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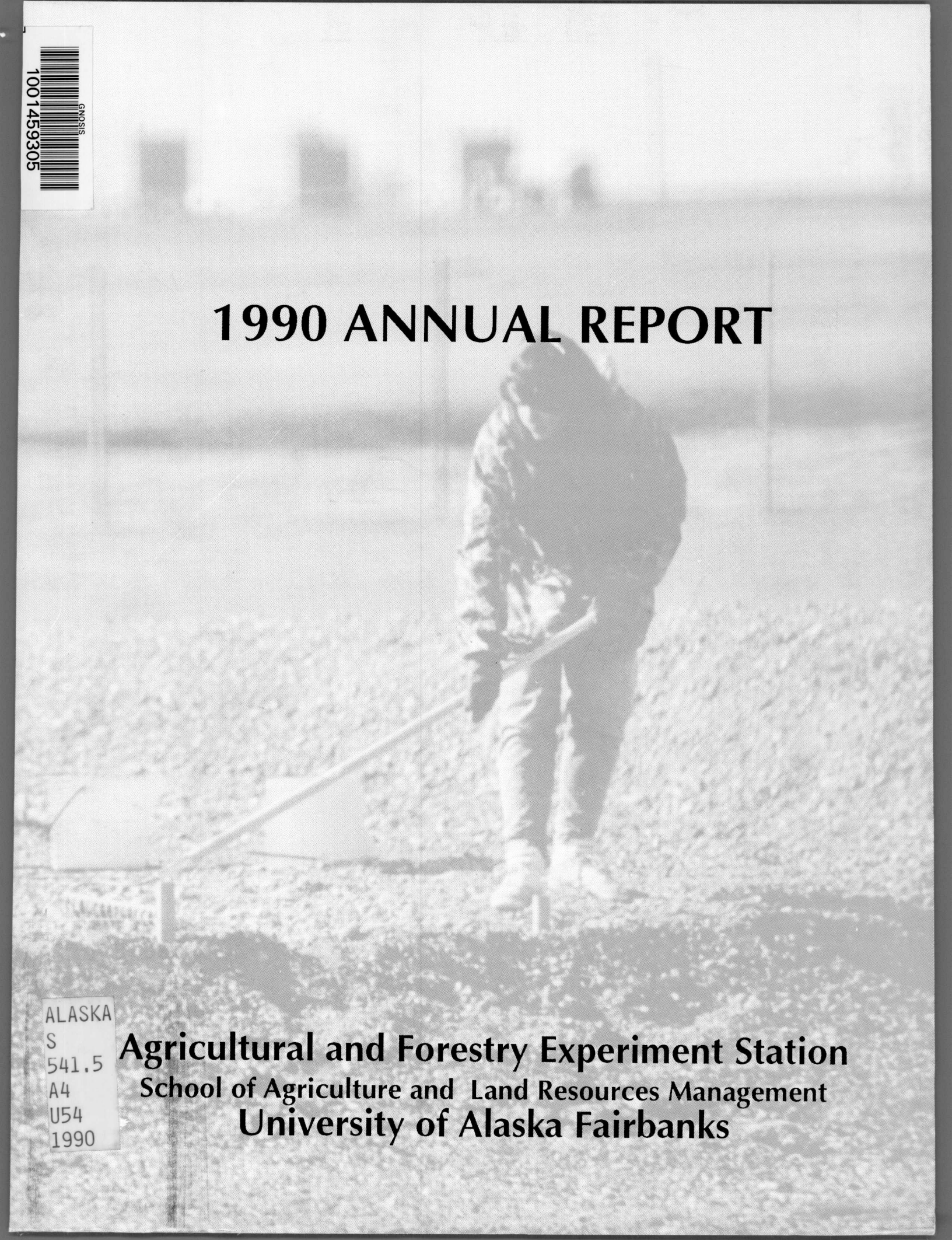

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Agricultural and Forestry Experiment Station

School of Agriculture and Land Resources Management

University of Alaska Fairbanks

Cover: Technicians plant test plots on a Prudhoe Bay gravel pad formerly used for an exploratory oil well. This is part of Dr. Jay D. McKendrick's long-term research project (1989 -1999) to test native plants for revegetation and seed production possibilities in the Alaska Arctic.

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Agricultural and Forestry Experiment Station

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ANNUAL REPORT

For the year ending December 31, 1990

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Misc. Pub. 91-1

Fairbanks, Alaska 99775-0080

June 1991

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Letter of Transmittal

The Honorable Walter J. Hickel
Governor of Alaska
Juneau, Alaska 99811

Dear Sir:

I submit herewith the annual report of the Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks, for the period ending December 31, 1990. This is done in accordance with an act of the 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,

James V. Drew

James V. Drew
Director

Fairbanks, Alaska
June 30, 1991

Statement of Purpose

This report summarizes research progress at the Alaska Agricultural and Forestry Experiment Station (AFES). Our research projects are designed to provide results useful for the development and conservation of land resources in Alaska.

Specifically, the AFES research objectives are to provide new information to:

1. provide a base of research information for the management of renewable resources of high latitudes; and
2. provide technology for enhancing the economic well-being and quality of life at high latitudes.

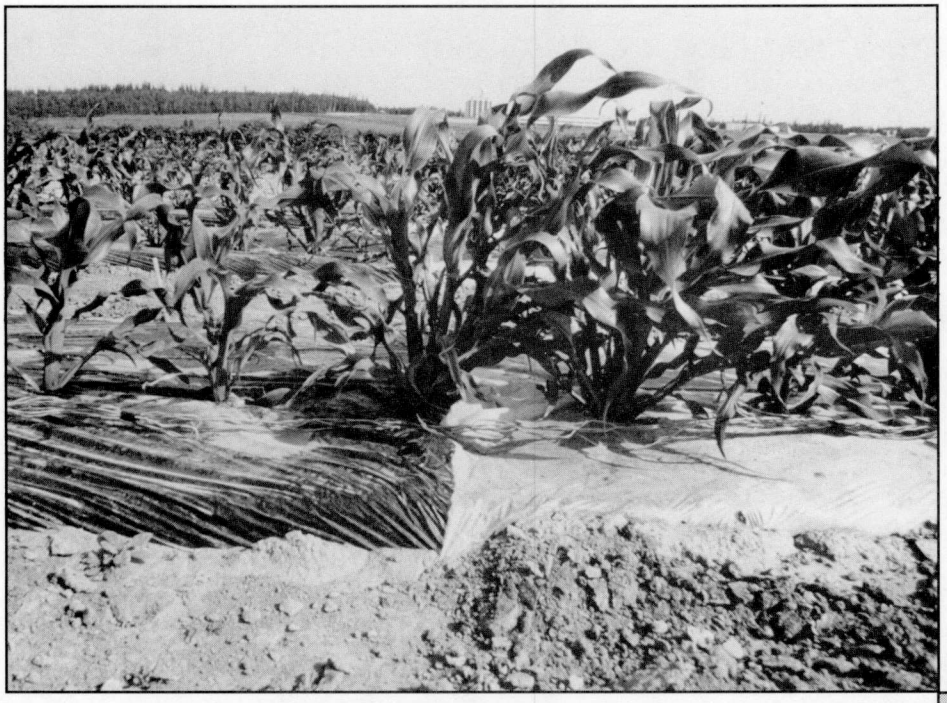
Foresters, farmers, and land managers use AFES research results. All Alaskans directly benefit from the wise use of land resources.

In identifying local Alaskan research needs, experiment station scientists regularly meet with land managers, foresters, and farmers from throughout the state to discuss specific needs and problems. Our researchers also work directly with producers through farm forums, agricultural field days, greenhouse workshops, vegetable conferences, reindeer herder workshops, and forestry workshops. Through these direct public contacts they discover additional research needs. In addition, experiment station scientists work with Cooperative Extension Service personnel who have day-to-day contact with land managers, foresters, and farmers. Agency managers and staff share their research needs with members of the AFES faculty and staff. Several experiment station scientists also serve on advisory panels for land and resource management agencies.

Because of these contacts, most of our research projects described in the plant and animal sciences section of this report were in response to producer requests. Research projects in the forest sciences and resources management sections were developed at the request of industry or state and federal agencies for information to address specific needs.

Research completed at AFES is published in scientific journals as well as experiment station bulletins, circulars, conference proceedings, books, and the station's own journal, *Agroborealis*. Experiment station scientists disseminate their findings through conferences, professional journals, workshops, and other public information programs. Subjects range from greenhouse operations to potato production, from reindeer herding to forest productivity, and from mine soil reclamation to the management of outdoor recreation.

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 direct linkage between research and teaching in forestry, agriculture and natural resources. Scientists who conduct research at the experiment station also teach, sharing their expertise with both undergraduate and graduate students.



Alaskans regularly use plastic sheets to warm the soil for warm weather crops such as corn. During the summer of 1990, AFES researchers tested a new type of plastic to retain heat. They had dramatic results when compared to the dark plastic commonly used by area gardeners.

Plant and Animal Sciences

Management of Alaskan beef cattle to maximize forage use

L.B. Bruce

The major objectives of this study are:

1. to maximize use of Alaskan forage, especially brome, for beef cattle through alternative management techniques; and
2. to manage Alaskan beef cattle on a fall-calving scheme and compare animal survival, health, and the economic considerations of labor and feed costs, with traditional spring-calving methods.

Currently the beef cattle (Angus x Hereford) at Palmer are bred in April and May to calve in late February and March. Through the winter, until calving, theses cows are often limit fed because of their efficient usage of feedstuffs. Cows are at midpoint in lactation (less nutrient demanding than earlier in the cycle) when they are placed on pasture in June. In September, calves are then weaned, placed in a feedlot, fed on usually a high-grain diet, and are ready for slaughter in May or June of the following year. After coming off pasture cows that are not pregnant are culled. Pregnant cows are maintained through the winter on harvested forages in large pens. In this study the herd will be shifted to a fall-calving scheme (breeding in November and calving in August). This will enhance the usage of forage and provide baseline data for Alaskan and northern latitude cattle producers. Fall-calving cows will begin their maximum lactation (requiring the most energy) in August when they are in excellent condition from being on pasture. Calves will be weaned before going to pasture and have the duration of the summer to graze. They will be placed in the feedlot and ready for slaughter in November or December. This will save considerably on the cost of grain because much more of the gain-to-slaughter weight will have been made on pasture.

Potato yield trials

D.E. Carling

Forty-five named cultivars and numbered selections of potatoes were evaluated under irrigated and non-irrigated conditions at the Matanuska Farm near Palmer in 1990. The 1990 growing season was warm but very dry. Average yields in the irrigated trial were very high and were comparable to 1989 yields. Average yields in the non-irrigated trials however, were very low. The top yielding cultivar in the irrigated trial was Acadia Russet which produced 23.6 tons/a of US #1

tubers. Nine other varieties produced US #1 yields in excess of 20 tons/a, and the average US #1 yield of all varieties in the irrigated trial was 17.7 tons/a. Top total yield in the irrigated trial was achieved by Green Mountain with a yield of 29.5 tons/a. Russet-skinned varieties in general performed very well in the irrigated trial. Extreme drought stress in July severely limited yields in the non-irrigated trials. Average yield of all varieties was 5.9 tons/a, approximately one third of the yield in the irrigated trials. The top yielding variety in the non-irrigated trial was Kennebec, with 9.9 tons/a of US #1, followed closely by Alpha, Katahdin, and Green Mountain. Specific gravity was unusually high in all varieties in the non-irrigated trial, indicating that severe drought stress promotes accumulation of dry matter in the potato tubers.

Effect of residual and applied nitrogen on yields of head lettuce

D.E. Carling, J.L. Walworth, C.L. Ping

In a repeat of a study conducted in 1988 and 1989, residual levels of soil N were established by applying 0, 50, 150 or 250 lbs/a N as ammonium nitrate to field plots in the summer of 1989. Plots were fallowed in 1989. In the spring of 1990, these plots were split and 0, 25, 50 or 100 lbs/a N was applied. Head lettuce (var. *Salinas*) was transplanted onto these 16 plots shortly after application of fertilizer in the spring. As was the case in the two previous years, high rates of residual N had a stunting effect on the lettuce transplants early in the season, and leaves of these plants were observed to be thicker and more rigid. Weights of mature heads harvested from the 0 lbs/a residual N plots increased as the rate of spring-applied N increased. However, as the level of residual N increased, average head weight decreased regardless of the level of spring-applied N. The harvest data again compared very closely with the data of the previous two years, and indicates that high levels of residual N in the soil have a negative effect on the growth and yield of head lettuce. Growers should probably avoid planting head lettuce in fields where tests detect more than 25 ppm N in the surface nine inches of soil.

Evaluation of foreign potato varieties

D.E. Carling

Single plots of 32 potato varieties developed in the Soviet Union and one variety each from the Netherlands, Scotland, and Finland, were grown in a non-irrigated observational trial in 1990. Due to the dry conditions, none of the varieties yielded well. However, five Soviet varieties: 'Caulin Alto', 'Kutri Jeevan', 'Isla Caucahua', 'Kameraz', and 'Chilac Ancyd' will be included along with 40 North American varieties in the 1991 yield trial at Palmer. The remaining 30 foreign varieties, along with 16 other varieties newly acquired from the Soviet Union, will be studied in observational trials again in 1991.

Chemical weed control in potatoes

D.E. Carling, J.S. Conn

In a repeat of an experiment conducted in 1989, five chemical weed control treatments including: EPTC, metribuzin (post-plant and pre-emergent) and linuron (post-plant and pre-emergent); plus a hand weeded and non-weeded control, were evaluated on four varieties of potato (Bake-King, Green Mountain, Shepody, and Superior) in southcentral and interior Alaska in 1990. Competition from weeds in the southcentral plots near Palmer reduced yields by nearly 40% in the non-weeded controls compared to the highest yield in chemically treated plots. Best yields were achieved in plots treated with metribuzin just prior to plant emergence (pre-emergent). Pre-emergent application of linuron and post-plant application of metribuzin resulted in significantly lower yields, followed by lower yields in plots treated with EPTC or linuron as a post-plant treatment. There was no significant interaction between weed control treatment and variety at either Palmer or Fairbanks. Competition from weeds in the Fairbanks plots was insignificant and did not cause any alteration in yields. The most commonly observed weeds in the Palmer plots included chickweed, common lambsquarter, shepherds purse and corn spurry. Either metribuzin or linuron appears to be capable of effective weed control when applied just prior to emergence of the potato plants. Field observations indicate moist soil enhances the effect of these herbicides.

Effect of hilling on yield in potatoes

D.E. Carling

In 1988 and 1989, four cultivars of potato (Bake-King, Green Mountain, Kennebec and Superior) were subjected to five hilling treatments (no hilling, shallow early, deep early, shallow late and deep late) in field trials at the AFES farm near Palmer. The experiment was repeated in 1990. Early hilling was done as soon as permitted by plant size, and late hilling was done approximately four weeks later. In 1990 there was less difference among treatments than in previous years, but all hilling treatments again produced higher yields of US #1 tubers than the no hill treatment. Gradeout percentages tended to be higher in the late hill and no hill treatments, and these higher percentages consisted mostly of green tubers. Varieties such as Bake-King tended not to turn green under any hilling treatments while Superior, Kennebec, and Green Mountain turned green to a much greater extent when hilling was done late or not at all. This experiment has been conducted for the past three season's under unusually warm field conditions. It will be repeated one more year, in the hope that 1991 will provide a cool season for comparison.

The effect of monocropping on rhizoctonia diseases of potato

D.E. Carling

Plots have been monocropped to potato, carrot, barley, bluegrass or no crop (fallow) since 1984 and monitored for changes in the population of *Rhizoctonia solani* AG-3. Populations of *R. solani* AG-3 were observed to decline and essentially drop below detectable levels over a 3-4 year period. In 1990, each plot was planted to potato (fungus-free seed). Plants were observed at the end of the season for evidence of Rhizoctonia disease. Few symptoms and signs of Rhizoctonia disease were present on potato plants growing on plots formerly fallowed or cropped to bluegrass or carrot. However, disease symptoms were common on potato plants growing in the plot monocropped to barley or potatoes. It was unexpected to see evidence of Rhizoctonia disease of potato in the barley plot since soil populations of R. solani had been so low. An explanation for this observation is not obvious at this time. This experiment will be repeated again in 1991.

Plant breeding

S. Doﬁng

The major areas of emphasis of the plant breeding program are barley cultivar development and basic studies in breeding and genetics. The goals of this research are to develop early-maturing, high-yielding cultivars adapted to Alaska, and to contribute to the understanding of breeding methodologies, genetics, and phenological development important to north latitude adaptation. In 1990, approximately 400 barley accessions, primarily from north-latitude areas, were evaluated for basic adaptation to Alaska in order to identify elite parental germplasm. In addition, segregating families and experimental lines were evaluated to select germplasm which will be advanced to the next level of testing in the breeding program. Several F_4 families demonstrated both early maturity and short plant stature. Approximately 2,000 head selections were made in these families for headrow evaluation in 1991. From tests in Alaska, Canada, and Finland, experimental line 'AK77II-69-63-3-1' showed superior resistance to lodging compared to 'Otal ', but it was slightly later maturing. Basic studies in plant breeding and genetics continue to supply valuable information which increases the efficiency of the plant breeding program. In one study, genotype x environment interaction of north-latitude and midwestern barley cultivars was assessed. Other studies estimated genetic variation for rate of grain fill, synchrony of tiller development as influenced by rate of seeding, and the influence of genes conditioning maturity on plant growth and development. Long-term breeding work, which attempts to develop near-isogenic lines differing in tillering ability, continues.

Use of on-site mycorrhizal inoculum for plant establishment on abandoned mined lands

D.J. Helm

Natural establishment of woody plant species may be slow at northern latitudes on dry, nutrient-poor soils of abandoned mined lands. Mycorrhizae and soil microorganisms needed for nutrient cycling were removed during the mining process. Mycorrhizae are symbioses (positive relationships) between fungi and plant roots in which the fungus assists the plant in nutrient and moisture absorption from the soil. The plant, in turn, provides the fungus with an energy source (carbon). Mycorrhizae occur on most plant species but the degree of dependency

varies with plant species and environmental conditions. Plant roots on disturbed sites generally are deficient in mycorrhizae. Several experiments were conducted near Jonesville in southcentral Alaska to evaluate soil transfer as an inexpensive source of mycorrhizal fungal propagules, which include plant roots, fungal hyphae, and spores. Soils from adjacent undisturbed vegetation communities were incorporated into the rooting zone of woody cuttings and seedlings on mine soils. Balsam poplar (*Populus balsamifera*) was selected as the primary target species for inoculation because it occurred naturally on the disturbed site. Soil transfer was effective in increasing growth of poplar cuttings when combined with fertilization. However, the successional stage of the vegetation community serving as the source for the soil transfer also affected the growth response. Growth of some target plant species, such as alder (*Alnus crispa*), were increased even more. Results of another experiment indicated that at least two treatments (microsites, fertilizer, soil transfer) were needed to improve growth of poplar cuttings planted on a steep slope. These studies were funded by the U.S. Bureau of Mines Abandoned Mined Land Program.

Usibelli vegetation studies

D.J. Helm

Coal mine operators are required to inventory vegetation and other natural resources prior to mining and then to reclaim the land to the desired post-mining land use. A pre-mining vegetation inventory of the Hoseanna Creek Basin area was begun in 1989 and continued in 1990. The objective of the study is to characterize existing vegetation in the area to facilitate reclamation planning. Parameters being measured include vegetation cover, woody species density, heights, and ages. Cover data are being sampled to the degree of precision required by state and federal guidelines. Plant species diversity is calculated from the cover data. Data will be synthesized with respect to slope, aspect, and disturbance history. To date, over 20 vegetation communities have been identified according to overstory and understory. The most common plant communities include white spruce (*Picea glauca*) forest, paper birch (*Betula papyrifera*) forest, mix of paper birch-white spruce forest, and resin birch (*Betula glandulosa*)-ericaceous shrub land. Black spruce (*Picea mariana*) forests are common on permafrost on north-facing slopes. This study is funded by Usibelli Coal Mine, Inc.

Reestablishment of woody browse species for mined land reclamation

D.J. Helm

Objectives of reclamation projects vary on different parts of a disturbed site. Specific objectives may include slope stabilization, wildlife habitat development, and plant species diversity. Achievement of these goals depends on careful selection of appropriate plant species and consideration of the biological, chemical, and physical properties of the soils. Important biological properties of soils include mycorrhizae and propagule banks (seeds, rhizomes, spores) of plants and fungi. To facilitate woody species establishment, soils from native communities were tested as plant growth media for seven woody species, including four species of *Salicaceae* (willows), two species of *Betulaceae* (birches), and one coniferous tree species (white spruce). The three native soils were selected from one forest community and two meadow communities chosen for their potential mycorrhizal fungal and plant propagules. Overburden was used as the control and was assumed to have little biological activity. Best growth at the end of two years was attained by members of the willow family. Plant growth was significantly greater on some soils compared to others. Numerous plant species colonized from the propagule banks. Woody plants appeared to grow better where natural regeneration was greater. Grass mixes were evaluated for their ability to reduce erosion, suppress undesirable native plant species, increase plant community diversity, and reduce competition with outplanted woody plants. Efficient use can be made of the natural vegetation and soil resources on mined lands if these are identified in advance and incorporated into the mine plan. These studies were funded by the Alaska Science and Technology Foundation and Idemitsu Alaska, Inc.

Effect of different planting techniques on rooting structure and growth of alder for mined land reclamation

D.J. Helm

Goals of mined land reclamation include soil stabilization and establishment of self-reproducing plant communities. Rooting structure is important for soil stabilization. However, the degree of branching and mycorrhizal relationships may depend on whether alder is established on the site from seed, seedlings grown in a greenhouse, or seedlings transplanted from local vegetation. The source of soil transferred to the rooting zone may also affect the amount of nodule formation for nitrogen fixation and the amount of mycorrhizal formation for nutrient absorption and soil aggregation. Seeds, greenhouse seedlings, and local transplanted seedlings were outplanted in late June on overburden with no additional soil or with soils from a paper birch (*Betula papyrifera*)-white spruce (*Picea glauca*) community with alder (*Alnus crispa*) understory or from a black spruce (*Picea mariana*) community with ericaceous shrub understory. Growth was sometimes improved with the soil from the birch-spruce community. None of the alder seeds germinated in the field. Roots of the alders grown in the greenhouse then outplanted in the field visually appeared better developed than those from local transplants. The difference, however, was not statistically significant. Nodulation was increased with use of soil from the birch-spruce community. No apparent benefits were gained by using soil from the black spruce community compared with results from overburden alone. This study was funded by the Alaska Division of Agriculture and Usibelli Coal Mine, Inc.

Propagation of *Polystichum aleuticum*, Aleutian shield-fern, by spores

P.S. Holloway, P.J. Wagner, G.E.M. Matheke

Spores of the endangered Aleutian shield-fern, *Polystichum aleuticum*, were collected in 1989 and 1990 and germinated on three nutrient agar and one peat/sand (2:1, v:v) media. Germination was most successful on the peat/sand mix but more rapid on the Knop's and Hoagland's agar-based media. In 1990, spores were sown on Hoagland's solution that contained 0, 2,4, 6, or 8 g/l agar. Spores germinated on all treatments, but development was slower by 2-3 weeks on the 6 and 8 g/l treatments. Sporophytes on the 0 and 2 g/l treatments showed significant leaf browning. On-going experiments include optimum light, pH, and temperature for spore germination.

Cultivar trials at the Georgeson Botanical Garden

P.S. Holloway, P.J. Wagner, G.E.M. Matheke

Cultivar trials were conducted with 250 annual flowers and 175 vegetable crops from commercially available and experimental sources. These plants were grown in the Georgeson Botanical Garden where newly-released cultivars were compared with those that had performed well during the last nine years. The vegetable trials included a collection of *Allium* species and cultivars from Novosibirsk, Siberian USSR. Evaluation of ornamentals begun in 1981, continued with extensive renovation and relocation of planting beds and the addition of 63 new cultivars for long-term evaluation including 66 herbaceous perennials, 18 woody ornamentals, and 20 ornamental grasses. A germplasm exchange program was initiated between AFES and two research programs in the USSR: VASKhNIL-Novosibirsk and the Lisavenko Research Institute, Barnaul. More than 250 seeds and plants of vegetables, fruits, trees, shrubs, herbaceous perennials, and herbs were collected or donated from research programs and from native stands in Siberia. They will be evaluated for hardiness and commercial potential in the Georgeson Botanical Garden.

Yield of 'Quinault' everbearing strawberries using polyethylene mulches and row covers

G.E.M. Matheke, P.J. Wagner, P.S. Holloway

Yields of 'Quinault' everbearing strawberries were compared during three seasons for plants grown under eight different mulch treatments with or without polyethylene row covers. In 1987, yields using clear polyethylene mulch with or without row covers (3.81 kg/m^2 and 3.45 kg/m^2, respectively) were significantly greater than all other mulch treatments. Yields ranged from 1.05 kg/m^2 to 2.60 kg/m^2 for black polyethylene; black over white two-sided, embossed polyethylene; black latex liquid; permeable landscape fabric; white over black two-sided, embossed polyethylene mulch, all with row covers or the unmulched control plot without a row cover. During the second year, yields using clear polyethylene mulch were significantly greater than all treatments except for black polyethylene (5.32 kg/m^2 and 4.74 kg/m^2, respectively). Yields

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for the other mulch treatments ranged from 3.55 kg/m^2 to 3.85 kg/m^2. The summer of 1988 was warmer than average which may account for the improved performance of the black polyethylene mulch. In 1989 results were similar to 1987 in which the clear polyethylene mulch had significantly higher yields (5.66 kg/m^2) than all other mulches (2.12 - 4.31 kg/m^2). Clear polyethylene mulch with or without row covers is recommended for everbearing strawberry production in Alaska.

Alaskan marine by-products in all-barley starter pig diets

F.M. Husby

Two studies were completed to determine the feeding value of two Alaskan marine by-products (black cod meal and salmon head protein hydrolysate) in approximately 50% all-barley early weaned pig diets. In both studies, pigs were weaned at 28 days and placed on test diets containing 20% CP, 1.15% lysine, and vitamins and minerals to meet NRC (1988) requirements. All diets contained 20% dried whey and were equalized to contain 4% dietary fat. The first study was conducted to compare protein and energy sources: soybean meal plus corn oil, extruded soybeans, canola meal plus seed, black cod meal, and soybean meal plus beef tallow. After four weeks, pigs fed black cod meal had improved feed intake and improved gains (1.08 vs 0.9 lb/day) over the other diets and a reduced feed intake for pigs fed canola meal plus seed. Efficiency of gain (1.7 lb feed/lb gain) was the same for all five diet treatments. In the second study salmon head protein hydrolysate replaced dietary soybean meal at 0, 5, 10, and 17.6% (total replacement). Hydrolysate (55% CP, 27% EE and 8% ash) was produced by low heat and screened to reduce ash. The daily gain of pigs fed the 17.6% diet were reduced (.7 vs .9 lb/day) compared to the control and other treatment diets, respectively. Although not significant, there was a tendency for the daily intake to be reduced for the 17.6% diet compared to the other diets (1.4 vs 1.6 lb/day), respectively. Similar results were reported earlier at this station for salmon meal. Salmon heads or meals may have some inherent nutrient or chemical characteristics that limits their utilization as the total replacement for soybean meal in starter pig diets.

Control of flower initiation in primrose by temperature and day length

M.G. Karlsson, J.T. Hanscom

Low temperature requirements for development (13-16°C) make primrose (*Primula vulgaris*) suitable for greenhouse production in high latitude areas. Primrose flower initiation has been scheduled and controlled by 6 weeks at 7-10°C. Recently, flower formation has been observed to occur without a cold treatment and cultural recommendations often call for the decrease in temperature after flower initiation has already taken place. The temperature below 10°C may break dormancy in the formed flower buds or may only delay development. The morphological changes and the efficiency of photoperiod, irradiance, and temperature on the primrose flower formation process are determined in this study. Flower initiation in primrose 'Dania Lemon Yellow' was studied under day lengths of 8, 11 or 14 hours, and temperatures of 8°, 12°, 16° or 20°C. Instantaneous light levels were 350, 300 or 250 $\mu mol \cdot m^{-2}s^{-1}$ to give the same total amount of light per day (10 $mol \cdot m^{-2}day^{-1}$) independent of day length. Temperature during early seedling development was maintained at 16°C. The seedlings were transplanted 30 days after sowing into 10 cm pots and placed under one of the selected photoperiod and temperature environments. The transition of the apical meristem to a reproductive stage was determined using scanning electron microscopy. After transplanting, 30 to 50 days were required before a transition of the meristem could be observed in plants grown at the different day lengths and temperatures. Flower initiation was detected earlier in plants grown under long days (14 hours) compared to 11 or 8 hours day length. Temperatures of 12° or 16°C resulted in an earlier noticeable change in the apical meristem than 8° or 20°C.

Growth regulator effects in seed-propagated tuberous begonia

M.G. Karlsson, J.W. Werner

Many growth regulator recommendations for the seed-propagated tuberous begonia (*Begonia x tuberhybrida*) are based on research with *Begonia x hiemalis* (hiemalis begonia, Rieger begonia or elatior begonia). Despite the large production, the effects of commonly available growth regulators on developmental growth and post-harvest performance have not been determined for the seed propagated or "NonStop" type cultivars of tuberous begonia. Chlormequat (Cycocel®), daminozide (B-Nine®), paclobutrazol (Bonzi®) and triadimefon (Bayleton 25WP®) were applied as a foliar spray treatment to plants of *B. x tuberhybrida* `Musical Orange' and `Clips Orange'. The plants were grown at 20°±2°C day and 18°±2°C night temperature, and a day length of 16 hours at 100 $\mu mol \cdot m^{-2}s^{-1}$ (5.8 $mol \cdot m^{-2}day^{-1}$). Seedlings were transplanted six weeks after seeding and the plants were treated two weeks after transplanting at application rates of 500 or 1,000 mg • $liter^{-1}$ chlormequat, 2,000 or 3,000 mg • $liter^{-1}$ daminozide, 5 or 10 mg • $liter^{-1}$ paclobutrazol, and 375 or 750 mg • $liter^{-1}$ triadimefon. Seven weeks from time of application, plants treated with any rate of the tested growth regulators were shorter than the control plants. Begonias treated with paclobutrazol were on average ca. 70% shorter, chlormequat and triadimefon treated plants ca. 50% shorter and daminozide treated plants ca. 20% shorter compared to the height of the control plants.

Photoperiodic control of developmental growth in tuberous begonia

M.G. Karlsson, J.T. Hanscom, J. W. Werner

Cultural recommendations for seed-propagated tuberous begonia (*Begonia x tuberhybrida*) production stress the importance of maintaining long days throughout the development to avoid plant dormancy and tuber formation. These recommendations are based on experience with the tuberous begonias propagated by tubers rather than seed. Cultivars of seed-propagated tuberous begonia (the "NonStop" cultivars) are primarily produced today and may respond differently to photoperiod than the tuber propagated types. The sensitivity at different stages of plant development to environmental factors causing undesired growth and tuber formation needs to be determined for the seed propagated tuberous begonia. Plants of seed-propagated tuberous begonia `NonStop Orange', `Clips Orange' and `Musical Orange' were exposed to 1, 2, 3 or 4 weeks of short days initiated at four stages of plant development (immediately upon germination, 5 weeks after germination, 10 weeks after germination and 15 weeks after germination). Prior to and succeeding short days, plants were exposed to a day length of 16 hours at 100 $\mu mol \cdot m^{-2}s^{-1}$. Short days were 9 hours at an irradiance level of 180 $\mu mol \cdot m^{-2}s^{-1}$ to give the same total daily irradiance (5.8 $mol \cdot m^{-2}day^{-1}$) as under long day conditions. The temperature was maintained at 21° ± 4°C during the day and 18° ± 2°C during night. One to four weeks of short days did not affect the appearance or morphology of the studied cultivars. First flower color under continuous long days was observed 67-68 days from seeding for Musical plants, 80 days from seeding for Clips plants and 84-85 days from seeding for NonStop plants. Short day exposure during any stage of development delayed flowering in plants of Nonstop with about 5 days. Four weeks of short days during early development delayed flowering in plants of both Clips and Musical with about 10 days.

Planting dates and nitrogen fertilization rates for barley

C.W. Knight

High nitrogen (N) fertilization rates and/or late planting often cause delayed barley maturity resulting in late harvest, high grain moisture, and low test weight. This study was designed to evaluate the effects of five N-fertilization rates (12 to 136 kg N • ha^{-1}) and three planting dates (May 5 to June 15) on yield and maturity of 'Otal' barley planted near Delta Junction. Highest yields, highest protein content, and lowest grain moisture were all obtained on the earliest (May 9) planted grain. On early planted barley, maturity was only slightly delayed by increased N-fertilization rates. However, the effects of N delaying barley maturity were amplified on later (May 25 or June 15) planted barley. N-fertilization rate had little effect on barley test weight except in late planted barley where high N rates delayed maturity enough that it did not

mature before autumn frost. Future research will focus on phosphorous (P) fertilization rates in an attempt to identify a proper balance of N and P to achieve early, uniform ripening in barley.

Cold Tolerant Trichoderma

J.H. McBeath

The University of Alaska Fairbanks has applied for the U. S. patent for "Cold Tolerant Trichoderma." Cold Tolerant Trichoderma is a fungus that lives in the soil. As a biological seed treatment, it offers the opportunity to protect food plants from pathogenic organisms which live in the soil without using chemical products. The patent is based on biotechnology work by Dr. Jenifer Huang McBeath.

Gravel vegetation project

J.D. McKendrick

A number of gravel pads used for exploratory drilling have been abandoned on the Arctic Coastal Plain. As pads and roads used for oil and gas production are abandoned, there will be even a greater number of such structures in the region. Vegetating these features is being considered to satisfy permit stipulations. The question of how to vegetate those features and simultaneously provide suitable wildlife habitat prompted this study. Project objectives are to identify:

- arctic plant species adapted to colonizing gravel soils; and
- methods for improving the environment for plant communities on gravel pads.

Experimental variables are gravel thickness, minimum topsoil additions, tillage, and snow cover. The project time frame is 1989-1999.

The 1989 growing season was unusually warm and persisted longer than normal, which favored seed production. Mixtures of seed from 27 indigenous species collected during the 1989 field season were planted June, 1990. Rows of individual species were also planted in a portion of an abandoned gravel pad to develop a uniform garden in which phenology and seed production of these plants can be observed. Emergence of seeded grasses was better than for forbs and shrubs this first year. Samples of gravel from each treatment were collected for physical and chemical analyses. Seed from 60 species was collected during the 1990 field season. These collections have been threshed, cleaned and are being tested for germination prior to planting as cohort plots to those of the 1990 planting. During our second collection season we emphasized forbs and shrubs over grasses, which seemed to be dominating our first year plots. Seed production by legumes was abundant in 1990, possibly a carryover from the favorable 1989 growing conditions. Strong winds persisted for nearly two weeks as seeds were maturing during the 1990 field season. That increased harvesting difficulty and shattered much of the 1990 seed crop before we could collect it. The 1991 field activities, in addition to planting and collecting seeds of native plants, includes sampling gravel and vegetation on four NPR-A (National Petroleum Reserve in Alaska) drilling pads. These sites were examined in 1984. The 1991 study is designed to document colonization by plant species since 1984 and to obtain baseline data on gravel conditions with respect to plant colonization at these exploratory drilling sites.

Evaluation of annual and perennial forage legume species

M.T. Panciera, S.D. Sparrow, R.G. Gavlak, W.E. Larson

Fourteen legume species (one variety of each species) were evaluated at Fairbanks, Delta Junction, Soldotna, and Point MacKenzie. Persistence of perennial species will be evaluated in 1991. Forage samples were collected and analyzed for *in vitro* dry matter digestibility (IVDMD), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and minerals (P, K, Ca, Mg). Rainfall was below normal at Point MacKenzie and Delta Junction and above normal at Fairbanks. Field peas were among the highest yielding species at all four locations (4.5 to 7.8 mg DM/ha). Faba beans produced high yields at all locations except Point MacKenzie (2.9 to 8.3 mg DM/ha). Red and alsike clovers performed well at Fairbanks. Moisture and soil pH likely limited growth at the other three locations. Winter survival was evaluated for perennial legumes planted in 1989. Fairbanks and Point MacKenzie both had good snow

cover during the 1989-1990 winter and survival was very good. As expected, varieties of red clover and alfalfa of northern origin survived best. Alaskland (AK), and Altaswede (Canada) red clover, Denali (AK) and Peace (Canada) alfalfa, and both alsike clovers had good stands in the spring of 1990. Many non-adapted varieties of red clover, white clover, and birdsfoot trefoil were also evaluated. The insulating effects of snow cover were evident as varieties from as far south as Florida and Louisiana survived, though stands did not compare favorably to the northern adapted varieties. Future plans include continued screening of forage legume species and management trials with species and varieties that have potential for Alaska livestock production systems.

Management of fodder rape

M.T. Panciera,
R.G. Gavlak,
B.A. Tillman

Fodder rape and brassica hybrids (*Brassica napus, B. rapa* X *B. oleracea* and *B. rapa* X *B. pekinensis*) are high yielding, high quality forage crops that are well adapted to Alaska. Studies were conducted at the Matanuska Farm and Point MacKenzie to determine appropriate seeding rates and nitrogen (N) and phosphorus (P) fertilizer inputs for two varieties. 'Winfred' and 'Tyfon' were the two varieties studied. Seeding rates were 1.6, 3.2, 4.8, and 6.4 kg/ha. Responses were similar to 1989. Seeding rates affected yields at 47 days after planting, but the effects were not evident 75 and 103 days after planting. Average yields of Winfred (6431 kg/ha) were greater than Tyfon (4470 kg/ha) in these studies. Dry matter yields were lower than those observed in 1989 due to the lack of rainfall at the experimental sites. Nitrogen and P rates influenced the yield of both varieties. Nitrogen was applied at 0, 100, and 200 kg N/ha, and P was applied at 0, 50, and 100 kg P_2O_5/ha. Maximum yields were lower than those observed in 1989 (8.6 vs. 13.1 mg DM/ha) due to the low rainfall in 1990. Responses were similar for the two years. High N rates were required for high yields at both locations and applied P increased the yields of both varieties at Point MacKenzie. Nitrate analyses for 1989 samples indicated a high potential for nitrate accumulation, particularly for Winfred. Nitrate -N concentrations as high as 12,500 mg/kg were observed when extremely high rates of N were applied.

Responses of annual ryegrass varieties to applied N

M.T. Panciera,
R.G. Gavlak,
B.A. Tillman

Annual ryegrass is adapted to southcentral Alaska, but the effects of N rates on yield and quality have not been defined. Four varieties of annual ryegrass (*Lolium multiflorum* and *L. multiflorum* X *L. perenne*) were planted in 1989 and 1990 (Palmer and Matanuska Farm, respectively). Ammonium nitrate was applied at four rates: 0, 56, 112, and 224 kg N/ha. Dry matter yields averaged 3 Mg/ha in 1990 (vs. 6 Mg/ha in 1989). Yields increased as N rates increased in both years. 'Aubade' is a variety that produces many seed heads. Aubade yielded more than the three sparsely heading varieties, but forage quality was lower for Aubade. Forage nitrate levels were generally less than 3,000 mg/kg in the first cut and less than 500 mg/kg in second cut. Economic analysis of these results suggest that varieties and N rates should be selected to meet both yield and quality goals. Forage quality goals will depend on both the class of livestock being fed and the performance level that is desired for the animals.

Wetland properties of permafrost soils in Alaska

C.L. Ping,
J.P. Moore,
M.H. Clark

Permafrost soils in the subarctic regions of Alaska have been extensively influenced by recurring wildfire with a natural fire cycle of 50 to 200 years. The warmer permafrost in the subarctic zone is more sensitive to thermal changes. The permafrost may thaw below the control section or totally disappear after natural fire or mechanical disturbance because of loss of shading effect from the spruce forest and the loss of insulating effect of moss layer. The soil temperature regime may change from pergelic to cryic and the drainage class may change from poorly-drained to well-drained. Following the vegetation succession, the soils will cool and permafrost will reappear until another fire cycle. A thawed permafrost soil has low chroma mottles in the upper profile, thus it has the morphology of an aquic suborder. Yet the soil is often well drained and may no

longer support hydrophytic vegetation. When permafrost is within the control section, the active layer is usually saturated above the permafrost during summer, and has a temperature between 0 and 5°C which is below biological zero. Researchers in the arctic region, however, observed biological activity below this temperature. The validity of 5°C and growing seasons as hydric soil criteria is questionable in arctic and subarctic regions. To gather quantitative data on the duration and depth of saturation, and the redox potential of the active layer, a cooperative study on wet soil monitoring has been initiated.

Soil-geography in the Hoseanna/ Lignite Valley area

C.L. Ping

This is a two-year project funded by Usibelli Coal Mine, Inc., to establish soil resource baseline data in the 25,000-acre lease area east of Healy. The soil-landscape relationships were developed based on aerial photo interpretation supported by ground truth consisting of 60 soil pits, some auger holes, and road cut observations. Cryohemists are organic soils occurring on flat, poorly drained terrain, some north-facing slopes and broad valley bottoms. Most Cryaquepts have permafrost within control section and formed in deep loess deposit, lacustrine deposits, and broad north-facing slopes. Cryochrepts and Cryumbrepts are well to moderately well-drained soils formed in moderately deep loess deposits over outwash or sandstones on terraces and terrace breaks. Cryorthents and Cryopsamments are found on very steep slopes along canyon walls. Cryofluvents occur along stream terraces and drainage ways. Small areas of Cryorthods are found in sandy outwash deposits. In some areas, the soil-landscape relationships are complicated by fire history.

Humic substances in soil water

C.L. Ping, G.J. Michaelson, R.L. Malcolm

Soil humic substances interact with metal ions, metal oxides and hydroxides, chemical compounds such as pesticides, fertilizers, and inorganic components such as clays and salts. Thus soil humic substances are of great environmental significance in addition to soil fertility management and soil genesis and classification. The spodic horizon is a subsurface horizon of Spodosols, and is the accumulation zone of aluminum and iron-humus complexes. A preliminary study was conducted to determine the capacity of the spodic horizons to release humic substances. The spodic horizons of three tephra-derived Spodosols were sampled from Sukoi series (Baranof Island), Kachemak series (Kenai Peninsula) and Talkeetna series (Susitna Valley). Soil leachates were collected, filtered and the humic substances were fractioned by adsorbtion onto XAD-8 and XAD-4 resins. The humic substances in soil waters of the Sukoi and Kachemak series are dominated by fulvic acids with some low molecular acids. However, appreciable amounts of humic acids were found in the soil leachate of the Talkeetna series. Thus the apparent spodic horizon (Bhs) of Talkeetna series may be a buried A horizon. The isolated humic substances will be characterized in future studies.

The effects of rock phosphate fertilizer on timothy and bromegrass grown on volcanic tephra-derived soils

G.J. Michaelson C.L. Ping

Southcentral Alaska has extensive areas with tephra-derived soils. These soils being strongly acidic sorb high amounts of fertilizer applied phosphorus (P) and invariably test low in plant-available P even after years of P fertilization. Phosphorus soil test calibration studies and fertilizer trials for cereal forage production have been conducted on these soils. However, studies relating to the two most commonly grown annual forages timothy and bromegrass, have thus far been limited to only species and fertilizer rate response trials. A field study was initiated in 1988 to both investigate the response of timothy and bromegrass to rock phosphate applications and to provide interpretive information regarding the phosphorus soil test on these soils for the annual grasses. The study is for three years and includes forage yield, quality, and soil test monitoring of 384 individual plots located on tephra-derived soils at Montana Creek, Pt. MacKenzie, and Homer sites. Preliminary review of the data indicate that the less soluble rock phosphate is dissolving in all soils and that some fraction of the applied P is persisting in the available form. This dissolution

appears to be greatest at the more acidic Homer soil. The application of 100 lbs P_2O_5/acre increased stand establishment and production at all sites. Residual available P as a result of rock phosphate treatment was beneficial even with application of recommended rates of treblesuperphosphate. Mehlich 3 P soil tests correlated well with P treatment and indicated sampling depth to be of primary importance to test interpretation.

Surface charge characteristics of tephra-derived soils in southern Alaska

C.L. Ping,
G.J. Michaelson

Tephra-derived soils are extensive in southern Alaska. The exchange complexes of these soils are dominated by amorphous clays, mainly allophane/imogolite, which possess high variable charges as compared to soils containing layered silicates. Crops grown on soils high in variable charges respond poorly to applied phosphorus fertilizer due to the high P-fixing capacity of these soils. The object of this study is to gain a better understanding of the physiochemical properties of these soils in order to provide a more rational basis for fertility and engineering interpretations. Nine soils representing Cryohumods, Cryorthods, Melanocryands, Fulvucryands, Vitricryands, and Cryorthents were sampled according to genetic horizons. The cation and anion exchange capacities of these soil samples were measured by the modified compulsive exchange procedures of Gillman and Sumpter. The natural pH of these soils range from 4.1 to 4.9. The dark brown Bhs horizons of Cryohumods have the highest variable charge, followed by those of Fulvucryands; the Bhs and Bs horizons of Cryorthods, Melanocryands and Vitricryands have the lowest values. The Bw horizon of a Cryorthent showed measurable amount of variable charge indicating the admixture of tephra and loess in the parent material. Liming of these soils high in variable charge to enhance phosphorous availability may not be economic. Instead, by applying rock phosphate, the phosphorous availability and low soil pH can be improved.

Neonatal reindeer calf mortality on the Seward Peninsula, Alaska

C.L. Chetkiewicz,
L.A. Renecker

Reindeer (*Rangifer tarandus*) herding is currently practiced to harvest velvet antlers. Increasing demand for leaner, healthier meats and the potential for increased financial gains for Native herders, associated with diversification and sustainability, has shifted research focus to productivity and management of reindeer herds. Reindeer calf recruitment and survival is influenced by a variety of aspects including: nutrition of dam and calf, handling stress including abandonment and orphaning, predation, range conditions including insect levels, natural mortality, and genetic or congenital defects. In attempting to examine these aspects, focus was directed at following radio-collared calves for the summer of 1990 and attempting to determine cause of death. In addition, calves that were stressed and/or orphaned were subjected to treatments with probiotics in an attempt to assess weight gains and, ultimately, survival. Every May-June, reindeer are handled for commercial harvest of velvet antlers. During handling, cows and calves are separated to avoid severe trampling injuries and losses. Although a mothering-up pen is often used in an attempt to allow cow-calf pairs to re-associate, many calves may not be accepted by their mothers or the duration of their stay in the pen may not be of sufficient time to permit the calf to reform the bond with its mother. These animals are forced to consume a complete roughage diet but may not have the necessary microbial populations to digest it. Commercial cultures of *Lactobacillus acidophilus* have been used by the conventional livestock industry to improve health and performance of cattle by producing a more favorable balance of beneficial organisms. Reindeer populations on the Seward Peninsula currently number about 22,000 animals. Predation by bears (*Ursus arctos*) is purportedly intense on both neonate calves and adult reindeer. However, no firm data exist to support or refute this hypothesis. This will be examined in the summer of 1991 and 1992 to determine the extent on reindeer neonates and calves with implications for management of reindeer and grizzly bears. Of 61 reindeer fawns that were radio collared at the June handling in Nome (45 initially and then collars were refurbished and placed on additional

animals), deaths were attributed to predation and unknown causes that occurred throughout the summer. Assessment of probiotic effects was inconclusive due to inadequate weighing schedules. Assessment of handling stress is currently under investigation with blood cortisol analysis.

Computer based data management program for commercial reindeer and game farm production

D. Blodgett, A. Clark, L.A. Renecker, R. Dieterich, W. Thompson

A computer based data management system was developed over a 10 year period to manage production and research records of the commercial reindeer (*Rangifer tarandus*) industry on the Seward Peninsula. This program was designed to help researchers and reindeer herders make management decisions. The program has recently been modified to also meet the needs of the game farm industry. Modifications were made after consultation with several game farmers [wapiti (*Cervus elaphus*), reindeer, bison (*Bison bison*), musk-ox (*Ovibos moschatus*)] and analyzing their data needs as well as re-evaluating the needs of the reindeer industry. The new program prototype has flexibility, allowing users to adapt the program to meet their needs. The program can be used with a portable identification (ID) reader to capture the alphanumeric code of implanted electronic animal ID transponders directly into the computer. Another option has been added to connect an electronic scale to the computer and read animal weights directly into the software program. The program includes three subroutines: data entry, query, and report generation sections. The program was developed and compiled with dBase on a Toshiba portable computer. The optimal system including both the ID reader and electronic scale requires a computer with two serial ports and a hard disk. The complete system of computer, program, portable ID reader, scales, and all necessary connections provides for accurate, efficient and easy record-keeping, as well as quick information retrieval and reporting.

Sexual segregation and dispersal of reindeer (*Rangifer tarandus*) on the Seward Peninsula

C.L Chetkiewicz, L.A.. Renecker, W. Thompson, R. Dieterich

Sexual segregation is common among northern temperate ungulates and has been investigated for a number of species. From 1987-1990, radio collared reindeer (*Rangifer tarandus*) (bulls, cows, and steers) in the Nome region were located each month to monitor animal movements. Observations and radio-tracking data suggest male and female reindeer on the Seward Peninsula utilize different habitats during the summer and abandon segregation during rut in the autumn. In addition, it appears that this population has dispersed to utilize a larger range over the period of observation. We postulated that female reindeer are selecting habitats separate from males for a number of reasons:

1. female requirements for raising young and regaining condition for the winter are markedly different from males;
2. predator avoidance strategies in males, females, and females with young select for different habitat use; and
3. increasing numbers of animals and deterioration of range have created competition between males and females for various habitats.

Evaluation of the habitats utilized and the movement of radio-collared animals throughout the year will be assessed in an attempt to delineate the above hypotheses. This will have range management implications, as well as possibly suggest times of the year when animals should be herded and handled. These conclusions can be incorporated into herding strategies and a range management plan to increase herd productivity and financial returns.

Use of an implantable electronic identification system for reindeer herders

L.A. Renecker, W. Thompson

Currently, reindeer herds on the Seward Peninsula are identified by ear notches and color of plastic ear tags. Specific animals within a herd are distinguished by birth year and an unique number on the tag. This animal specific number is associated with detailed herd records compiled on a computer data base. However, tags are often ripped out of the animal's ear and as a result, all important management and production records are lost. For example, when an animal is slaughtered the blood is a valuable by-product but it must be tested for the presence of Brucellosis before it can be marketed. If the

ear tag and therefore the animal's record are lost and a positive titer was detected from this example animal then there would be no method of determining if it was a reaction to the vaccine (given reindeer on the Seward Peninsula) or an actual reactor to Brucellosis. The result would be a possible loss in revenue. If animals were identified with the transponder implants then the unique alphanumeric code would remain with the animal until it is deleted from the herd. In 1990, about fifty transponders were implanted in reindeer adults and calves at the Large Animal Research Station, University of Alaska Fairbanks and on the Seward Peninsula. Implant sites included the tailhead, brisket, and on the head at the base of the antler. No migration of implanted transponders nor secondary infection in association with the procedure were detected. The subcutaneous site at the base of the antler was chosen as the most suitable for efficient handling of reindeer. A larger number of implants will be tested in 1991 and linked to a computer database.

Meat yield test of reindeer carcasses

L.A. Renecker, H.C.H. McIntyre, K. Krieg, J. Olsen

Development of appropriate management strategies for a long-term meat market demands both a consistent supply and quality of product for the customer. The first stage is to determine meat yield, carcass composition, and optimal slaughter age as it relates to production characteristics and economics of the species and the herding operation. In 1990, a number of reindeer at the University of Alaska Fairbanks were slaughtered. Half of each carcass was used to conduct a preliminary meat yield test. Carcasses were cut into both the New Zealand and Texas styles. Results indicated that the loin, nine rib rack, and hind leg made up 48% of the carcass. Average carcass weight of reindeer slaughtered at a commercial slaughter house was 70 kg. In 1991, this study will incorporate animals from commercial herds of the Seward Peninsula and Nunivak Island.

Monitoring brucellosis in Seward Peninsula and Nunivak Island reindeer herds

L.A. Renecker, J. Bevins, W. Thompson, R. Dieterich

Over more than a decade, a comprehensive health management program has addressed the control of brucellosis in Seward Peninsula reindeer herds. Now, a large portion of the reindeer are vaccinated against the disease. Commercial reindeer herds on the Seward Peninsula and Nunivak Island were sampled in order to monitor frequency of brucellosis. This program will continue to monitor both the occurrence of brucellosis in Alaska reindeer herds and the antibody response of vaccinated animals.

Age specific fecundity and its relationship to production in Seward Peninsula reindeer

H.C. McIntyre, L.A. Renecker, M. Sousa

Productivity of the 15 reindeer herds on the Seward Peninsula, Alaska varies and reflects differing levels of management intensity and ultimately productivity. In this study, blood serum samples were collected from female reindeer of several herds from 1987 to 1991. Pregnancy will be detected by analyzing for elevated serum progesterone levels with a radioimmunoassay. These samples will be analyzed in 1991.

Nitrogen, phosphorus and carbon mineralization in soils from a long-term tillage study

E.B. Sparrow, V.L. Cochran

A study was conducted to determine N and P mineralization potentials and respiration rates in crop residues and soils obtained from a long-term tillage study. The tillage plots established in 1976 and planted to alternate winter wheat/spring wheat are located near Pullman, Washington where the climate is characterized by humid winters and dry summers. Surface soils collected from tilled and no-till plots, and new straw (left after current crop had been combined) and old straw from the no-till plots were incubated at 0.02 MPA moisture at 25° C for 16 weeks. Total N, ammonium, nitrate, total P, inorganic P (Pi), Bray P, organic C contents and CO_2 evolution rates were measured. Net mineral N, Pi and Bray P decreased to below pre-incubation levels in both new and old wheat straw indicating a potential for net immobilization of N and P in the field. *In vitro* net N and P mineralization was higher in the no-till than in the tilled soil indicating a potential for higher N release from the no-till soil in the field. Although the new straw had the highest organic C, it also had the widest C:N ratio, hence the lowest rates of CO_2 evolved;

respiration rates seemed to be limited by the small levels of mineral N and P. Carbon dioxide evolution was highest in the old straw indicating that much of the wheat straw left on the no-till plots did not decompose in the field. The high *in vitro* C mineralization rates suggests a potential for high organic matter decomposition rates in no-till systems if favorable field conditions occur.

Residual nitrogen from legumes

S.D. Sparrow, V.L. Cochran

A recently completed study indicated that some legumes in Alaska have the potential to fix large amounts of atmospheric nitrogen (N) into plant useable forms. A question that remains is how much of the fixed nitrogen will remain in the soil and become available for crops following legumes. In this study, barley without N fertilizer added was planted on four land treatments: green manured legumes; legumes harvested for forage; barley harvested; and fallow. Barley whole plants were harvested at physiological maturity and dry- matter yield and N uptake under the different crop histories compared. The field aspects of this study, which were done at the AFES research farms at Delta and Fairbanks, were conducted in 1989 and 1990. Samples are now being prepared for N analysis. In both years at Fairbanks and in 1989 at Delta, total plant yields were higher on plots in which N-fixing legumes had been green manured and or had been fallowed than on plots in which the legumes had been mowed and removed or on which non-N fixing crops had been grown. At Delta in 1990, dry conditions severely limited barley growth and no treatment differences were noted. Preliminary results from this study indicate that substantial amounts of N from green manured legumes can be mineralized and made available to crops in the year following the legume crop but legumes harvested for forage late in the season are of little value as N sources for the succeeding crop.

Salmon bone meal as a fertilizer

S.D. Sparrow, A.P. Snow

Salmon bone meal is produced in Alaska as a by-product of aquaculture diet production. Currently, most of the salmon bone meal produced in Alaska is sold outside of Alaska at a financial loss. The material contains about 9% nitrogen (N) and 5.5% phosphorus,(P, 12.5% P_2O_5) and thus may have value as a fertilizer for organically grown crops in Alaska. However, nutrient release rate and plant availability of the N and P is unknown. A Sea Grant funded project was begun in 1989 to determine how fast soil microorganisms can release N and P from bone meal into a form useable for plants. Most of this study, which involved laboratory, greenhouse, and field evaluations, was completed in 1990; some of the chemical analyses and data analysis remain to be done. Field studies were done at AFES research farms at Fairbanks and Delta. Although, the salmon bone meal was found to generally produce somewhat lower yields of leaf lettuce than commercial fertilizer applied at the same rate of N and P, preliminary results indicate that it is a good organic fertilizer for Alaska.

Residual nitrogen and phosphorus from salmon bone meal

S.D. Sparrow, A.P. Snow

A recently completed field study indicated that salmon bone meal has value as a nitrogen (N) and phosphorus (P) fertilizer for Alaska. However, results indicated that not all of the N and P in the salmon bone meal became available for the crop in the year of application. In this study, done at AFES research farms at Delta and Fairbanks, barley is planted following lettuce which was fertilized with salmon bone meal and commercial N and P fertilizers. Growth and N and P uptake of barley without additional N or P added following these treatments is compared with barley fertilized with commercial fertilizer at planting time. Preliminary results at Fairbanks showed that barley grown on soil which was fertilized at planting time grew only slightly better than barley which relied on residual nutrients from the fish bone meal. Barley grown on plots which received commercial fertilizer in the previous year but none in 1990 did not generally yield as well as did barley on the old fish bone meal plots. At Delta, barley was water stressed and no fertilization effects were

noted. The results at Fairbanks indicate that much of the salmon bone meal becomes available for crop use in the year following application. This research will be continued for at least one more growing season.

Effects of chloride and sulfate on potato yield and quality

J.L. Walworth, R.G. Gavlak

A field trial was initiated in 1990 to study the effects of chloride (Cl^-) and sulfate (SO_4^{2-}) ions on yield and quality of potato tubers. The experimental design was factorial, with three rates each of $CaCl_2$ and $CaSO_4$. These materials were applied at rates equivalent to 0, 64, or 128 lbs S/a and 0, 145, or 290 lbs Cl/a. All plots received identical amounts of nitrogen, phosphorus, and potassium, all of which were applied as salts containing no Cl^- or SO_4^{2-}. Application of Cl^- reduced tuber specific gravity; SO_4^{2-} had no effect on this tuber quality. Total and US #1 tuber yields were not affected by either of the test materials applied. However, as the Cl^- level was increased, the number of tubers set by each plant decreased, and the average weight of the individual tubers increased. Chloride decreased tuber set, but the tubers that were present grew to a greater size which effectively compensated for the reduction in tuber number.

Evaluation of potato vine desiccants

J.L. Walworth, R.G. Gavlak

The use of chemical vine desiccants is standard practice in most potato growing regions. Vine death facilitates mechanical harvesting and promotes tuber skin setting, which reduces tuber damage. Generally, three to four weeks is generally provided to achieve acceptable vine death and skin set. Vine desiccants have not been sufficiently tested under Alaskan conditions. Four such chemicals were tested on five potato varieties in the Matanuska Valley. Enquik®, at a rate of 15 gal/a in combination with either 1 or 2 pt/a of Diquat®, was compared with Diquat® alone at a rate of 2 pt/a, with ThioSul® at 40 gal/a, and with an untreated check. Varieties included Bake-King, Superior, Iditared, Lemhi, and Green Mountain. Vines were rolled, and chemical treatments were applied on September 4. The foliage was visually rated for mortality and desiccation after one and two weeks. Harvested tubers were graded according to USDA standards, weighed, and visually rated for skin damage. Visual field ratings indicated that all materials tested effectively desiccated potato leaves and vines. The Enquik® plus Diquat® combinations were slightly more effective at desiccating vines than the other treatments. Total and US No.1 tuber yields were identical among vine desiccation treatments. Tuber specific gravity was slightly higher in potatoes from the untreated check plots than from those in the treated plots. Yields varied among varieties, but there were no significant interactions between potato variety and desiccant. Tuber skin damage was minimal and unaffected by the chemical treatments.

Evaluation of methods of increasing soil temperatures

J.L. Walworth, R.G. Gavlak

The relatively short growing season in Alaska is a principal limitation to commercial production of potatoes. Potatoes accumulate a large portion of their bulk late in the season and lengthening the growing season may be expected to improve potatoes yields. This study was set up to evaluate the effects of planting potatoes into pre-formed hills. When hills are pre-formed in the fall an increase of snow retention in the furrows between hills can be expected. A companion treatment of graphite applied in the early spring was included to accelerate snow melt. The objectives of the study were to evaluate plant nutritional status, and measure potato tuber yields in association with:

- Fall- and early spring-formed hills versus conventional tillage management (hills formed when plants are about one foot tall).
- Graphite treatment versus no graphite treatment.

The graphite treatments had no significant effect on tuber yield or quality. When hills were formed either in the fall or in the early spring before planting, both US #1 and total yields were both improved. The conventionally hilled potatoes yielded significantly less than the potatoes planted into pre-formed hills (294 cwt/a total tubers conventional versus 356 cwt/a fall-hilled, and 374

cwt/a early spring-hilled). The US #1 yield was significantly greater in the early spring-hilled treatment than in the fall-hilled treatment (353 versus 307 cwt/a), primarily due to a reduction in the amount of undersized tubers.

Effects of potassium source and secondary nutrients on potato yield and quality

J.L. Walworth, R.G. Gavlak

A field trial was initiated in 1989 and repeated in 1990 to study the requirements for supplementary magnesium (Mg), calcium (Ca), and sulfur (S) by potatoes grown in southcentral Alaska, to determine the effects of potassium (K) source on yield and quality of potatoes, and to determine optimum foliar levels of K, Ca, Mg, and S for the purpose of interpreting results from plant tissue analyses. All field plots received identical quantities of nitrogen and phosphorus and all but the check plots received 200 lbs K/a. Potassium was supplied as KCl or K_2SO_4 to compare the effects of the chloride (Cl^-) and sulfate (SO_4^{2-}) ions on production and quality of potato tubers and to determine whether supplemental S is required. Sulfate salts of Mg and Ca were added to plots receiving KCl to determine needed levels of these nutrients. Application of K in either Cl^- or SO_4^{2-} forms increased yield as soil at the site selected for this experiment was low in K. There were no differences in the yield of total tubers or US # 1 tubers with K_2SO_4 versus KCl. Yields did not increase in response to added Mg, Ca, or S, suggesting that these nutrients were present in adequate supply. Application of KCl reduced specific gravity from that of the control plots; application of $MgSO_4$ or $CaSO_4$ reduced it further.

Effects of soil fertility on potato plant development in the Matanuska Valley

J.L. Walworth, R.G. Gavlak

A field study designed to define potato plant development under various nitrogen (N), phosphorus (P), and potassium (K) regimes was initiated in 1989 and continued in 1990. Treatments consisted of four rates of N (0, 60, 120, and 240 lbs N/a), P (0, 53, 105, and 210 lbs P/a), and K (0, 100, 200, and 300 lbs K/a). At tuber initiation, and every two weeks thereafter, mass and composition of plant tops, tubers plus stolons, and roots were measured to determine growth rates of various plant parts and to determine the fate of nutrients absorbed by the plant. Preliminary second year results indicated that:

1. Marketable (US #1) tuber yield was maximized by application of 60 to 120 lbs N/a, 210 lbs P/a (in 1989 53 lbs P/a was adequate), and 100 to 300 lbs K/a.
2. Application of 240 lbs N/a reduced the number of tubers per plant.
3. Phosphorus and K stimulated growth of plant tops; N did not.
4. Higher rates of N and K increased average tuber size; P did not.
5. Increasing rates of all three nutrients was associated with reduced tuber specific gravity.

Rates of nitrogen, phosphorus, and potassium for head lettuce

J.L. Walworth, R.G. Gavlak

The objective of this study was to determine optimum rates of banded nitrogen (N), phosphorus (P), and potassium (K) for head lettuce production. Three rates of N (75, 125, or 175 lbs N/a) and four rates each of P (0, 44, 88, or 132 lbs P/a) and K (0, 83, 166, or 249 lbs K/a) were applied in factorial combinations. Nitrogen was applied as ammonium nitrate, P as triple super phosphate, and K as either potassium chloride or potassium sulfate. The fertilizer was applied at planting in a band 2 inches to the side and below the lettuce transplants. Average lettuce head weights were maximized by application of 88 lbs P/a, but were not significantly affected by application of N or K. Head diameters followed a similar pattern. Potassium source had no effect on head weight. There were no significant interactions between the treatment variables. Days from transplant to maturity was decreased by increasing rates of applied P, and increased as the rate of N increased. The incidence of tip-burn was significantly increased by increasing rates of added P; the other variables had little effect.

Nitrogen rates for russet potatoes

R.G. Gavlak, J.L. Walworth, W. Campbell

A field trial was initiated in 1990 to study the nitrogen (N) requirements of six russet potato varieties grown in southcentral Alaska. The potato varieties 'Allagash', 'Belrus', 'Frontier Russet', 'Hilite Russet', 'Russet Norkotah', and 'Russet Burbank' were planted on May 25. Fertilizer treatments included N at the rates of 0, 60, 120, and 180 lbs N/a applied at planting. Additionally, a treatment was included consisting of 120 lbs N/a at planting supplemented with 60 lbs N/a applied on July 8. All N was applied as ammonium nitrate. Yield of total and US #1 tubers of Russet Norkotah, Belrus, and Russet Burbank increased when 60 lbs N/a was applied, but responded very little to a single application of higher rates of N. However, tuber yields of Frontier Russet, Allagash, and Hilite Russet increased as the single application rate of N increased to 180 lbs/a. Total and US #1 tuber yields of all varieties increased with 180 lbs N/a in the split application treatment versus single application of this rate of N. Frontier Russet had the greatest response to the split N application, while Allagash and Hilite Russet had the least. Specific gravity of tubers of all varieties decreased as the total amount of N increased. For all varieties except Belrus, the split N application reduced specific gravity more than the single application of the same rate of N.

Effect of foliar calcium materials and rates on head lettuce yield and tip-burn incidence in southcentral Alaska

J.L. Walworth, R.G. Gavlak

Tip-burn is a serious disorder affecting head lettuce. It results from localized calcium (Ca) deficiency in leaf tips. The objective of this study was to demonstrate the effect of foliar Ca materials on the incidence of head lettuce tip-burn, yield and quality. Two foliar Ca materials were applied at three rates each (1, 2, or 4 pints/a) on two spray schedules (every 3 or 7 days). The materials were Wuxal® suspension Ca (Aglukon Agri-Products) and Link® Ca-Zn (Wilbur-Ellis). The Wuxal contains 10% nitrogen, so all treatments, including checks, received equivalent N as urea. All materials were applied in 30 gallons of water per acre. Applications were started one month after transplanting and were continued until harvest. The Wuxal® Ca treatments had no effect on head lettuce yield or on the incidence of tip-burn. Link® Ca-Zn tended to reduce tip-burn incidence, particularly at the highest rate, although the reduction was not statistically significant at the 5% level. Link® Ca-Zn had no effect on head lettuce yield.

Effect of protein and energy source degradability on rumen bacterial fermentation in continuous culture

P.M. Windschitl

An experiment was initiated to study the effects of different protein and energy sources on rumen fermentation patterns. Two sources of protein (soybean meal vs. salmon meal) and two sources of grain (corn vs. 'Thual' barley), each differing in rumen degradability, were used in this trial. This study was performed using a continuous culture artificial-rumen fermentation system. Treatments were arranged as a 2 x 2 factorial and included soybean meal-corn, soybean meal-barley, salmon meal-corn, and salmon meal- barley. Salmon meal constituted 5% of the total diet dry matter. It is hypothesized that salmon meal is best utilized as a protein source in ruminant diets when barley is used as the primary grain in the diet. This study will examine the relationship between protein and grain source rumen degradability, and will help in establishing optimum feeding strategies for utilization of Alaskan produced feeds in cattle diets. Data will be analyzed and results published during 1991.

Effect of low levels of salmon meal in dairy cow diets on lactational performance

P.M. Windschitl

Thirty-six early lactation Holstein cows were used in a 12-week trial to study the effects of low levels of salmon meal on milk yield and composition. Experimental diets contained 0, 1.4, 2.8, or 4.2% salmon meal, and were designated as SBM, SM1, SM2, and SM3, respectively. Total mixed diets consisting of 55% concentrate mix/ 45% bromegrass silage and containing 17.1% protein were fed twice daily. Feed dry matter intake (DMI) was lower with the SM3 diet (17.5 kg/d) compared to all other diets (SBM, 19.7 kg/d; SM1, 19.0 kg/d; SM2, 19.7 kg/d). Milk production tended to be higher with the salmon meal-containing diets (SBM, 34.3 kg/d; SM1, 35.4 kg/d; SM2, 36.4 kg/d; SM3, 34.9 kg/d). Milk fat percentage decreased as the level of salmon meal

increased in the diet (SBM, 3.79%; SM1, 3.75%; SM2, 3.57%; SM3, 3.09%). Milk protein percentage was not affected by treatment. Four percent fat-corrected milk was decreased with the SM3 diet as a result of the lower milk fat percentage. Lactational efficiency (kg milk produced/kg feed DMI) increased as the level of salmon meal increased in the diet. The proportion of long-chain fatty acids and the degree of unsaturation in the milk fat increased as the level of salmon meal increased. Small amounts of salmon oil omega-3 fatty acids were detected in the milk fat of cows consuming salmon meal. The feeding of salmon meal resulted in improved milk production and lactational efficiency; however, milk fat percentage decreased with increasing levels of salmon meal. Income over feed cost was highest for SM2, followed by SM3, SM1 and SBM.

Effect of probiotic supplementation on growth rate, rumen metabolism, and nutrient digestibility in holstein heifer calves

P.M. Windschitl

Sixteen Holstein heifer calves were used in a 112 day trial to study the effects of probiotic supplementation on growth performance and rumen metabolism. Calves were divided into four groups of four calves each, with two groups receiving the probiotic supplement and two groups serving as controls. Calves were limited to 4 lbs dry matter of a corn-barley based grain mix per day. Long-stem bromegrass hay was fed as forage the first 56 days and bromegrass silage the last 56 days of the trial. Probiotic (1 oz/d/calf) was fed along with the grain mix twice daily. Data were analyzed for the entire trial and also for the separate hay and silage feeding periods. Total weight gain and average daily gain were not affected by probiotic supplementation. Dry matter intake was lower and feed efficiency (lb feed/lb weight gain) was improved slightly during the hay feeding period for the probiotic-supplemented calves. Wither height gain was greater during the hay period and lower during the silage period for probiotic-supplemented calves. Heart girth gain was improved by probiotic supplementation, particularly during the hay feeding period. Total rumen volatile fatty acid (VFA) concentration was higher with the probiotic-supplemented calves. Molar proportions of individual VFA were not affected. Rumen ammonia-N and plasma urea-N concentration were lower for probiotic-supplemented calves during the hay feeding period. Total tract nutrient digestibility was not affected. Some improvements in animal performance and changes in rumen and blood metabolites were observed in calves supplemented with probiotic. Effects due to probiotic supplementation were most pronounced during the hay feeding period.

Effects of probiotic supplementation of hulless barley- and corn-based diets on rumen bacterial fermentation in continuous culture

P.M. Windschitl

A study was conducted using a continuous culture fermentation system to determine effects of probiotic supplementation on ruminal bacterial fermentation of hulless barley- and corn-based diets. Treatments were as follows: barley without probiotic, corn without probiotic, barley + probiotic, and corn + probiotic. Probiotic was added directly into the fermenter flasks. Diets consisted of (dry matter basis) 46% bromegrass silage, 5% alfalfa meal, and 49% barley- or corn-based concentrate mix and contained 16.5% CP. Dry matter digestibility was higher with corn-based diets compared to barley-based diets. Ammonia N concentration was higher with corn- based compared to barley-based diets. Protein degradation tended to be higher with probiotic supplementation. Efficiency of bacterial protein synthesis was similar across all treatment combinations. Digestibilities of neutral detergent and acid detergent fiber, hemicellulose, and cellulose were not affected by grain source or probiotic supplementation. Within grain sources, non-fiber carbohydrate digestion was lower with the probiotic supplemented corn diet and tended to be higher with the probiotic supplemented barley diet. Probiotic supplementation had no significant effect on total volatile fatty acid (VFA) concentration or molar proportions of individual VFA. Propionate was higher and butyrate lower with barley compared to corn as the grain source. Treatment differences observed during this experiment were more a result of grain source effects than probiotic

effects; however, limited responses suggest that probiotic supplementation possibly can be used as a method to alter nutrient digestion. This study was designed to assist in characterizing Alaskan produced feeds and in developing feeding strategies for their optimum use.

Effect of probiotic supplementation on growth and health of dairy heifer calves housed in outdoor hutches

P.M. Windschitl

A two-year experiment was initiated to study the effects of probiotic supplementation on dairy calf growth performance and health. Calves will be fed 1 oz of probiotic per day. The control group will receive no probiotic. Calves will be housed outdoors in individual hutches until weaning at 6 weeks of age. Four to five lbs whole milk will be fed twice daily, depending upon body weight. Probiotic will be suspended in the milk with 1/2 oz probiotic given at each milk feeding. Long- stem brome hay and grain mix will be offered free-choice during the experiment. Body weights and measurements will be taken at birth (within 24 hours) and at weaning. Blood samples collected at 3 and 6 weeks of age will be used to monitor any physiological changes due to probiotic supplementation. Complete health records will be recorded for each calf. A minimum of 60-80 calves are needed for this study. Under the relatively stressful environmental conditions found in Alaska, it is hypothesized that probiotic supplementation may be of benefit to dairy heifer calves housed in outdoor hutches.

Forestry researchers remove sections of the trunk at specified intervals for detailed measurement. The data gained from the sampling provide foresters with growth information needed for proper management of the resource.

Forest Sciences

Forest hydrology/ watershed management research

J.D. Fox

Research in forest hydrology/watershed management has focused on the interrelationship between vegetation and the hydrologic cycle - the link between the terrestrial and aquatic dimensions of the ecosystem. A model of the watershed hydrologic balance (budget) is used as the framework for organizing knowledge, forming hypotheses to be field tested, and gaining insights on probable impacts of vegetation changes. The model developed has been used to investigate the effects of visually harvesting visually on water yield in the boreal forest and to investigate the effects of climate change scenarios on the sub-arctic water balance and frost depths. The current specific research objective is to develop a daily weather simulator for the Fairbanks area. Although most forest ecological phenomena are not monitored daily, knowledge of daily climatological variables and their significance in water balance, energy budget, and forest production models, would yield insight into the sensitivity and variability of such ecological phenomena and into the potential impacts of management policies. Given an adequate historical record of climatological variables, it is feasible to develop a "stochastic weather generator." Such a model would randomly calculate a meteorologically meaningful set of weather variables for each day, while maintaining the overall statistical characteristics of the historical record. Such a model could then be used with a variety of deterministic hydrologic models to estimate probability distributions of such dependent phenomena as snow depths, frost depths, dates of snow melt or soil thaw; dates when critical soil moistures or river stages are reached and so forth. This study is now exploring ways to develop the appropriate stochastic weather model from the Fairbanks data. Markov models are being developed from the National Weather Service data for Fairbanks and used in conjunction with Monte Carlo methods to stochastically generate daily rainfall, maximum and minimum temperatures, wind, dewpoint temperature, and cloud cover. Although it is fairly straightforward to model each variable independently, the challenge is to generate a meaningful set of values for each day such that one does not get, for example, rain with no clouds! Many of the hydrologic and biologic phenomena of the north can only be understood and managed in the

context of the probabilities of random events deterministically affecting physical processes and natural system structure. This ongoing research should enable more meaningful results to be obtained from a variety of management and ecological models and present a means of converting decision-making situations of "uncertainty" into ones of "risk."

Old-growth riparian Sitka spruce ecosystem structure

G. Juday,
P. Alaback,
R. Solomon,
J. den Ouden,
J. Blakeman

The largest trees in Alaska are found on the fertile floodplains of the larger rivers on islands of southern southeast Alaska. A distinctive Sitka spruce-devil's club plant community occupies these sites. Most large old-growth forest examples of this ecosystem have been harvested because these sites are the natural routes for access roads, and the stands contain large volumes of valuable Sitka spruce timber. We evaluated three alternative riparian spruce stands in cooperation with the Tongass National Forest Plan Update for possible establishment as Research Natural Areas (RNAs). Our previous studies had located a very few trees of 300 cm diameter and nearly 70 m height; we also found that height of intact dominant trees is the best single guide to site productivity. We established a 0.25 hectare permanent forest reference monitoring plot in each of the three RNAs. We found trees up to 205 cm diameter and 60 m in height, and we believe trees larger than these have been harvested throughout the state of Alaska. Rio Roberts was our most impressive stand; it supported 106 m^2 of tree basal area per hectare (1.06% of the plot). The stand was made up of trees from two age classes that probably originated after floods. We found that ferns in the understory occupied very specific sites made up of the piles of bark and wood in the understory in characteristic cones around the base of huge trees. Riparian spruce stands are probably important in regional carbon balance because of the massiveness of the trees.

Natural white spruce regeneration at Bonanza Creek

G. Juday,
R. Solomon,
J. Dudley

This project is a long term study of natural tree regeneration following the Rosie Creek Fire in 1983 in the Bonanza Creek Experimental Forest Long-Term Ecological Research (LTER) site. Work in 1990 focused on locating and mapping white spruce seedlings in a 1.0 hectare reference stand. All white spruce seedlings on the site belong to two age classes, 1983 seed crop and 1987 seed crop. In 1989 during an intensive effort 305 white spruce seedlings were located and mapped. The growth of 1987 seed crop seedlings made them significantly more visible during the year. In 1990 the total number of spruce seedlings mapped in the hectare stood at 581. The 1987 seed crop seedlings face severe competition from grass and forbs, but the 1983 seed crop seedlings reached heights of 50 centimeters or more and will soon overtop the competing vegetation. The major challenge to the near term survival of the established spruce seedlings is snagfall. The large dead trees from the stand that burned in 1983 will begin to fall soon and may cover or affect between 5% and 10% of the reference stand surface area.

Green Island 1990

G. Juday,
R. Solomon,
J. Blakeman,
A. Whitworth ,
L. Stuby,
S. Wyllie-Echeverria

We studied the condition of beaches and intertidal communities at Green Island Research Natural Area (RNA) in Prince William Sound in the second growing season after the *Exxon Valdez* oil spill as as part of a long-term monitoring study. First-year results at Green Island demonstrated that the natural background condition of shoreline and intertidal ecosystems is exceptionally dynamic and that oil spill effects were concentrated in predictable portions of the intertidal and lower beach zone that relate to tidal heights on the day the oil arrived and shortly after. In June 1990 we found that most beaches exposed to pounding winter storms at Green and Little Green Island appeared dramatically cleaner than the summer before. Few traces of oil or tar remained at the surface of these high-energy beaches. The winter surf naturally cleansed or buried the dried tar residue of the oil spill that coated the beach. A newly

deposited annual layer of gravel buried shallow (2 to 9 cm thick) tar deposits in locations where our 1989 study found pools of oil from the spill. Many organisms that appeared alive in August 1989 had died by June 1990, including blue mussels, rockweed, and barnacles. Most of our study locations also supported colonies of tiny new barnacles (called barnacle "sets") that had arrived since the oil spill in late March of 1989, and a vigorous growth of new small Fucus (rockweed) plants at appropriate tidal heights. Two important sources of further damage from the oil spill at our study site are the refloating of buried oil by extreme high tides and changes in the balance of organisms that make up intertidal communities especially because of the death of sea otter.

Natural diversity in the southern Tongass National Forest

G. Juday, M. Mueller, P. Alaback

We examined alternative Research Natural Areas (RNAs) that have been proposed to include several elements of natural diversity in the Ketchikan area of the Tongass National Forest. Two sites, Thunder Mountain and Grace Mountain on Dall Island, contain stands of subalpine fir trees growing in a very unusual outer coastal location. The occurrence of these stands is clearly restricted to limestone outcrops above about 700 meters elevation. Some subalpine fir are rooted on the rim of limestone sinkholes. Only a handful of subalpine fir trees survive at Thunder Mountain and they do not appear to be producing cones and seed; the stand has produced a few trees from layering (vegetative reproduction), but it could easily go locally extinct naturally. Grace Mountain supports an excellent stand of subalpine fir but has been largely transferred to private ownership. A few vascular plant species range extensions were discovered at Grace Mountain. Thunder Mountain contains alpine karst terrain. We discovered several small caves and solution features, including some very deep (over 20 meters) limestone solution pits or sinkholes. A world-class cavern system has been discovered at El Capitan on Prince of Wales Island, and a potential RNA that includes low-elevation limestone-related and caves is being sought, although other land use options may be substituted for RNA.

Natural diversity at Pete Dahl Slough on the Copper River delta

G. Juday, R. Ott

The 8,474-acre (3,431 ha) Pete Dahl Slough Research Natural Area (RNA) is located in the Chugach National Forest on the Copper River delta, a wildlife habitat of international significance for migratory birds and a productive wetland that serves as a critical habitat in the life cycle of many aquatic and marine species. A final establishment report was prepared for the RNA. The RNA supports breeding populations of the dusky subspecies of Canada goose, which nests only on the Copper River delta and trumpeter swans in a wetland complex of freshwater ponds, sedge marsh, and tidal sloughs. A significant portion of the North American population of the Aleutian tern occurs on the delta, and several nesting colonies are within the RNA. An unusual freshwater population of the harbor seal, a declining species of management concern, occurs on the delta and makes use of the RNA. The delta is a critical feeding stop for the total populations of two shorebirds during their spring migration, the western sandpiper and the long-billed race of the dunlin. Millions of these shorebirds feed and rest on the delta, and the RNA contains a small amount of their optimum feeding habitat. The delta supports healthy populations of moose and brown (grizzly) bear, and both species use the RNA seasonally. Our analysis of climate data found a significant decrease in the number of days with snow on the ground in the last two decades on the delta. We discovered a strong predictive correlation between springs with early snowmelt and high dusky goose numbers and years with late spring snowmelt and low goose numbers the following year. Pete Dahl Slough RNA is within one of the geologically most dynamic areas on earth, and was uplifted 2 m in the 1964 Great Alaska Earthquake. Since the uplift shrubs have advanced vigorously onto former

wetland surfaces, significantly altering wildlife relationships and habitat. The RNA is being shaped actively by down-canyon dune-building winds, strong onshore coastal winds, and aggregation of a sediment-laden braided glacial river in an estuarine delta. The area is certain to be displaced by major tectonic movement in the future.

Natural disturbance and diversity in upland forests of the northern Tongass National Forest

R. Ott,
G. Juday

A study of the role of disturbance regime, especially wind-created canopy gaps, has been planned for contrasting inner and outer coastal island sites in the Tongass National Forest. The Tongass is a unique expanse of largely intact temperate rain forest that is particularly suitable for studies of natural regulation of bio-diversity. It is hypothesized that canopy gaps comprise a larger portion of the forest area at the outer coastal sites and that gaps are larger there than at the inner coast sites. Trees should have experienced more growth release from competition on outer coastal sites and forest turnover should be more rapid there. The outer coastal sites should also contain a greater proportion of light-demanding species. A graduate resource fellowship and U.S. Forest Service support have been secured for this study. Field studies in several proposed Research Natural Areas and other sites are planned for 1991.

Predicting the growth and of forest stands in interior Alaska

E.C. Packee

Growth and yield information is essential for effective management of the northern forests of interior Alaska. Efforts concerning site index curves for tamarack continue; three additional sites were located and sampled during 1990. A graduate student continues to finalize a thesis on site index and early growth of paper birch. Trees from 10 balsam poplar/western black cottonwood plots remain to be measured; evaluation of height growth supports the previous observation that there are two distinct height growth patterns for balsam poplar/cottonwood. North of the Alaska Range there is a distinct tendency for the curves to flatten off. South of the range, some trees, even trees over 100 years old, exhibit no tendency to flatten off. South of the Alaska Range both patterns of height growth occur. The differences in height growth patterns may reflect environmental, species, or interaction differences. Black cottonwood is found only south of the Alaska Range whereas balsam poplar is found both north and south of the range. South of the range the two species hybridize; some authorities consider western black cottonwood to be a subspecies of balsam poplar. Additional field observations will be made in 1991. Sampling of aspen sites was begun in 1990 and will be completed in 1991. Three (two white spruce and one tamarack) Levels of Growing Stock (LOGS) plantations established in the spring of 1986 were remeasured for survival and height growth in spring and fall of 1990. Height growth data indicate that the majority of seedlings have broken out of planting check; many tamarack seedlings are in excess of 5 feet with some over 6 feet tall. Spruce seedlings are now putting on leader growth of 6 to 10 inches. A site near Tok, Alaska (elevation above 1,500 feet) has been selected for a LOGS installation. Clearing of the site, within the 1990 Tok fire perimeter, will begin in 1991. A formal paper on specific gravity of northern forest species has been accepted for publication pending revision. A formal paper on energy content of the species is being prepared by a graduate student. Individual tree volume table needs were further assessed. Variation between tables can be greater than 40 percent. Tables commonly have a minimum number of trees and often times are limited to a few stands. Their general applicability cannot be ascertained. In fall of 1990 a strategy was developed to begin data collection for volume table construction for all species. Data collection will begin in summer of 1991.

Forest products

E.C. Packee

A grant from the Alaska Science and Technology Foundation to investigate the marketing and utilization potential of northern forest species was used to collect additional information on value-added products. These data are now providing the opportunity to begin to develop simple models of value-added benefits to the people of the state. Using only one product, bleached chemithermomechanical pulp (BCTMP), the end-product value of a solid cubic foot of spruce or aspen is in excess of $8. Using current inventory and Alaskan volume tables, suggests that an inventory cubic foot of wood is worth approximately $10. Individual characterizations of the wood characteristics of each species was initiated in 1990; drafts have been prepared for six northern forest species; effort in early 1991 will concentrate on the coastal forest species. During 1990 oriented strandboard, pressurized groundwood, remanufacture (hardwood and softwood) plants were visited in the Great Lake states and Pacific Northwest. A final report has been delayed due to the untimely and serious illness of one of the cooperators. During 1990 an inventory of forest inventories of Alaska forest inventories was initiated. Completion of the report is expected in late 1991.

Forest regeneration

E.C. Packee

In the heavy snow winter of 1989-1990 high moose numbers in the lower Susitna Valley severely damaged hardwood regeneration. In spring 1990 paper birch sampling was initiated to assess the impact of moose browsing on early growth. Based on 20 sites, height growth of birch can be seriously retarded for 15 to 25 years and the butt log so severely damaged to make it nearly worthless. Damage ranged from browsing of twigs of one-half inch or more in diameter, tearing of branches from the bole, and breakage of the bole (diameter at point of breakage ranged upward to 2.5 inches). Similar damage was noted on aspen and cottonwood. Preliminary evidence suggests that hardwood regeneration is not a serious problem; the real problem is getting the regeneration to reach a "free-to-grow" status and may mean reduction in useable volume and lengthening of the rotation. Analysis of five-year survival results of a 1983 white spruce seeding trial continued. Data analysis indicates that there was a considerable natural regeneration. This has greatly complicated analysis. The objective of regeneration should be to ensure that growing space based on desired number of trees per acre is occupied by a crop tree; success is then based on occupancy of seed spot (success versus failure) which is binary data and is not normally distributed. Categorical data analysis techniques are being used. Including volunteer seedlings, there was a substantial decrease in occupied seed spots. This study confirms the conclusion, hand sowing of white spruce seed on hand-scarified microsites is not a satisfactory approach to stand regeneration.

Forest tree improvement

E.C. Packee

A graduate student continues to develop a tree improvement program plan for the state of Alaska. During 1990, objectives of the tree improvement program were clearly defined and finalized; a seed collection manual draft was prepared in conjunction with the Institute of Northern Forestry of the USDA Forest Service; plus tree selection criteria were developed; and flowering characteristics of Alaskan species were summarized. Approaches to clone banks and seed orchard design and management were investigated. Drafts of the various portions of the plan are regularly submitted to members of the Alaskan Reforestation Council which includes individuals from the private and public sectors for comment. These comments are then addressed in revisions to the drafts. Completion of the plan is planned for early autumn 1991. A review of the literature was initiated on methods for stimulating flower and seed production. A formal report is anticipated by early summer 1991. An immediate benefit has been to slow further investment into flower stimulation of white spruce since no method has been reported that gives consist positive

results. This report will also provide additional guidance for the selection of sites for clone banks and seed orchards.

The forest floor ecosystem

K. Van Cleve, J. Yarie

The forest floor is a key ecosystem compartment controlling the supply of elements that maintain forest growth. Our research emphasizes the control exerted by the organic matter chemistry on nitrogen supply for plant growth in successional vegetation types on the Tanana River floodplain and in the adjacent uplands near Fairbanks. This work has three areas of emphasis:

- establishing the net rate of N supply in relation to vegetation development;
- establishing the net rate of N supply in response to clearing of vegetation in different successional stages; and
- analyzing the role of organic matter chemistry as a control of the net supply of N.

The most detailed analysis of experimental results deals with river floodplain ecosystems. During a four-year period we evaluated net N supply in 14 stands representing a range of successional stages and contrasting control with vegetation clearing. Net N supply during the growing season in the forest floor (surface detrital layers) declined from 1.2- to 1.1- to .4g$\cdot$m^{-2} as vegetation developed from alder/poplar to poplar to white spruce. Vegetation clearing more than doubled the seasonal N supply to 2.8g$\cdot$m^{-2} in alder/poplar and increased it by 60% to .6g$\cdot$m^{-2} in white spruce. Seasonal net N supply in the surface 5 cm of mineral soil doubled from early successional willow (.3 g$\cdot$m^{-2}) to late successional white spruce (.6g$\cdot$m^{-2}). However, vegetation clearing had no consistent effect in increasing N supply in the mineral soil. The decline in seasonal net N supply with advancing succession reflects major and significant decline in the N concentration and increase in the lignin concentration of the detritus. Regression analysis showed that the lignin:N ratio of the organic matter explained 88% of the variation in seasonal estimates of net N supply for the successional sequence. Surface mineral soil N supply was strongly related to the increasing soil organic matter and nitrogen content. Approximately 76% of the variation in seasonal estimates of net N supply were explained by the nitrogen concentration of the mineral soil. Warming of organic layer temperatures in response to vegetation clearing caused the increase in N supply in this material. Temperature change had little effect on N supply from surface mineral soil. Vegetation clearing resulted in marked increase in the portion of nitrate present in both surface organic materials and mineral soil.

Overview of taiga LTER activities during 1990

K. Van Cleve, L.A. Viereck, J. Yarie

The taiga LTER program during 1990 encompassed:

- field and laboratory experimental work testing hyothesized controls of succession;
- long-term monitoring and assessment of ecosystem state and functional variables;
- using supplemental funding from NSF continued upgrading of computer facilities in connection with GIS and data management operations;
- interaction with other programs on a national and international basis; and
- inter-site activities including LTER network-wide research, LTER sponsored workshops, executive and coordinating committee meetings.

The year-round weather stations at LTER1 and LTER2 were successfully operated in the uplands and on the floodplain at Bonanza Creek Experimental Forest. Record snowfalls during the winter of 1990-1991 made access difficult. However, a near complete climatic record was obtained during the year. Long-term monitoring of ecosystem state and function emphasized the first 5-year re-

sampling of vegetation plots in early successional sites in the uplands and on the floodplain. Laboratory analysis of all upland and floodplain soil and forest floor samples collected from each of the replicate sites and successional stages was completed. Pre-treatment green leaf tissue analysis was completed for sample trees in each of the replicate treated and control plots in the respective successional stages. The analysis found generally higher phosphorus content of forest floors and green leaf tissue from upland compared with floodplain ecosystems. Leaf tissue P concentrations range from .13% to .75% for upland types and from .06% to .21% for floodplain types. In the uplands, early successional willows have the highest P content (.5% to .75%). Later successional species tend to show declining values. Time since the last fire and an associated period of higher P availability may account for these trends. No consistent difference among successional types was evident for floodplain species. Sucrose and mineral element fertilizer treatments were applied to all designated sites in upland and floodplain locations early in the 1990 growing season. Respiration estimates were conducted using the inverted box, soda-lime technique in the treated plots at all the "A" sites on the floodplain and in the uplands for the remainder of the summer following treatment application. Three enclosures were constructed in early successional sites in the uplands. Plant root growth dynamics studies were initiated in primary and secondary successional sites. Rhizotron tubes were installed inside and outside of exclosures on the floodplain. Supplemental funding from NSF upgraded computer workstations and provided a SUN-IPC workstation. We also acquired one additional hard disk drive for the SUN 4/390 computer. The local area network connected the Institute of Northern Forestry, the Geophysical Institute and the LTER computer. The chancellor gave SALRM an additional $96,000 to expand our GIS capability. This supported GIS class offerings and equipment purchase. In 1991 this support will fund a GIS faculty position. Our inter-site activities and interaction with other programs expanded during 1990. We established a 17 inter-site litter bag study and will participate in an international litter bag study. Inter-site activities involving taiga LTER scientists included a root workshop in April, and the spring coordinating and executive committee meetings. All taiga LTER scientists attended the October all-scientists meeting.

Prediction of landscape level effects of global change on the Alaskan boreal forest

J. Yarie

The fundamental objective of this new research project is to develop a set of simulation models which can be linked to a geographic information system (GIS) to predict the effects of global climate change on selected properties of the Alaskan boreal forest at the landscape level. A system of models will be assembled to address the following issues related to prediction of the affects of global change in the boreal forest: (a) regeneration of tree species, (b) change in carbon dynamics within selected vegetation types, (c) change in carbon dynamics through typical successional sequences, and (d) expansion of the site-specific predictions to a landscape or regional level. Two specific issues will be addressed with regards to regeneration:

- Will changing climatic conditions restrict regeneration of endemic tree species after disturbance?
- What environmental characteristics are necessary for the movement of treeline or the natural or artificial establishment of new vegetation types?

Specific questions to be addressed with regards to changes in the carbon cycle within vegetation types and throughout a successional sequence are:

- Will predicted global change have a substantial effect on forest productivity? Will changes in productivity be balanced by changes in decomposition?

- What are the changes in carbon source/sink relationships throughout various boreal forest successional sequences?
- Can large scale reforestation with potentially fast growing exotic tree species help to mitigate the global effects of increases in $C0_2$?

Specific objectives with regards to landscape level dynamics will include:

- Assessment of the potential changes in the distribution of current vegetation types.
- An assessment of changes in the carbon source/sink relationships at the landscape or regional level due to change in vegetation distribution, successional development, and disturbance patterns.

Long-term ecological research: An analysis of the relationship between resource availability and forest productivity

J. Yarie

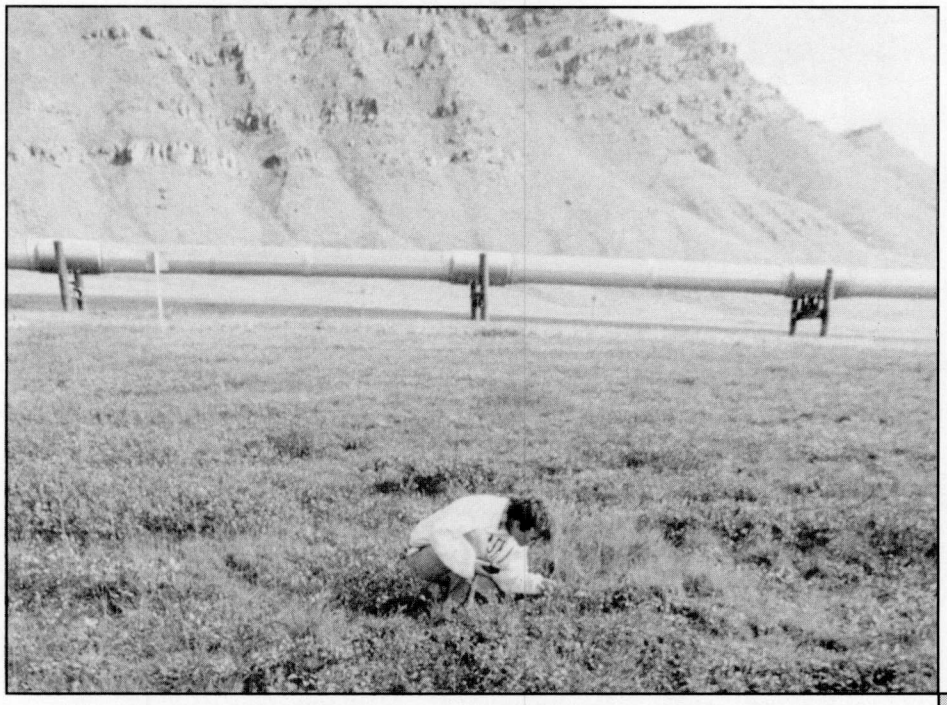
All experimental treatments were completed during the summer of 1990 including the moisture control treatments. Dendrometer bands were installed on all selected trees for analysis of treatment effects on tree growth. An analysis of variance on the first partial year of growth data indicated that none of the treatments were significantly different within each site type during this initial phase of measurements. Expected trends should indicate that the sugar, sawdust and drought treatments should result in growth reductions while the fertilizer treatment should increase growth above that of the control. These types of trends were shown by spruce in the FP3, FP4 and UP3 sites poplar in the FP2, FP3, and UP2 sites. The initial years data should be considered as a relative measure of growth changes at best and not absolute tree basal area growth. Foliage sampling was again carried out in all treatment and control plots during 1990. Neutron probe access tubes have been installed in all drought plots and the corresponding controls in sites UP2 and FP3. Weekly measurements will be made during the snow-free period in 1991 to establish the soil moisture trends for the control and drought plots. Forest floor respiration measurements indicated that the moisture control plots did have a significant effect on forest floor respiration measured with the inverted box method. The differences began as soon as the plots were covered and continued throughout the remainder of the year in both the upland and floodplain treatment series. Additional work to be carried out this summer will include remeasurement of diameter and diameter increment on all banded trees, an additional season of tree foliage sampling, and litter collection to attempt to quantify the effect of treatment on green foliage and litterfall chemistry.

Long-term ecological research: development of a geographic information system capability

J. Yarie

Funding from supplemental grants from the National Science Foundation in 1989 and 1990 have resulted in the acquisition of a Sun4/390 computer system, the upgrade of three SUN 386i's to Sparc1+ workstations, and the acquisition of a Sun-IPC workstation. This equipment is being used to implement the LTER database management system and as the foundation for a Geographic Information System (GIS). Hardware purchased from the 1989 and 1990 supplemental grants includes the Sun4/390 computer with a two 1-GB IPI hard disk drives, one nine-inch color monitor, CG6 color board, keyboard and mouse, Hewlett Packard DraftPro EXL plotter, 24" x 36" digitizer, and ARC/INFO software package. Networking hardware, which allowed us to connect to the campus wide fiber optic backbone and gives us direct access to the Internet, was also installed. We have begun our GIS activities by first determining what databases are available for boreal forest areas in the state. We have been able to locate a substantial database for two key areas in the state: the Tanana Valley State Forest (TVSF), which includes Bonanza Creek Experimental Forest (BCEF), and the upper Yukon River drainage, a 12 million hectare unit which includes the Porcupine River drainage. We are currently in the process of developing a data library for the Tanana River drainage derived primarily

from data available through the Division of Forestry, State of Alaska. The database for the TVSF will be especially useful in developing our base maps for the LTER sites in BCEF. Data available for the TVSF include aspect, elevation, bedrock geology, hydrology, soils, roads, wetlands, and vegetation. This data is available at a scale of 1:31,680 with a five acre resolution for the 84 USGS quadrangles in the TVSF. Because the LTER experimental sites are physically located within this area this database will give us a direct link to scaling up from site specific information to landscape level analysis. A database is currently being constructed for the 12 million hectare area centered around the upper Yukon River drainage in Alaska. Data layers being developed include: streams, rivers and lakes; elevation; slope; aspect; vegetation type; burn history; and lightening strike information. This study is a cooperative effort between scientists connected with the BCEF-LTER program and the USFS Pacific Northwest Research Station in Anchorage, Alaska.



Sheila Moore examines the tundra looking for edible wild plants. A group of 12 SALRM students visited Prudhoe Bay and the oil development facilities in the region during a week-long field trip studying natural resources management. BP Exploration (Alaska) and ARCO Alaska helped fund the trip with a grant to SALRM.

Resources Management

Outdoor recreation project

A. Jubenville

The outdoor recreation project in the past has focused on the supply side—management programs, resource allocation, etc. The actual studies have usually concentrated on major problems throughout Alaska. Currently, several studies are underway under this project umbrella:

1. *Anaktuvik Pass subsistence study, entitled "A Case Study of a Homeland and a Wilderness: Gates of the Arctic National Park and the Nunamiut Eskimos:"* The study involved detailed interviews of NPS personnel, conservation leaders, and the Nunamiut Eskimos, with follow-up interviews as needed. The major problem was differing world views of human relationships with the natural environment. The conclusion suggests co-management as a viable option to protect the homeland of the Eskimo and the wilderness attributes of the park. Vince Mathews completed and defended his thesis on the topic.

2. *Study of the Wrangell-Saint Elias subsistence permit system*: A thorough legal analysis of subsistence and an analysis of the subsistence use (from the ADF&G data base) have been completed. The database had to be reformatted so that the subsistence use by specific local communities could be estimated. An analysis of changing social structure from existing databases was also completed. The final step is assessing the impact of subsistence based on changing community social structure. The ultimate policy question of impacts based on rural zones (everybody qualifies) or individual permits can then be addressed. All primary and secondary data have been collected and analyzed, and a draft of Randy Rogers' thesis has been accomplished. Rogers gave a paper on this at the Western Social Science meeting in Portland, Oregon.

3. *Management of scenic overlooks*: There were approximately 300 interviews of visitors to the state of Alaska to determine how well their expectations were being met. The data have been collected and initial analysis completed. The preliminary conclusions paint a poor picture of Alaska's scenic overlooks. Analysis of stated preferences give a strong indication of the future direction of management. Marianne Kane is completing this study for her non-thesis professional paper.

4. *Statistical model of visual preferences along the Dalton Highway*: Approximately 200 interviews of Alaskan visitors using a photo-choice technique was done in 1990. It took considerable time to do the data analysis of the interviews, and the measurement of the physical parameters represented in the photos. Now a correlation between those parameters and visitor choice will be done to determine which parameters are significant and their level of contribution to the landscape. The results will be used to locate recreational developments. Jon Kamler will complete this thesis project by August 1991.

Natural resource education: The Commons Game

C.A. Kirts

The Commons Game was developed by Richard Powers in 1985 for use in psychology classes. Its purpose is to provide an experiential means of teaching about social traps. In natural resources management, dilemmas incurred when managing commons properties are similar to social traps. As such, The Commons Game was evaluated for use in a natural resources management context through several research projects. Initial research indicated the game is a useful technique for teaching about commons dilemmas. Results showed:

- Players should be a mix of majors and class standing;
- Initial confusion and frustration at the beginning of the game is a normal occurrence;
- Specific discussions of the game's solutions is needed after the game, otherwise, players may think there is no solution; and
- Instructors or game facilitators should play the game before using it in an instructional capacity.

The game is most effective when used with lecture and discussion strategies.

Other research showed that several modifications were needed to present the game in a natural resources management context. Changes were made in the terminology describing the management options a player may use, color of the enforcement card (from black to blue), rates at which the commons may improve, and an economic incentive for the players. The original Commons Game is copyrighted and has been used herein by permission. A prototype of the natural resources management version is being assembled and will be submitted to the original author for approval.

Natural resources management curriculum project

C.A. Kirts, J.D. McKendrick

The Alaska State Department of Education, Office of Adult and Vocational Education funded a two-year project designed to develop a secondary instructional unit entitled "An Introduction to Natural Resources Management." Last year, a draft was pilot tested and teacher-validated. In general, the teachers liked the unit. Most importantly, they liked having access to a unit which dealt with complex concepts in a practical manner and linked the social and natural sciences (more in line with the whole language approach to teaching in which many of the respondents were involved). Analysis of the teachers' evaluations suggested several major changes in the instructional unit:

- Don't call the individual components lessons because they really aren't. Instead, they are instructional guides, from which a teacher can develop a specific lesson.
- Include more background information. Assume the teachers have very little background in biology and environmental science. Many basic concepts must be explained.
- Consider omitting the lessons specifically on careers, and instead, intertwine career information within the other topical lessons, as appropriate. Revisions incorporating these suggestions are in progress.

Natural resources education: an undergraduate experience

C.A. Kirts,
J.D. McKendrick

With Alaska's short snow-free season, providing field experiences during regular semesters is difficult. Arctic field trips are more restrictive. To overcome that limitation, BP Exploration (Alaska) and ARCO Alaska co-sponsored an August field trip to Prudhoe Bay. The tour encompassed oil field sites from Endicott to Kuparuk. The tour exceeded that normally given to visitors. To provide an instructional opportunity for the students, a junior-level course was designed. Nineteen individuals participated: four faculty, 12 students (two freshmen, one sophomore, two juniors, and seven seniors) and three staff. Topics investigated during the trip included: oil production, environmental protection, permitting processes, soils (especially permafrost), geology, ecology, forest management, and wildlife and fish management. Students were required to take field notes, prepare and conduct a professional seminar, and write a publishable paper. Both were on the same topic. The course continued through the 1990 fall semester. Instruction concentrated on papers and seminars topics which included: major geologic formations between Fairbanks and Prudhoe, precipitation sampling equipment, Prudhoe Oil Field changes during the last decade, medicinal and edible plants along the Dalton Highway, and pipeline design. Meeting professional standards for an oral presentation and a technical paper challenged undergraduates. Seminars were highly structured and intensively evaluated. Papers had to meet the AFES editor's standards. Several students had difficulty meeting the writing requirements in the semester. They did not readily grasp the necessity of repeatedly revising. Most planned and prepared their seminars before writing their papers, opposite the method suggested to them. If this course is offered again, a rigorous structure with deadlines, graded drafts and other incentives for completing the paper early is highly recommended. Both freshmen completed course requirements on time. Academic standing and critical course work are only part of the readiness needed. This suggested class standing may not be the most important course prerequisite and that the amount and quality field/tour information compared with student-generated, in class information indicated that participants needed more pre-field trip information. Perhaps pre-field sessions offered in the spring semester would better prepare students for the tour. The fall semester could concentrate on synthesis discussions, seminars, and writing. UAF faculty and students appreciated the generous support from BP Exploration (Alaska) and ARCO Alaska which provided funding, housing, and transportation support as well as technical experts. Dr. Maynard Fosberg, University of Idaho professor of soil science emeritus, provided expertise on soils. Dr. John Fox, UAF, gave insight into watershed and geographical considerations of northern ecosystems. Stephen Lay, AFES editor, instructed students in writing and preparing papers, and reviewed their papers. Without this cooperation and sponsorship, it would have been impossible to have conducted the tour and course .

Farming systems research views Alaska as a microsystem in the macrosystem of the agricultural circumpolar north

C.E. Lewis,
R.W. Pearson

The farming systems research program concentrated on analysis of three development models for the Alaskan agricultural industry based on the degree of federal, state, and private investment. Minimum federal and state investment was provided to the vegetable and potato segment. The dairy received moderate support. Substantial state but little federal and private investment was available to grain and livestock production. Of the three models, the least successful has been the latter. The varying degrees of success is directly related to transportation and infrastructure specific to each industry segment. Elements specific to the grain and livestock industries (slaughterhouses, grain and fertilizer facilities, port elevators) were not in place when development was promoted. Reasonable facilities were available for dairy, vegetables, and potatoes. Federal capital injections were not forthcoming. Without a compelling need to produce food—not evident in Alaska at the present time, and without the need for agricultural income—it is doubtful Alaska's public sector will construct the appropriate transportation systems and infrastructure. Alaska's agribusiness industry is a microsystem in the macrosystem of the circumpolar north. Five other regions have been identified which initiated

agricultural production in a manner similar to Alaska's—an initial, critical need for food by those engaged in extraction of natural resources. These regions are : Transbaikal Region and the Yakuti Republic in the Soviet Far East; northern region of Finland; Canada's Yukon Territory and the MacKenzie District; Canadian Shield in eastern Canada and northern region of Alberta in western Canada. Information concerning successes or failures will add perspectives to agricultural development in Alaska and prospective directions for development in other agriculturally underdeveloped regions.

UAF-USSR cooperative research agreement continues

C.E. Lewis

The Agricultural and Forestry Experiment Station and the Russian Academy of Agricultural Sciences, Siberian Branch (RAAS SB, formerly VASKhNIL), are continuing a cooperative research agreement. The program emphasizes four areas of research: germplasm exchange, integrated cropping systems, economic problems of northern areas, and musk ox research. One horticultural scientist from the AFES and another from the Alaska Department of Agriculture visited central Siberia in August 1990 to exchange production information, seeds, and plant materials. In July 1990, AFES scientists hosted a delegation of seven agricultural researchers from RAAS SB. Seeds and plant materials of grains, grasses, and legumes were collected. Soviet scientists shared production techniques with producers in Alaska's interior and the Palmer area. Three AFES scientists, a cropping systems specialist, soil microbiologist and horticultural pathologist, and one USDA/Agricultural Research Service weed scientist visited Novosibirsk, Ulan Ude, Severobaikalsk, and Yakutsk in July, 1990. The scientists viewed and discussed cooperative research begun in 1989, discussed and planned new research projects, and visited Yakutsk to bring back any appropriate information from a Siberian agricultural area located near the same latitude as Fairbanks and Delta. An economics workshop was held in Novosibirsk, USSR, in May 1990. Five U.S. (two from AFES) and five Soviet economists participated. The topics addressed agricultural production, distribution, marketing, and policy and agency roles in the U.S. and USSR. The purpose was to provide basic information to those working in agricultural economics and policy enabling more efficient communication. Joint musk ox research between UAF's Cooperative Wildlife Unit (CWU) and the Institute of Extreme Northern Agriculture (IENA) in Norilsk was continued. Scientists from the CWU and the IENA continued on-going projects through visits to each others research sites.

Potential markets for indigenous Alaskan blueberries are investigated

C.E. Lewis, R.B. Swanson

Small berry processors, supermarket produce managers, specialty product retailers, and the general public have shown increasing interest in obtaining indigenous Alaskan blueberries. Whether it is for enjoyment, quality, preserving, or to save money, blueberries are popular among those who harvest them. Partial funding from the Alaska Division of Agriculture enabled AFES to complete a blueberry market survey for Alaska as part of a natural resources management student project. Mail questionnaires were sent to retail markets, in-state processors, and wholesalers. A telephone questionnaire was administered in Fairbanks and Anchorage to households randomly selected from 1990 telephone directories. No fresh or frozen indigenous Alaskan blueberries were sold in 1989 in Fairbanks or Anchorage supermarkets or by wholesalers. The indigenous blueberry is considered a direct substitute for imported berries. Thus, sales volume of imported berries was used to estimated a maximum market volume. In 1989, 153,000 lbs of fresh and 62,000 lbs of frozen blueberries were sold. All retailers and wholesalers indicated a willingness to buy Alaska blueberries, but only one had purchased them. Those purchased were of poor quality: soft and mushy with red berries and stems present. This respondent indicated only cultivated, graded berries would be purchased in the future. There are a number of entrepreneurs who have invested in small berry processing ventures. The estimated volume of fresh, indigenous Alaskan blueberries sold to these processors in 1989 was approximately 20,000 lbs. The amount of indigenous blueberries purchased is limited by supply. It is unclear whether this difficulty in obtaining berries is related to abundance, lack of pickers, or price paid. Estimates based on consumer responses indicated that urban Alaskans purchased

198,000 lbs of blueberries in 1989, and picked 168,000 lbs. There was a positive response to purchase of Alaska blueberry products with half indicating they purchased some processed items. Estimates from consumer and processor surveys give an indication of the potential size of the indigenous blueberry market. If one-half of the retail market can be captured by indigenous blueberries, approximately 100,000 lbs could be sold, based on 1989 data. It is possible some of those who pick blueberries for preserving (16% of those surveyed) would purchase if given a choice of a competitive, high quality, Alaskan product. Survey respondents picking for quality harvested 87,000 lbs. Again, if provided with the choice of an equal quality berry in retail markets, some may purchase. Assuming 75% of those picking would purchase, 124,000 lbs of berries could be sold. Alaskan processors indicated they could triple the amount of blueberries now used if the berries were available. This would account for an addition 60,000 lbs. The total estimated market for Alaska blueberries, based on survey data, would thus be 284,000 lbs. To make this possible, however, it would be necessary to maintain quality and price competitiveness.

Readability of nutrition books recommended to consumers

R.B. Swanson, C.A. Birklid

Nutrition and health concerns are increasingly influencing consumer choices in the marketplace. Consumer choices are frequently based on misinformation and misbeliefs. Because consumers typically rely on publications rather than professionals for food and nutrition information, professional organizations often issue recommended reading lists on current foods and nutrition *"hot"* topics. Readability of books recommended to consumers by professional nutrition and dietetics organizations was determined. Representative text samples from 32 publications were evaluated. Writing style and Flesch reading ease were assessed with microcomputer analysis. Grade level required to read the recommended books was 10.3+/-2.7, although reading skills required to understand these publications ranged from fifth grade to those of a college graduate. More than 40% of the recommendations required a reading level that exceeds that of popular magazines. Only one recommended book was written at a level that was understandable by adults with low-literacy skills. Publications containing more passive sentences tended to be more difficult to understand and are likely to pose particular difficulty for those consumers whose first language is not English. For many consumers, comprehension and application of the concepts presented in these recommended books will probably require interaction with professionals. Readability analysis is an additional tool that can be used by nutrition and dietetics professionals who make recommendations to consumers. It may assist professionals who select books for recommended reading lists to convey foods, nutrition, and health information to a broader range of consumers.

Food buying profile of urban Alaskan consumers

R.B. Swanson, C.E. Lewis, C.A. Birklid

A food buying profile based on telephone surveys of urban Alaskan consumers was established. Frequency response was tabulated and relationships were delineated using Chi-square analysis. Responses were compared to a national profile, where appropriate. Urban Alaskans, like consumers in the contiguous 48 states, expected a nutritious, safe and abundant food supply. These consumers were most dissatisfied with the quality of available fresh products, particularly produce. Nearly three-quarters of these consumers looked for *Alaska Grown* products. Production location was an important factor in selecting among available fresh and processed fruits and vegetables. However, there was a tendency to assume that products typically associated with Alaska, like blueberries, were produced or harvested in-state even when the product was imported. Urban Alaskans are twice as likely as U.S. consumers in general to use labels in product selection. Clearly identifying production location on Alaskan products would allow producers to capitalize on its importance to Alaskan consumers. Continued use of a single logo backed with quality standards on all Alaskan produced products is suggested. Although convenience was the primary determinant of supermarket selection, price was an important factor among consumers in lower income groups. However, once the consumer was in the store, price was the primary determinant of the selection made among similar products. Brand, a typical indicator of the

importance of quality, was also a major factor in the final selection. This indicates the need for Alaskan produced products to be available in neighborhood supermarkets and to be competitively priced. The importance of quality is reiterated. Specific fruits and vegetables harvested in state, their availability throughout the year and the *Alaska Grown* program were addressed in a pamphlet distributed by SALRM/AFES at the 1990 fairs.

Quality assessment of Alaskan reindeer meat

R.B. Swanson

Quality of meat from the forequarters of field-slaughtered Alaskan reindeer is being assessed through a cooperative agreement with The University of Tennessee in three on-going studies:

1. *Relationship among dietary fat, flavor and acceptability*: Composite meat samples from the chuck blade muscles of 6 and 5 reindeer harvested in March and September, 1989, respectively, were studied. Samples from those animals harvested in March were higher in saturated fatty acids and lower in monounsaturated fatty acids than were those harvested in September; variation in polyunsaturated fatty acid content was less than 1 percent. However, these differences have little practical nutritional significance because the low overall fat content (approximately 3.5%) of the reindeer chuck muscles ensures a low consumption of saturated fat, despite the variation in fat composition. Flavor notes have previously been related to the fatty acid composition of red meats. However, when sensory panelists (n=24) evaluated comminuted samples grilled to endpoint temperatures of 70-74 degrees C, no differences in flavor were found. When an intensity scale was used to evaluate gaminess, three-quarters of the sensory panelists (n=10) rated this flavor note below the midpoint, indicating that a mild gamy flavor was present. Approximately two-thirds of these panelists also rated overall acceptability of these reindeer samples in the acceptable range.

2. *Quality parameters of intact muscles/muscle groups*: Sensory profiles and yield were established for forequarter muscle groups from reindeer harvested in September, 1989. Salable yield from the 5 forequarter shoulder sections was 75.5+/-10.1%. In preliminary fabrication and sensory evaluation studies (n=8), roasts and steaks comprised of the chuck blade face (except the infraspinatus, supraspinatus, trapezius, rhomboideus and speinius) were successfully prepared using moist- and dry-heat methods, respectively; production of supraspinatus steaks prepared using a dry-heat method was also feasible. Extensive internal connective tissue precluded the use of the intact infraspinatus muscle. A consumer sensory panel (n=25) characterized similarly fabricated and prepared chuck blade roasts from 4 additional forequarters as moderately soft and chewy, and slightly moist and greasy with a mild gamy flavor. Fifty-eight percent of these panelists, the majority of whom were not consumers of hunt-killed deer or field-slaughtered reindeer, rated reindeer chuck roast samples in the moderate to very acceptable range of the scale.

3. *Production feasibility of restructured steaks*: Restructured steaks were fabricated from meat flaked to two sizes (1.295 and 1.905 cm) and with (0.5%) and without sodium chloride and with (0.5%) and without sodium tripolyphosphate. Phosphate alone did not appreciably affect sensory properties and negated the effects of salt. Larger flakes and salt improved quality and acceptability, therefore additional steaks were fabricated from meat flaked with a larger cutting head (4.06-cm openings) and with three levels of salt (0.0, 0.5 and 0.75%). Steaks containing 0.75% salt were less chewy, softer, juicier and more acceptable than those made with 0.5% salt. Feasibility of production of restructured steaks from the reindeer forequarter was demonstrated. The reindeer forequarters used in these studies are representative of animals harvested in March and September, 1989. However, additional work is needed to verify these results over time.

Who's Planning Alaska updated

S. Todd

First published in 1985, *Who's Planning Alaska: The Alaska Planning Directory* was updated in 1990 and released in 1991. The directory provides a comprehensive list of completed and on-going plans prepared by federal, state, and municipal agencies, incorporated communities, and Native regional and village corporations. It includes contact people, addresses, and telephone numbers for each plan listed. The directory is widely used throughout Alaska by agencies, communities, libraries, and non-profit groups.

Financial Statement

Expenditures — July 1989 through June 1990

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1989, and ending June 30, 1990 (FY 90).

Federal		
		(% of total)
Hatch Regular Formula Funds	$742,704	11.2
Hatch Regional Formula Funds	109,274	1.6
USDA–Agricultural Research Service	132,129	2.0
McIntire–Stennis Formula Funds	413,827	6.2
Other Grants and Contracts	892,365	13.4
State Funds	$4,365,094	65.6
TOTAL	$6,655,393	100.0

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Professional Staff

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Cathy A. Birklid, Research Assistant; University of Alaska '77, A.A. B.B.A. Ms. Birklid began working for AFES in 1979. Her major responsibilities have included development and administration of market surveys concerning statewide demand for various agricultural projects. Ms. Birklid is now utilizing statistical software packages to analyze the effects of tillage methods, straw treatments, nitrogen fertilizer source, and seeding methods on barley production in the Delta area. She is currently examining the transportation network for seafood and agricultural commodities produced in Alaska.

Leroy Ben Bruce, Associate Professor of Animal Science; New Mexico State University '74, B.S., '78, M.S., '79, Ph.D. Dr. Bruce was previously with the University of Hawaii at Hilo and South Dakota State University. Dr. Bruce's work in Hawaii was primarily teaching and research in such unusual feedstuffs as taro. In South Dakota, he was extension specialist in feedlot nutrition, providing service to cattle feeders statewide. His work with AFES is with beef cattle at the Palmer Research Center. His general areas of research interest are beef cattle nutrition and management; he is working specifically with cow-calf and feedlot research.

Larry Burke, Farm Superintendent; University of Idaho '66. Before joining AFES in 1980, Mr. Burke farmed in eastern North Dakota. He has also been a retail manager and big game guide. In 1987, he was named farm superintendent.

Rudy Candler, Laboratory Supervisor; Colorado State University '67, B.S.; University of Alaska Fairbanks '74, M.S., '87, Ph.D. Dr. Candler worked as a lab technician in the Mineral Industries Research Laboratory (1907) and the Forest Soils Laboratory (1971-1972, 1974-1978). In 1978 Dr. Candler was awarded a National Science Foundation grant to study metal-organic interactions in soils. He worked as a research associate from 1978 to 1982 when he returned to school full-time. Dr. Candler spent seven months as guest scientist at the University of Bayreuth, Federal Republic of Germany in 1985.

Donald E. Carling, Associate Professor of Horticulture; St. Cloud State University, Minnesota '67, B.A.: University of Missouri-Columbia '69, M.S.; '75, Ph.D Dr. Carling's research background is in plant pathology with emphasis on ultrastructural studies, plant endomycorrhizal relationships, and diseases of vegetable crops. He joined AFES in 1981 and has since concentrated a basic and applied research program on potatoes and vegetables. Applied research with potatoes includes variety testing and evaluations of cultural practices. Applied research with vegetables includes variety trials, nitrogen fertilization studies, and evaluation of transplanting as an alternative of direct seeding. More basic research includes the study of root disease of potatoes and vegetables caused by Rhizoctonia solani, and of the taxonomy of this important soilborne fungus.

Verlan L. Cochran, Soil Scientist/Research Leader Subarctic Agricultural Research Unit, USDA; Affiliate Associate Professor of Agronomy; California State Polytechnic College '66, B.S.; Washington State University '71, M.S. Mr. Cochran's research interests have included gaseous losses of fertilizer nitrogen, nitrogen transformations in soil, nitrogen use efficiency, fertilizer management and interactions of crops and weeds, and water-use efficiency in supplemental irrigation of dryland wheat. Mr. Cochran joined the AFES staff in 1985 after 19 years with USDA Agricultural Research Service at Pullman, Washington. His work with AFES is on crop residue management in reduced tillage for interior Alaska.

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James V. Drew, Dean, School of Agricultural and Land Resources Management, and Director, Agricultural and Forestry Experiment Station; Rutgers University '52, B.S., '57, Ph.D. Dr. Drew began his professional career at the University of Nebraska-Lincoln where he became professor of agronomy and, later, dean for graduate studies. His research in agriculture emphasized soil genesis and classification, and plant-soil relationships, as well as interpretations of soil surveys for agriculture and land management. Dr. Drew came to his present dual position in 1976. He is an American Society of Agronomy Fellow and an American Society for the Advancement of Science Fellow and has received numerous state and local civic and government appointments since joining SALRM.

John D. Fox, Jr., Assistant Professor of Land Resources; Trinity College '68, B.S.; University of Washington '70, M.S., '76, Ph.D. Dr. Fox came to the University of Alaska with experience in remote sensing and computer modeling in forest hydrology. He worked with the Institute of Water Resources on several projects including snowmelt-soil moisture interactions, modeling of air pollution, aquatic ecosystems, lake-level changes, and watershed geomorphology. Dr. Fox has continued his research interests in land-use hydrology and modeling natural resource systems with AFES, currently researching runoff relations of boreal forests. He teaches courses in watershed management, forest systems, forest management, resource measurements, simulation and modeling, and biometeorology.

Thomas J. Gallagher, Associate Professor of Regional and Land Use Planning; University of Oregon '69, BLA; University of Michigan '74, M.S., '77 Ph.D. Dr. Gallagher's research concerns ways to improve the management and planning of Alaska's land and resources. His specific research areas are in improving the effectiveness and efficiency of planning and permit coordination processes, of increasing the opportunity for the public to participate in public land management, and in understanding the history and problems of land planning in Alaska and other arctic countries. He teaches SALRM's required graduate courses in planning theory and practice and an undergraduate course in land use planning. Each year he also offers one course in environmental design or landscape architecture. In 1988 he served as SALRM's curriculum review coordinator overseeing the major review of the SALRM instructional program.

Anthony F. Gasbarro, Extension Forestry Specialist and Associate Professor of Extension, Cooperative Extension Service; Colorado State University '62, B.S.; University of Alaska '79, M.S. Mr. Gasbarro has worked in the areas of forest management, international forestry development, land-use planning, and extension forestry. He worked for five years with the US Forest Service both in California and Alaska, two years with the Peace Corps in the Dominican Republic, and 2 1/2 years with the Food and Agriculture Organization of the United Nations in Rome, Italy. Since joining the university staff, Mr. Gasbarro has served as a forestry and land-use planning instructor and researcher. He is principal investigator of the Intensive Forest Management Program and currently holds a joint appointment between SALRM and the Cooperative Extension Service.

Joshua A. Greenburg, Assistant Professor of Resource Economics; University of Connecticut '82 B.S.; University of Alaska Fairbanks '84 M.S.; Washington State University '1990 Ph.D. Dr. Greenburg's academic background is in natural resources and agricultural economics. Research interests include bioeconomic modelling, economic issues pertaining to the allocation of Alaskan renewable natural resources, and the economics of the Alaskan reindeer industry. He teaches natural resource and environmental economics.

Charles W. Hartman, Executive Officer; Rutgers University '64, B.A., Geology; University of Alaska '67, B.S., Engineering. Mr. Hartman worked as a research engineer/hydrologist for the Institute of Water Resources from 1967 to 1974. In 1974, he became IWR's executive officer where he continued until 1979 when he transferred to SALRM in the same capacity.

Dorothy J. Helm, Plant Synecologist; University of Delaware '69, B.S., University of Michigan '70, M.S., Colorado State University '77, M.S., '81, Ph.D. Dr. Helm's research includes vegetation succession in relation to natural and man-caused disturbances along rivers, behind retreating glaciers, and on mined lands. These studies have encompassed soil and wildlife relationships as well as baseline vegetation inventories. She is currently investigating the role of mycorrhizae in vegetation recovery from disturbances, especially on mining-disturbed lands. Dr. Helm has also assisted agencies with range ecology observations and data synthesis. Her teaching experience at the University of Alaska Fairbanks includes principles of ecology, range management, and ecology of disturbed lands.

Mary Lou Herlugson, Research Associate in Animal Sciences; New Mexico Institute of Mining and Technology '74, B.S. Ms. Herlugson joined AFES in 1981 after five years in animal science research at Washington State University. She provides support to animal science faculty through data reduction, manipulation, and statistical and computer analysis and assists in design of research and in interpretation of results.

Patricia S. Holloway, Associate Professor of Horticulture; Millersville University of Pennsylvania '73, B.A.; Washington State University '76, M.S.; University of Minnesota '82, Ph.D. Dr. Holloway's research background is in pomology and fruit breeding with major concentration on domestication and cultivation of the lingonberry. She joined SALRM in 1984 and teaches courses in plant propagation, general horticulture, vegetable crops, and greenhouse crops production. Her research involves the improvement of production of horticultural crops in Alaska with emphasis on the cultivation of Alaska native plants for ornamental and fruit-crop production.

Yong Huang, Research Associate; University of Wisconsin, Madison, Ph.D., Recently, he worked as a Post-Doctoral Fellow at Dr. Clearance Kado's Laboratory, Department of Plant Pathology, University of California, Davis. Dr. Huang's expertise is in the cloning, expression, and regulation of bacterial genes.

Fredric M. Husby, Associate Professor of Animal Science; Washington State University '66, B.S., '69, M.S., '74, Ph.D. Since joining AFES in 1975, he has conducted nutrition research with cattle, dogs, sheep, and swine to determine the nutritional and feeding value of Alaska's barley and marine by-products, making it possible for AFES to make recommendations for feeding crab waste meals to livestock. He has also investigated the value of chitin in ruminant rations. His current research is aimed at evaluating barley protein quality and the feeding value of a new hulless mutant variety 'Thual' in swine and sled dog rations. Dr. Husby has developed and offered courses in introductory animal science, livestock feeds and feeding, and nutrition and metabolism for undergraduates and graduates through the Natural Resources Management degree program.

Alan Jubenville, Professor of Resource Management; North Carolina State college of Agriculture and Engineering '62, B.S.; West Virginia University '64, M.S.; University of Montana '70, Ph.D. Dr. Jubenville joined the school in 1979 after nine years at the University of Wyoming. His primary teaching and research interest is in outdoor recreation management. He has developed a series of papers on basic management theory, authored several textbooks, and been involved in the study of several major state projects in Alaska, including Phase 1 of the Susitna Hydroelectric Project and the Kenai River Special Management Zone. He is the chairman of W-133 Regional Hatch Project, entitled "Benefits and Costs in Resource Planning." Dr. Jubenville has recently completed work on a textbook integrating theory into the management process during a concluded sabbatical leave.

Glenn P. Juday, Assistant Professor of Forest Ecology; Purdue University '72 B.S.; Oregon State University '76 Ph.D. Dr. Juday's research background is in community ecology, especially the structure of old-growth forests, natural area protection and management, and long-term environmental monitoring. He was Chairman of the Oregon Natural Areas Commission from 1973-76, and has served as Alaska Ecological Reserves Coordinator since 1977. He was coordinator of the Rosie Creek Fire Research Project from 1983 to 1989. Dr. Juday's work since joining AFES in 1982 has included the identification of important elements of natural diversity in Alaska, incorporation of important scientific areas into Research Natural Areas on public lands in Alaska, analysis of landscape-level processes responsible for natural diversity, and studies of forest structure. Dr. Juday served as President of the Natural Areas Association from1985 to 1990. Dr. Juday serves on the Science Board for the University of Alaska Fairbanks Center for Global Change and Arctic System Science.

Meriam G. Karlsson, Assistant Professor of Horticulture; The Swedish University of Agricultural Sciences '79, B.S.; Michigan State University '84, M.S., '87 Ph.D. Her primary research interest is the environmental physiology of greenhouse-produced crops. Since joining the University of Alaska Fairbanks faculty in 1988, Dr. Karlsson has

concentrated her studies on flower initiation under low light and temperatures.

Carla A. Kirts, Assistant Professor of Agricultural Education; Virginia Polytechnic Institute and State University '76, B.S., '77, M.S.; University of Missouri-Columbia '81, Ph.D. Dr. Kirts teaches courses in natural resources management, resources communications and extension, general agriculture, and agricultural education. She has been recognized for outstanding teaching. Dr. Kirts conducts research on student teaching management in agricultural education; effective teaching techniques such as peer evaluations, games and simulations, internships and class projects; and secondary natural resources curricula applicable to Alaska. She also assists vocational agriculture teachers in Alaska with program planning and implementation. Dr. Kirts received the Honorary State Farmer Degree in 1983 from the Alaska Association of the Future Farmers of America (FFA) and the Honorary American Farmer Degree in 1986 from the National FFA. In 1989, she received a national commendation for "exemplary achievement in strengthening the nation's vocational-technical education programs."

Charles W. Knight, Assistant Professor of Agronomy; Kansas State University '70, B.S., '71, M.S., University of Alaska Fairbanks '88, Ph.D. Mr. Knight's background in research is with chemical fertilizers and conservation tillage. He came to Alaska in 1971 and worked until 1973 as a research technician for AFES. From 1973 until 1978 he was superintendent of the East Central Kansas Experiment Field for Kansas State University. He returned to Alaska in 1978 to concentrate on soil and water conservation practices and fertility requirements in the Delta Agricultural Project. Mr. Knight is currently pursuing a Ph.D. degree in soil chemistry at the University of Alaska. He teaches an undergraduate course in soils.

J. Stephen Lay, Publications Supervisor and Public Information Officer, SALRM, Trinity University, '69, B.A.; Ohio State University, '88, M.A. Mr. Lay has been with the University of Alaska since 1979, and with SALRM since January 1989. As head of publications, he oversees the production of the station's journal, Agroborealis, as well as a variety of other publications; as information officer for SALRM, Mr. Lay provides information to many agencies and publics.

Carol E. Lewis, Associate Professor of Resources Management; University of Florida '62, B.S.; '64, M.S.; Georgetown University '70, Ph.D.; University of Alaska Fairbanks '76, M.B.A. Dr. Lewis was previously active in research for the U.S. Navy, applying high-frequency sound technology in explosive and medical research. A member of the AFES research faculty since 1973, her research efforts have been primarily in controlled-environment agriculture, feasibility of small-grain and livestock operations in Alaska, and the economic impacts of agricultural development in the state. At present, she serves as project leader for conservation tillage research in small-grain production conducted in Delta Junction, concentrating on the efficiency of tillage systems in terms of energy use and cost of production. Her teaching responsibilities are in the area of farm management.

Jenifer Huang McBeath, Associate Professor of Plant Pathology; National Taiwan University, Republic of China '65, B.S.; University of California, Davis '70, M.S.; Rutgers University '74, Ph.D. Dr. McBeath's research background is in plant virology, plant mycoplasmology, immunology, insect tissue culture, and electron microscopy. Dr. McBeath's first faculty position, in 1977, was at the Institute of Arctic Biology, UAF, for work on rust diseases of spruce trees. She joined AFES in 1980 and is currently conducting research on fungal and bacterial diseases of wheat and barley plants, anther culture and protoplast fusion of winter wheat, cold tolerant biological control agents of plant pathogens, witches' broom diseases of cottonwood and willow, spruce rusts, and wood decays. Dr. McBeath teaches courses in plant pathology and forest protection. She was an Associate Research Fellow, Academia Sinica, Republic of China, 1975; and a Postdoctoral Fellow, Thomas Jefferson University, 1976. In 1985-86, she was a visiting scientist at USDA-ARS, Beltsville Agricultural Research Center, Maryland.

Jay D. McKendrick, Professor of Agronomy; University of Idaho '63, B.S., '66, M.S.; Kansas State University '71, Ph.D. Dr. McKendrick's Alaskan research activities include: tundra revegetation; secondary plant succession in Arctic tundra; fertility of tundra soils; oil spill reclamation in Arctic and boreal zones; livestock, musk ox, and bison grazing; range plant nutritional qualities; hay quality; sand dune revegetation; Susitna Basin vegetation for the hydroelectric project; mine spoil reclamation; the effects of burning on browse quality; and range plant quality for Sitka blacktail deer. He has served as a consultant to industry on matters relating to the effects on vegetation of development activities. Dr. McKendrick has also served as a member of the National Academy of Sciences Committee on Alaskan Coal Mining and Reclamation and as a staff advisor to the National Governors' Association Range Resource Subcommittee.

Gary J. Michaelson, Research Associate; University of Arizona '74, B.S.; Iowa State University '81, M.S. Mr. Michaelson has a background in agricultural chemistry and soil fertility. He has conducted his work in soil testing and plant tissue analysis as Plant and Soil Analysis Laboratory supervisor at the Palmer Research Center. He is also currently working in soil fertility and fertilizer requirements of newly cleared Alaska soils.

G. Allen Mitchell, Associate Dean-SALRM, Associate Director-AFES, and Associate Professor of Agronomy; University of California, Riverside '71, B.S., '73, M.S., '77, Ph.D. Dr. Mitchell rejoined AFES in September 1987. He has previously served UAF as Agronomy Specialist with Cooperative Extension Service, and as Assistant Professor of Agronomy with AFES. Dr. Mitchell has a M.S. and Ph.D. in Soil Science with emphasis in Soil Fertility from the University of California, Riverside. He brings experience to AFES from several land-grant institutions, including the University of Arkansas where he was Director of both the Northeast and Southeast Extension and Research Centers, and Head of the Agriculture Department; and from the University of Georgia where he was Assistant Professor of Agronomy.

William W. Mitchell, Professor of Agronomy; University of Montana '57, B.A., '58, M.A.; Iowa State University '62, Ph.D. Dr. Mitchell's background of research is with grasses in natural ecosystems, with particular respect to ecotypical adaptation and teaching in biological sciences. He joined AFES in 1963 where he commenced studies on native grasses of Alaska, investigating the taxonomy, distribution, adaption, and cytological races of selected species. Dr. Mitchell conducted revegetation research in the Prudhoe Bay oil field, along the trans-Alaska pipeline route, and on Amchitka Island, leading to the release of native grass varieties for revegetation use. He is currently studying revegetation of surface-mined lands in interior and southcentral Alaska. His major activities now include research on application and management of grasses for forage uses in a number of agricultural areas in the state and turf studies at the Palmer Research Center.

Edmond C. Packee, Associate Professor of Forest Management; University of Montana '62, B.S., Yale University '63, M.F., University of Minnesota '76, Ph.D. Dr. Packee's research background is in the coniferous forests of the Pacific Slope from the redwoods north, the Rocky Mountains, and interior Alaska as well as the northern hardwood forests of the Great Lakes states. He also has forest management experience in northern Wisconsin and coastal British Columbia. Prior to joining UAF, he worked in private industry as a silviculturist. Dr. Packee joined AFES in 1983 and has concentrated on forest growth and yield, forest products' markets and applied silviculture including forest tree improvement. Dr. Packee teaches courses in silvics and dendrology and silviculture. He is a consultant on forestry and timber matters to the University of Alaska Statewide Office of Land Management. He is a member of the Alaska Reforestation Council where he serves on several technical committees. He is chairman of the International Union of Forest Research Organizations Working Party S1.05-12, Northern Forest Silviculture and Management.

Michael T. Panciera, Assistant Professor of Agronomy; University of Guelph '77 B.S., '79 M.S.; Pennsylvania State University '82, Ph.D. Dr. Panciera was previously with the Agronomy Department of Ohio State University. Dr. Panciera was responsible for teaching Forage Crops courses and his research program focused on forage quality. His research assignment with AFES is Forage Crops and he is located at the Palmer Research Center. Dr. Panciera's research program will emphasize development of management alternatives to improve forage quality and reduce feeding costs for ruminant animals.

Barbara J. Pierson, Research Associate, Soils; Montana State University '77, B.S., '85, M.S., Ms. Pierson's research and work experience has been directed toward soil fertility and soil management problems. She was employed by the Soil Conservation Service prior to beginning graduate study. After joining the AFES staff in 1985, she is working primarily with conservation tillage systems and fertilizer management in research plots established in the Delta area.

Chien-Lu Ping, Associate Professor of Agronomy (Soil Scientist); Chung-Hsin University, Taiwan '65, B.S.; Washington State University '73, M.S.; '76, Ph.D. Dr. Ping's research background is in soil chemistry; the movements of pesticides, heavy metals, and pollutants in soils; and related land-use issues. He was previously with the Washington State Department of Natural Resources, working on a statewide forest land-grading (survey) program to correlate forest productivity with soil types and to design soil-map units for urban planning

in western Washington. He joined AFES in 1982 to investigate soil genesis and classification in Alaska. He also represents the experiment station in his participation in the National Cooperative Soil Survey program in Alaska.

Lyle A. Renecker, Assistant Professor of Animal Science;Wilfred Laurier University '74, B.S.; Laurentian University '75, Honours Sc.; Laurentian University '83, M.S.; University of Alberta '87, Ph.D. Dr. Renecker heads the university's Reindeer Program. His research interests range from wildlife management to commercial game production.

Peter C. Scorup, Research Associate; Colorado State University '66, B.S. Mr. Scorup was a range conservationist with the Soil Conservation Service for three years and an instructor of agriculture and natural resources management at Colorado Mountain College for two years before joining the experiment station in 1972. His Alaska experience entails identification and verification of vegetation types using aerial photography and satellite data. Mr. Scorup has assisted with vegetation inventorying, mapping, and classification of the Susitna River Basin Cooperative Survey and the Seward Peninsula Reindeer Ranges.

Elena B. Sparrow, Soil Scientist, USDA, Affiliate Associate Professor of Soil Microbiology; University of the Philippines '62, B.S. Cornell University '66, M.S.; Colorado State University '73, Ph.D. Dr. Sparrow's research experience is in soil and environmental microbiology and plant-soil relationships. She has worked for the International Rice Research Institute, Depts. of Soil Chemistry and Soil Microbiology, Philippines; the Arctic Environmental Research Station, Environmental Protection Agency; and as a consultant on research funded by United States Army Cold Regions Research and Engineering Laboratory, Alaska Projects Office. She was an International Rice Research Institute Scholar to Cornell University in 1964, a Rockefeller Institute travel grantee in 1969, and a postdoctoral fellow at Colorado State University in 1973. She has worked and is currently working with AFES and ARS staff on microbial biomass and decomposition, nutrient cycling, and oil spill pollution studies.

Stephen D. Sparrow, Jr., Associate Professor of Agronomy; North Carolina State University '69, B.S.; Colorado State University '73, M.S.; University of Minnesota '81, Ph.D. Dr. Sparrow's research background is in soil microbiology, plant-soil relationships, and soil fertility. He worked for AFES as a research technician from 1973-1977, went to Minnesota to attend graduate school in 1977, and returned to Alaska in 1981. Currently he is doing research in the area of nitrogen cycling in Alaskan agricultural soils and on legume-Rhizobium relationships in the subarctic.

Ruthann B. Swanson, Assistant Professor of Food Science; University of North Carolina-Greensboro '77, BSHE; The University of Tennessee '81, MS, '86, Ph.D. Prior to joining AFES in 1988, Dr. Swanson worked with the North Carolina Agricultural Extension Service and held a visiting professorship with UAF's Institute Of Northern Engineering. She has conducted extensive research into the use of Alaskan hulless barley in bakery products and Alaskan food consumption patterns. Her recent work includes assessment of the quality of Alaskan reindeer meat.

Susan Todd, Visiting Assistant Professor of Regional and Land Use Planning; Bryn Mawr '75, B.A.; University of Michigan '79, MRP; University of Michigan '82 Ph.D. (ABD). Prof. Todd's research is concentrated in the areas of conflict resolution, mediation, and public land planning. She teaches SALRM's required graduate courses in planning theory and practice and an undergraduate course in land use planning. Each year she also offers a course in conflict resolution.

Gwendo-Lyn Turner, Research Associate; Humboldt State College '70, B.A.; University of California '75, M.S. Ms. Turner's background includes research in aquatic plant ecology concerning agricultural and domestic wastewater pollution. Her Alaska experience has been with various environmental monitoring programs and studies on the North Slope for industry, providing program development, field sampling and report preparation and review support. She has been with the Experiment Station since July 1988, working on revegetation programs on the North Slope.

Keith Van Cleve, Professor of Forestry (Soils); University of Washington '58, B.S.; University of California, Berkeley '60, M.S.; University of California, Berkeley '67, Ph.D. Dr. VanCleve has a background in research and teaching in soil-plant relations with research emphasis on the Alaskan taiga. He was formerly associated with

USIBP Tundra Biome and taiga forest ecosystems research programs funded by the National Science Foundation. Dr. Van Cleve is in charge of the SALRM Forest Soils Laboratory, and co-principal investigator for the Bonanza Creek Long-Term Ecological Research Site. His current research interests deal with the structure and function of subarctic forest ecosystems.

James L. Walworth, Assistant Professor of Soil Fertility/Horticulture; University of Wisconsin '76 B.S., '80 M.S., University of Georgia '85 Ph.D. Dr. Walworth joined the University of Alaska faculty in 1989 after spending three years teaching and soil fertility research at Rutgers University. His current research is designed to produce information for providing improved fertility recommendations for potatoes and other vegetable crops based on soil and plant-tissue analyses. Applied research with potatoes include studies of field responses to applied fertilizer materials, nutrient uptake and distribution patterns, vine-killer efficacy, and cultural practice evaluations. Applied research with other vegetables includes variety testing and evaluation of fertilizer requirements.

Paul M. Windschitl, Assistant Professor of Animal Science; South Dakota State University '81, B.S.; '83, M.S.; University of Minnesota '87, Ph.D. Dr. Windschitl's research interests are in the area of nitrogen metabolism in high-producing dairy cows, with particular emphasis on the concept of low-rumen-degradable nitrogen. Also of interest is the effect of nitrogen and carbohydrate sources on microbial protein synthesis in the rumen of dairy cattle. Research efforts will also examine the use of feed additives in dairy diets and their effects on rumen metabolism.

Frank J. Wooding, Professor of Agronomy; University of Illinois '63, B.S.; Kansas State University '66, M.S., '70, Ph.D. Dr. Wooding's background is in soil fertility, chemistry, physics, and management; and crop physiology and production. He joined AFES in 1970, where he has studied crop adaptation in the subarctic, cereal grains, oilseed crops, turfgrass management, revegetation of disturbed land, and the effects of off-road-vehicle use on soils and vegetation. He is currently involved with soil and plant problems associated with development of new lands in the subarctic.

John A. Yarie, Assistant Professor of Silviculture; West Virginia University '71, B.S.; University of Maine '74, M.S.; University of British Columbia '78, Ph.D. Dr. Yarie has a background of research in forest nutrient cycling and plant-soil relationships. His current research interests deal with an analysis of the factors influencing forest productivity from both a theoretical and an applied standpoint. He is also interested to the application of site specific knowledge to dealing with landscape level problems through the use of Geographic Information Systems.

Peikun (Peter) Zhu, Instructor; Zhu spent over 10 years at prestigious Fudan University, People's Republic of China, teaching and conducting research. He came to the U.S. in 1987 as a Research Fellow at the University of Minnesota. His expertise is in plant transformation. A patent, entitled "Dynamic transfer method for obtaining hybrids with exogenous genetic materials," was granted to him by the Patent Bureau, People's Republic of China. A U.S. patent on this invention is pending.

Emeriti

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1990 Annual Report

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