM RECEIPTS	3,939,489	62.3
TOTAL	$6,323,429	100.0 percent

Financial Statement

Expenditures — July 1997 through June 1998

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1997 and ending June 30, 1998 (FY 98). NOTE: This is not an accounting document.

FEDERAL		(percent of total)
Hatch General Formula Funds	$ 697,238	12.2
Hatch Regional Formula Funds	147,756	2.6
McIntire–Stennis Formula Funds	501,830	8.8
OTHER GRANTS AND CONTRACTS	1,034,506	18.1
STATE APPROPRIATION/PROGRAM RECEIPTS	3,324,948	58.3
TOTAL	$5,706,278	100.0 percent

FY 98 research funding

Grants and Special Funds; July 1, 1997– June 30, 1998

National Science Foundation

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

United States Department of Agriculture

Jenifer McBeath ..... Cooperative agriculture pest survey
Chien–Lu Ping ..... Wet soils monitoring studies in Alaska; *(SCS funding also)*
Chien–Lu Ping ..... Carbon storage in subarctic soils
Tricia Wurtz ..... Spruce and alder interactions
John Yarie ..... Carbon balance of the Alaska boreal forest

University of Alaska Natural Resources Fund

Stephen Dofing ..... Continuation of a program in plant breeding and genetics
Pat Holloway ..... A plant propagation system for horticulture, forestry and photoremediation in Alaska
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
Glenn Juday ..... Study of recent climatic stress on white spruce
Edmond Packee ..... Establishment of permanent sample plots
Edmond Packee ..... Initial forest stand density and wood quality attributes
Stephen Sparrow, Carol E. Lewis ..... Alaska hosts the third circumpolar agricultural conference
Stephen Sparrow ..... Agronomic and economic evaluation of forage crops for AK
Stephen Sparrow, Steve Becker ..... Mycorrhizal inoculation techniques
Jay McKendrick ..... Recording tundra recovery on Alaska oil exploration sites NPR–A
Dave Verbyla ..... Development of an Alaskan wildfire detection and mapping system

AK Department of Natural Resources

Tobi Campanella ..... Forestry students
Dot Helm ..... Abandoned mined lands reclamation
Pat Holloway ..... Mulches for tree planting in Alaska landscapes
Jenifer McBeath ..... Virus free seed potatoes
Stephen Sparrow, Carol E. Lewis ..... Third Circumpolar Agricultural Conference

UA International Arctic Research Center (IARC)

Val Barber, Glenn Juday ..... Confirming recent climatic stress on white spruce from global warming
Elena Sparrow ..... GLOBE: Global change education for K-12 students

Bedding Plants Foundation, Inc.

Meriam Karlsson ..... Light intensity and temperature requirements for flowering and development of *Ranunculus*

National Biological Survey — Chien–Lu Ping ..... Rock Creek water quality
USDA Forest Service — John Yarie ..... Forestry research
Environmental Protection Agency — Elena Sparrow ... Global change environmental education project
University of Nebraska Lincoln — David Valentine ..... Modeling of methane
AK Bureau of Land Management — Dot Helm ..... Thompson pup revegetation monitoring
AK Science and Technology Foundation — Jenifer McBeath ..... Seed potato

BP Exploration (Alaska), Inc. — Jay McKendrick ..... Gravel vegetation studies
Frito–Lay — Donald Carling ..... Potato tests for Frito–Lay
Silverado Mines Inc. — Dot Helm ..... Nolan Creek revegetation
U.S. Army Corps of Engineers — Tobi Campanella ..... Chena Lakes project
MAPCO Alaska Petroleum Inc. — Meriam Karlsson ..... Interactive digital image database
University of Alaska Foundation — Pat Holloway ..... Georgeson Botanical Garden
Fairbanks Private Industry Council — Pat Holloway ..... Summer youth employment
Fred Gloeckner Foundation, Inc. — Meriam Karlsson ... Day and night temperature requirements for cyclamen
Office of the Governor — Susan Todd ..... Reaching consensus on diverse issues
NASA — Dave Verbyla ..... Satellite remote sensing of forest canopy closure across the subarctic landscape
Fitzgerald Family Foundation — D. Maddux, C. Knight ..... Wastewater treatment in rural villages
M.J. Murdock Charitable Trust — D. Maddux, C. Knight ..... Rural wastewater treatment study
U.S. Fish and Wildlife — Dave Verbyla ..... Radar remote sensing of alluvial habitat

USDA–CREES —
Donald Carling ..... Screening accession of *Solanum ssp.*
Donald Carling ..... Alaska's NAPIAP program
G. Allen Mitchell ..... Potato cultivars
Mike Panciera ..... SARE, no–till forage establishment to improve soil and water conservation

Usibelli Coal Mine, Inc. —
Dot Helm ..... Usibelli vegetation studies
Dot Helm ..... Wishbone Hill revegetation plot monitoring
Dot Helm ..... Healy Valley premining inventory
Dot Helm ..... Revegetation studies on Two Bull Ridge

Formula Funds

Hatch General; USDA

Harry Bader ..... Comparative legal analysis of private property use and regulation in the rural U.S.
Michael Panciera ..... Maximizing forage quality at northern latitudes
Chien–Lu Ping ..... Hydric soil properties of permafrost–affected soils
Stephen Sparrow ..... Nitrogen fixation, herbage yield and persistence of perennial legumes in Interior Alaska
Stephen Sparrow ..... Tillage and crop residue management effects on properties of a subarctic soil
G. Allen Mitchell ..... Palmer administration
Meriam Karlsson ..... Environmental plant physiology of greenhouse produced crops
Carol E. Lewis ..... Marketing Alaska's agricultural and processed seafood products
Charlie Knight ..... Alternative crops for the subarctic
Don Carling ..... Evaluation of production practices, cultivars, and some diseases of potato and vegetables
Pat Holloway ..... Horticulture crop production for AK
Joshua Greenberg ..... Regional economic modeling for rural AK
Jay McKendrick ..... Long–term responses to tundra revegetation experiments, Arctic, AK
James Walworth ..... Nutrient management in bioremediation of petroleum contaminated soils

Hatch Regional; USDA

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

McIntire–Stennis; USDA

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

Achievements, activities, news

AFES–SALRM long–timers

The following employees received awards through the Employee Longevity Recognition Program:

25 Years: Peter Scorup, Carolyne L. Wallace

15 Years: Larry Burke, Roy Erickson, James Levison

10 Years: Phyllis Adams, Tim Evers

5 Years: Cynthia Mason

Four AFES long–timers retire

Dr. Alan Jubenville

AFES photo

Dr. Alan Jubenville was SALRM's Professor of Outdoor Recreation Management for the last 21 years. His recent research has focused on recreational usage trends along the Gulkana River.

Jubenville's booming laugh, heard echoing down the halls of the O'Neill Building, will be missed. In the future, you will most likely find him on a hunting or fishing expedition, enjoying life and the great outdoors.

photo by Dave Verbyla

Dr. Jay McKendrick

AFES photo

Since joining the faculty of Palmer's Research Center in 1972, Dr. Jay McKendrick has had an impact on the management and development of Alaska's natural resources. His mission–oriented research has established him as a leader in arctic region reclamation of disturbed and contaminated sites. McKendrick assisted both industry and regulatory agencies. He was also an important teaching link in the Natural Resources Management degree program. He was conferred with the degree of Professor Emeritus and will split his retirement time between Idaho and Alaska where he will continue his work in the arctic.

Peter C. Scorup

Arriving in Palmer in 1972, Peter Scorup began a career with AFES using his expertise in mapping and aerial photo interpretation. He teamed up with Dr. Jay McKendrick in 1985 to work on the North Slope providing technical support on projects involving Arctic revegetation.

Scorup has started his own business, Northern Native Seeds, which provides seed for tests and applications in oil field revegetation. He is also working on an Alaska Science and Technology Foundation project to evaluate potential use of a native alkali grass that has shown possibilities for revegetation lands at airports.

Patricia Wagner

AFES photo

For 20 years, Pat Wagner has poured over catalogs, planted, cared for and worried over thousands of plants, given speeches, taught classes, mixed tons of soil, waged war with aphids, fixed leaky hoses, and trained hundreds of volunteers and students at the AFES Georgeson Botanical Garden.

Wagner will pursue her talents in pottery after retirement, an activity she has enjoyed for several years. Her garden expertise will be sorely missed.

1998 SALRM graduates

Congratulations to the 1998 School of Agriculture and Land Resources Management graduates:

Ph.D.: T. Scott Rupp

Masters of Science: Leslie C. Adams, Jonathan H. Andrews, Ardella Follmann, David W. Fluetsch, Sergei Ivanov, George H. Plumley, Daniel C. Rees, James Rossler, and Susan A. Willstrud

Bachelor of Science: Brian Charlton, Dwight Douglas Adkins, Tommy Baxter, Rodlyn Marie Bundy, Jennifer A. Cabbage, Jennifer Henderson, Janel Hermann, Shawn C. Holcomb, Erik M. Johnson, Joseph A. Korpusik, Terri Jo Lomax, Julia Long, Mihail V. Mihailov, Amy J. Morowski, Sharon Nagel, Anthony L. Payne, Eric P. Peterson, Rochelle L. Piqors, Emily M. Schutte, Jerry Soplanda, Rhonda M. Swor, Nichole K. Thibodeau, and Jennifer M. White

After a hard days work, a nap is just the thing. These pigs, at the Fairbanks Agricultural and Forestry Experiment Station, are taking a well earned rest after digging a hole big enough for all three of them.