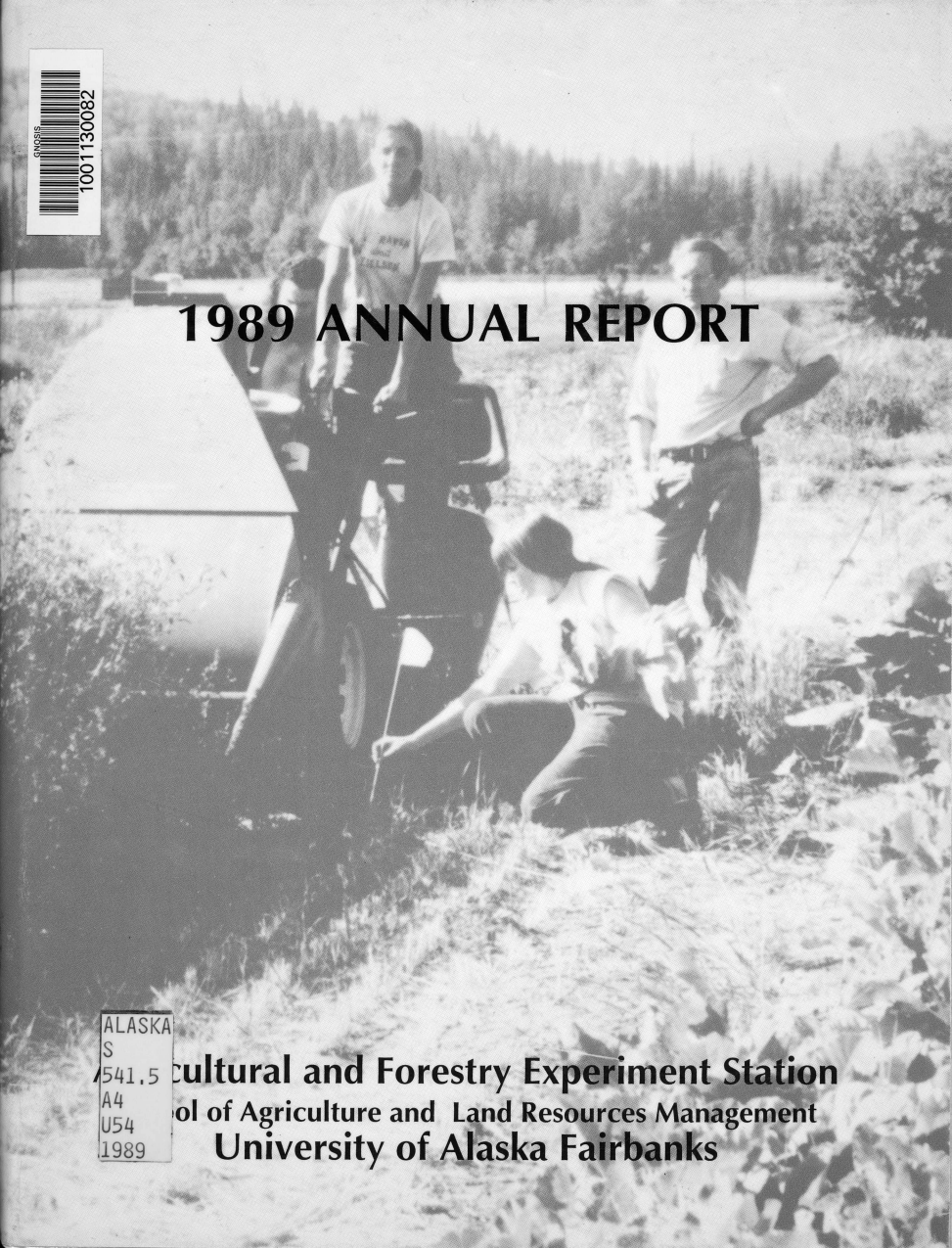
1989 ANNUAL REPORT



cultural and Forestry Experiment Station
ol of Agriculture and Land Resources Management
University of Alaska Fairbanks

Agricultural and Forestry Experiment Station

School of Agriculture and Land Resources Management

University of Alaska Fairbanks

ANNUAL REPORT

For the year ending December 31, 1989

Fairbanks, Alaska 99775-0080

Misc. Pub. 90-2

June 1990

Letter of Transmittal

The Honorable Steve Cowper
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, 1989. 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, 1990

Contents

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 animals 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.

Dr. Meriam Karlsson, assistant professor of horticulture, examines a few of the poinsettias she grew in the UAF greenhouse as part of a research project.

Plant and Animal Sciences

Feedstuffs for Beef Production in Alaska

Two major areas are being studied in this project:

1). Alternate approaches for calculation of beef cattle diets, and

2). Evaluation of Alaskan feedstuffs for use in beef production in Alaska.

Use of net energy values to balance beef cattle diets for specific intakes and average daily gains is difficult because feeds are utilized differently for maintenance and gain. In this study, coefficients were derived for use in the quadratic formula which precisely calculated percentages of two feeds needed to meet required NEg and NEm. Once this algorithm was established, the intake prediction equation used by the NRC was evaluated. This equation was incorporated into the balancing equation and reduced. This was done for several classes of beef cattle, yielding simplified equations for use with a hand-held calculator for predicting intake. Evaluations are continuing to develop equations for use in calculating least-cost feeding programs.

Alaska produces a variety of non-traditional crops that have significant potential as livestock feeds, if they can be used correctly in a balanced diet. To study this problem, a trial was initiated in December, 1989 with finishing beef steers. Sixteen steers were divided into four groups and placed on finishing rations using 80 percent Alaskan-grown whole barley and 20 percent Alaskan brome hay; 80 percent 'Thual' barley and 20 percent hay; 80 percent Alaskan hay and 20 percent whole barley; and 80 percent hay and 20 percent Thual barley. These animals will be weighed every two weeks, with careful feed intake records maintained daily. When the steers are slaughtered carcass data will be gathered. From these studies a better understanding of Alaskan crops as beef cattle feeds should be gained, so that ration recommendations can be made for producers using local feeds.

L.B. Bruce

Dietary Selenium in Supplementation for Beef Cattle

Feedstuffs grown in Alaska are typically deficient in selenium (Se). A study with 32 crossbred Alaskan beef cows was conducted to compare methods of Se supplementation. The cattle were studied in four groups: no Se supplementation; Se supplemented by ingestion of soybean meal; Se supplemented with monthly intramuscular injections; and Se supplemented by a injection every eight week period. Cows were weighed and blood samples are taken monthly. Dietary intake was closely monitored. The feeding and injections began in mid-December and continued until April. At calving, observations were made on the status of both the cow and her calf. Blood analyses and cow and calf performance are being used to evaluate the success of the various supplementation treatments. Preliminary results indicate supplementation with small amounts of feedstuffs containing adequate Se and injections every one or two months will supply adequate Se; however, single injections will not supply adequate selenium. Selenium has recently become available in a sustained release bolus and in trace mineral salt. A follow up study will compare Se supplementation by salt or continual release bolus for use under Alaskan conditions. The cattle will also be monitored as to the effects of Se on their ability to withstand cold stress. Two groups of cattle (mature, pregnant beef cows) will be fed, 18 in each pen, at the published NRC energy requirement level for maintenance. One group will have access to Se trace mineral salt blocks and the other only to trace mineral salt blocks. One-half of each group of the cows will be given a Se bolus. To compare the groups the following information will be collected: blood samples (beginning and end), daily dietary intake by pen, and bi-weekly measurement of weights, hair length, shoulder height, and backfat thickness. Station weather conditions will be monitored. *L.B. Bruce*

Potato Yield Trials

Forty-five named cultivars and numbered selections of potatoes were evaluated under irrigated and non-irrigated conditions at the Matanuska Farm near Palmer in 1989. The 1989 growing season was warmer and longer than usual, and average yields were at record levels. The top yielding cultivar was 'Green Mountain' which produced 23.3 and 18.5 tons per acre of US #1 tubers in the irrigated and non-irrigated trials respectively. A numbered selection from the collection of C.H. Dearborn (6-78-139-80) ranked third in the irrigated trial and second in the non-irrigated trial with 22.2 and 18.2 tons per acre of US #1 tubers respectively. Other top yielding cultivars included 'IditaRed,' 'Sable,' 'Kennebec,' 'Rosa,' 'Lemhi Russet' and 'Allagash Russet.' The average yield of US #1 tubers for all varieties was 17.7 tons per acre in the irrigated trial and 14.1 tons per acre in the non-irrigated trials. Average total yield for all varieties was 20.7 and 16.1 tons per acre in the irrigated and non-irrigated trials respectively. Specific gravity values were somewhat lower than in previous years, and this may have resulted from the warmer growing season. Moisture stress was evident during June, but was not severe enough to cause wilting in the field. Rainfall provided adequate water for the crop after mid-July. *D.E. Carling*

Pathogenicity of Rhizoctonia solani and Other Rhizoctonia on Potato at Different Temperatures

Pathogenicity of 47 isolates representing 11 anastomosis groups (AG) of *Rhizoctonia solani* and 12 isolates representing other multinucleate or binucleate species of *Rhizoctonia* was determined on sprouts and roots of emerging potato plants at 10°C, 15.5°C and 21.1°C. Isolates of *R. solani* AG-3 killed significantly more sprouts than any other group. Isolates of most groups killed no sprouts. While isolates of *R. solani* AG-3 and AG-5 damaged sprouts significantly more than other groups, most damage to roots was caused by isolates of *R. solani* AG-8 and AG-3. Other isolates, including those representing other anastomosis groups of *R. solani*, *R. oryzae*, *R. zeae* and binucleate *Rhizoctonia* caused a minimal amount of damage to sprouts and roots. Isolates of *R. solani* AG-3 heavily damaged sprouts at 10°C, 15.5°C and 21.1°C but caused significantly more damage at 10°C. Isolates of AG-3 also damaged roots at all three temperatures. Isolates of AG5 damaged sprouts at 15.5°C and 21.1°C but caused minimal damage to roots. Isolates of AG-8 caused heavy damage to roots at all three temperatures, but minor damage to sprouts. It is apparent that in cool climates isolates of *R. solani* AG-3 are more pathogenic. In warmer climates, isolates of AG-8, AG-5 and perhaps representatives of other groups of *Rhizoctonia* may be more important in the etiology of *rhizoctonia* disease of potato.*D.E. Carling*

Effect of Residual and Applied Nitrogen on Yields of Head Lettuce

In this repeat of a study first conducted in 1988, residual levels of soil N were established by applying 0, 50, 150 or 250 lbs per acre N as ammonium nitrate to field plots in the summer of 1988. Plots were fallowed in 1988. In the spring of 1989, these plots were split and 0, 25, 50 or 100 lbs per acre N was applied. Head lettuce (var. Salinas) was transplanted onto these 16 plots shortly after application of fertilizer in the spring. High rates of residual N had a stunting effect on the transplant early in the season, and leaves of these plants were more rigid and thicker in appearance. Weights of mature heads harvested from the 0 lbs per acre 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 compares very closely with the previous years data, and again 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.

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

Soilborne Populations of Rhizoctonia solani AG-3 and Trichoderma sp.

This study was begun in 1984 and initially was designed to determine the effects of various crops on populations of *R. solani* AG-3. In the first years populations of *R. solani* AG-3 were comparatively high in plots planted with contaminated and non-contaminated potato seed, and lower in plots planted with carrots, bluegrass, barley or left fallow. After several years, populations of AG-3 had essentially disappeared

from the non-potato plots, but remained relatively high where potatoes were grown. By 1988, populations of AG-3 in the potato plots clearly had declined; suspecting an increase in competing microorganisms, we began monitoring populations of *Trichoderma* sp. Also, sampling in an identical plot was initiated in 1988, with all six crops, so fluctuations in *Trichoderma* populations could be monitored from the beginning of the mono cropping cycle.

In 1989 populations of R. solani were comparatively high in all potato plots, but lower where potatoes had been grown continuously since 1984. Populations of AG-3 in the non-potato plots (those initiated in 1987) were higher than in non-potato plots initiated in 1984. It was possible occasionally to detect AG-3 in the 1984 non-potato plots, but on a season long basis, populations in these plots was extremely low. Populations of *Trichoderma* tended to be somewhat higher in potato plots than in non-potato plots. *Trichoderma*, along with other soilborne microbes, may be responsible in part for declining populations of *R. solani* AG-3.

D.E. Carling

Evaluation of Foreign Potato Cultivars

In 1989, small lots of seed of 32 Russian potato cultivars, and single cultivars from the Netherlands, Scotland, and Finland, were increased in the field for future evaluation at the Matanuska Farm. All produced small quantities of seed which will be increased further in 1990. Those yielding well and possessing good type and taste will be included in the 1991 yield trial. Generally speaking, the quality of the tubers produced thus far has not been high enough to compete with the quality of varieties currently grown on a commercial scale in Alaska.

D.E. Carling

Chemical Weed Control in Potatoes

Five chemical weed control treatments including: EPTC, metribusin (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 1989. Intense competition from weeds in the southcentral plots near Palmer reduced yields by 83 percent in the non-weeded controls. Pre-emergent applications of metribusin or linuron or a post-plant application of linuron controlled weeds; potato yields were not reduced in these plots. A post-plant application of metribusin was slightly but significantly less effective, while EPTC was ineffective in controlling weeds. There was no significant interaction of weed control treatments and varieties 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 lamb's-quarter, shepherd's purse and corn spurry. Chickweed covered more than 50 percent of the non-weeded control plots throughout the season while common lamb's-quarter covered 25 percent of the non-weeded control by late August. Either metribusin or linuron appears

to be capable of effective weed control when applied just prior to emergence of the potato plants. *D.E. Carling and J.S. Conn*

Effect of Herbicide Residues on Crop Growth and Yield

Bio-assays for residues of metribusin, linuron, and diphenamide were conducted in a non-replicated manner in the field on plots that one year earlier had been treated with recommended rates of the respective chemicals. The assay consisted of planting seed of head lettuce, red leaf lettuce, romaine lettuce, cabbage, and barley in each plot. Percent emergence was recorded, after which the stand of surviving plants was thinned and maintained until harvest. In addition to the seeded crops on various plots, transplants of head lettuce were planted in plots that one year earlier had received either metribusin or no chemical treatment. Emergence of cabbage was reduced to 34, 95 and 95 percent by metribusin, linuron, and diphenamide respectively. Cabbage plants that survived early stages of growth in all treatments went on to produce marketable heads. On plots treated with metribusin, emergence by head lettuce, red leaf lettuce, romaine lettuce, and cabbage was reduced to 27, 23, 16 and 34 percent respectively. Once again, plants surviving the seedling stage appeared to grow and develop normally. Head lettuce transplants placed in the metribusin treated plot grew normally and yielded similarly to transplants placed in the non-treated control plot. Harvest weight of barley was reduced by approximately 85 percent by residues of diphenamide, but barley growth was not affected by residues of metribusin or linuron.

Metribusin and linuron are herbicides being considered for use by potato and vegetable growers. This preliminary evidence indicates residues of linuron may pose only a limited risk to various vegetables grown in fields treated the previous year. Fields treated with metribusin pose a greater threat to vegetable crops planted from seed, and longer rotations may be necessary where metribusin is used. Use of transplanted vegetables may permit shortening of the rotation.

D.E. Carling and J.S. Conn

Screening Accessions of Solanum sp. from the IR-1: Collection for Resistance to Rhizoctonia Solani AG-3

Seed tubers of 237 plant introductions (PI) representing 55 species of *Solanum* were planted in field plots inoculated or not inoculated with *R. solani* AG-3. The purpose of the study, which has been in progress for three years, is to identify resistance and susceptibility to this fungus in the various PI. This year, 26 PI representing 13 species demonstrated some tolerance to the fungus including: *S. acaule, S. alandiae, S. chacoense, S. demissum, S. marinasense, S. microdontum, S. okadae, S. phureja, S. tarijense, S. trifidum, S. tuberosum* ssp. *andigena, S. vernei* and *S. verrucosum*. Twenty-four PI demonstrated susceptibility representing species including: *S. acaule, S. chacoense, S. demissum, S. megistacrolobus, S. microdontum, S. multidissectum, S. papita, S. stoloniferum, S. tuberosum* ssp. *andigena* and *S. verrucosum*. Next season we plan to acquire seed tubers of PI evaluated in the past. By reevaluating PI that showed resistance or susceptibility in the past, we can confirm the existence of a characteristic in a particular PI.

D.E. Carling

Bacterial Ring Rot Symptoms on Potatoes in the Field

Tubers of five potato cultivars ('Bake-King', 'Green Mountain', 'Lemhi Russet', 'Shepody', and 'Superior') were inoculated with the bacterial ring rot organism [*Corynebacterium sepedonicum* (syn. *Clavibacter michiganense* subsp. *sepedonicum*)]. The bacterial isolate used was a typical mucoid strain known to produce typical field symptoms in susceptible varieties. Inoculated and non-inoculated seeds were planted in the field in early June and observed throughout the summer for symptoms of the bacterial ring rot disease. By late August, typical wilting was observed in the leaflets and leaves of Lemhi Russet and Superior plants. Lesser amounts of wilting was observed in Bake-King and Green Mountain, but no symptoms were observed in the foliage of Shepody. At harvest in mid-September essentially all foliage of Lemhi Russet and Superior plants had wilted and died, while less than 20 percent of foliage of Bake-King and Green Mountain plants had wilted and died. Tubers produced by inoculated plants of all five varieties possessed characteristic symptoms of bacterial ring rot disease. In addition, tubers of Shepody produced large, sunken discolored lesions on tuber surfaces as well as a type of internal degradation that more closely resembled frost damage than the type of rot generally associated with infection by *C. sepedonicum*. However, no freezing temperatures had occurred prior to harvest.

D.E. Carling

Nitrogen Dynamics Following the Incorporation of Various Crop Residues into Subarctic Agricultural Soil

Crop residues with high nitrogen (N) contents (narrow C/N ratios) are good sources of N for succeeding crops. Barley which has a low N content and wide C/N ratio generally immobilizes N (ties up N during decomposition). Learning when and how much nitrogen is immobilized or mineralized (released) from various crop residues will aid in designing fertilizer programs which maintain yields, but reduce fertilizer inputs to reduce costs and contamination of ground water.

Field and laboratory studies were used to estimate the amount of N immobilized by barley straw and mineralized by alfalfa, faba bean, and rape when incorporated as a green manure crop. Barley was found to immobilize about 10 lb of N/acre the first year, while rape, alfalfa, and faba bean mineralized about 25, 20, and 10 lb of N, respectively. Assuming a target yield of 3000 lb of barley per acre, we estimate that 80 lb of N per acre is required following a barley crop and 45, 50, or 60 lb N per acre required following rape, alfalfa, or faba bean as a green manure crop. These estimates are based on returning 3000 lb per acre of each plant material to the soil.

The long term dynamics of N from these plant residues are being studied in the field using ^{15}N labeled plant material.

V. L. Cochran and R. T. Koenig

Barley Breeding

Approximately 400 barley accessions, primarily of northern-latitude origin, were grown in single row observation at Palmer in 1989. Rows which headed not more than two days later than the check cultivar 'Otal' were harvested for more thorough evaluation in four-row plots in 1990. Forty-three successful crosses were made in the

greenhouse in 1989. This F_1 seed also was grown in the greenhouse to produce F_2 seed. Field evaluations of previously-developed segregating families in the F_2, F_3, and F_4 generations were also conducted. A number of these families demonstrated earlier heading and stronger straw than Otal, and appear to offer potential for extracting superior genotypes.

The Northwestern Canada Barley Yield Trial, consisting of Otal and 29 Canadian cultivars, was grown at Palmer in 1989. Mean yield was 92.5 bushels per acre, with Otal yielding 96.1 bushels per acre. No cultivars in this test were earlier-maturing than Otal. Early maturity was significantly correlated with low yield and tall plant height.

S. M. Dofing

Plant Breeding and Genetics

Several studies which investigate the inheritance and contribution to northern-latitude adaptation of important traits were initiated in 1989. Barley genetic stocks containing genes conferring single- or low-tillering were crossed to Alaskan cultivars. After several cycles of backcrossing, it will be possible to measure the direct of the single- and low-tillering phenotypes in common genetic backgrounds.

The smooth brome (*Bromus inermis*) cultivars 'Carlton' and 'Manchar', along with plant collections of native Alaskan pumpelly brome (*Bromus pumpellianus*), were grown and vernalized in 1989. It is hoped that interspecific hybridization of these species will be possible in 1990, allowing for the comparison of two parental genotypes and hybrid genotype having equal genetic contributions from both parents.

The comparative phenology of early-maturing barley and wheat cultivars was studied in 1989. The superior adaptation of barley resulted more from its rapid grain fill and ripening compared to wheat than early heading per se. In addition, barley cultivars produced more leaves, and had a faster rate of leaf appearance.

S. M. Dofing

Use of On-site Mycorrhizal Inoculum for Plant Establishment on Abandoned Mined Lands

Native plant species may colonize abandoned mined lands, but their growth may be stunted by poor growing conditions. Normal growth of many plant species requires mycorrhizae under field conditions. Mycorrhizae are mutualistic symbioses between fungi and plant roots where nutrient and moisture absorption by the plant is improved and the fungus obtains energy (carbon) from the plant. Mycorrhizae go through succession the same as vegetation communities. Hence different soils may be appropriate for use as inoculum under different conditions. Local soil was assumed to have the needed mycorrhizal propagules to improve the colonization levels in poplar cuttings and alder seedlings.

A study was initiated in 1988 to investigate the use of local topsoil as a source of mycorrhizae for forest regeneration on abandoned mined lands where mycorrhizal colonization potential is usually low. An initial survey was conducted to determine the existing levels of mycor-

rhizae on native and disturbed soils. Four experiments were implemented to determine:

1). the effects of fertilizer and mycorrhizae on poplar growth;
2). differences in growth response of poplar cuttings and alder seedlings to soil inocula from different successional sites;
3). effects of fertilizer and alder as a source of nitrogen; and
4). the importance of microsites, fertilizer and mycorrhizae in establishing vegetation on a steep slope.

Plant heights and basal diameters were measured at the start and end of the growing season each of the two years of the study. Several plants per plot were harvested and additional physical dimension measurements were made during the last sample period in August 1989. The harvested plants were analyzed for root dimensions, current growth, nutrient levels of leaf tissue (only the fertilizer and inoculum source experiments), root colonization by mycorrhizae (both endo- and ectomycorrhizae), and spores.

At the end of the second growing season, plots treated with mycorrhizae and/or fertilizer had improved plant growth. Fertilizer appeared to enhance the growth response to soil transfer, but the difference was not significant compared to soil transfer or fertilization alone. The successional stage of vegetation on soils used as inoculum was important for some plant species. Poplar had slight differences between the two sources. Alder plants grew twice as much with soil from a mature site compared with that from an intermediate successional site. The steep slope (30° to 40°) needed any two treatments (microsites, fertilizer, or mycorrhizae) to achieve the best plant establishment. Microsites were small (10-cm wide) benches constructed in the hillside to stabilize the slope and improve moisture relations. Although these results indicated short-term benefits from this soil transfer, the plots need to be monitored over a longer period. More needs to be learned about the interactions of plant species and soils.

This project was funded by the U.S. Bureau of Mines. *D.J. Helm*

Usibelli Vegetation Studies

Coal mines 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 to characterize existing vegetation in the area. Parameters being measured include vegetation cover, woody species density, heights, and ages. Plant species diversity is calculated from the cover data. Data will be synthesized with respect to slope, aspect, and disturbance history.

A successional study was conducted in 1989 on disturbed sites ranging from 0 to 35 years of age to determine site characteristics associated with seeded and naturally colonizing species. Woody species, especially alder (*Alnus crispa*), colonized certain areas, although some plant-site relationships need to be understood. These results were combined with data from four previous years of evaluation studies. Sites were classified based on species composition; then the relationship of environmental characteristics (age since seeding, slope, aspect, interaction of slope and aspect, substrate texture, and pH) to

these vegetation types were investigated with discriminant analysis. The extent of living cover and its species composition depended on slope, age since seeding, interaction of slope and aspect, and substrate texture.

Species and site characteristics that need to be considered for revegetation are being compiled for desired woody species. These characteristics include methods of propagation, seed dispersal, germination and establishment requirements, soil conditions, mycorrhizal requirements, successional relationships, and other environmental characteristics. This information is being collected from the literature and successional studies and will be used to plan reclamation strategy on mined lands.

These studies are funded by Usibelli Coal Mine, Inc. *D.J. Helm*

Reestablishment of Woody Browse Species for Mined Land Reclamation

Requirements of woody plant species must be matched with physical, chemical, and biological soil properties for successful revegetation of mined lands. Goals in this study included plant cover, moose browse, and diverse natural communities. Soils vary in their biological properties, especially the buried propagule banks and mycorrhizal colonization potential. Buried propagules may increase plant species diversity, or they may compete with more desirable plant species. Mycorrhizae are needed for successful growth of many plant species under field conditions. First year results indicated that tall fireweed (*Epilobium angustifolium*) regeneration is favored by fertilization. Species composition of natural regeneration varied among soils although some of the same native colonizers occurred on all soils.

Grass seed mixes used in revegetation must be adjusted for their goals on specific sites: good cover where soil erosion is a concern, diversity, and low competition with woody regeneration. These may be conflicting goals. Trials were made with species as a monoculture, mixed with 'Arctared' red fescue (*Festuca rubra*, a very successful conservation grass in past studies), and in a mix. Ratios of species within a mix and rate of mix application were varied to meet the various goals. Grasses were seeded in early July 1989 under very dry conditions. Late season rains improved cover. The best grasses in this first dry year included Arctared red fescue, 'Nortran' tufted hairgrass (*Deschampsia caespitosa*), and 'Gruening' alpine bluegrass (*Poa alpina*). No grasses were large enough to compete with the woody species, but cover of the better grasses appeared to suppress fireweed cover in some cases.

These studies are funded by the Alaska Science and Technology Foundation and Idemitsu Alaska, Inc. They were initiated in 1989 and will be monitored for at least three years into the 1991 field season.

D.J. Helm

Wishbone Hill Vegetation Studies

Vegetation studies on the proposed Wishbone Hill Coal project were initiated in 1988. Work continued in 1989 on pre-mining vegetation inventory interpretations and applications. These cover, density,

and browse data were synthesized with information concerning plant species propagation and values for wildlife to help develop a revegetation plan of plant communities. These studies provided needed information for a mining permit application but went well beyond the legal requirements for coal companies.

These studies were funded by Idemitsu Alaska, Inc. *D.J. Helm*

Flower, Vegetable and Fruit Demonstration Cultivar Trials

Cultivar trials were conducted with 280 annual flowers and 175 vegetable crops from experimental and commercially available sources. These plants were grown in a public demonstration garden where newly-released cultivars were compared with those that had performed well during the last eight years. 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 27 herbaceous perennials, 12 woody ornamentals, four evergreens, and 20 ornamental grasses.

Cultivar trials with fruit crops were initiated in 1989 at six sites in interior Alaska and seven sites in southcentral Alaska. Most cultivars of *Amelanchier, Ribes,* and *Vaccinium* survived with little winter injury, but some raspberry cultivars did not survive partly due to poor planting stock. Information on plant hardiness, reproductive phenology, fruiting, and fruit quality will be gathered during the next five years.

P. Wagner, P. Holloway and G. Matheke

Effects of Different Polyethylene Mulches and Row Covers on Yield of Day-neutral Strawberries

Strawberries have been produced commercially and by home gardeners in interior Alaska since the late 1970s using clear polyethylene mulch and row covers to promote early fruiting of day-neutral strawberries. The major drawback of this technique is that it requires the use of herbicides or inefficient hand weeding. Black or opaque mulches have been used with limited success as a means of weed control. The objective of this three-year study was to determine the effect of various mulches on strawberry yield, soil temperatures beneath the mulch, and air temperatures above the mulch. In 1987, yields (0.76 lb/sq ft) using clear polyethylene mulch were significantly greater than all other mulch treatments (0.41-0.52 lb/sq ft) for black polyethylene; black over white two-sided, embossed polyethylene; black latex spray mulch; permeable mulch; or white over black two-sided, embossed polyethylene mulch. During the second year, yields using clear mulch were significantly greater than all treatments except for black polyethylene (1.03 lb/sq ft and 0.94 lb/sq ft, respectively). Yields for the other mulch treatments ranged from 0.70 to 0.76 lb/sq ft. The summer of 1988 was warmer than average, and this may account for the improved performance of the black plastic mulch. In 1989, the clear polyethylene mulch had significantly higher yields (1.11 lb/sq ft) than all other mulches (0.54 to 0.86 lb/sq ft).

If maximizing yields is important, clear polyethylene mulch with a polyethylene row cover is the best mulch treatment for everbearing strawberries. Black polyethylene mulch with a clear polyethylene row

cover may be used to avoid extensive hand weeding or herbicides; however yields may be decreased significantly especially during cool summers.

G. Matheke, P. Wagner and P. Holloway

Propagation of Polystichum Aleuticum, Aleutian Shield Fern, by Spores

The Aleutian shield fern, *Polystichum aleuticum*, is an endangered species whose known distribution is confined to three populations, two on Adak Island and one on Atka Island in the Central Aleutian Island District, Alaska. The total number of plants on Adak is estimated to be approximately 125. The possible causes for the rarity of this species have not been identified. The objectives of this study were to attempt to germinate spores of this fern, establish plants *in vitro* and eventually establish a greenhouse-cultivated population that would facilitate future studies in reproductive biology.

Spores were collected on 29 August 1989, air dried, and sown onto a variety of sterile agar-based media or a 2:1 (v:v) peat/sand medium. Initial germination was observed 61 days after sowing. Germination was best on the Hoagland's solution followed by Knop's solution and the peat/sand mix. Germination was favored by cool, alternating temperatures (18/12 C) with 18 hours of the high temperature.

P. Holloway, P. Wagner and G. Matheke

Fertilizer Trials for Greenhouse Production Of Pulsatilla Patens and Iris Setosa

The wild crocus, *Pulsatilla patens*, and wild iris, *Iris setosa* ssp. *interior*, are two Alaska native plants that have potential for commercial cultivation, however little is known about techniques for greenhouse production. This experiment was designed to determine optimum fertilizer requirements for the production of seedlings in cell packs using a commercial peat lite potting mix. Treatments included all possible combinations of five levels—0, 50, 100, 150 and 200 mg/l—of N, P_2O_5 and K_2O applied as weekly liquid feed.

P. Holloway, G. Matheke and P. Wagner

Row Orientation for Red Raspberries in Interior Alaska

Red raspberries in Alaska traditionally have been grown in an east to west row orientation presumably to intercept the maximum summer sunlight. Because of low sun angles, large differences in fruit yield and quality have been observed between the north and south sides of the rows. These differences have never been quantified. The advantages of an east to west orientation over rows that are north to south have not been identified, therefore an experiment was initiated in 1988 to determine the best row orientation for red raspberries in order to maximize yield and obtain the best fruit quality.

During the first growing season, rows oriented east to west averaged 188.0 g of fruit per 6 m row (north and south sides combined), while rows oriented north to south averaged 135.5 g per row (east and west sides combined). The north-, east- and west-facing sides of each row averaged 65.0-70.5 g per plot, whereas the south-facing side

averaged 117.5 g per plot. Yield data will be collected for at least three seasons along with information on vegetative growth and fruit quality once the plants have matured.

P. Holloway, G. Matheke and P. Wagner

Hulless Barley (Thual) and Corn in Beef Cattle Finishing Rations

Six Hereford steers (704 lb) were randomly allotted to two diets for a 127-day feeding trial to compare ground hulless ('Thual') barley to corn as a sole energy source in beef cattle finishing rations. Simplified diets balanced for minerals were formulated to maintain an 85:15 (concentrate:roughage) ratio throughout the study. At the 85:15 ratio, hulless barley-bromegrass diet provided adequate energy, but exceeded the crude protein requirement. Therefore, to maintain the diets to be approximately isocaloric, isonitrogenous, and isofibric,the corn-soybean meal-bromegrass diet was fed throughout the entire feeding period. Steers received one million and 150,000 IU of injectable vitamins A and D, respectively, were individually penned and provided free choice feed and water. Growth promotants and feed additives were not included in the dietary treatments.

Final body weights were 1080 lb for all six steers and both the rate and efficiency of gains were not significantly different. The average daily gains (3.05 and 2.88 lb per day) and feed efficiencies 6.18 and 6.85 (lb feed/lb gain) for steers fed hulless barley and corn diets, respectively, tended to be in favor of the barley treatments. In conclusion, hulless barley diets produced acceptable growth and feed performance and can be utilized as the sole grain in beef cattle finishing diets.

F.M. Husby

W-166, Hulless and Covered All-Barley Starter Pig Diets Containing Black and Gray Cod Fish Meals

A completely randomized study with a 2 x 2 factorial arrangement was conducted with 64 weaner pigs to compare four all-barley (one covered, 'Datal'; vs one hulless, 'Thual') starter diets that contained 20 per cent crude protein (CP) and included 20 percent dried whey, 10 percent black or screened gray cod meals and were equalized to four per cent fat with the addition of herring oil and included 125 percent NRC trace minerals and vitamins. Pigs were weaned at 28 days (18.5 lb) and fed to 56 days (48.6 lb). Growth (.92 lb/day) and feed conversions (1.74 lb/lb gain) were not significantly different between barley types or fish meals.

A second trial was initiated to compare all barley (Datal) starter pig diets containing soybean meal-corn oil, black cod meal, whole canola-canola meal, extruded soybeans, soybean meal-beef tallow as protein and energy supplements with a 20 percent CP and four percent dietary fat. With the exception of the extended soybean diet in the first replicate, pigs were fed the diets from 28 days of age (15.6 lb) to 56 days (43.1 lb) and the only difference in performance was improved rate of gain (1.07 to .88 lb per day) of pigs fed the black cod meal vs soybean meal-corn oil, respectively. Efficiency of gains (1.68 lb feed/lb gain) were equal and the improved daily gains for the black cod meal diet were attributed to an increased daily feed intake (1.8 to 1.4 lb feed).

In other studies of potential swine feeds, six cultivars 'Azure', 'Cougbar', Datal, 'Morex', 'Otal', 'Steptoe') grown in Fairbanks for the cultivar x growing location study had average test weights and yields of 49.2 lb per bushel and 73.1 bushels per acre respectively.

Following two growing seasons at Fairbanks, four amaranth accessions [K343, 4779134 (1011), 477914, R158 (Ames 3216)] from USDA, Ames, failed to either set seed or produce mature seed in 111 day growing periods, but did demonstrate forage potential (4.5 tons dry matter per care and 20.6 percent CP). *F.M. Husby*

Optimization of Flower Formation in Primrose by Environmental Factors

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 six 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.

P. vulgaris 'Dania Lemon Yellow' was chosen for this experiment. Constant day and night temperatures of 8°, 12°, 16° or 20°C were maintained during the flower initiation process. Day lengths of eight, 11 and 14 hours were selected to include critical photoperiods for most short day and long day plants. Flower initiation was studied under irradiance levels of 2, 10 or 18 mol/(m^2• day). The instantaneous irradiance level was adjusted based on day length to give the desired total daily irradiance level. The plants were moved to 16°C, 11 hours day length and 10 mol/(m^2• day) after flower initiation has occurred.

The transition from vegetative to reproductive meristem at 16°C occurred faster under long day conditions. Averaged over the three irradiance levels, flower initiation was observed after 45 days from transplant (75 days from sowing) for plants grown at eight hours day length, 42 days at 11 hours day length and 36 days for plants grown at 14 hours day length. Total daily irradiance also affected the rate of flower initiation. Averaged over the three day lengths, flower initiation had occurred after 48 days at 2 mol/(m^2• day), 36 days at 10 mol/(m^2• day) and 40 days at 18 mol/(m^2• day). The fastest flower initiation rate observed at 16°C was 28 days for plants grown under environmental conditions of 14 hours day length and 10 mol/(m^2• day). Photoperiod and irradiance level affected plant morphology at 16°C. Eight weeks after transplanting, the length of the longest leaf on the plant doubled from 65 mm to 130 mm as the day length increased from eight to 14 hours and irradiance decreased from 18 to 2 mol/(m^2• day). No differences were observed in flower number, flower size, and shoot number among plants grown at the different environmental conditions during flower initiation.

Primrose development under long day conditions at 16°C resulted in fast floral initiation while the formation of long leaves lessened plant

quality. Intermediate long photoperiods (11-12 hours) may be required to attain both satisfactory flower initiation rate and plant quality.

M. Karlsson, J. Dart and H.C.H. McIntyre

Low Temperature Effects on Floral Initiation and Development in Chrysanthemum

The effect of low temperature (10°C) on the transition from vegetative to reproductive meristem was determined in *Chrysanthemum morifolium* Ramat. Maintaining optimum greenhouse temperatures for flower development may not be feasible during periods of outside low temperatures. Under such conditions, an understanding of the low temperature effects during flower initiation will facilitate early decision making. The extent of damage during flower formation may warrant early crop termination or adjustments in the environmental conditions during successive plant development.

Rooted chrysanthemum cuttings of the cultivar 'Bright Golden Anne' were planted in a peatlite® medium and grown at a day length of 16 hours (360 µmol/(m^2• s)) and constant 20°C. After 11 days, plants were pinched and the temperature reduced to 10° or 15°C. The day length was shortened to 10 hours and the irradiance level maintained at 13 mol/(m^2• day). Shoot apices were collected weekly for five weeks from three randomly selected plants grown at each temperature. Light, fluorescent, and scanning electron microscopy (SEM) were used to determine the transition from vegetative to reproductive growth.

The increase in meristem size and the continued floret development had a slower rate at 10°C compared to 15°C. Plants grown at 15°C and sampled after 14 days had comparable meristem size to the plants grown at 10°C and sampled after 21 days. After 21 short days, 7-8 rows of florets were observed on the meristems of the 15°C grown plants, while after 28 short days only 3-4 rows were visible on the meristems of the low temperature grown plants. SEM provided the best documentation for the progression of floral formation while the event of flower initiation was most easily detected using a fluorescence microscope or a stereo-microscope.

M. Karlsson and H.C.H. McIntyre

Temperature Driven Leaf Unfolding Rate in Hiemalis Begonia

Vegetative growth in *Begonia* x *hiemalis* (hiemalis begonia, Rieger begonia or elatior begonia) is favored by long days and reproductive growth by short days. The desired final plant size and marketing date determine the timing of the switch from long days to short days. Rate of leaf unfolding is a method to follow vegetative growth progression. A lower leaf unfolding rate is expected during short days and reproductive growth compared to long day conditions. Information on temperature controlled leaf unfolding rate will enable correct timing of the short day treatment for predictable begonia growth and development.

Leaf unfolding rates for *B.* x *hiemalis* 'Hilda' and 'Ballet' were determined under long day conditions (16 hours of light, 280 µmol/(m^2• s)) and temperatures of 13°, 16°, 19°, 22°, 25° and 28°C. After the switch to short days, rate of leaf unfolding for the two cultivars was determined at 21°C. The number of leaves above the leaf initially marked at the beginning of the experiment was recorded daily for each shoot.

Regression analysis on the recorded number of leaves gave the leaf unfolding rate of individual shoots. These resulting rates were used to develop the functional relationship for begonia leaf unfolding rate.

The two cultivars had similar rates of leaf unfolding, during the initial long day period. The following functional relationship was developed to describe the rate during long days: Leaves $day^{-1} = -0.2083 + 0.03145 \cdot °C - 0.0007631 \cdot (°C)^2$, ($r^2 = 0.94$). Fastest rate of leaf unfolding occurred at 21°C as indicated by the developed function. The predicted leaf unfolding rate at 21°C was 0.1065 leaves day^{-1} (9.4 days required to unfold one leaf). Rate of leaf unfolding at 13°C, was 0.0733 and at 28°C, 0.0811 leaves day^{-1}.

The response to temperature and leaf unfolding rate varied for Hilda and Ballet during the short days following the initial long day period. Ballet continued to unfold leaves at a similar rate as under 21°C and long days, while Hilda leaf unfolding rate slowed considerably. The difference in response may indicate the cultivar Hilda is more sensitive to photoperiod than Ballet. Short day treatment to time and schedule flower initiation in Ballet may be of little or no value.

M. Karlsson and H.C.H. McIntyre

Detection of Snow Mold Resistant Properties in Winter Wheat Plants and Androgenic Plantlets

A method was developed to assess the effects of extra-cellular enzymes of *Sclerotinia borealis* and sclerotial low temperature basidiomycete on winter wheat. Leaf segments, taken from cultivars Capitan, Froid, Roughrider, and Blizzard and from plantlets derived from the anther cultures of these cultivars, were weighed and treated with various concentrations of snow mold extracellular enzymes (consisting mainly of cellulolytic and pecteolytic enzymes). After a seven day incubation at 10° C, the chlorophyll content in the leaf segments was extracted and measured. Gradients of responses were observed of cultivars and plantlets ranging from no change to chlorosis. Enhancements in resistance to snow mold enzymes were observed in plantlets derived from Froid and Roughrider which possess moderate snow mold resistant properties.

J.H. McBeath

Expressions of Resistance to Extracellular Enzymes of Snow Mold Fungi in Anther Culture Derived Callus System

Calli derived from anther culture of winter wheat cultivar Roughrider were screened for expressions of resistance (or tolerance) to extracellular enzymes of snow mold fungi *Sclerotinia borealis* and sclerotial low temperature basidiomycete (sLTB). Over 2,000 calli with green centers (leaf primordia) from 16 clones were treated with snow mold enzymes (consisting mainly of cellulolytic and pecteolytic enzymes) and incubated at 10° C for four weeks. Calli were evaluated weekly and their extent of reactions was recorded using a numerical rating (0-4). The responses of calli to snow mold enzymes treatment varied widely, ranging from no change (rated 0) to complete discoloration and death (rated 4). Among all calli treated 2.6 percent and 3.4 percent showed degrees of resistance to enzymes of *S. borealis* and sLTB respectively.

J.H. McBeath

Comparisons of Pectinase and Cellulase Activities of Six Snow Mold Fungi

Partially purified extracellular enzymes of six snow mold fungi—*Fusarium nivale*, *Sclerotinia borealis*, sclerotial low temperature basidiomycete (sLTB), *Typhula incarnata*, *T. idahoensis*, and *T. ishicariensis* — were tested for poly-galacturanase (PG), pectin methylesterase (PME), pectin transeliminase (PTE), and carboxymethlycellulase activities. Among the six snow mold fungi, *S. borealis* was found to have the highest level of enzyme activities in PG (tested by measuring the reducing group), PME (determined by the Wich and Schroeder method) and PTE (detected by the UV Absorption Method). Enzymes of sLTB have the lowest PG activity but the highest carboxymethylcelluase activities (determined by reducing group analysis and by the loss of viscosity method). The lowest PME and PTE activities were found in enzymes of *T. incarnata* but the lowest carboxymethyl-cellulase activity was found in enzymes of *T. ishikariensis*. *J.H. McBeath*

Gravel Pad Vegetation Experiments Arctic Slope Alaska 1989-1999

Gravel fill used for road, camp, and other facilities in Alaska's arctic oil fields needs to be vegetated to improve conditions for wildlife habitat and conform to federal and state environmental stipulations. This series of experiments was started to provide information on plant species adapted to gravel soils in the Arctic, effectiveness of various manipulations of gravel fill on vegetation establishment, and to monitor plant succession on abandoned gravel pads at exploratory well sites in NPRA (National Petroleum Reserve in Alaska).

The research is conducted in conjunction with a comprehensive evaluation of wildlife uses of impoundments and gravel pads in the arctic oil fields of Alaska. LGL Research Associates (Anchorage, Alaska) is conducting the wildlife studies. The gravel vegetation research is being performed by personnel from the Alaska Agricultural and Forestry Experiment Station and is sponsored by BP Exploration (Alaska), Inc., the State of Alaska, and U.S. Department of Agriculture. BP Exploration is sponsoring the LGL research on wildlife uses of disturbed habitats in arctic oil fields.

The main project is scheduled for a 10-year period because vegetation establishment and community formation occur relatively slowly in the Arctic, and it is desirable to monitor stands for several years following establishment to determine trends in the resulting plant communities. Search for species adapted to gravel soils and monitoring changes on the NPRA sites began in 1984 and will span approximately 15 years. Manipulating gravel surfaces began in 1989 at the BP Put River No. 1 Well site, which was restructured to produce variations in gravel thicknesses and snow trapping berms. Seeding lightly with *Poa glauca*, adding minimal amounts of silt loam, and tillage to loosen compacted gravel are other variables being tested. Vegetation and soils on these plots will be sampled during alternate years to document changes over time. Also photo-points are being established to obtain a photographic record.

Table 1 contains a list of the species for which seed was collected during autumn 1989. Seed in these collections will be divided equally among the 144 plots on the BP Put River No. 1 pad. Our approach is to

focus on introducing to such plots indigenous plant species, which occur naturally on gravel soils in the region. Our theory is to introduce the species and encourage formation of plant communities by improving the soil (gravel) conditions of the gravel surfaces for supporting plants.

Table 1. Listing of 40 taxa from which seed was harvested during the 1989 field season. These seed collections are being threshed and cleaned and will be used to inoculate plots at the BP Put River No. 1 gravel vegetation study site during 1990.

SPECIES	COLLECTION SITES
INDIGENOUS FORBS	
Androsace chamaejasme	1
Armeria maritima	1
Artemisia borealis	1
Artemisia arctica	2
Artemisia glomerata	1
Artemisia tilesii	1
Aster sibiricus	1
Braya pilosa & B. purpurascens	1
Cerastium beeringianum	1
Chrysanthemum bipinnatum	1
Descurainia sophioides	1
Draba spp.	1
Epilobium latifolium	2
Eutrema edwardsii	2
Melandrium apetalum	1
Parrya nudicaulis	1
Pedicularis sudetica	1
Polemonium boreale	1
Primula borealis	1
Sedum rosea	1
Senecio congestus	1
Silene acaulis	1
INDIGENOUS GRASSES	
Agropyron boreale (or *macrourum)*	2
Alopecurus alpinus	3
Arctagrostis latifolia	5
Arctophila fulva	1
Bromus pumpellianus	1
Deschampsia caespitosa	4
Dupontia fisheri	1
Elymus arenarius mollis	1
Festuca brachyphylla	2
Festuca ovina	1
"Festuca vivipara"	1
Poa arctica	1
Poa glauca	3
Puccinellia langeana	2
Trisetum spicatum	2
INDIGENOUS SEDGE	
Carex maritima	3
INDIGENOUS WOODRUSH	
Luzula arctica	1
INDIGENOUS SHRUB	
Salix arctica	1

This is a departure from past approaches to vegetating barren sites in the Arctic, which required large supplies of seed to rapidly establish a grass (monoculture) cover to protect soils from erosion. There is no threat of erosion for gravel pads on the coastal plain of Alaska's Arctic Slope, and many of these gravel fills are located considerable distances from naturally occurring seed sources. Therefore, introducing several species and growth forms to such sites initially seems most practical and desirable because it ensures diversity in the community and does not require large quantities of seed which are commercially unavailable.

If this theory proves sound, it may be advantageous in the future to establish seed production stands of indigenous plant species on abandoned sites at suitable locations in the Alaskan Arctic, i.e. inland where growing conditions favor seed production over sites near the seacoast. Seed could be harvested from such stands to vegetate gravel fill throughout the region, and the tolerance of species to arctic conditions would be ensured.

Also a botanical garden is planned for the BP Put River No. 1 Well site. This garden will consist of 100 ft rows of indigenous species and will provide plants for monitoring growth, seed production, and other related factors from year to year as well as for seed for experimental purposes.

Table 2. Available nutrient data for dust from three locations along the Spine Road in the Prudhoe Bay Oilfield. Dust accumulations on adjacent surfaces of the tundra were sampled 22 September 1987 and represent the finest fractions in the gravel used to construct the road plus any silts, clays, and rock cuttings from reserve pits that may have been spread on the road during the early stages of development in this oilfield. Reserve pit water was often used to control road dust on these roads during the early 1970's, which included a period of relatively low construction activity. These dust samples were analyzed in the Palmer Research Center Service Laboratory at Matanuska Farm.

			ppm					
PH	NH_4-N[1]	NO_3-N	P[2]	K[3]	Cu[4]	Zn	Mn	Fe
			Junction near DS #13					
8.44	<1	1	1.3	32	1.2	1.7	5.1	12
			Between Lake Judith and DS #14					
8.16	<1	1	2.2	28	0.8	1.7	3.4	10
			Near Lake Patrawke - Central Power Station					
8.03	<1	1	2.1	20	1.4	1.9	7.4	21

1 All nitrogen is reported as 2N KCl extractable.
2 Sodium bicarbonate extractable.
3 NH_4-0Ac extractable.
4 All minor elements (Cu, Zn, Mn, Fe) are reported as DTPA extractable.

Table 3. Electrical conductivities (mmhos/cm) for fine fractions (<2 mm) in gravel collected from the BP Put River Number 1 Wellsite and Oxbow gravel pits near the Putuligayuk River. Samples were collected August 1988 and analyzed in the Palmer Research Center Service Laboratory at Matanuska Farm. Conductivities >4 mmhos/cm indicate soils inhospitable to plants intolerant to salinity.

BP Put River Wellsite No. 1		Oxbow Gravel Pits		
Lab No.	E.C. (mmhos/cm)	Lab No.	Site	E.C. (mmhos/cm)
		South Pit		
JM9S323BP-1	.96	JM9S336	Mid east bank	.56
JM9S324BP-2	2.96	JM9S337	6 ft below berm	.64
JM9S325BP-3	.42	JM9S338	North bank	.90
JM9S326BP-4	.34	JM9S340	Bottom south pit	1.77
JM9S327BP-S	.48	North Pit		
JM9S328BP-6	.48	JM9S339	North bank	.64
JM9S329BP-7	.34	Junction Pit		
JM9S330BP-8	1.28	JM9S341	Disturbed gravel	.68
		JM9S342	NE edge surface soil	.90
		JM9S343	NW edge scraped soil	3.10
		JM9S344	NW edge surface soil	1.91
		JM9S345	Lowest point normal color	.76
		JM9S346	Lowest point red color	.72

Tables 2 and 3 contain preliminary soil data for dust carried from gravel roads in the Prudhoe Bay oil field and fine fractions in gravel mined from the Oxbow pits near the Putuligayuk River. It is clear that available mineral nutrients are quite limited in these materials, and that will have a major effect on supporting plant communities. We also noted a wide variation in the composition of gravel throughout the region. Gravel in portions of the Kuparuk oil field contain much greater quantities of silt size and finer particles than gravel in the Prudhoe, Endicott, and Lisburne fields. Soil moisture holding capacities and fertility are factors of major importance to plant growth in these environments. It will be useful to relate these factors to plant density and species composition of plant communities establishing on gravel fill in this region.

J. D. McKendrick

Arctophila Fulva Revegetation Feasibility Project

The 1989 field season was the fifth and last for the *Arctophila fulva* revegetation feasibility study. Study objectives were to determine the feasibility of introducing *Arctophila fulva* into new aquatic environments (primarily impoundments resulting from oil field development) to enhance the value of those sites for wildlife. The research effort was divided into two studies. One study focused on life history of *Arctophila fulva* to determine how the grass colonizes, grows and reproduces in the arctic environment. The other study was directed to acquiring data and a better understanding of the aquatic environments that this species occupies.

This final field season's work included acquiring data for

missing elements in the array of measurements of aquatic environments and continuing the routine collection of temperature, photographic, and seed production data. Five boreal zone sites were added to the array from which plant and soil (mud) chemical data were obtained. Data gaps existed in the seasonal measurements of water chemical properties. Samples had been acquired previously for the period from late July through early October, but late June, and early July were missing from the series. Collections were obtained for those two periods in 1989.

The hourly temperature recording at six study sites was continued. This year we were able to obtain a record from breakup to freeze up (except for Endicott sites which were inaccessible until after high water receded). Now we have complete records for the 1988 and 1989 growing seasons. This record should be continued to document long-term variations in temperatures of air, water, and soil in this region.

We continued the photo record of seasonal changes at 42 photopoints at 30 locations. This record spans the five years of research on *Arctophila fulva* and is believed to be worth continuing for not only its value to this project but also for unforeseen uses in the future.

Soil characterization of muds within and adjacent to *Arctophila fulva* beds was continued. We discovered there were insufficient amounts of soil from some horizons for the necessary laboratory analyses. Based on findings from the 1988 field season, we calculated that by collecting 12 cores from each site there would be sufficient material for the laboratory and also permit a more complete array for observing variations within the soil.

Our site mapping and permanent marking operations continued. We now have maps for 86 locations completed. These maps are proving useful for other research projects in the region. It will help keep track of site-specific data for the Prudhoe Bay region and is intended to establish a procedure that others might use to better organize the various environmental data being collected in the arctic oil fields.

In 1988 we initiated a sampling procedure to obtain measurements on a variety Arctophila fulva and pond features. Thirty-five locations were sampled for mud, water, and plant chemical properties. Data included stand density and size, plant leaf widths, water depths occupied by Arctophila fulva, pond edge characteristics, thaw depths of mud, etc. After completing the first season's measurements, we concluded the data array was not evenly balanced in terms of technical standards. The field personnel acquired skills and improved their techniques during the study. We decided to repeat the measurements in 1989 and modified the sampling procedures based on previous experiences.

Based on findings from the plant and water chemical data obtained in 1988, we expanded the site array for habitat study to include Big Lake (a water supply source) and C-Pad Pond (a disposal site for treated wastewater). Both locations contain beds of Arctophila fulva. Shoot tops of Arctophila fulva were collected during June, July, August, and September from 47 locations in 1989. (Note: Arctophila fulva tissues were collected for chemical analyses at more locations than were sampled for water.)

Inventorying of shoot numbers at sites where we had transplanted Arctophila fulva was continued this year. However, the populations at

some locations, primarily those fertilized with phosphorus, were approaching numbers that are beyond the practical limits for this procedure.

Inflorescences were collected again this year to measure seed production. We discovered viable seed was produced at nearly every coastal plain stand of *Arctophila fulva* sampled in 1989. This was an unanticipated discovery, because during the four previous growing seasons little or no mature seed was found on *Arctophila fulva* plants growing on the coastal plain sites. Foothill stands produced mature seed each year of this study. Apparently seed production occurs regularly on *Arctophila fulva* growing in the boreal zone. We believe the seed production observed this year on the coastal plain resulted from the unusually warm and longer growing season.

One graduate student completed her doctorate degree while working on this project. Her research was based on testing the hypothesis that *Arctophila fulva* occurring in aquatic and terrestrial environments was a phenotypic response rather than genotypically controlled. She used reciprocal transplants and excavated rhizome connections between aquatic and terrestrial shoots to confirmed differences in growth form were due to phenotypically plasticity and not genotypic distinctions within the species. *J.D. McKendrick*

Evaluation of Annual and Perennial Forage Legume Species

Forage legumes are not widely used or recommended in Alaska. In the past, grass forage was nutritionally adequate for dairy cattle, but the production potential of Alaska's dairy cattle has increased dramatically in recent years. High crude protein (CP) concentrations are required in dairy rations. Imported feed supplements are currently being used to increase ration CP, but Alaska grown forage legumes could reduce the dependence on imported feedstuffs.

Sixty-nine varieties of 16 species were studied at Fairbanks and Point MacKenzie, while a smaller set of 16 varieties of 10 species was planted at Soldotna. The following data were collected: emergence, flowering dates, yield, growth habit, and extent of nodulation. Persistence of perennial species will be evaluated in 1990. Forage samples were collected and analyzed for *in vitro* dry matter digestibility (IVDMD), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF).

The yield and quality of red clover were noteworthy at all three locations. Other promising species include vetches, medics, field pea, white clover, berseem clover, and crimson clover. Basic agronomic information—seeding rates, fertility requirements, harvest management, etc.—is needed for most legumes in Alaska. Long-term performance, winter survival of perennials, and specific management practices must be defined before these crops can be recommended.

Some species, such as lupine and arrowleaf clover, had poor stands, but individual plants were large and vigorous. The poor stands may have been related to soil pH or agronomic variables such as seeding rate. The reasons for poor stands must be explained before these species are eliminated as possible crops for Alaska. Future plans include continued screening of forage legume species and management trials

with species and varieties that have potential for Alaska livestock production systems.

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

Management of Fodder Rape

Fodder rape and brassica hybrids (*Brassica napus* and *B. rapa* X *B. campestris sensulato*) are high yielding, high quality forage crops that are well adapted to Alaska. Studies were conducted at Palmer and Point MacKenzie to determine appropriate seeding rates and nitrogen (N) and phosphorus (P) fertilizer inputs for two varieties, Winfred (*B. napus*) and Tyfon (*B. rapa* X *B. campestris sensulato*). Seeding rates were 1.6 , 3.2, 4.8, and 6.4 kilograms per hectare. 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 (7785 kilograms per hectare) were greater than Tyfon (5481 kilograms per hectare) in these studies.

Nitrogen and P rates influenced the yield of both varieties. Nitrogen was applied at 0, 100, and 200 kilogram per hectare and P was applied at 0, 50, and 100 kg P_2O_5 per hectare. Maximum yields of 12,500 kilograms dry matter per hectare were observed at the highest N rates. Applied P increased the yields of both varieties at Point MacKenzie, but no response was observed at Palmer. The excellent quality of these crops is due to the high energy and protein concentrations of the forage. At other locations, N fertilization over 100 kilograms per hectare resulted in high forage nitrate levels. Excess nitrate represents a health hazard to livestock, so the maximum safe N rates must be defined for Alaska. Nitrate analysis is in progress.

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

Forage Management Software

The economic value of forage crops and forage quality have proven to be difficult to assess because forages are primarily an input for livestock production rather than a cash crop. Forage animal systems are complex. Research on the whole system is expensive, so less comprehensive research is generally conducted. As a result, management decisions are based upon fragmented pieces of information.

A computer program is being developed to aid producers in forage management decisions. Forage management alternatives are compared based on total feed costs rather than on agronomic factors. Inputs for the program include crop yields, production costs, crude protein, TDN concentrations, and the costs of energy and protein supplements. Rations are calculated for each management alternative using a specified livestock class and production/performance level. Feed costs are calculated from the rations and the above inputs. This program integrates agronomic, livestock, and economic information. It will be useful in planning research to maximize the economic benefit and for customizing extension recommendations to meet the needs of individual producers.

M.T. Panciera, L.B. Bruce, R.G. Gavlak, and P.M. Windschitl

Genesis and Classification of Tephra-derived Soils in Alaska

Soils derived from tephra (volcanic ash) are important not only because they account for nearly one per cent of the total land area of earth, but also they are very productive in food and fibers. Thus, an Andisol order was proposed by the International Committee on Andisols to cover the tephra-derived soils and was adopted as the eleventh soil order in the U.S. soil classification system—soil taxonomy. The classification and land-use interpretation of tephra-derived soils are also important to Alaska due to their extensive distribution in the southern part of the state. Based on research data mainly from Alaska, all the cold Andisols are grouped into Cryand suborder which is further divided into six great groups to accommodate soils with different properties. The unique property of Andisols is that their exchange complex is dominated by amorphous material either from allophane-imogolite or Al-humus complex. In addition, they are low in bulk density, high in organic matter, and contain appreciable amounts of volcanic glass. However, the recently revised criteria of Spodosols also include the Al-humus complex. The difference between the two orders is that Al-humus complex in Andisols is formed in-situ, whereas in Spodosols it is translocated.

To solve the Andisol/Spodosol transition problems, soils representing various stages of soil development were selected for detailed study. They include the Nancy and Talkeetna series from the Upper Susitna Valley, Kachemak and Mutnala series from Kenai Peninsula, and the Sukoi series from Sitka. Both morphological and chemical properties suggest that there is translocated Al-humus or Fe-humus complex in these soils; thus, they should be classified as Spodosols. However, upon micromorphological examination of thin sections from these soils, only Talkeetna and Sukoi series have direct evidence of translocated Al- or Fe-humus complex, as in the form of cracked coatings on the surface of mineral grains. Spodic process in other tephra-derived soils does exist but is not the dominant process because it did not leave any signatures. Thus, the Nancy, Kachemak, and Mutnala series are Andisols.

C.L. Ping

Organic Matter and Carbon Conversion Factor in Subarctic Soils

Soil organic matter is commonly estimated by organic carbon (OC) content determined by the Walkley-Black wet combustion method or by the Allison method. For many years the Van Bemmelen factor of 1.724 was used based on the assumption that organic matter contains 58% organic carbon. However, it has long been recognized that the proportion of OC in soil organic matter is highly variable for a range of soils, and the conversion factor not only varies from soil to soil but also among horizons in the same soil.

The purpose of this research project is to study the quantity of organic matter and carbon and their conversion factors of subarctic soils in Alaska. A total of 130 soil samples were taken from Southeast, Southcentral, and the Interior. The organic matter content was determined by total combustion, and organic carbon content was determined by Leco induction furnace after the sample was treated with acid to remove inorganic carbon. Preliminary data indicate soils formed in loess deposit in interior Alaska have conversion factors ranging from 2

in topsoil to over 5 in subsoils. Soils formed in tephra in Southcentral and Southeast have conversion factors ranging from 1.9 in topsoils to more than 3 in subsoils. On the average, use of a factor of 1.728 will lead to more than 30% underestimation of soil organic matter.

C.L. Ping and G.J. Michaelson

The Effect of Rock Phosphate Fertilizer on the Establishment of Timothy and Bromegrass Grown on Volcanic Ash-derived Alaska Soils

The distribution of tephra-derived soils is extensive in the Susitna Valley, Pt. MacKenzie, and the lower Kenai Peninsula areas of southcentral Alaska. These soils are often strongly acidic and have the capacity to adsorb large quantities of phosphorus (P). As a result of the high P sorption capacity, these soils often test low in available phosphorus. Forages show a growth response to higher rates of P fertilizer on the tephra-derived soils than on other soils of the state. However, there is little benefit from residual fertilizer even with larger amounts of P applied, due to the high P sorption by these soils. Currently, the recommended forage grass for production on these soils is timothy. Bromegrass is recommended for other areas of the state, but it has not established and produced well on the tephra-derived soils. It is likely that the acidic reaction and the high P sorption (lower P availability) in these soils are responsible for the poor performance of bromegrass. Higher P rates are necessary because of the lower P use efficiency, even when timothy is produced. The commonly used triplesuperphosphate (TSP) fertilizer readily dissolves in the soil solution. In these high P sorbing soils, dissolved P is largely sorbed by the soil and becomes unavailable.

A field study was initiated in the spring of 1988 to investigate the use of P fertilizer as it relates to the performance of timothy and bromegrass on these soils. The first objective is to compare the effects of various rates of rock phosphate (RP) fertilizer material in relation to the recommended rate of the commonly used TSP source. The second objective is to investigate the residual effectiveness (two-three years) of RP by observing its effect on the P fertilizer requirements of the two grasses.

The results of the second year of study can be summarized as follows:

1. The 0-2" extractable P and Ca levels indicate that the less soluble RP fertilizer is dissolving in all soils. The dissolution appears to be greatest at the Homer site where pH is lowest.

2. Increases in stand establishment/production of both grasses were observed at all sites with the application of RP at the rate of 100 lbs $P_2 0_5$/acre. Only at the Montana Creek site were slight increases in production observed at a higher RP rate (200 lbs $P_2 0_5$/acre).

3. Indications are that the more slowly-available (less soluble) nature of the RP may have a beneficial effect on availability of P to the establishing grasses. Yield responses were observed with RP treatment even when applied in addition to the recommended rate of TSP.

G.J. Michaelson and C.L. Ping

Soil Climate Study in Alaska

In soil taxonomy, pergelic soil temperature regime is defined as mean annual soil temperature at or below 0°C. As a result, most soils in the Interior and the Arctic Slope are classified in the pergelic subgroups of Cryaquepts, Cryochrepts and Cryorthods. However, in the Tanana Basin and the Copper River Basin areas, some pergelic soils have thawed after the duff layer and the forest vegetation were removed through either land clearing or fire. The mean annual temperature of these soils will remain above 0°C, warm rapidly in the spring, and the soil temperature regime becomes cryic. Similar pergelic-cryic temperature cycles were also found in natural succession after forest fire, although the stages and pattern are more complex. Based on a study in cooperation with the USDA-Soil Conservation Service, a proposal has been made to separate the warm pergelic soils in the zone of discontinuous permafrost from the cold pergelic soils in the zone of continuous permafrost. Based on recent soil survey and field studies in interior Alaska, many Pergelic Cryaquepts were found lacking the wetland characteristics. Their classification and land-use interpretation needs to be reevaluated. *C.L. Ping*

Soil Resource Baseline Study in the Hoseanna/Lignite Valley Area

A study on the soil resource baseline data in the Hoseanna (Lignite Valley) area of Usibelli Coal Mine was initiated in April, 1989. The study area occupies approximately 16,000 acres (25 sections) of land in the south one-third of T11A, R6W., and southeast one-third of T11S, R7W., Fairbanks Meridian. The purpose of the study is to characterize and classify the soils in the mine lease area, with respect to their chemical and physical properties, depth and extent, and geographic distribution. The data thus obtained will be used to develop a soil resource map with interpretations for the mine to use as a management tool for the best use of the soil resources. In the initial scope of the study, topographic maps, geological maps, and aerial photographs were reviewed to formulate some generalized soil-geography relationships. The following stage of the study involved field identification of soil types and distribution by open-pit examination, sampling through transecting, and physical and chemical analyses in the laboratory.

C. L. Ping

Salmon Bone Meal as a Fertilizer

Salmon bone meal is produced in Alaska as a by-product of aquaculture diet formulations. Currently, most of the salmon bone meal produced in Alaska is exported at a financial loss.

The material contains about nine percent nitrogen and 5.5 percent phosphorus (12.5 percent P_2O_5) and thus may be useful as a fertilizer for organically grown crops in Alaska. However, the nutrient release rate and plant availability of the nitrogen and phosphorus in salmon bone meal is unknown. A Sea Grant-funded project was initiated in 1989 to determine how fast microbes can release nitrogen and phosphorus from the bone meal and present it in a useable form for plants. Different phases of the project involve laboratory, greenhouse, and field evalu-

ations. The laboratory and greenhouse aspects of the study are currently in progress. A field study was completed in 1989 at the AFES Delta research site and at the Fairbanks research farm, with lettuce as the test crop, to determine the value of salmon bone meal as a soil nutrient. At both sites, lettuce production on bone meal amended soil was similar to production on land fertilized with inorganic nitrogen and phosphorus fertilizers. The field aspects of the project will be repeated in 1990. Information from this study will be used to determine the fertilizer value of salmon bone meal to Alaskan growers.

A. Snow and S. Sparrow

Changes in Organic and Inorganic Phosphorus with Cultivation of Subarctic Soils

Information on changes in soil nutrient levels as forested lands are cleared and cropped would be helpful in determining the most economical and efficient soil and crop management practices. A study was undertaken to assess changes in organic and inorganic phosphorus (P) with cultivation of subarctic soils. Soil samples were collected from fields of various ages with reference to clearing out of forest and time of cropping. These fields, located in five different sites in interior Alaska, represented four different soil series. Soil samples were analyzed for organic P, inorganic P, total P and soil test P, total nitrogen (N), organic carbon (C), and pH. Soil pH increased in three sites but decreased in one upon cropping. At all but one site, levels of organic C, total N, and the ratio of organic P to total P (Po/Pt) decreased markedly and rapidly upon cropping. On the other hand, there was a significant increase in inorganic P in all sites, and in total and soil test P in most sites as the number of years of cultivation increased. In one particular site, after 25 years of cropping, the enormous increase in soil test P to more than adequate levels, suggests that it is not necessary to apply any more P fertilizer to these fields. Generally, significant correlations were found between organic C levels and Po/Pt ratios. The decrease in the ratio of Po/Pt was likely due to the mineralization of P during organic matter decomposition and to addition of inorganic P as fertilizer.

E. B. Sparrow, V. L. Cochran and S. D. Sparrow

Decomposition and Nutrient Cycling in Forest and Cleared Soils

When land is cleared for agriculture in Alaska, most of the forest floor and often a portion of the A horizon is removed. The removed material contains large amounts of valuable plant nutrients, but these nutrients are unavailable to plants until the organic matter decomposes. There is little information on how fast these nutrients would become available to plants if part or all of the forest floor were left on the soil during land clearing. A study was begun near Delta Junction in 1988 to measure rates of mineralization of nitrogen and phosphorus from the decomposition of forest floor material in soils under virgin forest and in cleared fields. The study involves the use of mesh bags and sealed plastic bags containing different kinds of forest floor material and buried at different depths in a black spruce forest and in a cleared field. Weight loss and production of mineral nitrogen and phosphorus in these bags is being measured. The field aspects of this study were finished in 1989, but sample analyses have not been completed. There-

fore, no results from this study are available at present. Information from this study will be used to aid in making recommendations for optimum management practices for newly cleared soils in the subarctic.

S.D. Sparrow, E.B. Sparrow, and V.L. Cochran

N_2–Fixation and Green Manure Potential of Annual Legumes in Alaska

This study was designed to measure forage production and N_2–fixation by several annual forage legumes in Alaska and to determine the availability of residual N from legume crops to non-legume crops planted in the year succeeding the legume. This three-year study, which started in 1988, is being conducted at the AFES research farm in Fairbanks and at the Delta research site near Delta Junction. Total plant N and ^{15}N are not yet available so we do not have any estimates of N_2–fixation at this time. Plant yield data for 1988 and 1989 show that some of the legumes tested have a very high potential productivity. For example, inoculated yellow sweetclover, red clover, Austrian peas, and faba beans produced more than three tons per acre of dry matter at Fairbanks and more than two tons per acre at Delta when the soil at Delta was limed. Liming of the acid soil at Delta caused a substantial increase for most of the legumes tested. At Delta, inoculation with root-nodule bacteria (*Rhizobium*) resulted in yield increases by as much as five-fold for some legumes; at Fairbanks there was little or no effect of inoculation. One-half of each legume plot was mowed, and all of the above ground material was removed. The crop on the other half of each plot was disked under as green manure in the fall. Barley was planted without the addition of nitrogen fertilizer to the plots in 1989. Barley yields were generally higher on the green-manured plots than on the plots from which the legumes crops had been removed. At Delta barley yields following inoculated legumes were generally higher than barley following uninoculated legumes. At both locations, barley yields from plots cropped to barley the previous year were generally lower than barley yields following legume crops. These results indicate that at least some of the nitrogen fixed by the legumes became available to the barley crop in the year following the legumes. This study will continue for at least one more year. *S.D. Sparrow, E.B. Sparrow, and V.L. Cochran*

Effect of Hilling on Yield in Potatoes

Four cultivars of potato (Bake-King, Green Mountain, Kennebec and Superior) have been 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 for the last two years. Early hilling was done as soon as permitted by plant size, and late-hilling was done approximately four weeks later. Combined data from 1988 and 1989 showed no significant ($p = 0.05$) difference in US #1 yield among the four treatments that were hilled. However, the no-hilling treatment yielded significantly fewer US #1 tubers than all other treatments. There was no significant interaction between cultivar and hilling treatment. There was a trend toward higher US #1 and total yields in deep-, early- and late-hilling treatments, but the trend generally was not significant. Yield of green tubers was significantly higher in the no hilling treatment than in all other treatments in 1988 and 1989. Also, the shallow-late

hilling treatments produced more green tubers than the shallow early-, deep-early-, and deep-late treatments. Any hilling treatment appears to result in higher yields than no-hilling and the depth of hilling appears not to affect yields. The study will be repeated in 1990.

D.E. Carling and J.W. Walworth

Fertilizer Placement in Potato Production

Efficiency of fertilizer use by crops plants may be affected by fertilizer placement, particularly in cold soils. Plant response to applied fertilizer materials can generally be maximized by placing fertilizer as close to the plant root zone as possible without incurring salt injury. A study was conducted to determine optimum fertilizer placement for potato production in southcentral Alaska.

Field plots were established with a uniform fertilization rate [120 lbs nitrogen (N) per acre, 105 lbs phosphorus (P) per acre, and 200 lbs potassium (K) per acre] with fertilizer placement as the experimental variable. All fertilizer was broadcast uniformly and mixed with the soil, or all the fertilizer was placed in a band approximately four inches wide located about two inches below the seed pieces, or 20 percent of the N, P, or K, or factorial combinations thereof, was banded with the remainder of the fertilizer applied as a broadcast treatment. Foliar samples were collected to determine whether fertilizer placement affected concentrations of nutrients in the potato plants.

No visual differences among treatments were observed and potato tuber yield and quality were identical regardless of fertilizer placement. Determination of concentration of nutrients in the foliage has not been completed, but there appears to be little reason to recommend a specific fertilizer placement strategy for potato production in southcentral Alaska.

J.W. Walworth

Effects of Potassium Source and Secondary Nutrients on Potato Yield and Quality

A field trial was initiated in 1989 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 per acre. 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. The use of KCl resulted in 33 cwt per acre more total tubers and 30 cwt per acre more US No.1 tubers than K_2SO_4. 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 to 1.079, addition

of fertilizer materials containing both Cl^- and SO_4^{2-} resulted in tubers with an intermediate specific gravity of 1.086, and when K_2SO_4 alone was used, tuber specific gravity was 1.092.

This study will be expanded and repeated in 1990.

J.L. Walworth and R.G. Gavlak

Effects Of Soil Fertility On Potato Plant Development In The Matanuska Valley

Knowledge of plant development and nutrient partitioning among various plant parts is important in terms of the general understanding of the growth habits of potatoes and for improved management of field production of this crop. Nutrient response data provide a basis for fertilizer application recommendations. Nutrient uptake and physiological development in potato plants have been investigated in major potato growing regions, but comparable studies have not been conducted in high latitude areas such as the potato producing sections of southcentral Alaska.

A field study designed to define potato plant development under various nitrogen (N), phosphorus (P), and potassium (K) regimes was initiated in 1989. Treatments consisted of a non-fertilized check, and three rates of N (60, 120, and 240 lbs N per acre), P (53, 105, and 210 lbs P per acre), and K (100, 200, and 400 lbs K per acre) in various combinations. At tuber initiation, and every two weeks thereafter, mass and composition of plant tops, tubers plus stolons, and roots were measured to determine the effects of nutrient availability on growth processes, to measure growth rates of various plant parts, and to determine the fate of nutrients absorbed by the plant.

Preliminary results indicate the following:

1). Marketable tuber yield was maximized by application of as little as 53 lbs P per acre and 60 lbs N per acre;
2). Fresh tuber yield was greatest when applied K was 400 lbs per acre, the highest rate in the experiment;
3). High rates of P fertilizer increased top growth without affecting tuber yield or other measured growth parameters;
4). The amount of shatter-cracking during harvest increased as the rate of N application increased;
5). Increasing rates of either N or K depressed tuber specific gravity.

This study will continue in 1990. *J.L. Walworth and R.G. Gavlak*

Micronutrient Status of Southcentral Alaskan Soils

Field studies were conducted on three southcentral Alaskan soils, Knik and Bodenberg silt loams in Palmer, and Kashwitna silt loam at Pt. MacKenzie, to evaluate methods of determining soil micronutrient status and to determine whether further study on crop response to the studied micronutrients is warranted. Factorial trials were conducted on each soil with two levels each of copper (Cu), zinc (Zn), boron(B), manganese (Mn), and molybdenum (Mo). On the Bodenberg soil the test crop was broccoli; on Knik soil it was potatoes, and on the Kashwitna soil forage rape was grown. Plant tissue samples were taken to help establish baseline requirements of the studied micronutrients in foliage of the test crops and to determine the extent of plant uptake of

micronutrients.

Crop yield did not respond to any of the five micronutrients applied, indicating that these nutrients are available at quantities sufficient for the quantities of crops produced in the field trials. Analysis of soil samples collected after allowing time for equilibration of applied fertilizers, and plant tissue samples are now being conducted. Soil samples are being extracted by several methods. The quantities of removed micronutrients will be correlated with the amounts taken up by the test crops to establish laboratory protocol for determination of micronutrient availability.

J.L. Walworth, R.G. Gavlak, and M.T. Panciera

Evaluation of Potato Vine Desiccants

The use of chemical vine desiccants is standard practice in most potato growing regions because vine death facilitates mechanical harvesting and promotes tuber skin setting which reduces damage during harvest and handling. However, three to four weeks is generally required to achieve acceptable vine death and skin set. The length of the Alaskan growing season does not allow sufficient time for these chemicals to act effectively. Four chemical potato vine desiccants were tested on five potato varieties in the Matanuska Valley.

Enquik, at a rate of 15 gal per acre in combination with either one or two pt per acre of Diquat, was compared with Diquat alone at a rate of two pt per acre, with ThioSul at 40 gal per acre, 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, weighed, and visually rated for skin damage according to USDA standards.

Visual ratings indicated that the Enquik plus two pt per acre of Diquat treatment was rapid and most effective at desiccating leaves and vines, while Diquat alone was least effective, regardless of potato variety. Total and US No.1 tuber yields were identical among vine desiccation treatments. Numbers and weights of green and undersized tubers were also unaffected by the applied treatments. Yields varied among varieties, but there were no significant variety/desiccant interactions. However, visual skin damage was affected by an interaction between theses two factors. Lemhi and Green Mountain showed more skinning than other varieties. When treated with two pt per acre of Diquat alone, Enquik plus two pt per acre Diquat, or with ThioSul, these varieties displayed slightly less tuber damage than when treated with Enquik plus one pt per acre of Diquat or with no desiccant. This study will be repeated in 1990. *J.L. Walworth and R.G. Gavlak*

Fishmeal as a Source of Rumen Escape Protein for Dairy Cattle

Thirty Holstein cows with an average weight of 1353 lbs were used over a 12 week lactation trial to study the effects of diets containing salmon meal and urea on milk production and composition. Two experimental diets, one containing six percent salmon meal (SM) and the other 5.5 percent salmon meal + .45 percent urea (USM) were

compared to a soybean meal control diet (SBM). Total mixed rations consisting of 60 percent concentrate mix and 40 percent bromegrass silage were fed twice daily. Diets averaged 17.2 percent crude protein and 17.6 percent ADF on a dry matter (DM) basis. Total DM feed intake (lb per day) was lower with SM (44.5) compared to SBM (48.9), while USM (46.7) was intermediate. Actual milk production (lb per day) was similar for all diets (SBM, 92.7; SM, 88.6; USM, 90.1). Percent milk fat and total solids were lower with SM (2.56; 11.24) and USM (2.50; 11.14) compared to SBM (3.03; 11.72). Milk protein percent and solids-not-fat percent were not affected by treatment. Four percent fat-corrected-milk (FCM) (lb per day) and solids-corrected-milk (SCM) (lb per day) were lower with SM (69.6; 72.2) and USM (69.2; 71.4) compared to SBM (79.1; 79.9). Gross efficiency of milk production (lb milk/lb DM intake) was not affected by diet and averaged 1.94. Production efficiency of FCM and SCM (lb/lb DM intake) was higher for SBM (1.64; 1.67) compared to SM (1.53; 1.60) and USM (1.48; 1.53). Rumen ammonia-N concentration was decreased with SM compared to SBM and USM, suggesting lower ruminal protein degradation for the SM diet. Total volatile fatty acid concentration was similar for all diets. Acetate:proportionate ratio tended to be higher with SBM compared to SM and USM, suggesting that the depression in milk fat percent observed with the salmon meal-containing diets was in part due to a rumen effect. Under conditions of this experiment, when considering factors such as milk price, feed intake, and milk production, an economic advantage was found for the SBM diet compared to either of the salmon meal-containing diets. The large drop in milk fat percent with the salmon meal diets resulted in a lower on-farm milk price.

P.M. Windschitl

Evaluation of Low Levels of Salmon Meal in Dairy Cattle Diets: Effects on Milk Production and Composition

A lactation trial was initiated to study acceptability and utilization of low levels of salmon meal in dairy cow diets. Forty lactating Holstein cows will be used in a 12-week lactation trial to compare a soybean meal-based diet (control) to diets containing 1.5 percent, 3.0 percent, and 4.5 percent salmon meal in the total diet dry matter (DM). This trial is designed to determine optimum levels for salmon meal utilization in dairy diets. Cows will be individually housed and fed a total mixed diet consisting of 45 percent bromegrass silage, 5 percent alfalfa meal, and 50 percent grain mix (DM basis). Cows will be blocked by calving date and randomly assigned within blocks to their respective diets. Milk weights and feed intake will be recorded daily. Milk will be sampled weekly and analyzed for fat, protein, lactose, and total solids. Rumen fluid will be collected monthly and analyzed for pH, volatile fatty acids, and ammonia-N. Jugular blood will be sampled monthly and analyzed for serum urea-N. During peak lactation (weeks 6-8 post-partum) blood will be collected from the tail artery and mammary vein for purposes of calculating nutrient uptake by the mammary gland. Of special interest is the effect of low levels of salmon meal on milk fat percentage. An economic analysis of each diet will be done following the completion of the experiment.

P.M. Windschitl

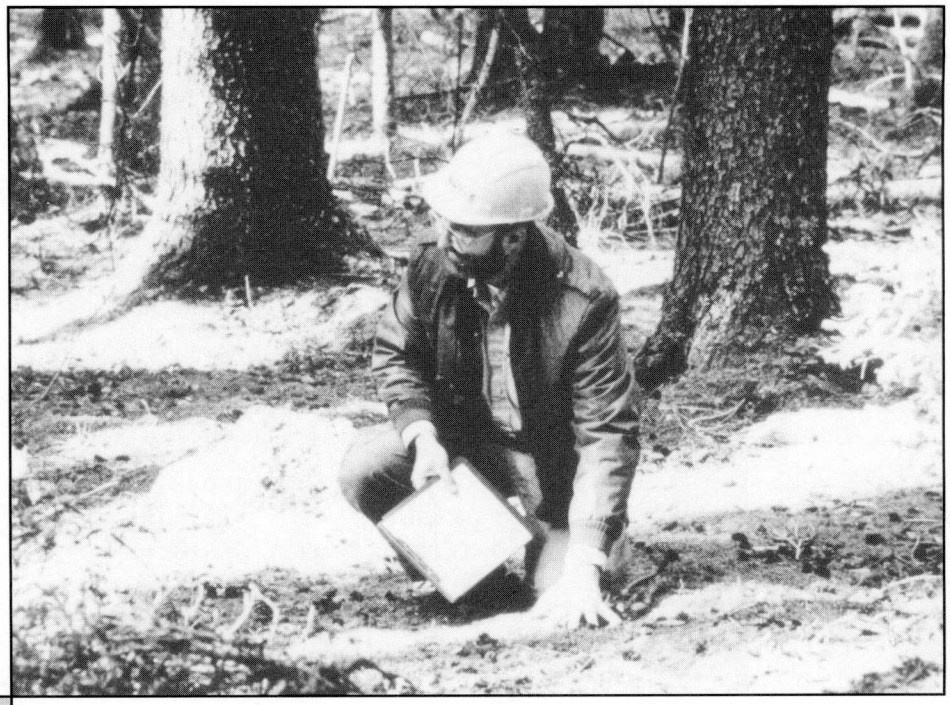
Plant Germplasm Introduction, Increase, Evaluation, Documentation, Maintenance, and Distribution

Grain variety trails are conducted on an annual basis so that new varieties developed in other northern agricultural regions can be evaluated to determine their adaptability to Alaska's growing conditions. These trials are the basis for making variety recommendations to Alaskan farmers.

During 1989, 23 barley, 14 oat, and 16 wheat varieties and experimental lines were evaluated in replicated standard trials at Fairbanks, Delta Junction, and Palmer. The Fairbanks and Delta Junction sites were situated on land that had been summer-fallowed the previous year. The Palmer site as situated on barley stubble land. In 1989, all three Alaska sites experienced excellent grain growing conditions which resulted in above average yields and high test weights.

The varieties and experimental lines for each grain type were reported in two maturity classes: very-early-to-early and medium-to-late. At Fairbanks, the highest yields in each of these crops for the very-early-to-early maturity class were as follows: 'Hankkija's Eero' barley, 87 bushels per acre; 'Toral' oats, 133 bushels per acre; and 'Chena' wheat, 90 bushels per acre. The highest yields for each of the crops for the medium-to-late maturity class were: 'Ellice' barley, 100 bushels per acre; 'Calibre' oats, 168 bushels per acre; and 'HY320' wheat, 106 bushels per acre. At Delta Junction, the highest yields in each of the crops for the very-early-to-early maturity class were: 'Datal' barley, 83 bushels per acre; Toral oats, 149 bushels per acre; and Chena wheat, 67 bushels per acre. The highest yields for each of the crops for the medium-to-late maturity class were: 'Hankkija's Pokko' barley, 92 bushels per acre; 'OT 755' oats, 162 bushels per acre; and HY320 wheat, 88 bushels per acre. At Palmer, the highest yields in each of the crops for the very-early-to-early maturity class were: Hankkija's Eero barley, 90 bushels per acre; 'Athabasca' oats, 136 bushels per acre; and Chena wheat, 57 bushels per acre. The highest yields for each of the crops in the medium-to-late maturity class were: 'Lewis' barley, 90 bushels per acre; 'Cascade' oats, 138 bushels per acre; and 'Blue Sky' wheat, 56 bushels per acre.

F.J. Wooding



Dr. Glenn Juday, assistant professor of forest ecology, checks the forest floor in a mature spruce forest in the Bonanza Creek LTER.

Forest Sciences

Forest Hydrology and Watershed Management Research

Research in the area of 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 serves to focus research on those projects that will most enhance our capability for realistic and reliable predictions of hydrologic impacts. Also, by working within this framework, a variety of specific research directions are kept relevant to the management context.

Recent efforts have focused on collecting data on spring runoff from a 10 sq. mile forested watershed north of Fairbanks, and in developing a model of snow melt runoff that incorporates the effects of frozen soils. The model currently is capable of reproducing general dynamics of vegetation-streamflow-soil freeze/thaw interactions via linking the St. Paul equations (Stefan equations for layered soils) with daily accounting of air temperature and snow depths. Spring snow pack and weather conditions dictate the rate of snow melt, while soil moisture conditions in the profile just prior to frost penetration largely dictates the spring infiltration capacities for meltwater. The variation in these two processes explains much of the variability observed in spring runoff from year to year.

The model developed in this project has been used to investigate the effects of timber harvest 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 former study reinforced the

hypothesis that significant increases in overland flow may occur during the second year after harvest and that results are sensitive to initial soil moisture conditions and to the precipitation during the post-harvest years. The results also indicate that the drier the initial soil conditions, the longer the delay in runoff response to harvest. The second study indicated a variable response to climate change depending on whether temperature was only climatic variable changed or whether compound changes of temperature, precipitation, and sky cover were simulated. Results indicated that specific effects on the water balance were strongly influenced by whether the control case evapotranspiration was limited by water availability or energy availability. Although these results are conditioned by the specific circumstances simulated, the model does allow the sensitivity of the results to those conditions to be studied systematically. The model also serves as a framework for improving our knowledge of the system by indicating where additional field work would be most rewarding. The next phase of this research is to develop a daily weather simulator for the Fairbanks area to drive the water balance model. Such a tool will facilitate exploring the dimension of risk and uncertainty in watershed management cause and effect studies.

J. D. Fox

Rosie Creek Fire Research: Regeneration and Forest Structure

The Rosie Creek Fire Research Project started in 1983 in the Bonanza Creek Experimental Forest—now also the Bonanza Creek Long Term Ecological Research (LTER) site—following an 8,600 acre wildfire. Two projects—regeneration silviculture and forest structure—remain active in the study, but are being incorporated into the LTER data base and monitoring program.

The regeneration silviculture study covers 60 acres and started in 1986 to evaluate different site preparation and planting techniques for establishing white spruce stands after a wildfire. In 1989 survival and growth of planted white spruce seedlings were evaluated in their fourth year of growth on the site. White spruce seedlings grown in the state forest nursery were highly successful with over 90 percent survival. Seedlings achieved rapid growth rates both with and without site preparation. Typical total heights were between 0.5 and 1.0 m (planted as 2.0 stock).

Several site preparation techniques were used to expose mineral soil, including two levels of disk trencher scarifier treatment, a bulldozer blade, patch scarifier, and a control (no treatment). There are no obvious major differences in growth and survival response among the treatments or with the control. Data will be collected at the end of the fifth growing season and analyzed thoroughly to provide definitive results. These results will be applicable only to burned (not commercially logged) sites for planted seedlings (not direct seeding).

Direct broadcast seeding and spot seeding with and without plastic shelters were carried out in this study. Evaluations of those treatments are underway. Generally, direct seeding treatments have lower stocking rates and smaller seedlings (generally less than 30 cm total height). These small seedlings may not survive competition with dense stands of bluejoint grass. Because of the slow growth of these installations,

results of "early" growth and survival may not actually be clear until 10 years after planting, twice the standard five year evaluation period.

Natural regeneration mapping and measurements were completed on the three burned hectares – aspen, white spruce, and paper birch. All seedling trees were mapped and measured on the burned white spruce and paper birch hectares and on a 1/8th subsample of two 25 m X 25 m (1/16th ha) plots in the burned aspen stand. The basic system for fixing the locations of seedling trees was a 100 percent grid of 1 m X 1 m plots within a framework of 10 m X 10 m cells. The burned white spruce stand was poorly stocked with seedling white spruce, totaling only 305 in the hectare. In addition white spruce seedlings were patchily distributed; 35 percent of the 10 m X 10 m cells had no white spruce seedlings, 15 percent had only one, and 11 per cent had two. On the other hand, seven per cent of the cells had 10 or more white spruce seedlings, mainly along the northern edge of the hectare that lies within the critical 200 m effective dispersal radius of surviving mature white spruce trees that serve as propagule sources. By contrast aspen reproduced vigorously at nearly 3000 stems in the hectare, or ten times the stocking of white spruce. While aspen was a minor component of the stand before the fire, 56 percent of the cells had aspen stems, which in most cells were wind-borne seedlings. In portions of the Rosie Creek Fire Research (continued) stand that supported aspen before the fire, aspen sprouting was especially vigorous. Thirteen percent of the cells had 50 or more aspen, and four cells had 400 or more aspen stems.

The burned birch hectare supported nearly equal numbers of aspen and paper birch stems at a low stocking level (1,126 and 1,087 respectively), probably because of high fire severity in that portion of the burn. Paper birch stems were distributed more evenly than aspen. Seventy-four percent of the cells supported paper birch but 71 percent had zero or only one aspen; six percent of the cells had 50 or more aspen stems but no cell had 50 or more paper birch stems. Stem densities in the burned aspen stand were especially high; six cells (48 percent of the total cells in the subsample) were stocked with 600 or more aspen stems, projected rate of 60,000 per hectare. Snagfall was monitored in all burned stands. Six years after the fire the only material that fell to the ground in the burned paper birch and white spruce stands were tops of trees, limbs, and a very few snags. By contrast, snagfall was very dynamic in the burned aspen stand. Sixty-six white spruce trees (6.0 to 41.0 cm dbh) fell in 1989, and 48 aspen trees (9.0 to 36.5 cm dbh) came down compared to total aspen snag and log population of 197 trees in 1988. Most of the trees fell in afternoon gusts during a two week clear weather windy interval in mid-June and an intense convective thunderstorm on July 4, 1989. Large primary falling trees, especially white spruce, often knocked down other trees as they fell. The direction of fall was predominantly from the southwest to the northeast. Most snagfall was associated with the gradual enlargement of one major and two minor canopy gaps, probably because of the ragged edge the gaps presented to the wind. Salvage logging operations entered the southeastern corner of the burned aspen stand, invalidating further monitoring there. Funding for a replacement quarter-hectare is being sought.

G. P. Juday, R. Densmore, and R. C. Solomon

A 10-Year Monitoring Update of the Hugh Miller Inlet Plots in Glacier Bay National Park

This research involves a long-term study of growth, structure, and changes in a dense shrub jungle and sparse black cottonwood forest in the Hugh Miller Inlet region of Glacier Bay National Park. Glacier Bay Park is the site of one of the largest and most rapid retreats of a large glacier in historic times. The response of ecosystems to the dramatic warming associated with glacial retreat can be a model for global change studies.

Glacial ice retreated from Hugh Miller Inlet in Glacier Bay in 1892. In 1979 a 25m x 25m (1/16th ha) monitoring plot was established; all woody stems greater than 3 cm were mapped and measured. The 1979 monitoring plot encompassed two plots of 1 m^2 (W.S. Cooper's Station 33, Quadrats 7 and 8) that were established in 1916 and have been periodically remeasured since. In 1989 the 1/16th ha monitoring plot was remeasured and expanded. Continued monitoring of the small plots represents one of the longest, if not the longest, scientific studies of succession on a single piece of ground in North America.

In 1979 the 1/16th ha monitoring plot contained 395 woody shrubs and three trees (6320 shrubs and 48 trees ha^{-1}). About three fourths of all shrub stems were *Alnus sinuata*; the willows *Salix alaxensis*, *Salix barclayi* and *Salix sitchensis* were also present. Willows are evenly distributed in small numbers throughout all size classes, a distribution characteristic of a random initial seedling establishment at low densities with subsequent growth suppression. Alder stems, by contrast, displayed a left-skewed normal distribution at much higher densities, characteristic of a dominant colonist.

In 1989 the 1/16th ha monitoring plot contained 316 shrubs (5,056 ha-1). Between 1979 and 1989, 43 alder stems and one willow stem recruited to the population and 86 alder stems and 33 willow stems died, a net decrease of 43 alders and 32 willows (75 shrubs). No trees died or were recruited. Numbers of alder stems in the 4, 6, and 8 cm diameter size classes decreased while numbers in the 10, 12, 14, and 16 cm size class increased. Plot basal area for all woody stems was practically unchanged at 7.39 m^2 ha^{-1} in 1979 and 7.33 m^2 ha^{-1} in 1989.

Our results pose some problems for the overall scheme of primary succession that was developed as the result of earlier research at Glacier Bay. In terms of that model, willows are clearly declining in dominance. Alders are maturing, growing larger, and experiencing significant net mortality, but unlike willows they may persist longer. Alders have a longer life span, larger potential size, and they can achieve significant recruitment of new stems, even if below the replacement level. As the alder stems have matured and become large their weight has forced them to become recumbent on the ground; growth has placed the crown farther away from the center of the clone, not higher above it as in ordinary height growth. As a result of this pattern of growth, light reaches the center of mature alder clones, stimulating sprouting that adds new stems to the population. No tree reproduction was found in a 0.5 ha expansion of the monitoring installation, even though Sitka spruce and black cottonwood trees of about 50 to 60 years of age are present. At this point the local landscape is a semi-permanent brushfield, not a successional shrub stage advancing toward forest conditions.

The National Park Service provided logistical assistance and transportation from Park Headquarters to the site.

G. P. Juday and R. C. Solomon

Conservation Biology of Natural Areas

In cooperation with the Indiana Department of Natural Resources, Division of Nature Preserves, a study of remaining natural areas on the Tipton Till Plain of central Indiana was undertaken. This project was initiated in 1988. The Tipton Till Plain is a 28-county region that represents the heart of one of the most productive and intensively developed agricultural regions in the world. The area provides a look at problems of conservation biology at the opposite end of the continium from the vast, intact, and naturally functioning landscapes of Alaska. However, many of the same processes of fragmentation, extinction, and truncation that have so dramatically affected the Tipton Till Plain have occurred or are occurring in Alaska, even though to a lesser degree.

Most natural areas on the Tipton Till Plain are mature deciduous forest; numerous but very small ferns, marshes and prairies also occur. Out of 330 potential natural areas surveyed only 53 substantially retained their natural character. Twenty-five were mature forest tracts. Qualified forest natural areas totaled 582 ha with an average size of 15.2 ha (s.d. 10.1). The Tipton Till Plain core counties (those not including segments of other landforms) retain an average of only 6.2 percent (s.d. 2.6) forest cover of any condition. Only 39 forest blocks, either natural or disturbed, greater than 40 ha survive on the till plain; 26 of those forest blocks are less than 80 ha in size. About half of the large forest blocks are isolated by distances of at least 16 km from the next nearest large block.

The degraded condition, small size, and high degree of isolation of the forests of the Tipton Till Plain pose an exceptionally high threat of extinction to the plants and animals native to them. Many species are unable to effectively maintain their populations in the current environmental equilibrium and will go locally or regionally extinct over time without management intervention. If the forest of the region is further reduced (no existing conservation program focuses specifically on this region) then regional or hemispheric effects are possible. For example, with less than the current forest cover and an even greater degree of isolation, birds migrating from the tropics to the high latitudes may not be able to find suitable cover in this deforested region. Many of these species are forest insect predators or seed dispersers in the boreal forest during the summer, and their absence may have major repercussions for that system.

G. P. Juday

The Effects of the *Exxon Valdez* Oil Spill at Green Island Research Natural Area

In 1986 we conducted surveys of the beaches and intertidal zone of the Green Island Research Natural Area (RNA) in the Prince William Sound region of the Chugach National Forest. Within a few days of the March 24, 1989 grounding of the supertanker Exxon Valdez, oil from the wreck arrived at Green Island RNA. In August 1989 we began a research and monitoring project at Green Island and established permanent beach and intertidal transects.

We visited three beaches for three to four hours each during the minus tide series of July 20-22, 1986. We took extensive notes on intertidal zonation, plant and animal taxa, and collected voucher speci-

mens of intertidal and beach organisms for later identification. We identified 96 animals (invertebrates and fishes) and 39 plants (algae and seagrasses). Our observations included three species previously unrecorded from Prince William Sound. The uppermost zone on the shore of Green Island RNA, about three meters above MLLW, has a black appearance caused by the lichen *Verrucaria*. Animal inhabitants of this zone include the littorinid snails *Littorina sitkana* and *L. scutulata*, and the limpet *Tectura persona*. Zone 2 (generally from +3.0 m to +1.5 m) is dominated by a band of either barnacles, including *Balanus glandula, Semibalanus balanoides,* and *Chthamalus dalli*; or by *Fucus gardneri* and *Mytilus edulis*. In Zone 3 (from +1.5 m to 0.0 m) the dominant species are several brown algae including Fucus, Leathesia difformis, and several species of *Alaria;* and the red algae *Palmaria* spp. and *Halosaccion glandiforme*. Zone 4 (below 0.0 m) is characterized by *Laminarians* (kelps) and seagrasses.

In August 1989 we documented oil on the beaches of the RNA, looked for evidence of visible damage to plants and animals of the intertidal zone, and established permanent intertidal transects and beach vegetation transects for long-term monitoring. The shoreline had a nearly continuous line of oil or tar which we mapped as 1-10 per cent (low), 10-50 per cent (medium), and greater than 50 per cent (high). We developed an index system to rank the degree of oil effects, and were able to rank our three study sites in increasing order as Little Green Island, Nora's Point, and Lunch Point. We infer that the height of the tides in late March and early April determined where on the beaches and in the intertidal zone of Green Island the oil came into contact with living organisms. Our interpretation is fundamentally based on the duration the unweathered oil was in contact with organisms.

We assign the highest relative effect to the zone from MLHW to MHHW. Any oil coming into contact with the shore on this tide would have been deposited and stranded at the upper range because it could not be refloated and removed by subsequent tides. We also infer that during the slow change of the tides fresh oil would have remained in contact with plants and animals near the height of the high and low tide stages.

Our model suggests that oil effects should be strongest at Green Island in the tidal height range of +2.0 to +3.7 m, with a secondary impact zone from +0.5 to +1.5 m. The higher range corresponds to the the Zone 1 and the upper part of Zone 2, dominated by *Fucus*, ballanoid barnacles, and *Mytilus*. The lowermost zone of vascular plants on the beach, above the upper intertidal zone, was also be affected by oil.

Total cover of organisms decreased in the more heavily oiled stations, especially in Zone 2 (actual tidal height from +1.75 m to +2.3 m), the tidal range that we infer experienced the greatest impact of oil. Total cover of dominant marine organisms is lowest at Lunch Point, consistent with our beach oil data that indicate it was the most heavily oiled site.

We identified 68 animals and plants during our August 1989 survey. In comparing the 1986 and 1989 collections, we found that 37 animals and six plants collected or observed in 1986 are not on our 1989 species list. The comparison provides a first list of potentially oil-susceptible or oil-affected organisms for our planned future research. However, we suspect that part of the difference in apparent species

richness is due to a greater taxonomic search effort in 1986, and part of the difference is due to the high rate of natural change typical of intertidal communities; this highlights the need for long-term monitoring. We identified 14 animals and two algae in 1989 that were not on our 1986 species list. We believe that our discovery of "new" species is largely explained by high natural rates of change between the sampling dates, and a certain number of species that were present but overlooked in 1986.

Many limpets and barnacles were initially heavily coated with oil. Oily *Semibalanus cariosus* experienced mortality at all three stations, but especially Lunch Point and Nora's Point. Surviving *Fucus* at Lunch Point were oiled and in particularly poor condition, as were Balanus *glandula* and *Semibalanus balanoides*. Corraline red algae below oiled beaches were dead and bleached white. Many *Halosaccion glandiforme* and *Palmaria* spp. appeared to be in poor condition, discolored by loss of pigmentation. Blades of seagrasses, especially those below oiled beaches, were dead and bleached white.

One must be cautious in ascribing unusual conditions on the beaches or in the intertidal zone of Prince William Sound in 1989 to the *Exxon Valdez* oil spill. The intertidal environment is dynamic and susceptible to both natural and human-caused disturbances. For example, extreme cold during a series of minus tides has been known to produce damage similar to an oil spill. The Alaska cold snap of January 1989 may be partly responsible for the mortality of *Semibalanus cariosus* in our area. *G. P. Juday, N. Foster, and R. C. Solomon*

Tree Selection Research Aids in Reforestation Program

Selection of the tree species and seed source best suited to the sites is the most important decision a forest manager can make. Research during 1989 changed focus in response to the Alaska Reforestation Council's interest in forest tree improvement. A graduate program to develop a tree improvement program for the state of Alaska was initiated in June 1989. The objective is the development of a cooperative forest tree improvement program plan for the state of Alaska. An overall program outline, introduction, and tree selection criteria have been drafted and reviewed by council members.

A blade-scarification trial established in 1982 following removal of paper birch, aspen, and dead white spruce from a mixed stand of spruce and hardwoods was assessed in early spring 1989. Natural white spruce seedling numbers and height of dominant seedlings on scarified patches were compared to that on unscarified patches; unscarified patches were dominated by the grass, *Calamagrostis canadensis*. Scarification resulted in all plots being stocked; only 27 percent of the unscarified plots were stocked. Mean number of seedlings per stocked plot were 92.75/m^2 and 1.28/m^2, respectively. Mean height of the dominant seedling on scarified plots was 2.4 times that on unscarified plots. It is recommended that the first regeneration survey be delayed until after the third growing season following site preparation and that a detailed survey not be made until after the fifth or sixth year after site preparation. Blade-scarification is an effective means of site preparation where a heavy grass sod is present. A formal paper has been accepted for publication in the Northern Journal of Applied Forestry.

A 1983 white spruce seeding trial was reassessed before the 1988 growing season. As could be anticipated, additional mortality occurred between the end of the second and end of the fifth growing seasons. Preliminary results confirm that success as evidenced by seedlings presence is better on mineral seedbeds than organic seedbeds. Based on this study, hand sowing of white spruce on hand scarified microsites generally is not a satisfactory approach to stand regeneration. A detailed analysis of the data will be completed in 1990.

In March 1989 arrangements were made for Alaska Division of Forestry personnel to visit forest nursery facilities in Saskatchewan and Alberta. Funding was a cooperative effort of the University of Alaska, the University of Alaska Natural Resource Fund, and the Alaska Department of Natural Resources Division of Forestry. Results of this visit have been directly implemented into production activities in Alaska: A passive cold storage facility for seedlings, modeled after a much larger one in Alberta, was built in Fairbanks; importance of regeneration atlases were recognized and approaches are being investigated by Division of Forestry; alternative container systems are being considered. In September 1989 visits were arranged for the Alaska Division of Forestry personnel to observe site preparation trials in northeastern British Columbia; alternatives to blade-scarification and the TTS-35 disk trencher are now being considered in Alaska.

Preliminary measurements in May 1989 indicate that the regeneration of paper birch in the Susitna Valley is commonly unsuccessful due to heavy browsing by moose. Although stems per acre are commonly more than adequate, trees often cannot reach the free to grow stage due to moose browsing. For example, one stand sampled was seven years old and less than two feet tall and another was seventeen years old and less than eight feet tall. Birch commonly reach a height of four to five feet by the end of the third growing season. Visual inspection of balsam poplar/black cottonwood and aspen stands indicate a similar situation. Formal sampling is planned for spring 1990.

A diameter limit selection harvest of white spruce made in 1949 was visited north of Athabasca, Alberta. The 1949 harvest only removed trees larger than 10 inches in diameter. The residual stand was allowed to grow with no management activities until harvested in early 1989. Many trees that were unintentionally damaged during the 1949 operation had butt and/or bole rot and a large percentage had additional damage due to ants. Radial growth following release of trees averaged three to five annual rings per inch for about 20 years. The quality of logs produced, except for the decay and ant damage, was excellent. Advance regeneration following the 1989 harvest cut is primarily balsam fir, a less desirable species. Lessons from this stand include:

1). Diameter limit cutting can produce a second stand which can be harvested within 30 to 40 years, or in about half a normal rotation.
2). Extreme care must be taken to avoid damaging residual trees since basal and bole wounds (bark removal) on spruce become infection courts for decay organisms with ants being a secondary problem; the result decay has a major impact on log quality and the yield of high quality products.
3). Although a partial harvest is possible in white spruce, it is questionable whether the approach can be carried out indefinitely in a stand as there are serious questions regarding regeneration. *E.C. Packee*

Predicting the Growth and Yield of Forest Stands in Interior Alaska

Growth and yield information is essential for effectively managing the tree species of interior and southcentral Alaska. Long-term studies of growth and yield are essential for implementing state-of-the-art forest management models which are in place elsewhere throughout the northern hemisphere. Species alternatives on a given site often depend upon the growth and yield superiority of one over the other. Replacement of native species with exotics cannot be seriously considered until the yield potential of native species is fully understood.

Efforts concerning site index for tamarack are continuing. Several additional stands toward the eastern limit of the contiguous range in Alaska were found and will be sampled in 1990. Draft site index curves for paper birch were completed in 1989; final curves are expected to be published in 1990 as a Master of Science degree thesis. During 1989 an additional 34 balsam poplar sites were sampled for the construction of site index curves; this brings the total number of plots with four trees to 72. Comparison of a limited number of freehand curves of trees from north of the Alaska Range with trees from south of the range suggests distinct height growth pattern differences. Approximately 60 percent of all balsam poplar disks have been measured. In 1990 quaking aspen sampling will begin.

Three (two white spruce and one tamarack) Levels of Growing Stock (LOGS) plantations established in spring of 1986 were remeasured for survival and height growth in the spring and fall of 1989. Review of height growth data suggest that the white spruce seedlings are beginning to break out of planting check; many of the tamarack seedlings have put on more than 10 inches of growth, maximum measured growth exceeded 36 inches. Tamarack leader growth commonly was less than straight.

Analysis of specific gravity data completed of Alaskan Boreal Forest species was completed. The Boreal species in Alaska have ovendry specific gravities similar or better than those commonly quoted for eastern Canada and the United States. Softwood specific gravities are similar to or better than those found in the Canadian Prairie provinces; Alaskan hardwood values are slightly less. A report is being finalized on specific gravity and a report on energy content being prepared.

E.C. Packee

Forest Products

Revised forest acreage and volume statistics for the state of Alaska were published by the USDA Forest Service in 1989. An analysis of the data indicates major changes from the previous published information. In 1969, it was stated that the northern forest portion of Alaska was dominated by white and black spruce, paper birch, aspen, and poplar and interior and southcentral Alaska contained approximately 22.5 million acres of commercial forest land. Revised figures published in 1989 indicate that the acreage of commercial forest land in the entire state was only 20.1 million acre, less than what was previously stated for the northern forest. Inventory figures for 1987 indicate only 10.0 million acres of commercial forest land available for timber harvest in the northern forest. Net merchantable volume of conifers on this acreage

is 6,052 million cubic feet and net volume of hardwoods is 4,149 million cubic feet.

During 1989 forest products operations were visited in Minnesota, Alberta, British Columbia, and the Yukon Territory. Operations in Minnesota included a specialty plant producing wooden match sticks, wooden popsicle sticks, tongue depressors, toothpicks (paper birch was the primary fiber supply) and a high density particle board plant. The high density particle board plant used low quality hardwood chips which included a considerable amount of leaves, bark, and twigs. A major use of the high density particle board is in automobiles—the average automobile contains 30 to 35 or more square feet of particle board. Experiments with birch as a component for oriented strandboard indicate that limited amounts of paper birch can be mixed with aspen quite successfully; a heavier board can be produced using paper birch as the sole furnish.

During 1989 the University of Alaska cooperated with the Alaska Department of Natural Resources Division of Forestry to fund travel for divisional personnel to visit industry operations in Canada. Operations visited included four sawmills, a waferboard plant, an oriented strandboard plant, a plywood and veneer mill, a bleached chemithermomechanical pulp mill, two logging operations, and a forest management area. This provided a much more comprehensive picture of what could be done with the northern forest resource of Alaska. A major result of these and past trips has been the demonstration that the northern forest resource has real economic value and, if managed properly, can contribute to the economic and social well being of Alaskans.

During 1989 a grant was obtained from the Alaska Science and Technology Foundation to further investigate the marketing and utilization potential of northern forest species; particular emphasis is on value-added products. Mills and research facilities were visited in Alberta and British Columbia. At one mill, lumber was being remanufactured into high quality products with particular reference to Pacific Rim countries. One end product resulted in an increased value of 5 to 6 times the cost of the mill-run lumber. Alaska white spruce and coastal hemlock could be similarly upgraded.

E.C. Packee

International Union of Forest Research Organizations

The main goal of the International Union of Forest Research Organizations (IUFRO) is "to promote international cooperation in scientific studies embracing the whole field of research, including forestry operations and forest products." The goals of the working party are essentially the same as the general goals of IUFRO except that emphasis is on the northern forest, also referred to as the boreal forest or taiga, of North America. The eleventh annual symposium was held in Newfoundland, Canada in August 1990. Proceedings are being published by the Canadian Forestry Service.

E.C. Packee

Forest Floor Ecosystem

This report summarizes results of research designed to evaluate the importance of the forest floor as the key ecosystem compartment controlling nutrient supply for tree growth in taiga forests of interior Alaska. Two areas of emphasis are being considered in this program:

1). the role played by forest floor organic matter chemistry in controlling decomposition and element supply for plant use from this detrital layer; and

2). the role of vegetation-caused changes in light, moisture, and nutrient availability in control of plant biomass, productivity, and organic matter distribution.

With regard to the second area of emphasis, field experimental treatments are now in place that will provide tests of our ideas concerning organic chemical control of element supply and moisture limitation for tree growth.

Characterization of selected inorganic elemental and structural organic chemical characteristics of the forest floor in primary successional stands of vegetation on the Tanana River floodplain show progressive change to increasing resistance to decay of detrital materials and therefore, potential for altered cycling of nutrient elements. The C:N ratios of forest floor materials ranges from approximately 15 in alder, to 20 in balsam poplar, to near 30 in white spruce. Lignin:N ratios range from between 10 and 15 in alder, to 20 in poplar to 30 in white spruce. Implications of these changes in organic matter chemistry are that availability of nitrogen and other nutrients potentially important for plant growth may be reduced with advancing forest succession.

Bio-assays conducted on alder forest floor organic matter show that separate applications of freeze-dried ether and methanol extracts of poplar O1 and O21+O22 layers reduce the N mineralization and nitrification rates by up to 10 times compared with control rates. However, estimates of respiration conducted on the incubating samples indicated that CO_2 production was increased by extract additions. Increased sample metabolic activity indicates that the cause of reduced N mineralization may be increased microbial competition for a limited resource, namely NH_4^+. Nitrifying organisms, being relatively poor competitors for NH_4^+, may be substrate deficient under these conditions. The reduced nitrification potential observed in the bio-assays may reflect this condition instead of, or in addition to, the inhibitory effect of organic chemicals.

The inhibitory effects were especially strong with ether extracts from the O1 layer. These results indicate that a combination of organic matter chemical properties perhaps dominated by plant secondary chemicals (ether extractable materials) may play a significant role in the control of nitrification observed in later successional forest floors.

K. Van Cleve and J. Yarie

The Long-term Ecological Research Program

Activities during the second year of the taiga LTER (Long-Term Ecological Research) program emphasized four general areas:

1). Interaction with other LTER sites in the national LTER network, attending workshops and network coordinating and executive committee meetings;

2). Completion of installation of two weather stations operated year-round in conjunction with eight other stations in upland and floodplain successional stages;
3). Completion of forest floor and mineral soil description and sampling; and
4). Establishing of:
    a). experimental treatments to test hypotheses dealing with substrate quality control of decomposition and element supply for plant use;
    b). experimental treatments to evaluate the importance of soil moisture as a control of tree growth; and
    c). long-term study of forest floor decomposition in a successional context using litter bags.

Coordinating activities within the LTER network involved attendance at several workshops, including GIS, data management, microclimate, and network Coordinating and Executive Committee meetings at various times during the year. The taiga LTER contributed two papers dealing with site perspectives, and site capabilities, to an effort compiling current thinking and capability across the network in connection with global change.

Installation of these two all-year weather stations substantially enhances our capability to evaluate above-ground and soil microclimatic conditions in the uplands and on the river floodplain. These stations estimate most standard weather parameters including precipitation (snow depth and density during winter), temperature, wind speed and direction, radiation, evaporation, and soil temperature and moisture. In addition, micro-met stations are located in one replicate of each stage of the primary floodplain and secondary upland successional sequences. These latter stations are operated year-round for soil temperature, and during the field season for additional standard meteorological parameters. A total of 10 weather stations are now operating in our LTER study.

Description of the forest floor and mineral soil and sampling of these ecosystem compartments was completed during the past field season. This completes a sampling of approximately 90 soil profiles in connection with the LTER successional sequences. Chemical analysis currently underway will help evaluate successional change in and plant species control of forest floor decomposition processes. Mineral soil analysis will add to our understanding soil chemistry controls in primary and secondary successional forest ecosystems.

We completed installation of three long-term studies designed to evaluate forest floor chemical control of decomposition and element supply for plant growth, establish the time transients for forest litter decomposition, and evaluate the importance of soil moisture as a control of tree growth. Forest floor chemistry is being manipulated to test the hypothesis that early successional stage vegetation types produce rapidly decaying organic detritus while the opposite condition exists in late successional vegetation types. Element supply for plant use declines in response to this change. Tree growth (diameter increment) and foliage chemistry will be the main indicators of response to treatment. These experiments were established in each of the three replicate successional stages in the upland and floodplain sequences.

Time transient estimates for forest litter decomposition are designed to last for 10 years, and were also established each of the replicated successional stages. Changes in organic and inorganic chemistry of litter bag materials will indicate the rate of change in detrital composition and help to evaluate chemical and species control of this process.

Precipitation barriers were installed in the three replicate mid-successional stage sites in the upland and flood plain sequences. The removable barriers are designed to prevent moisture from reaching the forest floor and tree root systems during the growing season. The consequence of moisture stress to tree growth will be estimated by following diameter increment.

Each of these experiments will improve our understanding of the importance and controls of resource supply to tree growth.

K. Van Cleve , J. Yarie, L.A. Viereck, and C.T. Dyrness

Salt Affected Forest Soils

In calcareous soils, the balance of $CaCO_3$ reflects net system acidification-alkalinization. The objectives of this study were to quantify $CaCO_3$ precipitation-dissolution and to quantify net system acidification along a plant primary successional sequence (250 years) on the Tanana River floodplain of interior Alaska. The $CaCO_3$ in the initial soil profiles was highly correlated (R^2 = .88) to silt concentration which suggests that the $CaCO_3$ is associated with the silt-size fraction. Differences in $CaCO_3$ concentrations between sites of similar age are largely due to differences in silt concentration which is controlled by the alluvial deposition process. There was no net precipitation of $CaCO_3$ which means that the $CaCO_3$ originated with the alluvial parent material. There was a linear decrease in $CaCO_3$ along the successional sequence. The loss of $CaCO_3$ was equivalent to a loss of acid neutralizing capacity of 9.92 keq ha^{-1} yr^{-1} which is a high rate of soil acidification. These base ($CaCO_3$)-containing Tanana River floodplain ecosystems offer a unique opportunity for examining processes of soil acidification under natural, relatively pristine conditions.

G.M. Marion and K. Van Cleve

Long-Term Ecological Research: An Analysis of the Relationship between Resource Availability and Forest Productivity

Installation of resource availability experiments began in 1988 and will continue through the summer of 1990. Starting in 1990, tree growth and foliar chemistry will be monitored for nitrogen fertilization, sawdust addition, sucrose addition, and summer moisture deficit effects. The sawdust and sucrose treatments were designed to examine the influence of the carbon source on microbial population and subsequently the availability of nitrogen. The nitrogen fertilization and moisture deficit treatments will complement the carbon source treatments and add to our information on how resource availability (nutrition and moisture) affects tree growth and foliar chemistry which in turn affects the availability of carbon to microbial populations through litterfall and the decomposition processes.

Work also continued on the analysis of seedling growth in two floodplain white spruce clearcuts. Three treatments—fertilizer nitro-

gen, phosphorus and N+P—were applied annually during the spring of 1986 through 1989. In mid-summer of 1988 three trees per treatment were sampled for calculation of allometeric relationships between height, above and below ground biomass and determination of the concentration of N, P, K, Ca, and Mg. Tree height measurements and seedling survival estimates have been completed in fall since planting. At the end of 1989 aspen was the tallest at 73 cm followed by poplar, alder, and spruce at 65 cm, 25 cm, and 16 cm, respectively. The effects of fertilization were not consistent between clearcuts. In general, seedling growth was depressed by fertilization in one clearcut but stimulated in the other. Spruce showed no response to fertilization in either clearcut. *J. Yarie*

The Role of Computer Models in Predicting the Consequences of Management on Forest Productivity

During the last 20 years a number of studies have shown that current and intensified levels of forest management may have significant effects on the long-term productivity of forest ecosystems. Because of the long-term nature and complexity of the problems, computer models represent one means of assessing future consequences of current management practices.

To define the type of model required to address the problem, specific questions were developed from both scientific and forest management perspectives. It was suggested that a scientist would ask the question "Why?" while a manager would ask "How Much?" Two types of models were defined: a theoretical model, which was based on perceived causal relationships, and an empirical model, which was based on observed relationships. The universe of applicability of the empirical model is smaller than that of the theoretical model, but the precision of the estimate from a theoretical model is unknown while the precision of the estimate from an empirical model is well defined.

Representative examples of both empirical and theoretical models were reviewed and it was concluded that no models currently exist that can answer both the "why" and "how much " questions. Future work should directed at developing a theoretically based empirical model. This model should contain three routines: growth, carbon allocation, and decomposition. At this time relatively simple formulations of both the growth and carbon allocation routines can be developed. Development of the decomposition routine would require additional work to yield the smallest possible subset of site specific variables that would be combined with general process equations. *J. Yarie*

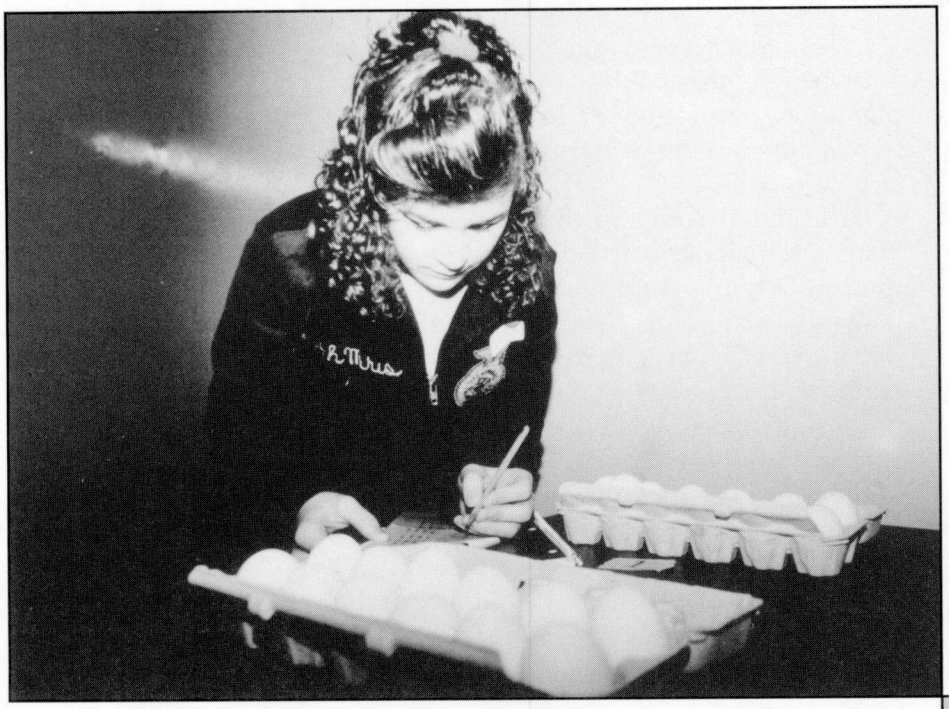
Long-term Ecological Research: Development of a Geographic Information System Capability

A supplemental request for funding was granted from the National Science Foundation this year to start to develop a capability in the field of Geographic Information Systems (GIS). We are currently working on getting both the hardware and software installed. In starting to develop our analysis capabilities, the Bonanza Creek Experimental Forest (BCEF) will be used as a test site. The BCEF Long-Term Ecological Research (LTER) site provides a northern base for long-term global programs such as IGBP and links with other global ecosystems.

The BCEF taiga site is important because:

1). the boreal forest is the northern extreme of forested ecosystems and thus provides a valuable contrast to temperate and tropical forests;
2). being circumpolar in its distribution, the boreal forest is the most widespread of any forest ecosystem;
3). the boreal forest should be highly sensitive to CO_2-related climatic change; and
4). the boreal forest of Alaska is one of the few areas still relatively unaffected by acid rain and human disturbance, providing an important comparison with plant-soil processes in temperate ecosystems.

BCEF is a logical test area because of the large amount of site data that deals with ecosystem structure and function. The procedures developed at the BCEF site will be applicable to the entire taiga forest of interior Alaska. The expansion of the knowledge gained at BCEF to other areas of the state will be greatly enhanced through the use of GIS. Because of the difficulty and expense in developing on the ground studies in remote areas of the state a monitoring and analysis protocol developed using GIS and remote sensing will substantially expand our knowledge of ecosystem dynamics to a large part of the taiga. *J. Yarie*



During the annual FFA statewide contest one of the contestants evaluates eggs during the poultry contest.

Resources Management

Improved Planning and Permitting Procedures

Agencies responsible for Alaska's vast public lands are required to prepare plans to direct land management. Agencies are also required to issue permits for certain uses of the land and resources. These permits and plans, if not coordinated, can become unnecessarily burdensome to project applicants. This research component examines how to reduce the burden of plans and permits without altering agencies' legal obligations.

The research began in 1985 with an analysis of Colorado's Joint Review Process, a means of simultaneously permitting and planning proposed mega-projects. The research continued to examine the cycle process, a formal way of developing a plan to reduce time and cost while enhancing participation. The research then focused on Alaska's permit coordination office and their consistency review process. Results presented last year indicate that the process is highly effective and supported by project applicants.

Through 1989 this research program focused on traditional Native forms of decision-making. The intent is to identify one or more Native decision-making systems (participants, authority, processes, principles) to determine how they differ from agency processes used in rural areas. The goal is to determine if these differences affect the success of agency planning in rural areas.

T. J. Gallagher

Public Participation in Planning

This research program focuses on how the public—particularly the Native peoples of Alaska—might be more effectively involved in planning conducted by state and federal agencies. Public participation in planning is often very frustrating to the public, agency planners, and elected officials.

The initial study in this program concerned problems affecting Native participation in planning. The study was completed in 1988. In that same year, a study of readability (the ease of reading) of agency plans was also completed. Both studies showed a variety of problems that the public, particularly Native peoples, faces in influencing agency planning programs.

In 1989 the research focused on three specific studies. Graduate student Wendy Jacobson completed background research for her study of the use of graphics in environmental impact statements. Her study examined whether graphics used in statements meet standard graphic criteria. Her report will be completed in 1990. Concurrent with this study is an examination of readability of the same sample of environmental impact statements. This study will help determine whether the writing of environmental statements suffers from the same problems as agency plans.

The third study is being conducted by graduate student Winton Weyapuk. In 1989 he completed background research on Native values that affect land use planning. Often, agency plans do not reflect the values of Native peoples. This study, when completed, will identify a set of values for a group of communities, and then evaluate whether or not they have been expressed in any of the agency plans in the region.

T. J. Gallagher

Coordination of Land Planning in Alaska

This research effort started with the data collection for *Who's Planning Alaska: the Alaska Planning Directory*. First published in 1985, the directory was updated in 1987 and is currently being updated for republication in 1990. The directory provides a list of current and ongoing plans prepared by federal, state, and municipal agencies, and by Native regional and village corporations.

Studies in 1987 focused on the status of land ownership and current problems in land management "10 years after ANILCA." In 1988, the program focused on the history of conflict among agencies in Alaska, examining conflict and attempts at cooperation back to 1900. In 1989, the research focus was shifted to an analysis of the regions of Alaska and their potential to serve as units for coordination of management.

T. J. Gallagher

Natural Resources Education Program

The education specialist at SALRM has three research and development projects in progress. The specific projects involve curriculum development, student teaching management, and applied teaching techniques.

The draft of the secondary instructional unit, "An Introduction to Natural Resources Management," is complete. The Alaska State De-

partment of Education, Office of Adult and Vocational Education has funded a study to teacher-validate the lessons, which is currently underway. Selected social studies, natural science, and natural resources (science and vocational) teachers will review the lessons and test their use in the classroom. A detailed evaluation instrument has been developed and audioconferences are being used to accommodate interactive discussions regarding the lessons and to provide an avenue for teachers from many areas of the state to participate. Revisions will be made according to the evaluations of each lesson. A final copy will be available for the 1990-91 academic year. This document will be designated as Agricultural Education Publication #5.

A national study of student teaching management in agricultural education is complete. The purpose of this study was to replicate a study conducted 10 years ago to determine whether significant changes have taken place during the last decade. More specifically, the study was designed to answer three questions:

1). What procedures and requirements for student teaching are currently being used by institutions in the U.S. which offer teacher preparation programs in agriculture?
2). Which of those procedures and requirements affect the most student teachers?
3). Has student teaching management in agricultural education changed in the last decade?

As discovered 10 years ago (Kirts and Claycomb, 1980 & 1981) a variety of procedures and requirements for student teaching are currently being used by institutions in the U.S. which offer teacher preparation programs in agriculture. To summarize, most institutions and most students are on semesters; have less than two full-time teacher educators in agricultural education; have 100 percent of the staff sharing in the student teacher visits; operate on a 10-12 week student teaching period; run one, full-time continuous block of student teaching; use only one student teacher per cooperating center; use student teaching as the last degree requirement; encounter visits three to five times during the student teaching period; give/receive eight to 12 semester credits for student teaching; and, give/receive a letter grade for student teaching. Ranges for many other variables such as time spent teaching adults, working with young farmers, and supervising students occupational experience programs were extreme and, therefore, did not indicate definite trends. In conclusion, student teaching management in agricultural education has not changed significantly over the past decade with the exception that the length of student teaching is increasing.

Teaching concepts regarding commons property resource management is the subject of the third project. In cooperation with colleagues from environmental engineering and student counseling, the Commons Game developed by Richard Powers was modified and is being used to teach about commons property in a natural resources management context. Via this long term research project, three specific perspectives are being investigated.

1). How effective is the game as a teaching technique?
2). Are patterns of play or strategies evident and/or predictable?
3). Do individuals play differently based on a personality inventory score?

Although data is still being gathered, preliminary research indicates that the Commons Game is an effective teaching technique when used in a natural resources management context and in combination with lecture and discussion sessions. Also, patterns of play are appearing, especially regarding players' decisions promoting enforcement (policing action).

C. Kirts

Farming Systems Research Concentrates on Farmers

Farming Systems Research (FSR) is an on-going and developing program at the Agricultural and Forestry Experiment Station. The concept of FSR is to place the farmer at the core of the research effort. There are four steps used in FSR research:

1). establish field research which is directly transferable to the farmer;
2). analyze historical and statistical trends in the agribusiness industry;
3). characterize typical farm management practices and farmers' goals; and
4). develop models of a farm industry in a specific social, political, and economic environment.

Previous field research in interior Alaska has included conservation tillage, fertilizer application techniques, rates of nitrogen, and seeding dates of dry-land barley grown in a continuous rotation. Farmers in the area have successfully adopted the technologies associated with this research. Field research is continuing with a greater emphasis on tillage techniques and residue management for weed control in barley and further refinements in fertilizer management.

Production costs and management techniques used in the production of barley in interior Alaska have provided benchmarks for farmers continuing to produce the crop. Surveys were continued in 1989 to expand characterization of typical farm management practices and in farmer goals to other crops, primarily vegetables, and other areas of the state.

The primary focus of the FSR program in 1989 continued to be on analysis of historical and statistical trends in the agribusiness industry. The definition of four periods in agricultural development in Alaska provided background for investigation of specific products and regions playing a major role since statehood. Three models for this period were identified. The first—typical of the vegetable and potato industry—is one in which minimum state or federal investments have been made. In the second, investments are a mixture of public and private funds. The milk industry is an Alaskan example. The third model—exemplified by the barley and red-meat industry—is where state government investments were perceived to be high, even though many of those planned were not made. The most consistent production was in the vegetable and potato industry. Production fluctuated most in the barley and red-meat industry. In 1989, research considering Alaska's boom and bust economy was completed. Six booms were defined beginning with the arrival of the Russians: furs, whales, salmon, minerals, military, and petroleum. Research focused on the cumulative impact on infrastructure of the booms. This research provides background on which to further assess the impact of agricultural development. A beginning of

this effort is an analysis of the impact of underdevelopment of infrastructure on the success of agriculture in Alaska.

The fourth component of FSR will be carried forward with comparisons of agricultural development in Alaska to those in other circumpolar areas. The objective is to provide guidelines to developers and individual farmers in all regions as well as Alaska to strengthen the agricultural industry. *C. E. Lewis, R. W. Pearson, and B. J. Pierson*

Food Acquisition Practices and Related Attitudes Among Urban Alaskan Consumers

Selection among available food products for home consumption is an important contributor to nutritional status and a major focus of nutrition education efforts in Alaska and elsewhere. Food choices differ with the specific consumer group and the associated lifestyle. The lack of homogeneity in consumer choices has been recognized by the food industry. This recognition has resulted in an increasing trend to develop and market food products to target audiences.

Information on the food acquisition practices of urban Alaskans should assist in-state producers and retailers targeting particular audiences. This information also should be useful to nutrition educators who help consumers make informed choices among resource alternatives available to them. In addition, it should assist educators, who must tailor national initiatives to Alaskan audiences and concentrate their efforts in areas of greatest need.

Setting (demographic and geographic) characteristics and resource availability and allocation on the food acquisition practices and related attitudes of urban Alaskan consumers are being examined. Primary food purchasers (n=400) have been surveyed by telephone. Frequency response has been tabulated and relationships have been delineated using Chi-square analysis. Where appropriate, responses have been compared to a national profile.

Urban Alaskans, like consumers in the contiguous 48 states, expect a nutritious, safe, and abundant food supply of high quality. These consumers are most dissatisfied with the quality of available fresh products, particularly produce. In-state producers, who now supply a minor share of the fresh food market, must emphasize quality if their share is to increase; competitive pricing and entry in convenient supermarkets will be necessary to reach the majority of households.

Urban Alaskans are more aware of food processing and food safety problems than are their national counterparts. This awareness likely reflects the remote location of the state, participation in subsistence activities, and dependence of large numbers of state residents on the seafood industry for employment. Despite this awareness, concerns exist about nutrition, health, and the food supply. Nutrition education efforts should emphasize benefits and risks associated with existing and new processing techniques and the relationship between diet and health. Information dissemination through newspapers is most likely to reach the largest segment of Alaskan primary food purchasers. In addition, labeling of Alaskan produced products could aid in consumer identification, serve as an assurance of quality, and provide a vehicle for nutrition education. *R.B. Swanson, C.E. Lewis, C.A. Birklid*

Quality Assessment of Alaskan Reindeer Meat

The Alaskan reindeer industry is expanding its meat production. Meat production increased from 320,000 pounds in 1987 to 432,000 pounds in 1988. Any future market expansion is likely to occur in urban Alaska and in areas outside the state where Alaskan reindeer compete with Scandinavian and Canadian reindeer and New Zealand red deer. Successful entry of the Alaskan reindeer into these markets and maintenance of market share will depend on meat quality characteristics.

Microbiological safety and nutritional content of representative forequarters from reindeer field-harvested during a spring, 1989 handling were studied under a cooperative agreement with The University of Tennessee. Low surface contamination levels (2.34 to 3.39 log Aerobic Plate Count per $inch^2$) indicated that the field-harvesting and handling procedures yielded a safe product. These values are considerably lower than the typical range found for beef slaughtered and processed in commercial facilities.

Nutritional analyses were limited to proximate composition and a fatty acid profile. Protein content was about 21 percent, approximately two to seven percent higher than that found in domestic red-meat animals. Total fat, which depended on the external fat cover was 9.5 percent in a composite sample; major fatty acids present were stearic, palmitic, and oleic. This composite reindeer sample had considerably less fat than did beef chuck with fat and beef short ribs. Reindeer shoulder muscle had a fat content of 3.5 percent with myristic acid present in the greatest amount. The fat content was lower than lean cuts of beef chuck blade roasts, lean pork shoulder, and lamb cuts. An inverse relationship was found between saturated:unsaturated fatty acids and amount of external fat. Low total fat content resulted in a saturated fat content that approximated that of poultry and fish. Reindeer should appeal to health-conscious consumers who wish to reduce their fat intake while consuming red meats. *R.B. Swanson*

Alaskan Food Costs

Food costs potentially influence dietary quality and nutritional status. Alaskan food costs have been reported to exceed the costs in other U.S. locales when specific items are compared. However, direct comparison of the costs of specific food items is not reflective of the potential impact of food costs on dietary quality and ultimately health status. Therefore, cost data for a market-basket based on USDA's low-cost food plan were analyzed. The cost data for 105 food items were obtained in urban Alaska and in five west coast cities in September 1988 by the University of Alaska Cooperative Extension Service.

Analyses are based on the consumption amounts needed by a family of four for a nutritionally balanced diet. The specific items surveyed reflect the typical American eating pattern. Previous surveys reveal that urban Alaskans have eating patterns typical of the average American. Alaskan consumers paid 19-24 percent more than did west coast consumers for the same market basket.

Fairbanks costs exceed those of Anchorage and Juneau which are about equal. The higher food costs could not be attributed to a single food group; increased costs are spread across all food groups. Within food groups, fresh products account for a slightly greater percentage of

the Alaskan food costs than is found in west coast cities. This breakdown has implications for increasing food cost disparity if Alaskans follow the national trend and increasingly select fresh products over their canned, dried, or frozen counterparts.

Costs for hypothetical breakfast and dinner meals representative of USDA's low-, moderate-, and liberal-cost food plans were also compared. Costs of the low-cost meals reflect costs of the low-cost market-basket. Moderate- and liberal-cost meals exhibit greater cost variability due to location; prices of moderate-cost meals in Alaska and the west coast are closest. Generally, the Alaskan cost increase for typical breakfast foods exceeds that of dinner items. These costs represent only a onetime view of the costs of a limited number of food items in these locations. Additional work is needed to verify the trends observed.

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

UAF—USSR Exchange Program Initiated

In 1988, the Lenin All-Union Academy of Agricultural Sciences, Siberian Branch (VASKHNIL S.B.), in Novosibirisk, USSR, and the University of Alaska Fairbanks (UAF), Agricultural and Forestry Experiment Station, signed a five-year agreement for cooperation in agricultural science. During the summer of 1989, researchers from both institutions initiated the series of exchanges outlined in the agreement.

Four areas were emphasized in the first year of the program. In germplasm, the purpose of the first summer was to collect and exchange seeds of grasses, cereals, and legumes adapted to high latitude. Two VASKHNIL S.B. and two UAF scientists spent one month together, two weeks in Alaska and two weeks in Siberia, collecting germplasm. Substantial progress has been reported.

In cropping systems, including conservation tillage, three scientists from each country spent time in the other discussing joint research. A high level of continuing research is envisaged.

In a third area, economic problems of northern agricultural development were observed by two agricultural economists, one from each country. Distance to market and transportation difficulties were obvious similarities.

Finally, joint musk ox research between UAF's Cooperative Wildlife Unit and the Institute of Extreme Northern Agriculture in Norilsk was started. Musk ox ecology is very much of common interest between Siberia and Alaska.

W.C. Thomas

Recreational Activity Expenditures Contribute to State's Economy

Recreational activities focusing on Alaska's wildlife and fishery resources involve expenditures that make important contributions to the economic bases of a number of local economies and may be significant within the state as well. Resource management agencies increasingly recognize the importance of these economic impacts and are interested in their quantification. In cooperation with the Alaska Department of Fish and Game and the U. S. Forest Service, a conceptual framework has been outlined to assess the contribution of wildlife-related expenditures to the Alaska economy. This work has resulted in

two chapters contributed to a forthcoming book on economic issues in Alaska wildlife. A spinoff of this work involves the identification of possible conflicts among objectives of recreation management programs, e.g., economic impact versus economic efficiency. Data from surveys of dall sheep hunters and sport fishermen in the state show frequent instances of such conflicts as expenditures and estimated consumer surpluses are compared among areas.

An investigation of Northwest Alaska reindeer herder management options and associated public lands policy issues has been completed and accepted for publication by the *Canadian Journal of Agricultural Economics*. A linear programming framework was used to examine the financial implications of the introduction of rotational grazing management systems. Simulations suggest that both the economic performance of a representative reindeer enterprise and the long term productivity of the range would be improved substantially by employing more intensive management systems. The estimated shadow values of forage under rotational grazing hold important policy implications for both the establishment of grazing fees and the assessment of the opportunity cost of allocating rangeland for caribou use.

A graduate student has completed a review and interpretation of the the history of land disposal policies and programs in Alaska. Findings will be incorporated into a previously-developed nonlinear programming framework designed to characterize optimal time patterns for disposal of durable resources when alternative objectives for disposal programs are considered. Results should permit both an evaluation of past disposal efforts and guidance for future programs.

W. G. Workman

Financial Statement

Expenditures — July 1988 through June 1989

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1988, and ending June 30, 1989 (FY 89).

		(% of total)
Federal		
Hatch Regular Formula Funds	$906,507	12.8
Hatch Regional Formula Funds	188,334	2.7
USDA–Agricultural Research Service	133,997	1.9
McIntire–Stennis Formula Funds	421,659	6.0
Other Grants and Contracts	939,985	13.3
State Funds	$4,487,686	63.3
TOTAL	$7,078,168	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, Assistant 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.

Jeffrey S. Conn, Research Agronomist, USDA; Affiliate Assistant Professor of Weed Science; University of Arizona '73, B.S., '76, M.S.; North Carolina State University '80, Ph.D. Dr. Conn's background of research is in weed science, physiological ecology, and remote sensing. He joined the Agricultural Research Service at the University of Alaska in 1980. His current research is in integrated weed control systems for reduced tillage agriculture, weed biology and ecology, and persistence of herbicides.

Robert F. Cullum, Assistant Professor of Agricultural Engineering; University of Tennessee, Knoxville '77, B.S., '82, Ph.D. Dr. Cullum's research background is in areas of structure in relation to environment and soil and water engineering. He joined the AFES research faculty in 1982 and has since concentrated on conservation tillage research in small-grain production for interior Alaska and waste-management systems for Pt. MacKenzie.

Robert A. Dieterich, Professor of Veterinary Science, Institute of Arctic Biology, University of California-Davis '61, B.S., '63, D.V.M.; Post-graduate training, University of Alaska Fairbanks, '68. Dr. Dietrich's research interests include: diseases of wildlife, applied methods for disease control in reindeer, methods for disease control in fur farming, equine medicine, and surgery.

Stephen M. Dofing, Assistant Professor of Agronomy; Kansas State University '78 B.S., University of Nebraska '80 M.S., '83 Ph.D. Dr. Dofing's research background is in genetics and plant breeding of agronomic crops. He served as Research Station Manager fora hybrid corn company, and as Assistant Professor of Agronomy at the University of Nebraska. He joined AFES in 1989 and has been responsible for variety development and applied genetic studies in small grains, forage grasses, and legumes. Research in variety development includes the improvement of barley and other agronomic crops for yield and quality characteristics. Other research interests include germplasm evaluation and adaptation studies, and use of genetic male sterility for population improvement of barley.

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.

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, Assistant 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.

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 has been coordinator of the Rosie Creek Fire Research Project since 1983. 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 Area proposals in major land management plans in Alaska, analysis of landscape-level processes responsible for natural diversity, and studies of forest structure. During a recently concluded special assignment project that included stops in 23 states and 4 provinces he analyzed natural area programs across North America. Dr. Juday has served as President of the Natural Areas Association since 1985, and was Guest Editor of a special 3-issue series on old-growth forests in the Natural Areas Journal.

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, Instructor 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.

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, Associate 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.

Feridoon Mehdizadegan, Postdoctoral Research Associate, Pahlavi University '78, B.S.; Tarleton State University '80, M.S.; University of Arkansas '84, Ph.D.; Oklahoma State University '87, Ph.D.; Dr. Mehdizadegan has been with AFES since 1987. His current research interest is studying host-parasite interactions between snow mold fungi and wheat cultivars.

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, Assistant 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, Assistant 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.

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.

Wayne C. Thomas, Professor of Economics; California State Polytechnic University '65, B.S.; University of Nevada '67, M.S.; Washington State University '71, Ph.D. Dr. Thomas's academic background is in agricultural economics. Since joining the University of Alaska Fairbanks faculty in 1971, he has conducted research into land management issues, the economics of Alaskan agriculture including reindeer, and the role of government in the agricultural development process. Dr. Thomas has participated in research activities supported by the United Nations and was named a Senior Fulbright Scholar to Australia in 1980. He served the university as acting vice chancellor for academic affairs in 1987-1988.

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. His current research interests deal with the structure and function of subarctic forest ecosystems.

Robert B. Weeden, Professor of Resource Management; University of Massachusetts '53, B.S.; University of Maine '55, M.S.; University of British Columbia '59, Ph.D. Dr. Weeden's research interests are in resource policy analysis, particularly in the renewable-resources field. He teaches advanced wildlife management (through a joint appointment with the Department of Biology, Fisheries, and Wildlife), environmental impact analysis and decision making, and natural resources policies and legislation.

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, oil-seed 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.

William G. Workman, Associate Professor of Economics, School of Management; University of Wyoming '69, B.S.; Utah State University '72, M.A., '78, Ph.D. Dr. Workman's research background is in natural resources and agricultural economics. His recent work includes valuation and allocation of nonmarket resources, land-use conflicts at the urban fringes, and reindeer grazing issues on public lands. He teaches courses in economic theory and natural resources economics and is coordinator of the M.S. program in Resource Economics in the School of Management.

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.