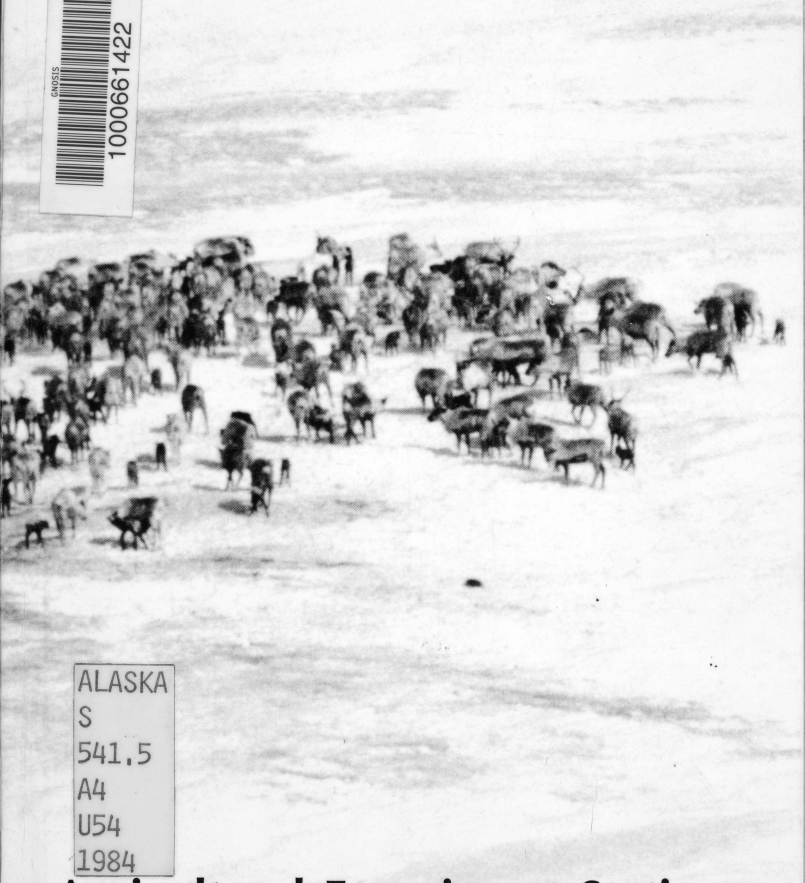
1984 ANNUAL REPORT



Agricultural Experiment Station

School of Agriculture and Land Resources Management
University of Alaska-Fairbanks

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Agricultural Experiment Station
University of Alaska-Fairbanks

"ANNUAL REPORT"

For the year ending December 31, 1984

Fairbanks, Alaska 99775-0080

Misc. Pub. 85-1 June 1985

Letter of Transmittal

The Honorable Bill Sheffield
Governor of Alaska
Juneau, Alaska 99811

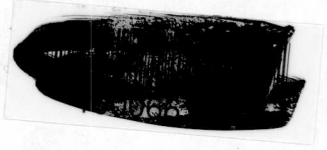
Dear Sir:

I submit herewith the annual report of the Agricultural Experiment Station, University of Alaska, for the period ending December 31, 1984. This is done in accordance with an act of the Congress, approved March 2, 1887, entitled "An act to establish Agricultual 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 Alaska Territorial Legislature, approved March 12, 1935, accepting the provisions of the act of Congress.

Very respectfully,

Sigmund H. Restad

Sigmund H. Restad,
Acting Director



Fairbanks, Alaska
June 30, 1985

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Purpose

The University of Alaska's Agricultural Experiment Station (AES) has statewide responsibilities for conducting research into agriculture and forestry and related land-use activities. AES is a unit of the School of Agriculture and Land Resources Management (SALRM). Through SALRM, research, teaching and service activities are performed in order to serve the several groups that are involved with land resource management issues in Alaska. Directly, these include farmers, foresters, land-management specialists, state and Federal agencies, and, indirectly, the public at large which benefits through wise use of land resources.

Research activities at AES are varied, not only with respect to focus, but in location. Research is conducted in field crops, horticulture, animal science, agricultural economics and development, forest soils, forest management, forest ecology, recreation, land reclamation, soil and water conservation, wildlife-agriculture interactions, and numerous related topics. AES conducts research throughout the state: the Matanuska and Susitna valleys, Point MacKenzie, Tanana Valley, Delta Junction, Fairbanks, Nenana, the Kenai Peninsula, the Seward Peninsula, and many other areas of the state.

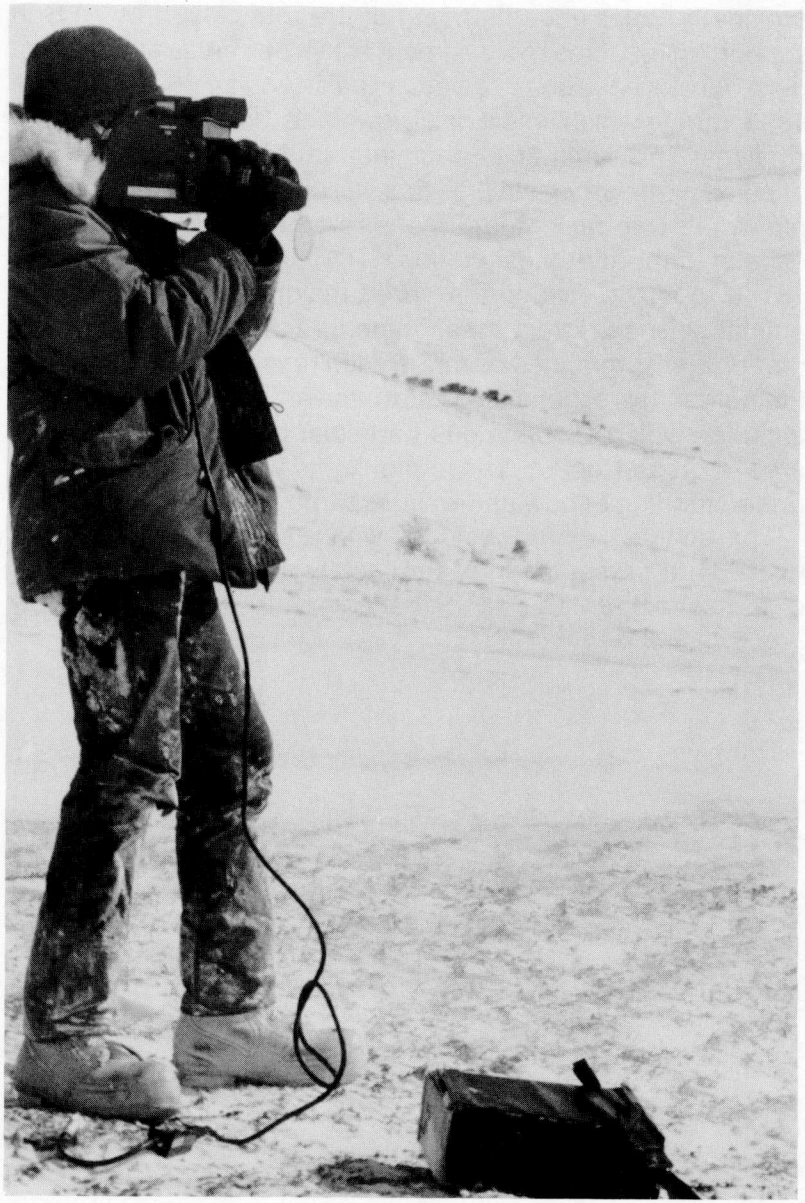
Not only is there diversity in AES activities, but in publications which disseminate research results as well. These include the station's journal, *Agroborealis*, bulletins, circulars, refereed articles in national journals, conference proceedings, and books. The variety of outlets allows for research information to be targeted to appropriate user groups.

It is the purpose of this annual report to describe those projects that were underway in 1984, who was responsible for each, and how the information associated with these research efforts was published. It is our intention that this information

provide a better understanding of the role played by AES in supporting resource management activities in Alaska. The people of Alaska have been served by the station for 86 years, since 1898, during which time it has grown and increased its responsibilities. The summaries contained in this annual report are of current research activities that will aid the state and its people in the twin tasks that lie ahead—those of land resource development and conservation.

The report is divided into three major sections: plant and animal science, forest management, and resource management. Brief summaries describe each research project and list the personnel responsible. Three research highlights are also included which examine one particular project in each major area in greater depth. These highlights will provide a greater understanding of how and why research is conducted at AES.

The annual report concludes with a list of all publications for 1984, a presentation of the faculty and professional staff of the school, and a financial statement.



The collection of range survey data is an integral part of the gathering of information on the interdependence of plant and environmental factors and grazing resources.

Plant and Animal Sciences

Applied Reindeer Program - Land Grant University in Practice

The University of Alaska-Fairbanks (UAF) has developed three programs in support of Alaska's reindeer industry: 1) applied reindeer research, 2) reindeer extension on the Seward Peninsula, and 3) instruction in reindeer husbandry and management at the university level. The Agricultural Experiment Station (AES) has developed this program in cooperation with the Institute of Arctic Biology and the Cooperative Extension Service. The program is supported by a legislative appropriation, secured by the reindeer industry, with legislative intent to AES. In securing this appropriation, the industry used a five-year plan, developed in 1978 by the Alaska Reindeer Herders' Asssociation (RHA), which outlines continuing goals and objectives for the industry. RHA is a statewide, legally constituted entity comprised of reindeer herders formed for the purpose of furthering the development of reindeer herding and marketing for the benefit of the members.

UAF has responded by developing a program to address issues articulated by the reindeer industry. RHA is advisory to the applied reindeer program of UAF, and the following objectives were cooperatively established for 1984:

1. To develop improved handling techniques to reduce stress on reindeer and evaluate supplemental feeding for emergency and fattening rations
2. To diversify meat and by-product marketing and aid in the development of a grading system for velvet antlers

3. To correlate range survey data with plant growth and environmental factors

4. To develop a preventive vaccine for brucellosis and an injectable treatment for parasites

5. To provide linkage among agencies, university staff, RHA, and the herders with respect to management options.

The industry's concern over losses during handlings was addressed on a demonstration basis with introduction of a pnuematic squeeze chute and pnuematic cutters. The use of the pnuematic chute proved effective for restraining individual reindeer without injury and for reducing struggling of reindeer while being handled in the chute. Pnuematic shears were found to be effective for cutting velvet antlers. The nearly instantaneous removal of antler reduces animal stress, nearly eliminates potential twisting injury to the animal, and reduces the work required.

Industry-supported research on supplemental feeding has been completed. This research assessed the value of commercial feeds

Harsh environmental factors can impact successful reindeer herd management significantly at such times as the spring calving.

for emergency feeding and/or fattening of reindeer for slaughter. Results indicate that both have potential, but application and economic analysis must still be accomplished.

In response to recommendations made by the industry, a major shift in program emphasis has occurred to address marketing issues. An educational and training workshop was held on utilization of reindeer by-products in November 1984. David Ward, a consultant from the New Zealand red deer industry, was brought in as a resource person. The workshop focused on potential markets as well as the removal, grading, and marketing of by-products. Results of this effort include development of a multilevel grading system for velvet antler and initiation of efforts on the part of herders to develop a marketing cooperative.

Preliminary work was begun to gather data on the effect of pre- and post-slaughter techniques as they influence meat quality in reindeer. This effort included testing within the local market as an initial effort to define preferred characteristics for reindeer meat.

Industry requests for information on the interdependence of plant and environmental factors (snow pack) on grazing resources has led to other research. Data are being gathered on the quality and availability of forage, including lichen productivity, on the principal sites delineated in a range survey. Results of work on snow have shown that in some situations on reindeer ranges, because of wind factors, snowfall is less important than vegetation height, since snow accumulation stops once the vegetation type is filled. This allows, in appropriate situations, the determination of winter grazing areas from range surveys developed by the Soil Conservation Service, U.S. Department of Agriculture.

Industry desires in the veterinary science program were focused on maintaining the existing program and the treatment of reindeer at winter handlings for internal parasites. Over 10,000 reindeer were treated this past winter with the injectable drug Ivermectin to prevent internal parasites. Federal approval this year for the use of Ivermectin on reindeer is a result of several years of testing and data accumulation. In addition, approval has been received to do some large-scale testing with the brucellosis vaccine which has been recently developed. This effort, along with accumulating data necessary for

More than 10,000 reindeer were treated during the 1983-84 winter with the injectable drug Ivermectin for prevention of internal parasites.

eventual application to Federal agencies for approval, will be continued.

The complexities of reindeer herding means that UAF has responsibilities other than research and demonstration. A university course is taught on the Alaska reindeer industry, and significant effort goes into public-service activities. The university plays a major support role in the Alaska Reindeer Council, which is comprised of public and private entitites involved in the reindeer industry. The council provides linkage among individual reindeer herders; governmental agencies; and public research, instruction, and service to the reindeer industry.

Real benefits accrue to Alaska's reindeer industry and, in a larger sense, to Alaska's society through the several aspects of the reindeer program at UAF. □

Cereal Breeding and Production

Barley breeding is currently directed toward the incorporation of disease resistance into adapted, early maturing, high-yielding barley materials. About one-fourth of the 10,000 barley selections grown at Palmer, largely from scald-resistant composites, were selected as showing disease resistance under natural infestations and some degree of adaptability to this environment. Four thousand of these lines were rated for disease resistance and maturity in Delta. A hybridization program involving thirty-two selected lines has progressed through a first cycle. A second series, involving sixty-four lines, has been initiated. A secondary breeding goal is to identify those characteristics which may provide superior performance under limited tillage conditions and determine if selection within segregating populations can promote improved performance under no-till conditions.

Oat breeding and evaluation is devoted to the twin goals of improving grain and forage yield performance. Almost 100 lines were evaluated for the first time for grain yield and agronomic performance. An additional 100 lines were selected from the breeding nursery for similar evaluation. Those exhibiting superior agronomic performance will join standard varieties for forage evaluation. North-adapted oat varieties from Canada and Alaska tended to produce high forage yields at Palmer.

Enhancement of earliness remains the predominant goal for the wheat breeding program. Although significant progress has been accomplished in this direction through selection within segregating populations, an additional cycle of directed breeding for this specific purpose has been initiated. Nearly 1,000 lines, the majority from the early maturity program, were evaluated for agronomic desirability.

Production studies centered around special problems or specific production areas. Alaska-adapted cereal varieties were evaluated for agronomic performance at Pt. MacKenzie. Recently released varieties

were examined for possible performance differences related to seeding rate. Chemical straw strengthening and shortening appears effective on barley and wheat; yield responses have not yet been completed. Successful breeder seed increases were conducted on six barley, four oat, and four wheat varieties. *R.L. Taylor.*

Conservation Tillage and Crop Residue Management

The Agricultural Experiment Station, in cooperation with the Agricultural Research Service, USDA, has conducted research since 1979 on the use of conservation tillage in the production of barley. The most recent effort was begun in 1983 and concerns the management of crop residues and use of conservation tillage in the production of barley grown in a continuous rotation. The elements of large-scale agricultural production in interior Alaska addressed are the short growing season, marginal water supply, serious potential wind erosion hazard, infertile soils, weeds and diseases, and cool soils.

The research site is on land which was cleared in 1978 and not cropped until 1982. The research design includes three residue treatments: residue removed, straw removed, and straw remaining; four tillage systems: no tillage, chisel in fall, disk in spring, disk in fall and spring; and three types of planters: double-disk, press-wheel drill, hoe drill, and disker seeder. Soil nutrients, temperature, and moisture are measured; and, throughout the season, net radiation, albedo, relative humidity, and windspeed are monitored as well. In addition, grain yield, moisture, and test weight are calculated.

Yields and grain quality (moisture and test weight) are a direct indication of the effectiveness of the various residue, tillage, and planter treatments. Use of analysis of variance to analyze grain yield showed there was a significant interaction (α = .05) between residue and tillage factors. Duncan's multiple range test was used to identify significant differences between mean yields for residue-tillage combinations. Plots from which straw was removed and any tillage except no-till was used provided the highest yields. The highest was 1.13 t/A from the plots with straw removed which had been disked in the fall and spring. All plots receiving no tillage had the lowest yields

for all residue treatments. The average was .72 t/A. We determined, by analysis of variance, that use of the drill was the only significant factor affecting grain moisture. Grain moistures ranged from 9 to 24 per cent. The highest moisture occurred when the hoe drill was used. The analysis of variance for test weight showed a strongly significant (α = .01) interaction between tillage and drill factors. Duncan's multiple range test was used to identify significant differences between means. Highest test weights were for the press-wheel drill (42.5 lb/bu) for all plots which had been tilled. Lowest were for the hoe drill (36.0 lb/bu) for all tillage treatments.

The general trend of the grain yield data indicates that, as tillage is intensified, yields increase. Tilled soil will increase in temperature more rapidly in the spring than will untilled soil. Yields from plots from which residue was removed tended to be lower. Removing residue limits the potential to trap snow during the winter, thus decreasing moisture available to the crop in the spring. Grain which is high in moisture at harvest generally has lower test weights. The hoe-drill plots produced grain which was highest in moisture and lowest in test weight. Depth of seeding was difficult to control with this drill and became more difficult as tillage increased. Grain was seeded deeper than recommended, resulting in late maturity and high moisture at harvest. *C.E. Lewis and W.M. Laughlin.*

Small-Grain Production in the Tanana Valley of Interior Alaska

Fall and spring applications of urea and ammonium nitrate, incorporated by tillage, were compared as a means for providing nitrogen to barley. Nitrogen was applied at the rate of 90 lbs N/A as urea, as ammonium nitrate, and as a combination of urea and ammonium nitrate (45 lbs N/A as urea, plus 45 lbs N/A as ammonium nitrate). The combination treatment provided one-fourth of the nitrogen in the nitrate form. In addition to nitrogen, all treatments received uniform applications of phosphorus (P), potassium (K), sulfur (S), and boron (B). These treatments were applied in the spring and supplied from triple superphosphate, potassium sulfate, and boric acid fertilizer

materials. The rates of application were 26 lbs P/A, 37 lbs K/A, 15 lbs S/A, and 0.9 lb B/A. These treatments were applied to barley grown at five sites in the Fairbanks and Delta Junction areas of interior Alaska. The soils for these sites varied in pH from 5.6 to 7.1. Three of these sites were on summer-fallowed land, and two sites were on land planted to barley the previous year.

There was little difference in grain yield among fall-applied urea, spring-applied urea, and spring-applied ammonium nitrate. For the five sites, these treatments produced average yields of 104.1, 103.3, and 103.7 bu/A, respectively. However, fall-applied ammonium nitrate produced an average yield which was noticeably lower (93.7 bu/A) than the preceding three treatments. This suggests that there may have been some leaching of nitrates out of the root zone. The combination of urea and ammonium nitrate was about equal in effectiveness when fall (97.7 bu/A) and spring (99.6 bu/A) applications were compared. Yields, however, were slightly less than fall and spring applications of urea and spring-applied ammonium nitrate. No appreciable benefits were gained from combining the two nitrogen sources.

The results indicate that urea can be effectively applied to interior Alaska soils during the fall of the year. This will enable farmers to spread out their workload and alleviate the time crunch during spring planting. Fall applications of ammonium nitrate should be avoided, particularly on lighter soils which are subject to leaching. *F.J. Wooding.*

Introduction, Multiplication, Maintenance, Evaluation, and Cataloguing of Plant Germ Plasm

Grain variety trials 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 conditions. These trials are the basis for making variety recommendations to interior Alaska farmers. During 1984, thirty-one barley, twelve oat, and fifteen wheat varieties and experimental lines were evaluated in replicated standard trials at Fairbanks and Delta Junction. The Delta

Junction site was situated on recently cleared forest land which had been summer fallowed the previous year. The Fairbanks site was situated on summer-fallowed land which had been in production for about 55 years. Throughout the growing season precipitation was adequate for good crop growth at both locations.

The varieties and experimental lines for each grain type were separated into 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: 'Paavo' barley, 106 bu/A; 'Toral' oats, 147 bu/A; and 'MS273-150 (ACA2571)' wheat, 104 bu/A. The highest yields for each of the crops for the medium-to-late maturity class were as follows: 'Hankkija's Pokko' barley, 108 bu/A; 'Calibre' oats, 176 bu/A; and 'Tapio' wheat, 112 bu/A. At Delta Junction, the highest yields in each of the crops for the very early to early maturity class were as follows: 'H349-204 (ACA2563)' barley, 115 bu/A; 'Athabasca' oats, 172 bu/A; and 'Rovaniemi Sel. 70-W' wheat, 80 bu/A. The highest yields in each of the crops for the medium-to-late maturity class were as follows: 'Hankkija's Pokko' barley, 114 bu/A; 'Cascade' oats, 186 bu/A; and 'Taava' wheat, 90 bu/A.

'Hankkija's Pokko' is a medium-maturing, stiff-strawed, six-rowed barley that has demonstrated very high yield potential at two interior Alaska sites. During three years of testing, this variety has averaged 81 bu/A at Delta Junction and 107 bu/A at Fairbanks. This variety was developed by the Hankkija Plant Breeding Institute at Hyrylä, Finland. *F.J. Wooding.*

Improving Rapeseed Production in Interior Alaska

The success of spring rapeseed production in interior Alaska depends upon the crop's ripening to a harvestable state prior to heavy snowfall in the autumn. To ensure early, uniform ripening, the seed must be in moist soil at a uniform depth (½- to 1-inch) early in the spring. The objective of this study is to determine whether spring rapeseed can be produced successfully from seed planted in late autumn or early spring when the soil is cold or frozen. Two cultivars,

'Candle' and 'Tobin', are each planted at weekly intervals from mid-September until snow depth exceeds 6 inches. Weekly plantings are resumed in the spring, as snow is leaving the fields, and continue through the first week in May. Plant-population counts are made during the seedling stage, and maturity notes are taken weekly throughout the growing season.

The results of two field seasons have shown that plant populations from early spring plantings greatly exceed plant populations from autumn plantings. Seed yields from spring-planted plots have not differed greatly regardless of planting date or cultivar. Although rapeseed must be planted no later than May 10 to have a reasonable chance of reaching maturity during the short growing season, results thus far have shown that seasonal rainfall patterns have a much greater effect on crop maturity than does date of planting. This study is being continued with greater emphasis on seed treatments and no-tillage seeding into protective crop residues as means of improving plant survival from autumn and early-spring plantings. *C.W. Knight.*

Integrated Weed Management To Reduce Tillage and Soil Erosion

Sampling of weed vegetation was undertaken in 1984 in conjunction with a multidisciplinary study designed to determine the effects of tillage and residue treatment on crop yields, soil erosion, and microenvironment. Tillage had a significant effect on weed species composition and cover. With reduced tillage, perennial weeds, notably bluejoint reedgrass (*Calamagrostis canadensis* [Michx.] Nutt.), increased in ground cover. Experiments were undertaken to determine the best time to apply various rates of gryphosate to control bluejoint reedgrass in no-till continuous barley. The results indicate that neither spring (preemergent to barley) nor fall (after harvest) treatments were effective. *J.S. Conn.*

Persistence of Herbicides

Six herbicides (dinoseb, metribuzin, chlorsulfuron, difenzoquat, triallate, and trifluralin) were applied at three rates in 1982 to determine their persistence and carry-over effects on four rotational crops (wheat, rapeseed, oats, and barley). Trifluralin, triallate, and metribuzin residues have been analyzed. At the end of the first growing season, 17.4 per cent of the metribuzin, 100 per cent of the trialate, and 82.3 per cent of the trifluralin remained. By the end of the second growing season, these values had dropped to 6.7 per cent, 53 per cent, and 71 per cent, respectively. The results suggest that degradation of herbicides, especially soil-incorporated ones such as trifluralin and triallate, proceeds at a slow rate under Alaskan environmental conditions. *J.S. Conn.*

Characteristics and Feed Value of Barley and Western Protein Supplements for Swine, W-166

Six barley varieties: Thual (hulless), Otal, Datal, Lidal, Weal (awnless), and Galt, were selected for production or collection in a cooperative barley-sampling study in order to determine the physical and chemical characteristics of Alaskan barley cultivars and their relationship to feeding value for swine. Five varieties were developed in Alaska (R. Taylor, ARS-USDA, Palmer), and the sixth is a Canadian variety which, until recently, has been produced commercially in Alaska.

Thual and its closest hulled isogene, Otal, were each seeded on 25-acre plots, and Lidal and Datal were each planted on 100-foot drill strips, all at the Agricultural Experiment Station Farm at Fairbanks. Weal and Galt samples were obtained from commercial producers in interior Alaska. Yield estimates and bushel test weights for Lidal, Datal, Otal, and Thual were 66, 61, 70, and 58 bu/A and 47, 46, 51, and 60 lbs/bu, respectively. The average moisture content of the four varieties was 10.8 per cent and crude protein of the four varieties

ranged from 11.6 to 12.5 per cent. All varieties will be analyzed for proximate components, Van Soest fiber, *in vitro* dry-matter disappearance, selected minerals, amino acids, starch, relative viscosity, beta-glucons, tannins, and kernel weight. Thual and Otal barleys and corn will be compared as energy sources in comparative growth trials with growing-finishing swine (40-220 lbs body weight). If a variation in feeding value is noted between the different barley cultivars, it will be related to chemical composition and physical characteristics of those barley varieties. *F.M.Husby.*

Utilization of High-Protein Cereal Grain Produced in Alaska for Quality Pork Production

A comparative growth trial with 27 Duroc pigs was conducted to compare Thual (hulless) barley with Otal, the closest isogene hulled variety to Thual, and corn as the main grain (energy) sources in growing-finishing pig diets. Thual (11.5 per cent crude protein) and Otal (13.8 per cent crude protein) were compared to corn (yellow dent No. 2) that was imported from the Lower 48. Dietary crude protein levels were maintained at 16 per cent (and 0.7 per cent lysine) from 40-125 lbs body weight and then changed to 13 per cent by increasing the grain and decreasing the soybean meal until pigs attained 220 lbs body weight. Soybean meal (47 per cent crude protein) was used to balance dietary protein, and all diets were balanced for minerals and vitamins. Thual had a 54-lbs/bu test weight, while Otal was 50 lbs/bu when compared to the expected test weights of 60 and 45 for hulless and hulled feed barleys, respectively.

Although not significant, the rate of gain for Thual-fed pigs was 1.8 lbs/bu while corn and Otal barley-fed pigs had 1.85 and 1.90 lbs daily gain, respectively. Feed efficiencies for Thual, Otal, and corn were 2.9, 3.2, and 3.3 lbs feed/lb body weight gain, although Thual was slightly below the desirable test weight. There would appear to be no advantage to feeding the hulless Thual variety to growing-finishing swine. A second study is currently in progress to compare corn and Otal barley to three test weights of Thual barley (47-60 lbs) as the main grain source in growing-finishing swine diets. *F.M. Husby.*

Improving Dairy Cattle through Breeding, With Special Emphasis on Selection

Although milk sales are the primary source of income on most commercial dairy farms, dairymen often consider transmitting ability for other traits, in addition to milk production, when selecting sires for use in dairy breeding programs. Multiple-trait selection, however, will reduce the expected genetic gain for individual traits from unity to one divided by the square root of N, where N equals the number of traits included in selection decisions. Consequently, if nine traits, including milk production, are considered, one would expect to make one-third of the genetic progress for milk production expected if milk production were the only basis of selection.

This experiment was initiated in 1968 to study the efficacy of single-trait selection for milk production and possible consequences on other traits ignored in selection. Two groups of dairy cattle have been generated in the University of Alaska herd using randomly selected sires of average and superior transmitting ability for milk production from two sets of sires used in a similar experiment at Iowa State University.

After six generations of selection, sixty-five cows in the high group and eighty-three cows in the average group have completed first lactations, respectively. Average milk production in the high group has been 15,560 lbs; production in the average group has been 13,275 lbs. Milk from the high group averaged 3.44 per cent fat; that from the average group averaged 3.72 per cent fat. Although percentage of fat was lower, total fat production was higher in the high group.

Group differences in animal size and conformation have been small, although animals within both groups appear to be smaller at comparable ages in later generations than those in earlier generations. Single-trait selection for milk production did not reduce type scores for cows in the high selection group, relative to scores for cows in the average group, but neither did type scores improve in either group after multiple generations of selection for only milk production. It appears that type scores will not be improved without placing some

emphasis on transmitting ability for desirable type characteristics in sire selection, but this will reduce selection pressure for milk production. *A.L. Brundage.*

Acceptability of Straw and Salmon Meal in Rations for Milk Production

Roughages used in diets for dairy cattle in Alaska include grass and small grain crops, which are relatively low in protein. Consequently, concentrates used in rations for milk production must be 18 per cent protein or higher in order to balance hay and silage in a diet which may be 10 per cent protein or less. Soybean meal is an excellent protein source, but it must be imported. Shellfish and fish wastes are by-products of Alaska's marine industry and are potential sources of supplemental protein in livestock feeds. Straw is a by-product of Alaska barley production and, in addition to primary use for animal bedding, is a source of roughage in rations for ruminants. Strawmix is a processed roughage in which straw serves as a carrier for molasses, grains, and minerals; these serve to enhance the digestibility of fiber in the straw. Fifteen Holstein cows in early lactation were fed one of three roughages (barley/oat silage, 50:50 barley/silage and strawmix, or strawmix) and five concentrates containing 0, 5.8, 11.4, 17.4, or 23.2 per cent salmon meal, which replaced 0, 25, 50, 75, or 100 per cent of the protein from soybean meal, respectively. Average milk production was 65.6 lb, and did not vary significantly for cows fed the three roughages and five concentrates in all combinations. Fat tests did differ significantly in milk produced by cows fed the five concentrates and were 3.8, 3.3, 3.2, 2.7, or 2.6 per cent for cows fed 0, 5.8, 11.4, 17.4, or 23.3 per cent salmon meal, respectively. Milk from these cows scored 3.5, 2.7, 3.8, 5.3, and 4.5 on a scale of 1 to 10, where 1 was the most acceptable and 10 least acceptable. Because milk did not have a distinctive fishy taste, lower scores may reflect correspondingly lower fat percentage in milk from cows fed increasing amounts of salmon meal. Twenty Holstein steers and twenty Holstein heifers have been fed the five concentrate diets

in group of four from 8 weeks to 1 year of age. Additional cows and young stock will be assigned to these diets. *A.L. Brundage.*

Matanuska Valley Breeders' Association - Dairy Herd Improvement Association

Matanuska Valley Breeders' Association (MVBA) is a nonprofit corporation, organized by Alaska dairymen in 1948 to enhance the genetic superiority of dairy herds, utilizing sires available through artificial insemination. Semen from beef bulls is also made available in Alaska through MVBA programs. Under a cooperative agreement with the University of Alaska, the project leader is the manager of MVBA and, is responsible for the Dairy Herd Improvement Association (DHIA) program in Alaska. This program is sponsored by MVBA and it is expected that MVBA will assume greater responsibility for DHIA activities in Alaska. The development of new dairy farms on the Pt. MacKenzie Agricultural Project will place increased demands on both MVBA and DHIA in Alaska to meet the needs of genetic improvement of livestock through the use of artificial insemination and dairy records, field service, and laboratory support. Efforts are underway to provide laboratory equipment necessary for milk fat and protein determination, to provide the field support required, and to place additional responsibility on MVBA as Alaska attempts to meet national DHIA quality certification standards. *A.L. Brundage.*

Red Meats — Homer Range

Laboratory analyses of rangeland plants and hay crops grown on the Kenai Peninsula over several years indicated native plant species usually surpassed introduced forages in their content of mineral nutrients and protein. Digestibilities of introduced grasses often exceeded that of native bluejoint reedgrass. Cattle gained better on mixed forbgrass than on bluejoint ranges, and "weedy" hays often tested higher in the laboratory than "clean" lots. To refine

understanding of native forage plant quality for that region, a sampling of thirteen native range species on six sites was undertaken. Weekly collections were taken over a period of 146 days (2 May to 25 September). Site elevations ranged from 150 to 1,100 feet. Species collected, and their respective numbers were: *Dyropteris dilata* (85), *Gymnocarpium dryopteris* (38), *Calamagrostis canadensis* (117), *Epilobium angustifolium* (106), *Angelica lucida* (32), *Heracleum lanatum* (52), *Equisetum arvense* (94), *E. sylvaticum* (42), *Trientalis europaea* (50), *Sanguisorba stipulata* (29), *Veratrum viride* (15), *Geranium erianthum* (13), and *Lupinus nootkatensis* (14). Laboratory analyses included: nitrogen (N), phosphorus (P), calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn), manganese (Mn), iron (Fe), molybedenum (Mo), cobalt (Co), silicon (Si), TNC, IVDMD and caloric values on intact aliquots and IVDMD residues. It is expected that the seasonal patterns in plant digestibility and nutrient contents will account for observed patterns in livestock weight gains.

Preliminary results indicate there are distinct differences among species and sites. Energy, protein, Cu, Zn, and P are nutrients that could be seasonally affecting animal performances. *J.D. McKendrick.*

Cooperative Feed-Testing Service

During the past year, 140 samples, submitted by farmers, have been analyzed for dry matter, crude protein, calcium, phosphorus, acid-detergent fiber, and *in vitro* dry-matter disappearance. Metabolizable energy was calculated from these data for each sample. Results are reported on as-received and dry-matter bases. The Agricultural Experiment Station returns results to the submitting farmer through Cooperative Extension Service (CES) personnel. This program is providing researchers and extension agents with base values for many of the feeds grown and used in Alaska. Over 50 per cent of the samples received were roughage; this group also accounted for the only imported samples analyzed (nine alfalfa samples). The number of samples analyzed per year appears to be stabilizing, with only nineteen more samples analyzed last year over the previous year. However, there was a significant increase in silage

samples from Pt. MacKenzie producers. Sixty-four per cent of all samples were received from August through October, with September (thirty-five samples) and August (thirty-four samples) as the peak months. Alaskan producers appear to be placing added significance on feed testing, as several producers purchased large lots of feed and several growers advertised crops based on lab analytical values this year.

AES, CES, and the Soil Conservation Service submitted 181 samples for selenium analysis this year in a statewide survey. Animal Sciences coordinated the study, prepared and submitted the samples for analysis to Oregon State University, and then distributed results to submitting agencies, as well as individuals. Selenium values for Alaska feeds are generally below minimum livestock requirements of 0.1 ppm, with grains especially low, averaging 0.01 ppm. Mixed feeds, averaging 0.378 ppm, appeared to overcome this problem without the addition of supplemental selenium. Samples from the Kenai Peninsula averaged highest for the regions sampled (0.17 ppm), those from the interior and western regions were lowest (0.03 and 0.06 ppm), and those from the Matanuska-Susitna region were intermediate (0.12 ppm). Selenium levels in Alaska feeds have been considered low, however, this has not been documented. This survey has given researchers and extension personnel some base data for selenium values in Alaska feeds. It also has provided farmers and producers with specific information on their individual feeds so they can feed their livestock more correctly. *A.L. Brundage and M.L. Herlugson.*

Dairy-Waste Management in the Pt. MacKenzie Agricultural Project

The Pt. MacKenzie Agricultural Project in southcentral Alaska covers 15,000 acres of land which was disposed of in 1982 with the primary purpose of developing the dairy industry. As part of the sale contract, nineteen parcels in the project area are required to support 1,400 dairy cows in 1988. This rather aggressive development schedule has forced those involved in conservation, as well as the

farmers themselves, to take a closer look at practices for storage and disposal of livestock waste.

The purpose of this study is to develop the best management practice to store and utilize dairy waste as a supplement for chemical fertilizer with a minimal risk of surface and ground water contamination within the Pt. MacKenzie Agricultural Project area.

The first objective is to develop an economical and effective method for storing dairy waste. Laboratory studies were conducted in 1984 to determine the suitability of topsoil as lining material in earthen basins used for storage of dairy manure. The treatments of topsoil, subsoil (sand), topsoil mixed with lime, topsoil mixed with bentonite, and topsoil layered with bentonite were packed into plastic cylinders to a depth of 4 in. Dairy manure was leached through these treatments, maintaining a 12-in head. After 14 days, the infiltration rate of the bentonite-layered treatment reduced from more than 0.24 in to less than 0.04 in per day, and that of the topsoil treatment reduced 0.05 in per day. For the field test, wells were drilled around the earthen basins to monitor the ground water quality. Baseline data of ground water quality were collected from domestic and utility wells in the project area. The second objective is to study the impact of surface application of dairy manure on ground water quality. Three test plots, 175 ft × 770 ft, were acquired from project farmers through a cooperative agreement in 1984. The field trial will be conducted in three field seasons from 1985 through 1987. Dairy manure will be applied at a rate equivalent to 0, 60, 120, and 240 lbs/A of N, and urea will be used for comparison. The methods of application include inject, broadcast, and broadcast-incorporate. The resulting quality and yield of oats as forage will be monitored. *C.L. Ping, R.F. Cullum, and K.J. Kaija.*

Effects of Application Rates and Disposal Techniques Of Dairy Manures on Oat Forage Yields Grown in a Subarctic Environment

Disposal of dairy manure and its interactions with cool, north-latitude soils will be evaluated to make adequate disposal recommen-

dations. Further, the effects of various applications and techniques will be analyzed to determine the best management practice needed to meet Alaska state water-quality standards and to avoid conflicts with environmental issues. The experimental design uses dairy manure and urea as nitrogen (N) sources at three rates (40, 80, and 160 lb/A) applied to plots (40 by 75 ft) by three techniques (broadcast, incorporate, and inject). Oat yields and nitrates in soil samples were determined as dependent variables, with source, rate, and technique as independent variables.

A cooperative agreement was developed in January 1984 among the Agricultural Experiment Station, the Alaska Soil and Water Conservation Board of Directors, the Alaska Agricultural Action Council, the USDA Soil Conservation Service, and the Wasilla Soil and Water Conservation District to provide specific equipment and services to derive the best management practices for storage and disposal of dairy waste. Within this agreement, manure-disposal equipment, technician assistance, and coordination between dairymen and researchers were obtained. A tankwagon, injectors, and manure pump were purchased and delivered in September. Land was made available through this agreement and was prepared for initial application rates in May 1985. *R.F. Cullum and C.L. Ping.*

Bison Diet Study

Plains bison which were introduced near Delta 56 years ago have caused significant damage in recent years to agricultural crops, especially during August and September. The bison regularly overgraze their summer ranges during the May-August period. Alaska Dept. of Fish and Game personnel used Tordon pellets to kill shrubs and trees on a portion of the summer range to improve herbaceous plant growth. A wildfire burned across shrub and forest lands between the summer range and the agricultural fields. This study was designed to measure forage yields and certain nutritional features affected by the herbicide and fire. Approximately 160 plant species were included in the survey. Laboratory analyses of plant tissues included: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium

(Mg), sodium (Na), copper (Cu), zinc (Zn), manganese (Mn), iron (Fe), and IVDMD. Life forms included forbs, graminoids, and shrubs. Preliminary analyses of forages that indicate that burning improves biomass and generally upgrades nutritional qualities during the first season after the fire. Some elements declined, i.e. Cu; this was possibly due to dilution with carbon. Generally, forbs were higher in IVDMD, Mg, Ca, P, and Cu than were graminoids and shrubs. *Festuca altaica* was usually more desirable in terms of forage quality than were *Calamagrostis canadensis, C. purpurascens,* or *Elymus ambiguous.* Caracies usually rated lower than grasses in digestibility. In terms of herbaceous plant growth, burning seemed beneficial. The persistence of those benefits warrants investigating because the recovery of shrubs was also evident in the burned stands after two to three growing seasons. *J.D. McKendrick.*

Factors Affecting Palatability Of Reindeer Meat

A taste panel consisting entirely of residents of Kotzebue, Alaska, was developed to test for the effects of age, sex, and condition on palatability of loin chops from field-slaughtered reindeer. Results indicated that these factors were secondary to preslaughter stress and cold shortening. Preliminary tests suggest that electrical stimulation of carcasses can eliminate dark cutters and reduce cold shortening. Electrical stimulators are a very attractive alternative to development of controlled-cooling environments on each reindeer range because they are portable and can be easily transported across the vast, roadless tundra to slaughter sites. *W.B. Collins.*

Veterinary Science

The Veterinary Science Program has been active in several areas of Alaska's livestock industry. Within the Applied Reindeer Research

Program, studies have been carried out to control the major diseases of reindeer. U.S. Food and Drug Administration approval has been gained for the use of Ivermectin in the treatment of reindeer parasites. This approval completes a two-year program of research on the effectiveness, safety, and residue levels of the product in reindeer. Agreement has been reached with state and Federal veterinary regulatory agencies to treat approximately 3,000 reindeer with a brucellosis vaccine developed after five years of study of the disease in Alaska's herds.

Livestock reproduction techniques are now being studied and equipment purchased to enhance the reproduction of quality animals using artificial insemination and embryo transfer methods. The goal of this project is to allow the maximum use of quality livestock already within Alaska and to facilitate the importation of new quality stock with a minimum of expense and risk of introduction of new livestock diseases.

Assistance is being given to such other livestock producers in the state as the fox farmers and musk ox producers in the form of diagnostic services and continuing education programs. The interaction of diseases of livestock and wildlife in the state will be increasingly important as new land areas begin to be developed. *R.A. Dieterich.*

Vegetable Variety Trials and Cultural Practices

Sixteen years of intensive evaluation of vegetable cultivars from both commercial seed sources and research breeding programs in the United States, Canada, and other northern-latitude countries, have resulted in significant improvement of yields, quality, and dependability of crops for interior Alaska. Trials of ten or more varieties were conducted for fourteen vegetables, including those with commercial potential (crucifers, carrots, and potatoes) and those of interest to home gardeners (container tomatoes, peppers, and eggplant). The published summary of vegetable trials lists yield, quality, first harvest date, and date and percentage of peak harvest.

A demonstration garden open to the public was planted with high-yielding varieties and examples of appropriate cultural practices such as use of plastic mulch for soil warming. Elevating soil temperature has been shown to be essential for success with crops such as sweet corn in interior Alaska. Temperature data were taken for three types of synthetic mulch (clear plastic, black plastic, synthetic turf) and for bare soil. Mulching with clear plastic resulted in the greatest increase in soil warming (49°F) on a sunny day. A technique for growing cucumber seedlings to transplant size in a cold frame has proven more successful than using greenhouse-grown plants. *G. Matheke, P.J. Wagner, and M. Griffith.*

Yield Trials with Transplanted Lettuce

Lettuce transplants (varieties 'Ithaca' and 'Salinas') were planted in the field at weekly intervals through the 1984 season. Each variety was also seeded direct each week, and harvest dates and yields were compared. Lettuce from transplants was harvested an average of 20 days earlier than that from seed sown the same day the plants were set out. Maturation of transplanted lettuce also appeared to be more predictable, suggesting a more regular supply once harvest began. Yields from transplants were consistently greater than from direct seed. Yield difference was due primarily to harvesting a greater number of heads from transplant plots where 91 per cent was harvested, compared to 53 per cent from seed plots. However, the cost of a transplant system is high, and it remains to be seen if this procedure is economically feasible. *D.E. Carling.*

Potato Variety Trials

Yields of potato varieties tested in replicated trials in 1984 were lower than those of the two previous years. Specific-gravity readings were also generally lower. Growing conditions were moderate to good, and moisture was adequate throughout the season. A killing frost oc-

curred on August 27, accounting for the generally reduced yields. The top-yielding variety was Kennebec (18.6 t/A), followed by the varieties 18-6, 10-1, Red Pontiac, Green Mountain, Shepody, and Alaska 114. Bakeking and Superior yielded 14.8 and 15.9 t/A, respectively. Shepody was tested for the first time at this location, and it compared favorably. Its yield, shape, specific gravity, and large average tuber size suggest it may be a useful commercial variety. However, it has yet to be tested by commercial growers. *D.E. Carling.*

Yield-Reduction Potential and Chemical Control of Rhizoctonia Disease of Potatoes

In a field study conducted at the AES Palmer Research Center, three potato varieties (Alaska 114, Bakeking, and Kennebec) were treated with either the fungicide PCNB or the fungicide Thiophanate methyle; some potatoes were left untreated. Potatoes from all three groups were planted both in uninoculated soil and in soil that had been inoculated with AG-3 *Rhizoctonia solani* Kuhn. Inoculation consisted of *R. solani* inoculated barley kernels applied at either a high or a low rate.

R. solani was found to reduce significantly the number of tubers, number of stems, total yield, and #1 yield of all varieties tested. Plant emergence was also affected adversely by *R. solani*. The number of plants emerging from the inoculated soil was only 55 per cent of the number of seed pieces which had been sown; emergence from the uninoculated soil was 97.2 per cent. In most instances of nonemergence, the seed piece had produced one or more sprouts which were killed by *R. solani* prior to penetrating the soil surface. Plants from seed pieces which had been treated with fungicide, but which were planted in uninoculated soils, had slight yield reductions. Inoculation at the high or the low rate resulted in severe yield reduction whether or not the seed pieces had been treated with fungicide. Under these experimental conditions, the fungicides evaluated were not able to reduce Rhizoctonia disease development and associated yield reduction to an acceptable level.

Performance of potato seed contaminated by *R. solani*, as evi-

denced by sclerotia, a natural inoculum, was compared with that of noncontaminated seed in another field study. Yields from the *R. solani* contaminated seed pieces were from 7 to 62 per cent lower than yields from noncontaminated seed for the four varieties tested (Alaska 114, Bakeking, Kennebec, and Superior). Stem damage was 1.8 to 6 times more prevalent in plants from the contaminated seed pieces. *R. solani* infected seed pieces had a varied effect on stem numbers. In most cases, stem numbers increased, but, with variety Kennebec, contamination decreased stem number. Contamination caused Kennebec to display the greatest yield reduction and the most stem cankering. *D.E. Carling.*

Alaska Crop and Livestock Studies

This project operates under a cooperative agreement supported by the USDA. Alaska Crop and Livestock Reporting Service, the Agricultural Experiment Station, and the Alaska Division of Agriculture. It collects and publishes agricultural production data for the USDA, as well as agency and industry use in the state. Production statistics are developed for livestock and poultry, including dairy cattle, beef cattle, milk production, hogs, poultry, eggs, sheep, and wool. Crops reported include barley, oats, hay silage, potatoes, lettuce, cabbage, carrots, and other vegetables. Fertilizer consumption and growing season weather data are also reported. *S.H. Restad.*

Fruit Variety Trials and Cultural Practices

Variety trials were conducted on four, day-neutral, everbearing strawberries grown as annuals with clear-polyethylene mulch in combination with row covers. Quinault averaged .29 lbs/ft^2; Hecker, .27 lbs/ft^2; Fern, .23 lbs/ft^2; and Tillikum, .14 lbs/ft^2.

A study was conducted to compare the response of Quinault strawberries to Osmocote 22-7-10 slow-release fertilizer, N-serve nitrification inhibitor used with ammonium phosphate, and the stan-

dard soluble fertilizer method. Strawberry yields using Osmocote at 200 lbs N/A were .41 lbs/ft², and at 300 lbs N/A were .33 lbs/ft². The N-serve trial using 300 lbs N/A yielded .37 lbs/ft². All three treatments surpassed yields using the soluble fertilizer method (.29 lbs/ft²). A study was also conducted to evaluate the use of seven herbicides and black plastic to control weeds and improve strawberry yields for commercial (pick-your-own) growers. Highest yields were achieved by weeding plots mulched with clear and black plastic, or by treating plots with diphenamid or terbacil. Each herbicide was also evaluated for control of specific weeds and for persistence in the soil.

Fifteen varieties of apples and crabapples planted in 1983 exhibited little winterkill with survival rates of 83-100 per cent for all but one variety. Eight new varieties of northern-adapted apples on *M. baccata* rootstock were planted for evaluation. There is considerable interest in any new varieties which might prove hardy in the Fairbanks area. *G. Matheke, P.J. Wagner, M.L. Farris, and M. Griffith.*

Ornamental Variety Trials

Variety trials were conducted with 450 annual flowers from experimental and commercially available varieties. These were grown in a demonstration garden open to the public and were evaluated on appearance and bloom period. As this is a display garden for All-American Selections, new winners can be shown to the public before they are commercially available. A new lathe house placed in the garden enabled evaluation of twenty-four varieties of annuals requiring shade. A list of all varieties and their seed sources was made available to the public at a guided garden tour in August. We feel it is important for local bedding-plant producers and home gardeners to see the newest flowers available and to see the range of flowers which can be grown successfully in interior Alaska.

Evaluation of herbaceous perennials, begun in 1981, continued with the planting of sixteen new varieties in beds treated with the herbicide Treflan. Thirty-four perennial varieties which had overwintered 1 to 3 years were moved to beds treated with Treflan to control serious weed problems. Twenty-nine new woody perennials are being

evaluated, including varieties of *Rosa, Ribes, Corylus, Salix, Caragana, Euonymus,* and *Fraxinus,* supplied by the Plant Materials Center, Palmer, Alaska. Eight *Syringa* and two *Lonicera* varieties from Canada were also planted for evaluation for winter hardiness and ornamental value. *G. Matheke, P.J. Wagner, and M. Griffith.*

Propagation of Alaska Native Plants

Methods of commercial propagation by seed, cuttings, layering and grafting are being investigated using Alaska native plants that have potential as landscape ornamentals and fruit crops. Studies include seed germination and vegetative propagation of lingonberry, *Vaccinium vitis-idaea* ssp. *minus*, wild iris, *Iris setosa* ssp. *interior*, wild blueberry, *Vaccinium uliginosum* bunchberry, *Cornus canadensis*, highbush cranberry, *Viburnum edule*, bearberry, *Arctostaphylos uva-ursi*, common juniper, *Juniperus communis*, tamarack, *Larix laricina*, and white spruce *Picea glauca*. Experiments include developing techniques of collecting, storing, pretreating and germinating seeds in order to establish methods of commercial production for Alaska's nursery/greenhouse industry. In addition, methods of vegetative propagation, principally rooting of stem cuttings, are being tested to determine appropriate seasonal collection dates, cutting treatments, rooting percentages, and cutting survival. *P. Holloway.*

Production of Horticultural Crops in a Greenhouse Using Simulated Waste Heat

Research on year-round greenhouse production of cut-flower roses using simulated, low-grade, waste heat (95°F water used to heat the soil) continued for the third year. Additional, perimeter heat was installed in the fall of 1984 to improve temperature control during the winter months, and lighting (HP Na vapor) was increased by 2.8 watts/ft^2 for better plant growth. Electric consumption for artificial lighting is being monitored as part of an economic feasibility study.

Fourteen cultivars are currently being tested. Selected average weekly yields (blooms/ft^2) for the first 38 weeks of 1984 were: Samantha, .58; Royalty, .54; Sonia, .59; and White Satin, .54. Production time for the roses ranged from 5 to 7 weeks, depending on variety, and was relatively constant throughout the year. Vase life was determined for roses grown under artificial lights and treated with various preservatives. This study will be repeated for summer roses grown under natural light. A marketing study was initiated to test the hypothesis that locally grown roses can be sold at a premium price due to the highly perishable nature of the product. Initial results from a survey of flower consumers in the Fairbanks area indicate that consumers will seek out and pay more for roses that will last longer than 1 to 5 days. *G. Matheke, H. McIntyre, P.J. Wagner, and M. Griffith.*

Plant Disease and Nematode Studies

Surveys for plant-parasitic nematodes in various parts of Alaska during 1984 revealed seventeen genera in nine families. This included two undescribed genera and several undescribed species. Genera included *Aglenchus, Criconomella, Cerchnotocriconema, Helicotylenchus, Merlinius, Nothocriconema, Pararotylenchus, Paratylenchoides, Paratylenchus, Pratylenchus, Scutylenchus, Subanguina, Thecavermiculatus, Trichodorus,* and *Tylenchorynchus.* Soil and plant samples were collected from the Seward Peninsula and northwest, interior, and southcentral Alaska. Plant-parasitic nematodes were found in all regions in association with crop plants (potatoes and grass) or native vegetation. One genus, *Thecavermiculatus*, is closely related to the cyst nematode and was found in association with potatoes in northwest Alaska. Its pathogenic effect on potatoes may warrant further investigation.

Rhizoctonia disease of potatoes and vegetables was commonly observed during 1984. A disease called wirestem is caused by *R. solani* on cauliflower, broccoli and other vegetables. On potato, *R. solani* produces stem and stolon lesions as well as several secondary, above-ground symptoms. Anastamosis group-3 (AG-3) is the *R. solani* most frequently associated with diseased potatoes. AG-2 is

the isolate most frequently found on vegetables. *Thanatephorus cucumeris*, the perfect state of *R. solani*, frequently develops on potato stems late in the season. Sclerotial, lesion, and mycelial isolations taken from potato plants most often proved to be AG-3. At one Matanuska Valley location, 33 per cent of isolates were AG-2, and, at another potato field, all isolates from sclerotia, mycelium, and lesions were AG-2. Subtyping revealed most AG-2 isolates taken from potato to be AG-2 type 1. *D.E. Carling.*

A Search for Ecotypes of Forage Grasses And Legumes Adapted to the Extreme North

Forage grasses and legumes provide the majority of feed units consumed nationally by beef and dairy cattle, sheep, goats, and horses. Some agricultural areas in Alaska currently in use, some under development, and others being considered for future development have moderately to strongly acidic soils. Many commonly used forage species, including bromegrass, Alaska's dominant cropland perennial forage, grow poorly on acidic soils.

Among productive, perennial forage grasses and legumes, reed canarygrass and alsike clover represent species relatively tolerant of acidic conditions and should be useful on such soils in Alaska. However, the most winterhardy varieties of both from commercial sources in North America and alsikes from Scandinavia have been marginal to poor in winterhardiness under cropland conditions in the Matanuska Valley.

A search to discover more northern-adapted and, hence, more winterhardy ecotypes within both species has led to obtaining reed canarygrass strains from the northern extent of the species range in Canada as well as others from north of the Arctic Circle in Norway. Alsike collections include seed from long-resident populations that may have undergone genetic modification toward subarctic adaptation following early introduction into Iceland and Alaska's Matanuska Valley. Plantings of these ecotypes were made in 1984 to compare their winterhardiness here with commercial varieties. *L.J. Klebesadel.*

Progress toward Productive Grass-Legume Association for Forage Production

Perennial forage legumes are valued for their unique ability to capture nitrogen (N) from the atmosphere and incorporate it into plant tissues and for their high yields of palatable herbage containing high levels of protein and other nutritionally important elements. Despite considerable recent progress in improving winterhardiness of forage legumes for Alaska, virtually no perennial grass-legume associations are grown currently for forage in this state. Rising costs of fertilizer N, an expensive input for stimulating production of forage grasses grown alone, argue for identifying and incorporating adapted, productive, competitive legumes into compatible associations with forage grasses.

An experiment was established in 1982 to compare 'Polar' bromegrass grown alone and topdressed with six different rates of fertilizer N with bromegrass grown in assocation with different legumes and not supplied with N. Bromegrass with N applied at 150, 200, and 250 lb N/A/yr were the highest-yielding treatments, averaging 4.5, 5.1, and 5.3 t/A dry matter in 1983 and 1984 with two cuts per year.

Alaskland red clover plus brome averaged 2.9 t/A, about midway between yields of brome alone fertilized with 50 and 100 lb N/A/yr (2.4 and 3.9 t/A, respectively). Birdvetch plus brome averaged 2.4 t/A, equaling the yield of brome alone with the 50-lb N rate. Lowest yields (1.0 t/A) were obtained from brome alone that received no N in 1983 and 1984.

Identification of desirable perennial legumes that are effective in N fixation and competitive with forage grasses and determination of desirable harvest schedules and other optimum managerial practices for such grass-legume mixtures can reduce costs of N fertilization of forages for Alaskan growers, enhance the quality of forage produced, and contribute to efficiencies in forage and livestock production. *L.J. Klebesadel.*

Yields of Cereals and Ryegrasses Compared for Annual Forages

Annuals are grown frequently for forages on newly cleared lands in Alaska. Cereals and ryegrasses are currently being tested for forage uses at Point MacKenzie in southcentral Alaska and near Delta Junction in interior Alaska, two sites recently cleared for agricultural purposes. Cereals are generally managed for a single harvest. Because of the regrowth capabilities of ryegrasses, they are managed for multiple harvests, grazing, or a combination of the two.

Without lime additions, oats have outyielded barley on Point MacKenzie soils with pH levels of 5.4 to 5.9. In 1984, the top-performing oats produced 2.90 to 3.27 t/A dry matter, cut in the milk stage, while Weal barley yielded 2.27 t/A, cut in the early-dough stage. In the trial conducted in interior Alaska on soil with pH 5.9, a number of oat varieties and Weal barley produced about 2.0 t/A, cut in the early head-emergence-to-emerged stage.

The highest-yielding ryegrass at the interior site, a tetraploid Westerwold type, produced only 1.27 t/A in the first harvest taken on the same day as the cereals, but added 1.31 tons in a second harvest, to total 2.58 t/A. A tetraploid Westerwold type also produced the highest ryegrass yield at Point MacKenzie, yielding 2.88 t/A in three harvests, the bulk of which was produced in the first two harvests. The ryegrasses did not exceed the single-harvest yield of the cereals at Point MacKenzie.

Results indicate that if appropriate cereal varieties are allowed to grow to the milk to early-dough stage, more than 3 t/A of dry matter are obtainable. Multiple harvests of ryegrasses may not achieve this yield level. Thus, cereals can provide more biomass in a single late cutting, but appropriate timing of ryegrass harvests can provide higher-quality forage. *W.W. Mitchell.*

Improved Biological N_2 Fixation by Alfalfa in Alaska Through Selection of Superior Rhizobia Strains

One of the problems with growing alfalfa as an economically viable crop in Alaska is that it is often poorly nodulated and does not fix enough dinitrogen (N_2) for adequate plant growth. Occasionally, plants can be found, especially in old stands, which are well nodulated and grow well without nitrogen (N) fertilization, indicating that they are fixing adequate N for good growth. This suggests that either the plants or the alfalfa rhizobia (*Rhizobium meliloti*) have the ability to adapt to subarctic conditions and that the potential exists for good nodulation and efficient N_2 fixation by alfalfa in Alaska.

One of the major factors limiting nodulation and N_2 fixation by alfalfa in Alaska may be low soil temperatures during the growing season. To test this and to determine if alfalfa plants and their associated rhizobia have become adapted to low soil temperatures, alfalfa cultivars from temperate regions and from Alaska are grown in growth chambers at different root temperatures. These are inoculated with strains of rhizobia isolated from Alaskan soils and from temperate-zone soils. Plant growth, nodulation, and plant N content are measured to determine the relative effectiveness of different cultivar-strain combinations. At present, procedures for growing the plants in growth chambers are being tested, thus no results from this aspect of the study are yet available.

A preliminary field study was done to determine if rhizobia strains from different geographical regions perform differently on seedling-year alfalfa in field soils in Alaska. An experimental Alaskan alfalfa line, inoculated with strains of rhizobia from Alaska and Canada and with a commercial alfalfa inoculant, was planted in single-row plots at three sites in Alaska. Two of the sites are on acid soils; the other is on a neutral soil. Some of the rhizobia strains used were reportedly acid tolerant. Plants were dug and assessed twice during the growing season for nodulation. Near the end of the growing season, plants were harvested, and yield and plant N content was measured.

At all three sites, plants in the control (uninoculated) rows were very

poorly nodulated, whereas the inoculated plots were fairly well nodulated. There was no significant difference between nodule scores for different rhizobia strains. Bison grazed the plots at one of the acid-soil sites, so neither yield nor plant N-content data are available. At the other acid site, the average forage yield was 0.9 t/A and the average N yield (forage yield × N content) was 31 lbs/A, with no significant difference between strains or between inoculated or uninoculated plots. Thus, at this site, little or no N_2 fixation occurred. At the neutral pH site, the average forage and nitrogen yields for the inoculated plots were 1.5 t/A and 75 lbs/A, respectively, compared to 0.9 t/A and 37 lbs/A for the uninoculated plots. Thus, a small but significant amount of N_2 was fixed. There was no statistically significant difference due to rhizobia strains, but the average N yield for the high-yielding strains was almost 20 lbs/A higher than for the low-yielding strain. Thus, the results of this study, although preliminary, indicate that, at least on some soils in Alaska, inoculation can improve N_2 fixation. Low pH may be part of the cause for little or no N_2 fixation by alfalfa in some soils in Alaska, however the low amounts of N_2 fixed even on the neutral soil indicates a need for more research on this problem. The study indicates that selection of superior rhizobia strains may be a feasible way to improve N_2 fixation by alfalfa in Alaska.

This work should result in the selection of *Rhizobium meliloti* strains which are adapted to Alaskan soils. We hope the results will also lead to the development of inoculants for use by the Alaskan farmer. Results of this study can be also used by plant breeders in the breeding of alfalfa cultivars with high N_2 fixation potential in the subarctic. *S.D. Sparrow.*

Split Fertilization Applications and Harvest Systems Studied on Bluejoint Grassland

Extensive stands of native bluejoint reedgrass (*Calamagrostis canadensis*) are the primary source of forage on the lower Kenai Peninsula. The grass is both grazed and harvested for hay. Ranchers in this area generally take a single harvest in July for hay purposes.

Fertilizer and harvest schedule trials are underway to test the effectiveness of split fertilizer applications vs. a single spring application in a two-harvest system as well as that of a single harvest vs. two harvests. Results to date have been inconclusive and have probably been affected adversely by an exceptionally dry summer in 1983.

A split application of nitrogen, applied half in spring and half after the first harvest in July, did not increase yields of the second harvest over that obtained with a single application applied in the spring. However, the split application did increase yields of the first harvest in the following year. Increasing nitrogen applications from 90 lbs/A to 180 lbs/A did not increase first-harvest yields but did increase second harvest yields. Second-harvest yields have been meager, however, with 17 lbs/A of P and 66 lbs/A of K applied, in addition to the nitrogen.

A trial of one-harvest vs. two-harvest effects, commenced in 1983 produced poorly defined results in 1984. Higher N-P-K rates had more effect than cutting regime.

Until more definitive results are obtained, judgement must be reserved on the relative merits of split applications and the different harvest systems. *Wm.W. Mitchell.*

Progress toward Improved Seed Yields Of 'Polar' Bromegrass

'Polar' bromegrass, developed in Alaska, represents hybridization between the introduced Eurasian smooth brome and northern ecotypes of native, North American pumpelly brome. It is the most winterhardy brome variety available for use in Alaska; its extreme hardiness provides insurance against costly winterkill that has occurred with less hardy brome varieties during occasional severe winters here.

A major impediment to adoption of Polar by Alaska farmers has been lack of seed due to low yields at the foundation and certified levels of increase. These low yields on a field basis have been perplexing because the sixteen individual clones comprising the vari-

ety headed abundantly as individual, spaced plants. Several exploratory and detailed experiments have revealed that Polar grown in rows for seed production is dramatically sensitive and responsive to several management practices that can be employed to enhance heading and, hence, seed yields in years after the establishment year.

An experiment was initiated in 1984 to attempt to maximize seed yields in the first year after planting. Polar bromegrass planted in rows in mid-May was harvested on four schedules and topdressed with different rates of nitrogen (N) during 1984. Objectives of this study are to determine 1) forage yields during the seeding year, 2) effects of the different harvest schedules on the type and abundance of new tillers caused to appear during the latter portion of the seeding-year growing season (a plant developmental stage that exerts significant influence on subsequent-year heading as it affects autumn induction of floral primordia), and 3) effects of the 1984 treatments on components of seed yield in 1985. Seeding-year forage yields from the four harvest schedules ranged from 1.3 to 1.8 t/A dry matter. Although forage yields did not differ greatly, the different harvest schedules had dramatic effects on the relative abundance and phenological stage of development of autumn tillers in evidence at freeze-up. These differences will be related to those that occur among treatments in components of seed yields in 1985. *L.J. Klebesadel.*

Evaluation of Six Perennial Pasture Grasses After Seven Years Near Cantwell

Increasing prospects of agricultural developments and a major hydroelectric project in the upper Susitna Valley forecast needs to establish perennial grasses for either forage or cover to stabilize exposed soils. In 1977, the late Dr. Jack Luick established a planting of six perennial grasses: *Deschampsia beringensis* (Norcoast), *Bromus inermis* (Manchar), *Arctagrostis latifolia, Festuca rubra* (Arctared), *Poa pratensis* (Nugget), and *Alopecuris pratensis* to test reindeer preferences among these species. Since these seedings were only lightly grazed during 1978 and 1979, the stands represented a valuable information source in this region of Alaska

for which little agricultural data are currently available. Dr. Luick welcomed our interest in reevaluating his plantings in 1980. During August 1984, we sampled the vegetation and soils in each planting. Stands were subdivided into poor, medium, and good cover classes and sampled accordingly to identify soil factors influencing stand quality. Species that survived well, such as *Alopecuris pratensis* and *Festuca rubra*, provided good ground cover and were least invaded by local species. A relatively diverse community established itself in the *Bromus inermis* plot where no brome survived.

Preliminary tests of soil-fertility factors showed that ammonium (NH_4), potassium (K), organic matter, and soil moisture were significantly related to cover classes. NH_4 was only 6.8 ppm on the high cover class areas, while it was 7.9 on both the low and medium areas. Potassium averaged 41, 33, and 36 ppm, respectively, for good, medium, and poor classes. This suggests that K is limiting plant growth at levels below 40 ppm, and, where adequate, plants are depleting available soil nitrogen (N). Fertility is quite low in these acidic soils (pH 5.3). Soil moisture was 48, 32, and 27 per cent for good, medium, and poor classes. Some of the higher moisture levels were attributable to seeps at the upper end of some plots. Similarly, organic matter content was related to cover classes with best sites averaging 14 per cent, while only 9 and 8 per cent on the medium and poor sites. Soil moisture and organic matter can both contribute to productivity, as well as be influenced by good vegetation cover. Poorest growth was also related to high sand content (42-90 per cent), indicating that soil physical factors are also influencing stand vigor.

Some unusually high available aluminum contents were discovered in several plots. The effects of that will be examined in a subsequent study to determine if the aluminum is taken up by plants and is, hence, potentially toxic to grazing animals.

Persistences of these grasses are being examined relative to how well they remain as forage species and how easily they are invaded by native plants. This will provide guidance in choosing species for forage crops as well as for revegetation purposes. *D.J. Helm, J.D. McKendrick, and W.B. Collins.*

Native Grasses Show Potential as Forage Grasses

Native Alaskan and other north-latitude grasses are being evaluated for their possible use as forages. The standard grasses now used for forage in Alaska include smooth bromegrass and timothy. The need for alternate choices most likely would occur in areas with acid soils, where timothy would be the current choice.

Eleven entries of polargrass (*Arctagrostis latifolia*) and twenty entries of tufted and Bering hairgrass (*Deschampsia caespitosa/beringensis* complex) were assessed in adjoining trials at the Palmer Research Center. 'Engmo' timothy was included in the polargrass trial for comparison. Polargrass and hairgrass are circumpolar species.

Established in 1981, the grasses were harvested in June (first harvest) of 1982, 1983, and 1984, and again in August (second harvest) in 1982 and 1983, for a total of five harvests. Engmo timothy averaged 1.95 t/A yield for the three first harvests, 2.39 t/A for the two second harvests, and 2.13 t/A for all five harvests. A number of the polargrass and hairgrass entries compared favorably with Engmo in yield results. The highest-yielding polargrass averaged 2.34 t/A for the first harvests, 2.07 t/A for the second harvests, and 2.23 t/A for all five harvests, exceeding timothy in first-harvest and overall averages. The highest-yielding hairgrass produced 2.25, 2.46, and 2.33 t/A for the respective averages, exceeding timothy in the first-harvest average and both timothy and polargrass in the second-harvest and overall averages.

Most of the polargrass entries contained over 12.5 per cent crude protein (CP) in the first-harvest herbage (1983 cutting) and over 14.4 per cent CP in the second-harvest herbage, compared with 10.4 per cent and 10.7 per cent CP for timothy for those harvests. The hairgrasses varied from 8.8 per cent to 13.6 per cent CP in first-harvest herbage, and from 8.8 per cent to 12.3 per cent in second-harvest herbage. Engmo timothy exceeded both the polargrasses and hairgrasses in IVDMD digestibility of both harvests, equalling 60.7 per cent for the first harvest and 65.7 per cent for the second harvest.

Yield and quality considerations suggest that both the polargrass and hairgrass species contain genetic types with forage potential. The better performers must be identified and their areas of adaptation determined. *Wm. W. Mitchell.*

Fate of Fertilizer Nitrogen in Agricultural Soils in Interior Alaska

A three-year study was begun in the spring of 1982 to examine the fate of fertilizer nitrogen (N) in an agricultural soil in interior Alaska. The field portion of the study was completed in 1984. The study was done on the University of Alaska Farm in the Delta Agricultural Project. The objectives of this study are to 1) estimate gaseous losses of N from soil (i.e. ammonia volatilization and denitrification), 2) determine nitrate leaching losses, and hence, potential pollution of ground water from urea and nitrate fertilizers, 3) measure crop uptake and determine efficiency of fertilizer N utilization by barley plants, and 4) determine net seasonal immobilization and mineralization of N in a field soil.

Two sources of fertilizer nitrogen, urea and calcium nitrate, applied at a rate of 90 lbs N/A, were compared. Also, the effect of fertilizer incorporation versus surface application was assessed. N-15 labeled urea was used to determine the fate of fertilizer N. Soil and plant samples were collected throughout the growing season and analyzed for different forms of N.

Most of the samples from the 1984 season have not yet been analyzed, and none of the N-15 samples have been analyzed. Therefore, results must be considered preliminary.

No losses of N due to ammonia volatilization were detected during any of the three field seasons. In both 1982 and 1983, all of the urea was hydrolyzed to ammonium within two weeks. In 1982, nitrification occurred rapidly in the urea plots; within four weeks of application, ammonium had dropped to low levels in these plots, and nitrate levels were similar to those in the nitrate plots. In 1983, ammonium levels in the urea plots remained high longer than in 1982, as did total inorganic N levels in the N-fertilized plots. The early part of the

1983 growing season was very dry; this probably inhibited microbial and plant root activity and, hence, caused low rates of nitrification, immobilization, and plant uptake of N. Nitrate levels were low below the 12-inch depth throughout both years, indicating that little or no leaching of nitrate occurred. Average grain yields of the N-fertilized plots were 49, 63, and 61 bu/A for 1982, 1983, and 1984, respectively. There was no difference in yield between urea and nitrate plots or between plots in which the N was incorporated and those with the fertilizer left on the surface.

This study will increase the knowledge of N cycling in interior Alaska agricultural soils. This knowledge will be used to make recommendations to farmers on management practices to make best use of fertilizer N. *S.D. Sparrow.*

Soil Nitrogen Relationships: Anhydrous Ammonia As a Fertilizer for Alaska

Anhydrous ammonia is manufactured in Alaska but at present all of it is shipped out of state and is not available locally. If demand for anhydrous ammonia were high enough in Alaska, it would be made available to the Alaskan farmers. Because anhydrous ammonia is potentially a cheaper source of nitrogen (N) than other N fertilizers, Alaskan farmers are interested in using it as a fertilizer for production of small grains.

Anhydrous ammonia is widely used as a nitrogen fertilizer in other regions. However there is little information on its use in the subarctic, where soils are cold throughout the growing season.

The primary objective of this study is to determine if the use of anhydrous ammonia as a nitrogen fertilizer for small grains is feasible in interior Alaska. The secondary objectives are 1) to compare barley response to applications of anhydrous ammonia with urea and ammonium nitrate, 2) to compare barley response to fall-applied anhydrous ammonia with that of spring-applied anhydrous ammonia, 3) to determine the distribution and nitrification patterns of anhydrous ammonia in an acid and a neutral soil in interior Alaska, and 4) to determine nitrogen-uptake patterns by barley plants at varying

distances from the ammonia injection slit.

Two sites in interior Alaska, one on an acid soil and one on a neutral soil, are used for this study. Anhydrous ammonia is applied at a rate of 90 lbs N/A in the fall and in the spring, and urea and ammonium nitrate are applied in the spring at the same N rate as the ammonia. Soil and plant samples will be collected throughout the growing season from the urea and ammonium nitrate plots and at varying distances from the application land in the ammonia plots. These will be analyzed for soil ammonium and nitrate or total plant nitrogen. Also, at the end of the growing season, grain yields and grain N contents will be measured.

This study was begun with a fall application of anhydrous ammonia in 1984, thus no results are yet available. Should the results of this study indicate that anhydrous ammonia is a good nitrogen fertilizer for grain production in Alaska, considerable savings in fertilizer costs could result for the Alaskan farmer. Increased knowledge of the distribution and nitrification patterns of anhydrous ammonia and nitrogen uptake of N by barley plants fertilized with anhydrous ammonia will lead to efficient utilization and management practices for anhydrous ammonia in interior Alaska. *S.D. Sparrow.*

The Sorption and Extraction of Phosphorus In Ten Alaska Agricultural Soils

A study was conducted to begin the evaluation of six soil phosphorus (P) extractants (Morgan's, Bray 1, Bray 2, double acid, Mehlich II, and Mehlich III) for use on Alaska's acidic agricultural soils. The study included a Cryandept, Cryorthent, four Cryochrepts, and four Cryorthods. Phosphorus sorption isotherms showed a wide variation in P sorption characteristics. For a soil solution P concentration of 0.2 ppm, the P sorbed (not in solution) by the soils varied from 0-1212 ppm (the Cryochrepts 0-563 ppm, Cryorthods 678-1212 ppm, Cryandept 1149 ppm, and Cryorthent 256 ppm). The P sorption isotherms were used to predict P additions necessary to adjust the solution equilibrium concentration of each soil to range from 0.05 ppm. Barley was grown as a test crop in pot culture. Regression

analysis was performed for percentage maximum production versus soil P concentration by each extractant. Bray 2 showed the highest r^2 (0.74) value followed by double acid ($r^2 = 0.71$), Mehlich III ($r^2 = 0.67$), Bray 1 ($r^2 = 0.65$), Mehlich II ($r^2 = 0.63$), and Morgan's ($r^2 = 0.59$). In 1985, eleven field plots located in major agricultural areas in the state will be set up for field calibration, including Tanana River Basin, Copper River basin, Mat-Su Valley, and the Kenai Peninsula. Both quantity and quality of barley grain yield and oat forage yield will be evaluated and calibrated with soil test P values. *C.L. Ping and G.J. Michaelson.*

Determination of Soil Amendments for Optimum Crop Production on Agricultural Soils in Alaska

First-cut bluejoint yields on Kachemak soil were increased by both N and P application with greater yields obtained using ammonium nitrate (AN) with urea. Second-cut yields were increased by each nitrogen (N) rate with no difference between AN and urea. Each phosphorus (P) rate increased second-cut yields only when high N was applied. Basic-H had no influence on beet, lettuce, carrot, barley, oat, and rape yield, nor did it influence the soil pH at Pt. MacKenzie. Alsike clover yields of both cuttings near Kenney Lake responded to P application. Total seasonal yield also responded to the highest potassium (K) rate. Brome yields of both cuttings tend to be increased by increasing K rates; second-cut was increased markedly by the heaviest K rate. Second-cut yields were increased by sulfur (S) when K was applied. Each increasing S rate as gypsum through 15 lbs/A increased yield of both brome cuttings on Knik soil. An S concentration of 0.13 per cent or less or an N/S ratio of 15 or more seems indicative of S deficiency. At Pt. MacKenzie, both rape straw and seed yields were increased by each N rate and by boron (B), but not influenced by lime. Seed yield was doubled by B. At Pt. MacKenzie each increasing P rate increased mature lettuce and carrot root yield. Lime increased both carrot and mature lettuce yield, the latter by three times. Beet root yields were increased by lime with the greatest in-

crease at low P rates. Without lime, each increasing P rate increased beet root yield, but had no effect when lime was used. Amplify D had no significant effect on emergence or yield of lettuce, table beets, carrots, or rape. *W. Laughlin.*

Development of timber-harvesting procedures emphasizing the use of a small cable yarder for interior Alaska forests is one goal of the Intensive Forest Management Project.

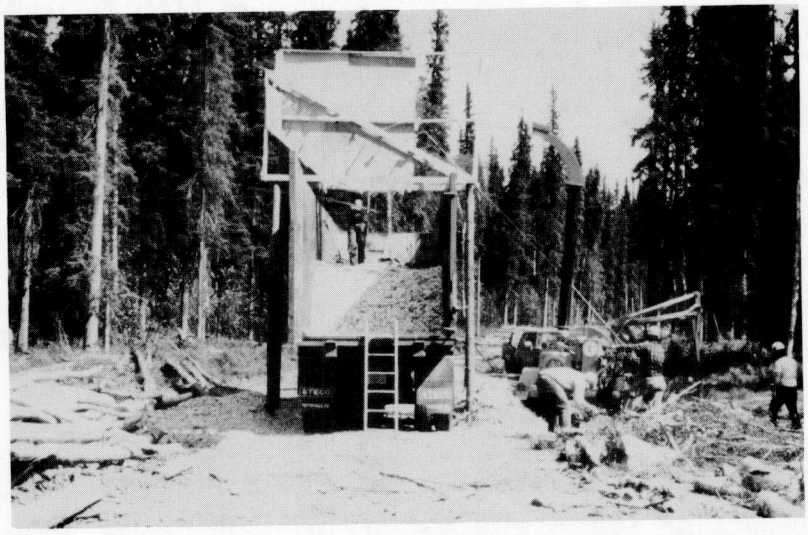
Forest Management

Intensive Forest Management Project

The Intensive Forest Management Project of the School of Agriculture and Land Resources Management began in 1980 to perform research in and demonstrations of intensive forest management practices. Management practices will become necessary if the demand for such local forest products as sawtimber, houselogs, fuelwood, and, possibly, wood chips, continues to increase.

The overall purpose of the project is to conduct applied research that will enable forest managers to "maintain or increase the biological and economic productivity of forest land to produce wood products." The project has four goals: 1) natural and artificial forest regeneration practices emphasizing site preparation and stand establishment; 2) stand manipulation practices in both soft- and hardwood stands emphasizing thinning, release, and fertilization; 3) timber- harvesting procedures emphasizing small cable yarder and tractor skidding; and 4) forest product utilization emphasizing the manufacture and utilization of wood chips and the utilization of black spruce. Natural and artificial regeneration of white spruce in interior Alaska is difficult because the thick organic mat on the forest floor creates very unfavorable germination and growth conditions. The project has been evaluating several types of site-preparation equipment that will remove portions of this organic mat and expose mineral soil. Studies evaluating the TTS-35 Disc Trencher and a moldboard plow were recently completed.

Good seed crops of white spruce are rare at northern latitudes. Techniques and cost of direct-seeding forest areas which have been



Another goal of the forestry project is forest product utilization which emphasizes the manufacture of wood chips.

scarified with site-preparation equipment are being evaluated. The seed for direct seeding could be collected and stored during good seed years for use later in direct seeding. This would remove regeneration from a dependence on poor or erratic seed crops.

Stand manipulation covers those silvicultural practices which change the species composition or stocking level of timber stands after they have been established. The Intensive Forest Management Project has established numerous plots for long-term measurement that are designed to show the effects on growth rates of different intensities of thinning in pole-sized spruce and birch stands and in sapling white spruce and sapling birch stands. As these stands are thinned, cost data are recorded, so that the economics of thinning can be evaluated.

The project is also involved in evaluation of timber-harvesting equipment and procedures. Evaluations have been performed testing the suitability of the Bitterroot Mini-Yarder and the Clearwater Yarder as alternative means of logging steep slopes in interior and southcentral Alaska. Demonstrations of this equipment will continue as long as there is interest from the logging industry. Use of this cable logging

Studies evaluating several types of site-preparation equipment are part of the project. Evaluation of the TTS-35 Disc Trencher were completed in 1984.

equipment will enable loggers to harvest timber from slopes that are inaccessible to crawler tractors. Research is also being conducted on the use of a modified farm tractor for logging small woodlots.

Significant forestry development in interior Alaska will only occur when small-diameter trees can be utilized. The Intensive Forest Management Project is investigating ways in which wood chips from these small trees can be used. The current project involves testing and feasibility of using wood chips in a mix with coal to generate electricity. The project is currently utilizing steam from the plant at the U.S. Army base, Fort Wainwright, just outside of Fairbanks. The first test-burn, using approximately 120 tons of chips, suggests that it is technically feasible to use wood chips to generate electricity. The possibility of performing a second burn, using 1000 tons of chips, is being investigated. The evaluation of the second burn will also include an economic analysis to determine if, on a BTU basis, wood chips can be delivered to the power plant for a lower price than coal.

Cooperating agencies in this project are: State of Alaska, Division of Forestry, and the U.S. Forest Service, Institute of Northern Forestry.□

Soil Nitrogen Supply in Relation to Forest Productivity And Successional Patterns in Interior Alaska

Nitrogen supply for tree use is being determined for the forest floor and surface 2 in of mineral soil in examples of the major forest types in interior Alaska. Field estimates of net nitrogen mineralization and nitrification in the forest floor and mineral soil of mature white spruce forests show a combined supply of 3 to 9 lbs/A for the period June through August. This compares with an annual requirement for above-ground tree parts of 6 to 25 lbs/A. The ranges reflect differences in site quality in relation to soil processes and tree growth. In laboratory studies, it was found that three to four times more nitrogen (N) was recycled in mineral form from aspen, birch, and upland white spruce forest floors (670-970 μg/g) than from black spruce forest floors (180 μg/g). Lowest rates of nitrogen flow, 50 μg/g, were encountered in floodplain white spruce. The higher rates of N mineralization and nitrification reflect a favorable balance of energy supply to nitrogen in the organic matter as shown by narrower (<30) C:N ratios.

In interior Alaska, fire is an important control of development of upland forest ecosystems. Fire dramatically alters nitrogen reserves in the forest floor. Between 30 and 50 per cent of N reserves may be lost in severely burned white spruce, birch, and aspen forests. However, substantial improvement occurs in amount of other important plant nutrients (phosphorus, potassium, calcium, and magnesium). In the case of black spruce, severe burning was generally associated with improved element content (including N). Higher forest-floor moisture content resulted in less complete combustion, and, with addition of ash from burned overstory, produced increased amounts of most nutrients, including N, in black spruce.

Floodplains are the sites of the most productive forest types in interior Alaska. They also are the site of a unique feature of subarctic Alaskan forest ecosystems — salt-affected soils. These soils develop through capillary rise of soil water from shallow floodplain water tables and surface evaporation of the soil solution. Principal salts include gypsum and calcium carbonate ($CaCO_3$). New research, supported

by the National Science Foundation, will evaluate hypothesized mechanisms of formation and demise of the pedogenic salts. In addition, the impact of salt-affected soils will be examined with respect to soil nitrogen phosphorus dynamics as well as plant colonization and growth on newly exposed mineral soil surfaces. *K. Van Cleve.*

Reproductive Capacity and Characteristics of Trees and Shrubs in Alaska

The rate of recovery of forest ecosystems depends on a number of variables, one of which is the reproductive capacity of the trees and shrubs. Trees and shrubs can regenerate vegetatively or from seed following disturbance. The composition, density, and rate of recovery will depend on the relative importance of seed and vegetative reproduction. The objective of this project was to do a thorough literature search on the reproductive capacity of interior Alaska tree and shrub species and to use this as a basis for determining the need for additional research. *B.J. Neiland and J.C. Zasada.*

Tree Species for Urban Planting in Interior Alaska

Although well-adapted, mature trees are a dominant part of the landscape in interior Alaska, there is a continual search for exotic species for use in urban planting. Over the years, people have tried exotic species with varying degrees of success. The final report of this study describes the exotic species that have been tested in interior Alaska and summarizes the available information on growth and development. Because trials have been limited to exotic species readily available, the number of species tested has been somewhat limited. Thus, a second objective of this project was to identify species that would most likely be well adapted to interior Alaska. The most emphasis was given to those species which occur naturally north of 60°N latitude or those species known to survive at high latitudes following introduction. *B.J. Neiland, J.C. Zasada, and S. Brooks.*

A Possible Means of Releasing Excess Manganese In a Willow Species

Native plants, growing on highly acidic soils in various regions of Alaska, often contain very high concentrations of manganese (Mn). As much as 20,000 ppm and as little as 4 ppm have been recorded in dry matter of plant tissues. Little information exists on critical tolerance levels with native plants for this element. Criteria for agricultural crops vary between about 5 to 122 ppm for deficiencies. Toxicities range from above 50 to 11,000, depending upon the crop species and other factors.

Upon examining Mn data for a willow (*Salix planifolia* ssp. *pulchra*) in Arctic tundra, we discovered an unusual pattern in seasonal Mn distribution in leaves. During the growing season, leaves increased in Mn from about 430 ppm in June to 830 ppm in August. Dead leaves persist on this shrub during winter, and we discovered those dead leaves contained 1,150 ppm Mn in our second year of sampling. Thus, leaves more than doubled in Mn concentration between the time they formed and the time they died, with the sharpest increase coinciding with senescence and death.

From these data, it appears as if a metabolic process may be blocking movement of Mn into new leaves. As these leaves age and eventually die, the removal of that metabolic block allows Mn to accumulate in the attached leaves. Losses in carbon compounds and changes in concentration of other elements were not sufficient to account for the change noted in Mn. We believe that, by retaining leaves on the stem during senescence, *S. planifolia* ssp. *pulchra* is able to rid living tissue of excess Mn. Further research on this phenomenon seems worthwhile to elucidate the possible physiological mechanisms for tolerating concentrations of heavy-metal in plants. *J.D. McKendrick, F.S. Chapin III, and D. A. Johnson.*

Intensive Management of Woody Resources in the Taiga — Evaluation of Potential Species and Their Growth Rates

The cost of electricity is very high in rural areas of Alaska. Based on 500 kilowatt hours (KWH), the cost per KWH to member communities of the Alaska Village Electrical Cooperative is $0.48 (1982 figures). The potential benefits to the community from development of a local power industry are enormous.

As a first step in this development, the potential growth rates and genetic gains from careful selection of parent stock will be estimated for eight hardwood species. The species selected are aspen (*Populus tremuloides* Michx.), paper birch (*Betula papyrifera* Michx.), thinlaf alder (*alnus tenuifolia* Nutt.), American green alder (*Alnus crispa* [Ait.] Pursh), balsam poplar (*Populus balsamifera* L.), black cottonwood (*Populus trichocarpa* Torr. and Gray), feltleaf willow (*Salix alaxensis* [Anderss.] Cov.) and bebb willow (*Salix bebbiana* Sarg.).

Estimates of post-planting growth rates and genetic variability will be made after the third (1985) and fourth (1986) growing seasons. *J. Yarie.*

Water Balance Procedures for a Boreal Forest Watershed

This study has involved the continued collection of hydrometeorological data on the 10-mi^2 Spinach Creek Watershed in conjuction with work on a computer watershed model. A Parshall flume installed last fall remained stable in the channel and operated successfully this summer. Submerged flow conditions occurred during breakup, and accurate, continuous-flow measurements were not obtained. Water stage at two points in the flume will be monitored continuously next season so more accurate breakup flow data can be obtained. No aufeis problems occurred at the flume.

Modeling efforts have focused on refining a cumulative degree-day

index estimate of soil freeze and thaw depths. Testing to date shows this approach renders simulations of spring runoff sensitive to pre-freezeup, fall soil moisture, canopy cover, and snow depth. The final stages of field data reduction, analysis, and use in testing the model are continuing.

The results of this research should enhance the planning and predictive capabilities of state resource management agencies dealing with the interactions of resource development and utilization with hydrologic systems. *J.D. Fox.*

Coordination of the Rosie Creek Fire Research Project

The second year of funding for the Rosie Creek Fire Research Project (RCFRP) was applied to 1984 field season preparations, research, data analysis, and reporting. There are twenty investigators carrying out sixteen research projects in three, broad, topic areas. Studies of product recovery include emperical yield recovery, wood-inhabiting beetles and borers and their woodpecker predators, a predictive model for tree survival, and fungal decay. Regeneration silviculture studies include seedfall and germination, a white spruce genetics (provenance) study, and levels of growing stock. Natural environment studies include microenvironmental monitoring, nutrient cycling, revegetation and shrub biomass, and erosion.

The May 1983 fire burned 8,600 acres of old-growth white spruce, aspen, birch, black spruce, and mixed hardwood-conifer stands. Severely burned spruce developed check, reducing sawtimber yield as much as 50 per cent. Many partially burned trees survived the direct effects of the fire, but 90 per cent or more of these trees are dead or will die from insects, especially the cerambycid roundheaded borers. Black-backed woodpeckers are specialized predators of wood borers on heavily burned trees. Wood-decay fungi have appeared, due more to release from control than to invasion of wood substrates. Effective spruce dispersal is limited to a 600-ft radius of parent trees. White spruce seedling establishment in heavily burned areas was reduced because the fire eliminated the 1983 seed crop. Competi-

tion with developing grasses and herbs has reduced the success of seedling establishment in 1984. Soils have been warmed considerably by the continuing effects of the fire. Cold soils limit site productivity in this area. Most of the forest understory species present before the fire have survived or returned.

An all-day symposium was held with forest managers in December of 1984 to communicate early results, and a written report and summary will follow in 1985. *G.P. Juday.*

Research Areas Coordination

This project covered a group of related activities involving the selection, documentation, and use of specific tracts for natural resources and scientific research as well as coordination of these activities among the private, state, and Federal sectors. A 129-acre research reserve tract of moderately and severely burned forest in the Rosie Creek burn area of the Bonanza Creek Experimental Forest was selected and marked. Most of the Rosie Creek Fire Research studies have plot locations in this heavily used area. Criteria for the selection of a group of Experimental Forests and Research Natural Areas (RNAs) in the Tanana Valley State Forest were developed and submitted to the Alaska Division of Forestry. Features to be emphasized include lakes and streams, dune-soil areas, rare-plant meadows, and typical white spruce, aspen, and birch forest types.

A 35-acre tract of hybrid Sitka-white spruce forest and bluejoint-fireweed meadow with high wildlife value above Homer, Alaska, on the Kenai Peninsula was evaluated. The parcel is being donated by a private owner as a nature study area. This project contributed to plans for an "Alaskan Heritage" information system, which is being launched through private contributions. A terrestrial environment research team was formed to look at succession in the wake of the retreat of the Columbia Glacier, and research plans were developed. Documentation of the proposed Gambier Bay RNA on Admiralty Island in southeast Alaska was completed. Gambier Bay has limestone soils and sinks; high form-factor, old-growth western

hemlock forest; productive coastal, brown bear habitat; and coastal salt marsh subject to high tidal amplitude fluctuations. *G.P. Juday.*

Coordination of the Alaska Ecological Reserves Program for 1984 "Pacific Northwest Ecological Reserve"

A search for scientifically interesting natural features on the public (BLM) lands of the Seward Peninsula, Alaska, led to a proposal for four Research Natural Areas (RNAs) in three size options each, ranging from 4,000 to 9,000 acres.

In the proposed Mount Osborn RNA, at the crest of the glaciated Kiguliak Mountains, several rare plant species are found on calcareous outcrops. *Artemisia senjavinensis*, under consideration for placement on the Federal endangered-species list, and three other Seward Peninsula endemic plants, including a possible new species of *Primula*, were found. Glaciers occupy only 3 mi^2 of the Seward Peninsula today, and much of this total is in the proposed Mount Osborn RNA. The principal small glacier in the Mount Osborn area has receded significantly in the past eight decades and may disappear within a few more decades.

The proposed Windy Cove RNA includes a segment of the impressive Kiguliak fault line, a shrub-lined coastal terrace, and a segment of the shoreline of the restricted-circulation saltwater Imurik Basin. Eurasian passerine birds, including the white wagtail (*Motacilla alba*), may nest at Windy Cove.

The proposed Clear Creek Hot Springs RNA contains a main vent issuing 140°F water, two other medium-grade springs, and a low-grade (70°F) seep. Several plant disjunctions were noted, including European mountain ash, *Sorbus aucuparia*. Comparative forest plots indicate that white spruce growth (to mature height and diameter) on the geothermally heated soil near the hot springs takes only about half the regional average time. The proposed Clear Creek Hot Springs RNA is only about 10 miles from the western Alaska tree line.

The Camp Haven Gap proposed RNA consists primarily of a poorly vegetated major limestone outcrop and a forested low pass which

funnels moose movements in the area. Major range extensions for seven plant species can be made as a result of collections done for this project. *G.P. Juday.*

Twig and Foliar Biomass Profile for Nonforest and Shrub Forest Communities in Interior Alaska

Regression equations were developed to predict twig, foliage, and combined biomass for fifty-nine species found in interior Alaska. The equations can be used to predict biomass from ocular estimates of per cent cover by 1-foot layers for a vertical profile extending from ground level to 16 feet. Very few differences were found in regressions of the same species between layers except in cases where the ratio of twig to foliar biomass changed drastically between layers.

These equations can now be combined with the vertical profile measurements made by the U.S. Forest Service, Forest Inventory and Analysis Unit, to develop detailed profiles of the amount and availability of understory species. These profiles are then useful in determining the quality of wildlife habitat in various communities across the state. *J. Yarie.*

Field work in conjunction with the land resources studies for the Susitna Hydroelecctric Project included mapping and inventorying of plant communities in the Susitna Basin Watershed.

Resource Management

Land Resource Studies for the Susitna Hydroelectric Project

The proposed Susitna Hydroelectric Project would be the largest, single, power-development project in Alaska. The use of hydropower for generation of electricity has been proposed for the railbelt region because of the size of its energy potential, proximity to population centers, and reliance on a renewable energy resource. Hydro projects are expensive initial investments, but over time operational costs are relatively low compared to hydrocarbon electrical generators, which have lower initial costs but increasingly expensive power demands in the long run.

To satisfy Federal and state regulatory requirements and for estimating impacts from this development on forest and wildlife resources, plant ecological studies were conducted by AES in cooperation with the Alaska Power Authority through APA's contractors. These included an inventory of plant communities in the upper and middle Susitna Basin watershed. The watershed, proposed access routes to rail and highway corridors, and the intertie power-line route between Fairbanks and southcentral Alaska were studied and plant communities mapped. Acreages of various plant communities that would be either inundated or otherwise destroyed were calculated to determine potential losses of moose habitat.

In the middle basin, significant forest production is confined to the river valley. Most of that forest would be flooded by the reservoir. Above the river and in the higher basin, scrub woodland and shrub birch predominate. These communities are in various maturity stages, depending upon when they were last burned by wildfires. Wildfire is a natural component in this ecosystem.

Note the mosaic pattern of vegetation and localized inundation in this photograph of the braided portion of the Susitna River below Talkeetna.

Permafrost prevents drainage of surface soils in much of the upland area; consequently many soils are boggy. This condition is also related to the natural fire cycle. For a period of time after burning, permafrost recedes, allowing soils to drain. When moss layers reform and insulate the soils, permafrost again restricts drainage, creating a wetland habitat. This natural cycle greatly impedes compliance with Federal regulations regarding the definition of wetland. The concept of wetlands' forming and disappearing naturally and even occurring on steep slopes was not adequately considered when the Federal definitions were written. There are many areas in the upper Susitna basin which were identified as wetlands according to the regulations, but these habitats may be of little value to wildlife while in their "wetland" condition. Following a fire, the "wetland" characteristics disappear and, as disturbed nonwetlands, they may be valuable moose range.

Other areas are naturally permanent wetlands, due to topography and underlying geological formations. These wetlands were not distinguished from those transitory types in our study because Federal regulations were inadequately defined. It is our recommendation that

The possibility of a need for revegetation of disturbed sites prompted studies to determine optimum fertilizer rates for use with native species.

the definition of wetlands for Alaska be reexamined relative to the original intent of protecting critical habitats and valuable water resources. It appears that the original intent of this regulation was based on experiences in which water is limited. In the upper Susitna basin, water is often surplus and can be a detriment to desirable wildlife habitat. Poor drainage and the transitory nature and unusual position of wetlands on steep slopes demand careful consideration based on an understanding of northern boreal ecosystems and permafrost conditions.

Below the dam, stream flow would be altered, with reduced summer flows and increased water levels in winter. Presumably, such changes would alter the natural river processes, perhaps eliminating those that perpetuate immature stands and significant browse for moose. Downstream, plant ecological investigations were designed to examine existing river-flooding processes, including local deposition and erosion, relative to creating and maintaining desirable moose range. These studies also provided basic information on soil and forest development in river valleys.

Influences on vegetation from the river are confined to very narrow

bands along the main banks and edges of islands from Talkeetna upstream to the dam site, because the channel is incised. Below Talkeetna, the valley was formed by glaciers; it is U-shaped and relatively flat. There, the river becomes braided, and islands and vegetation may change from one year to the next. Vegetation is affected across a broader area than further upstream. Aerial photographs from 1951, 1980, and 1983 permitted us to compare the relative stability of the islands both above and below Talkeetna. The addition of waters from the Chulitna, Talkeetna, and Yentna drainages will mitigate the influences of dams along the Susitna River and reduce any impacts on moose habitat.

The potential for creating improved moose ranges in the upper basin with controlled burning is a realistic mitigation of habitat losses due to reservoir formation and related construction activities. Determining how much and how often burning is needed requires assessing moose diets in the area, current browse production, and normal wildfire cycles in the basin. There is sufficient evidence that properly timed spring burning creates desirable moose habitat. Therefore, plans for the hydroelectric project can proceed without further detailing mitigation for losses of moose habitat. Effects of the dams on downstream moose habitat are more difficult to define than are those above the dams. We are confident that the river processes which normally disturb mature forests in the downstream area will continue. The degree of disturbance may be reduced, however, as it will occur at a lower water level. Should that reduction become significant, timber harvests and controlled burning are two viable methods for improving moose browse which can be used to offset losses of moose habitat.□

Snow Cover and Interpretation of Vegetation/Habitat Inventories

Criteria for classification of snow-cover types were investigated on important Arctic tundra sites near Kotzebue, Alaska, where snow cover lasts 7 months per year and strong easterly winds result in substantial redistribution and metamorphosis of snow. Through stepwise discriminant analysis, snow depth and hardness (total integrated Rammsonde hardness) were found to be useful variables to discriminate between snow covers. Five consistently different snow covers were identified, each associated with particular range sites. Increasing snow depth was highly correlated with increased shrub or grass height. Below 30 per cent tall-shrub or grass cover (above-snow), numbers of hard dunes increased with increasing cover, resulting in greater variation in snow depth and hardness. Above 30 per cent vegetation cover (above-snow), presence of hard dunes decreased with increasing cover and became more uniform in depth and hardness. Tundra snow covers that are greatly modified by wind are highly related to vegetation structure. Knowledge of these snow/site interactions should allow development of a snow-classification system for interpretation of vegetation inventories and related wildlife and livestock values. *W.B. Collins.*

Reconnaissance of Vegetation Affected By 1984 Seismic Activities In Arctic National Wildlife Refuge

During the winter of 1983-84, the oil industry sponsored seismic exploration of the Arctic National Wildlife Refuge (ANWR). During the summer of 1984, the contractor requested on-site examination of trails to assess impacts from the equipment. This survey included about 10 per cent of the winter trails.

Findings indicated impacts on the vegetation resulted from vehicular traffic, blasting, and fuel spills. None of these were of major consequence with regard to extent and long-term impacts.

Traffic created two types of visible disturbances — green trails and brown trails. Both of these were due to crushing standing dead vegetation, which revealed underlying green shoots or dead moss, respectively. Green trails predominated near the coastal areas, and brown trails occurred inland at higher elevation. The coastal communities are comprised of rhizomatous sedges and grasses, while the inland communities are tussock/shrub and willow/heath types. The standing dead represent several years' accumulations of predominately graminoid leaves. When these canopy covers are crushed, it leaves an obvious trail, but doesn't appear to adversely affect the species composition or growth of plants. These trails will remain visible for several years, or until the standing dead canopy is again developed. Ages of individual grass and sedge shoots are known to be at least 12 years in this region; consequently, a decade or more may pass before such trails disappear. They will become less obvious on the ground first and persist longest for aerial observers.

Blasting usually left little noticeable effect, except where ice-rich substrates were actually lifted out of place. Of the many holes examined, less than ten were noticeably affected. The recommendation was to leave these sites alone and allow natural processes to reclaim any barren soils. At most, only fertilizing should be permitted.

Fuel spills were relatively small, killing all plant life in the vicinity. Due to the relative size of those damages, they were judged inconsequential. No reclamation other than soil fertilization was suggested because more disruptive activities would probably exacerbate the problem. No areas in which total plant cover was removed by the seismic trains were discovered. *J.D. McKendrick.*

Long-Term Soil and Vegetation Research On Disturbed Sites at Prudhoe Bay

Research to identify techniques for revegetating disturbed sites in the Prudhoe Bay oil field commenced in the early 1970s. Objectives were to identify plants suited to that area and necessary fertilizers. Physically disturbed areas and oil spills were the primary targets of reclamation. Initial findings identified certain grass species of which Dr. W.W. Mitchell subsequently released varieties. We also discovered the critical need for phosphorus (P) fertilization in establishing seedlings on these soils. The objective of preventing thermokarst (melting of subterranean ice) through revegetation was never reached during the early years of study. Subsequently, industry support for this work terminated.

During August 1984, a reevaluation of study sites, sponsored by AES, revealed some significant responses by vegetation. During the 12-year period, several native species were successfully colonizing certain habitats. Soil moisture, microsite features, and fertilizers were apparently important factors favoring this process. Effects of a single phosphorus fertilizer application on reclaiming oil-damaged areas had persisted for twelve growing seasons. The only known successful revegetation of an oil spill in Arctic America with a seeded grass had died and was invaded with two native plants. These plants were growing only in plots where P-fertilizer was used. Unfertilized areas remained barren, substantiating the positive benefits from this fertilizer. Furthermore, there was measurable evidence that, after ten growing seasons, certain reestablished plant cover was beginning to reverse thermokarst.

These long-term observations are providing documentation to assist industry in meeting demand for environmental protection in this and future oil fields in the North American Arctic. They are revealing that, in certian instances, seeding may not be necessary because the natural revegetation processes will occur soon enough. In some situations, fertilization will be useful to enhance the natural process of revegetation, and, in other sites, planting and fertilizing are essen-

tial to regain plant cover within a reasonable time. Finally, if structure and human safety are not threatened, it may be best to permit thermokarst development, since it is a natural pond- and lake-forming process in this region. The eventual results blend aesthetically well with the surrounding landscape and plant communities. *J.D. McKendrick.*

Nutritional Quality of Browse Produced on Winter Moose Range Following Fire

The Chugach National Forest has been using controlled burning to improve browse production for moose on the Kenai Peninsula. Five control burns and two wildfire sites were studied to learn how burning affected the nutritional quality of the subsequently produced browse.

Burning is known to release mineral nutrients that have accumulated in plant biomass and to increase nutrient cycling rate by removing insulating organic layers from cold soils. It also causes woody plants to produce rapidly growing juvenile shoots as opposed to more slowly growing mature forms in undisturbed habitats.

Six browse species were sampled in burned and adjacent unburned areas: *Salix barclayi, S. scouleriana, Populus tremuloides, P. balsamifera, Betula papyrifera* and *Vaccinium vitis-idaea*. Ages of burns ranged from 1 to 24 years. Collections were made during summer and late-winter seasons. Our first interest was in the winter collection because it represents the season in which moose are stressed.

Features analyzed in the laboratory included: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn), and iron (Fe), total nonstructural carbohydrates (TNC), sequential NDF, ADF, cellulose, and lignin. Stems were also digested (IVDMD) in rumen fluids collected from a dairy cow and a free-roaming moose which had been killed on the highway.

Burning increased N, P, managanese (Mn), Zn, and NDF and decreased Ca, TNC, and IVDMDs. Individual species responses indicated all plants did not respond alike to burning. *P. balsamifera* decreased in Cu, Fe, and moose IVDMD and increased in NDF, ADF,

and lignin. *V. vitis-idaea* responded by increasing P, Ca, Cu, and Zn levels in stems. Certain nonsignificant, but consistent, trends among species indicated that, with burning, Mg, K, Fe, and Cu generally declined, while P and Zn usually increased. Fiber fractions NDF, ADF, cellulose, and lignin generally increased. Digestibility usually declined. Notable exceptions were *B. papyrifera* and *P. tremuloides,* which seemed to increase in digestibility following burning.

Dairy cow IVDMD, ADF, NDF, and TNC contents were used to predict moose IVDMD to learn if one of those would serve as a substitute for the more difficult moose digestion process. Overall predictability was fairly good using dairy cow IVDMD, NDF, and ADF, but not TNC. Certain factors among browse species exhibited varying usefulness to this approach, i.e. *P. tremuloides* and *P. balsamifera* NDF and ADF values were poor predictors of moose digestion, and no features for *V. vitis-idaea* were useful in the linear model. In contrast, all features for *B. papyrifera* predicted moose IVDMD well.

In the among-species comparisons, *P. tremuloides* and *P. balsamifera* outranked all others in digestibility in both moose and dairy cow rumen fluids. *B. papyrifera, S. scouleriana,* and *V. vitis-idaea* had lowest IVDMDs. Lowest N (crude protein) was found in *V. vitis-idaea* stems, even though this is an evergreen shrub and would be expected to maintain acceptable nutritional quality during winter. This plant outranked all other species in Mn levels, averaging 1,000 ppm, thirty times the level of the lowest species, *P. balsamifera.*

These data sets are providing valuable information not only about moose browse responses to burning management, but also about the natural qualities of these forages. We expect to also gain insight into nutritional relationships between domestic livestock and moose utilization of native ranges in this region and identify relative nutritional rankings for native browse. *J.D. McKendrick and K. Nelson.*

Range Resource Appraisal for Improved Management

The effects of burning on the chemical composition and nutrient contents of browse were investigated at seven locations, representing ages of burns from one to twenty-five growing seasons on the

Kenai Peninsula. Summer (stems and leaves) and winter (stems) collections are being analyzed for: N, P, K, Ca, Mg, Na, Cu, Zn, Fe, Mn, ADF, NDF, lignin, cellulose, IVDMD (cow rumen fluid, moose rumen fluid), and TNC. Species include: *Salix barclayi, Salix scouleriana, Betula papyrifera, Populus tremuloides, Populus balsamifera,* and *Vaccinium vitis-idaea.*

Browse quality was affected mainly during the first growing season, increasing leaf N, P, K, Na, stem K, and lignin and decreasing leaf cellulose stem Ca and Fe. Responses over time could not be distinguished from site factors. Burning affected four nutrient components in the two *Salix* species and only one component in *Vaccinium. Populus balsamifera* responded only by decreasing stem and leaf Mn. *Betula* decreased in stem Cu and leaf Fe and increased digestibility (cow) of its summer stems. *P. tremuloides* decreased in leaf Mn and cellulose. Burning mainly increased biomass, and it appeared not to degrade nutritional quality for moose, however declines in trace element contents, i.e. Cu, suggested a dilution of those metals with carbon compounds. Since Cu has proven deficient in some subpopulations of moose on the Kenai Peninsula and Se is also known to be low in Alaska and Canada's forages, there is reason to evaluate the effects of burning on forage micronutrient levels in the boreal forests. *J.D. McKendrick.*

Seward Peninsula Reindeer Range Mapping

This project, completed in 1984, was conducted in cooperation with the USDA Soil Conservation Service. Its primary objective was to complete soil and range surveys for Seward Peninsula reindeer grazing allotments. Information was compiled to assist reindeer industry managers in identifying grazing areas, designing seasonal-use patterns, and selecting proper stocking rates.

Landsat imagery, computer analyses, and color infrared aerial photographs were used to inventory range composition and forage yields, develop ecological site descriptions, and produce maps for approximately 6.5 million hectares of Alaska tundra. Range resource maps were checked for accuracy by aerial observations.

Forage collections were analyzed for various nutrient components. Phosphorus and sodium levels were insufficient to meet ruminant demands in nearly all summer forages. Vegetation composition, yield, and forage nutrient data were combined to compare total nutrient production among range sites. The more nutritious reindeer summer ranges are those with large deciduous shrub components. *P. Scorup.*

Characterization of Climate and Assessment of Impact on Agriculture and Other Renewable Resources

Twenty-year, long-term averages for each month at the AES Palmer Research Center were calculated for maximum, minimum, and mean temperature, and rain and snowfall for years 1961-81. By comparison, 1984 registered 2.7°F warmer than normal through July. Precipitation for this period was nearly average, although May was dryer than normal, allowing farmers relatively early access to their fields. No below-freezing temperatures were recorded from May 13 through August 27. August, a harvest month, received more precipitation than average, by 0.98 inches, but September and October received a total of 1.25 inches less than average. Lack of snow cover through mid-December, coupled with low temperatures, deepened the frost level well below normal levels.

The 1984 average annual temperature was 3.8°F above normal. Rainfall was 1 inch less than average. Cold temperatures and lack of snow cover could be hard on perennial forage crops, and the lowered frost level could inhibit soil warming in the spring.

An automated weather data collection system has been redesigned and installed at the Palmer site. Format for annual publication of weather information in English units for in-state use has been developed for the new VAX computer. Observations taken from this station are utilized by the National Weather Service, a local utility company for electric-use predictions, and the Crop and Livestock Reporting Service. *L.D. Allen.*

Utilizing the AgriData Network in Natural Resources Management

A Mellon Foundation mini-grant was received to purchase an initial subscription to the AgriData Network, an on-line computer service providing current, nationwide information regarding agriculture. Services provided include market information for hundreds of commodities, news, weather, correspondence courses, technical reports on a variety of topics, and electronic mail.

The subscription will provide an opportunity to evaluate the extent to which the services of the network are applicable to needs of students and faculty within the School of Agriculture and Land Resources Management. The use of this system for instruction, research, and public service will be observed during the coming academic year. The extent to which the service is used will help determine whether a long-term subscription is warranted. *C. Kirts.*

Survey of the Alaska Greenhouse Industry And Related Enterprises

A list of commercial greenhouses, nurseries, interiorscape businesses, landscape contractors, florist businesses, and variety stores that have departments that sell plant products is being developed in order to determine the scope of the horticulture industry in Alaska. Presently, 155 greenhouse, nursery, and interiorscape businesses have been identified along with 304 landscape contractors, 80 florist businesses, and 41 variety stores. A self-designed questionnaire will be used to determine the current status of these enterprises. The questionnaire used to survey the greenhouse, nursery, and interiorscape businesses will provide information on the region in which each is located; square footage of facilities, source of heating and lighting for greenhouses, number and type of employees, products purchased and/or produced, and total gross sales. The remain-

ing businesses will be surveyed primarily to determine the extent to which commodities are purchased from sources within Alaska. *P. Holloway, C. Kirts, and D. Brown.*

Utilization of Alternate Energy Sources in Alaska

Studies conducted at the AES Palmer Research Center demonstrate that several treatments in small polyethylene-covered greenhouses result in increased yield of ripe tomatoes.

Inadequate ventilation and cool nighttime air and soil temperatures, however, decrease fruit set and may increase mold damage, resulting in reduced yields.

In 1984, soil warming was accomplished in greenhouses with solar-powered and electric fans employed to circulate warmed greenhouse air through 6-inch diameter pipes, buried just below plant-rooting depth. This system resulted in a 6-10°F higher soil temperature and accompanying increases in tomato yield.

Two north-half insulated and six uninsulated houses were used to evaluate soil-pipe heat storage, solar door openers, solar ventilating fans, electric fans, and a control. Solar door openers replaced ventilation fans in two houses. Houses with solar door openers resulted in yields similar to those with electric fans, but the former had a higher incidence of defective tomatoes which we attributed to humidity and temperature extremes.

Insulated houses with no soil warming had lower seasonal ripe tomato yields, taller plants by an average of 10 inches, and a slightly longer growing season (7 days). Of all treatments, only those utilizing soil-pipe heating resulted in increased soil temperatures. *L.D. Allen.*

Management Systems for Small-Grain and Livestock Production in Interior Alaska

One of the aims of agricultural development in interior Alaska is to provide a feed-grain base for a growing livestock industry. Barley

is the primary crop used in this feed base. Livestock producers must be able to obtain barley at a competitive price while grain producers must be able to recover their costs. This cost/price relationship is important to individual producers as well as to state officials who must make decisions concerning sales of state land, expansion of the agricultural infrastructure in the state, and loans made to farmers.

The Agricultural Experiment Station has participated in obtaining barley-production information through surveys of farmers in the Delta Agricultural Project, an 85,000-acre area containing thirty-seven privately owned parcels. Farm size and the infrastructure which has been developed are primarily related to the production of barley. Surveys distributed to grain farmers in 1984 were part of a continuing effort to track the cost of production of barley in interior Alaska. Two other purposes are served: 1) determination of the types of equipment and management systems used and 2) provision of a historical record of production and production techniques.

Farmers were asked for information concerning production inputs, number of acres seeded, approximate yields, types and sizes of equipment, and sizes of grain dryers and storage facilities. Production costs were calculated from this information. The amount of fuel used and cost of repairs and maintenance were calculated using standard engineering equations and coefficients. Equipment prices were obtained from the Tractor Blue Book, plus shipping. All other costs were calculated using average prices in the Delta area.

Cash operating costs for production of barley in 1984 were $96.68/A, slightly under the 1983 average of $100.10/A. When repair, maintenance, and insurance costs of $15.38/A were added, the total was $112.06/A. The 1984 average was obtained from farmers whose farms range in size from 211 to 1540 acres. *C.E. Lewis.*

Modeling Production and Management Decisions For Alaskan Reindeer Herds

Most reindeer herd managers currently utilize an extensive management plan in operating their enterprises. This plan does not incorporate the use of a rotational grazing sytem. To investigate

whether or not this is an optimal management method, a simulated reindeer operation is modeled using a linear-programming framework. Three different range management plans were considered in the computer model: extensive, semi-intensive, and intensive. Results suggest that both the economic performance of a reindeer enterprise and the economic productivity of a reindeer range could be substantially improved. This occurred when management methods were altered from extensive grazing, using no rotational system, to intensive grazing, using a five-year rotational system. Net income earned by the operation increased by 333 per cent. *W.C. Thomas and J. Greenberg.*

Economics of Agriculture Development

An economic evaluation of milk processing in southcentral Alaska was conducted on an existing milk plant and a possible new plant of three different sizes. The work was undertaken because of the start up of the Pt. MacKenzie Agricultural Project and the financial problems of the farmers' cooperative which operates the milk plant. This study indicated that the establishment of a new plant would cost between $4 and $8 million, compared with approximately $2 million to make the existing plant competitive; thus, operation of the existing plant is the better decision for the present. A reassessment of this situation is recommended, with consideration for a new processing plant if the dairy industry expands as expected in the next few years. Efficient management of milk processing should allow Alaska's dairy farmers to compete with prices for fluid milk imported into Alaska.

Government policy is very influential to agriculture and its development. To improve understanding of the policy mechanism, work is continuing on the study of agricultural policy processes and measures of assistance to the agricultural sector. A case is made that the specification of policy is the outcome of the bargaining process and depends on actions of the participants, politicians, bureaucrats, producers, consumers, and general public. Policy outcomes appear more understandable if this bargaining process is examined in a market context. Collateral research on measurement of effective rates of assistance by government for agriculture can be related back to the

policy process and policy outcome. Presently, the methodological issues are being addressed. *W.C. Thomas.*

The Economics of Institutions Governing Private Land Use in Alaska

Preliminary work was conducted to examine agricultural interest-only (AIO) restrictions on deeds to agricultural lands recently transferred in State of Alaska land disposals. The main hypothesis under examination is that this deed restriction hampers the ability of farmers to acquire capital from private financial institutions, thus leaving agricultural enterprises dependent on state backing for their operations. No empirical results bearing on this proposition are currently available. We expect the findings of this research to provide useful input to legislative actions dealing with agricultural land policy.

Work has also been initiated to model state and borough government decisions regarding intertemporal patterns of land disposal. A Hotelling-like framework for resource depletion is being modified to account for asset (i.e. land) durability and secondary markets. Since governments are likely to have various and, often, conflicting goals in their land disposal policies, a goal-programming framework is also being examined as a possible tool for optimization of land disposal. *W.G. Workman.*

Outdoor Recreation and Public Interest: Benefits and Costs in Federal and State Resource Plans

A study was initiated to determine the perceptions of appropriate management strategies by subgroups of users of the Kenai River. The array of strategies was determined by consulting with management and special-interest groups. Six hundred of the 1,000 questionnaires mailed to river users have been returned, and data compilation is scheduled to begin this spring.

A contingent valuation bidding-game procedure was used to estimate the benefits of the state firewood program in Fairbanks. Results showed average permit values at $33 with aggregate benefits among all permit holders for 1983 estimated at $74,000. These benefits came at an estimated cost of $112,000 for administering the program.

Both travel cost and contingent valuation procedures were used in a survey of Dall sheep hunters in Alaska. Results of this survey are forthcoming. *W.G. Workman.*

Some Factors Affecting Revegetation of Mine Spoils

Reclaiming lands spoiled by surface mining is a legal obligation of mine operators according to Federal and state statutes and regulations. Posted bonds cannot be recovered until reclamation is sufficient to satisfy certain standards. Usually, criteria are based on establishing some degree of permanent vegetation cover. The purpose of such requirements is not questioned; however, determining what constitutes adequate reclamation (revegetation) efforts is controversial because plant succession is a poorly understood dynamic process on Alaska's mine spoils. Examples of acceptable and unacceptable revegetation occur and can be cited by opponents in this controversy.

A study sponsored by the U.S. Department of Energy at the Usibelli Coal Mine near Healy, Alaska, provided an opportunity to examine various degrees of revegetation with respect to spoil properties and various seeding mixtures used by the mining company during the previous 9 years. Two levels of sampling were used: 1) seedings rated good, medium, and poor; and 2) within a single seeding, bare and vegetated sites were sampled separately.

Plant cover of both seeded and naturally occurring species and spoil materials were sampled, and the number of species of plants seeded were determined from company records. These data were analyzed to identify features related to revegetation success.

Results indicated that the number of plant species persisting was related to the texture of spoil materials. Spoils were of two textural

classes, loam and clay-loam. Within those classes, percentages of sand and silt were positively related to species richness, and clay and rock were negatively related to species richness. We suspect moisture availabilities to plant roots were probably affecting plant survival in the heavy-textured spoils, and runoff was probably excessive on slopes.

Total number of species on these seedings was negatively related to the number of perennials in the original seeding mixture. This suggested that planting fewer species encouraged native plant invasion, thereby increasing species diversity in the permanent community. This conclusion was further supported when native plant cover and native plant biomass data were examined. The number of annuals included in the seeding mixture seemed to reduce native plant cover. As the number of seeded perennials increased, native plant biomass declined.

Examining spoil fertility and chemical features suggested that for seeded plant stands the optimum pH was between 6.2 and 6.8. When available ammonium nitrogen (NH_4-N) was less than 20 ppm, there was probably a nitrogen (N) deficit. The critical level of available potassium (K) was in the 14-30 ppm range, and plants responded to K in the 55-80 ppm range; there was no further response above 80-95 ppm.

Several areas of fruitful research for determining revegetation success were identified in this study: 1) spoil physical factors, i.e. heavy texture is a negative factor to vegetation establishment; 2) competition between seeded species and native plants is a factor to consider if species richness is important to the permanent stand, i.e. keep seeded plant species low if native plant invasion is desired; 3) competition between seeded annuals and native plant invasion is also a factor of importance, as there may be allelopathic effects from some annual plant residues that deter native plant invasion, at least during the early years of vegetation recovery; 4) chemical and fertility features of the spoils are important for establishing and maintaining plant cover (in this instance K and N were significant, but that should not be considered a universal situation, as spoils vary greatly among and within mines); 5) finally, no evidence of toxic substances was discovered in these spoils. *J.D. McKendrick, C. Elliott, and G.A. Mitchell.*

Minesoil Studies Testing Plant Species And Fertilizer Treatment Necessary For Reclamation Purposes

Research with grasses and alfalfas on minesoils at a site in interior Alaska is directed at determining necessary fertilizer treatments and appropriate species and varieties for a sufficient and enduring cover to satisfy reclamation requirements.

In one trial that was established in 1980 and fertilized in 1980 and 1981, the better performing grasses provided about 50 to 60 per cent live coverage in 1984 after three years without fertiliztion. Litter production was sufficient on a number of the plots to provide almost 100 per cent coverage of live growth plus litter. In another trial established in 1981 and fertilized only in the year of establishment, the better grasses provided 35 to 40 per cent coverage in 1984, with much less litter production than in the trial fertilized in two consecutive years. Refertilization in 1984 of a portion of the 1981 planting increased growth two- to threefold.

Some alfalfas in the 1980 planting showed considerable vigor in their fifth year of growth. The best performers, including the commercially available 'Anik,' provided about 60 to 80 per cent coverage with individual plants growing about 30 inches tall.

Whether the good coverage characteristics demonstrated by some of the entries in these trials can be maintained will depend on their winter hardiness (ability to endure a variety of winters), the nutrient cycling system that develops between the soil and the established plant population, and the ability of the plants to avail themselves of the nutrients that are present. *Wm. W. Mitchell.*

Susitna Vegetation Study

Three vegetation field studies, on phenology, preburn, and browse, were conducted during the summer of 1982 to assess impacts on

moose habitat and evaluate potential mitigation techniques for the Susitna Hydroelectric Project. The objectives of the phenology study were to identify what topographical or other factors affected early forage availability for moose in the impoundment zone. Microtopographical factors were generally more important than mesotopographical factors such as slope, aspect, and elevation.

The objective of the browse inventory was to assess the amount of browse available for moose in the major vegetation types: open and woodland white and black spruce, open birch, open spruce-birch, low shrub scrub, and low willow tundra. Although low willow tundra had the greatest biomass of current twig growth per unit area (21 lbs/A), the most available browse occurred in the open black spruce (105 lbs/A) and open white spruce (85 lbs/A) types. However, higher percentage utilization occurred in woodland spruce and open spruce-birch forest.

Vegetation in the Alphabet Hills area was cooperatively inventoried with two Federal agencies prior to a proposed burn for moose habitat improvement. The study was to be used to assess fire as a mitigation tool since the area overlapped the Susitna drainage and had similar climate, soils, and vegetation. *W.D. Steigers.*

Susitna River Basin Study (Resource Mapping)

This is a cooperative project with the USDA Soil Conservation Service. The primary objective is to complete soil and range surveys for Seward Peninsula reindeer grazing allotments. Information is being compiled to assist reindeer industry managers in identifying grazing areas, designing seasonal-use patterns, and selecting proper stocking rates.

Landsat imagery, computer analyses, and color infrared aerial photographs were used to inventory range composition and forage yields, develop ecological site descriptions, and produce maps for approximately 2.6 million acres of Alaska tundra. Range resource maps were checked for accuracy by aerial observations.

Forage collections were analyzed for various nutrient components.

Phosphorus and sodium levels were insufficient to meet ruminant demands in nearly all summer forages. Vegetation composition, yield, and forage nutrient data were combined to compare total nutrient production among range sites. The more nutritious reindeer summer ranges are those with large deciduous shrub components. *P. Scorup.*

Susitna Browse Biomass Inventory Pilot Study

The most time- and cost-efficient methods to sample current annual growth of shrubs were investigated in six vegetation types of the middle Susitna River basin: woodland black-white spruce, woodland black spruce, open mixed spruce-paper birch, open tall willow, open low dwarf birch-willow, and open low willow. Results were to be used in designing a large-scale inventory of moose browse in that area for the Susitna Hydroelectric Project. Quadrats sized 9.6 ft^2, 38.4 ft^2, and 96 ft^2 were compared for efficiency in estimating density of seven dominant shrub species: *Betula glandulosa, B. papyrifera, Salix pulchra, S. glauca, S. alaxensis, S. lanata,* and *Alnus sinuata.*

Basal diameter, maximum height, canopy depth, maximum length, and maximum width were measured on individual shrubs to use as independent variables in double sampling of current annual growth. Ocular estimates of total twig and leaf biomass were also recorded before the current annual growth twigs and leaves were clipped by height strata. Ocular estimate was the most reliable independent variable for double sampling. The 38.4 ft^2 quadrat was the most efficient size for density. Current annual growth per unit area was to be obtained by multiplying density times current growth per individual. Calculation of the error term for confidence intervals with double-sampling methods was difficult, sometimes questionable, and resulted in large variances.

A limited number of 9.6-ft^2 plots were clipped at each site in order to establish a criterion for comparison of the double-sampling results. Even though clipping quadrats was time consuming, the statistical analyses were much simpler and produced more reliable results. *W.D. Steigers.*

Susitna Plant Phenology Study

Alaska Department of Fish and Game had expressed concern on the Susitna Hydroelectric Project that the potential impoundments might inundate areas that were currently being used by cow moose prior to parturition. The early greenup of vegetation was believed to be important during this time period. Small exclosures had been constructed on south-facing slopes during spring 1982 and monitored for 5 weeks. This enabled us to relocate points exactly each week to follow the phenological development. North-facing slopes opposite the south-facing slopes transects were walked each week also, but less detailed observations were made. The only common factor among areas that developed earliest was that they had been burned within the last 50-75 years.

The study was conducted again in 1983, but this time a broader area was covered and less-detailed measurements were made, at the suggestion of Alaska Department of Fish and Game. The study was intitiated at the first sign of snow melt and continued for 5 weeks. Phenological development, vegetation type, elevation, slope, aspect, snow depth, relative abundance of *Equisetum* and overwintered berries, and presence of recent browsing were recorded in qualitative terms.

A larger percentage of vegetation observed on south-facing slopes was more phenologically advanced than on north-facing slopes, although some north-facing points were more advanced than some south-facing points. Elevation, categorized as above or below potential impoundment, had no effect on greenup. Along some transects, vegetation on steeper slopes developed earlier. Closed forests and herbaceous types were relatively advanced sites where they occurred; however, the sample size was small. Low shrub-scrub sites were the most phenologically advanced on about one-third of the transect groups. Transects that were snow-free earliest tended to develop earliest; however, there were exceptions. Most early-developing sites also appeared to be disturbed, although no measurements were made.

The pattern of overwintered berry availability varied among transects, but higher elevations tended to have more available berries. Slope and vegetation type were not usually related to berry availability. Horsetail was found more on south-facing slopes, at elevations below the potential impoundment level, on 0-3° slopes, and in open forest vegetation types. *W.D. Steigers.*

Mapping Vegetation for the Susitna Hydroelectric Project

Main objectives of this project included vegetation mapping, plant species inventory, endangered species search, and downstream floodplain vegetation succession for the Susitna Hydroelectric Project. A total of 660,000 acres in the middle and upper Susitna River basins were mapped using a statewide vegetation classification. Vegetation types ranged from tundra through low and tall shrublands to coniferous, deciduous, and mixed forests. Descriptions of these vegetation types and areas covered, as well as results of the other studies, were presented by McKendrick et al. (1982).

No proposed endangered species were found in our search of the area, which mainly emphasized calcareous outcrops, the main habitat of many of the proposed endangered species. A total of 277 vascular plant species, occurring in 140 genera in 56 families, were identified in the upper and middle basins and downstream floodplain combined.

Downstream vegetation succession was studied by selecting sites in various vegetation types, sampling vegetation cover and density for woody species, and aging trees and dominant shrubs. Early successional types included horsetail, willow, balsam poplar, and mixtures as well as dryas. Middle successional types included alder and immature balsam poplar, while later stages included mature balsam poplar and birch spruce forests.

These studies were important because they were among the earliest extensive surveys of an area with limited access. The downstream study was significant because it stressed the variability of soils and vegetation within successional stages. *J.D. McKendrick.*

Operations of the Alaska Ecological Reserves Council

This research involved site documentation of the proposed Pete Dahl Slough Research Natural Area (RNA) on the Copper River delta in the Chugach National Forest. Managers there are concerned about the low population level of the dusky subspecies of the Canada goose, which nests only on the delta and overwinters only in the Willamette Valley of western Oregon. This project documented rapid shrub (*Alnus crispa*) encroachment onto former *Carex lyngbyaei* wetland surfaces, permanently raised by the great 1964 earthquake. Shrub encroachment may be partly responsible for the goose decline. Preliminary indications are that shrubs reduce habitat quality by 1) allowing nest predators a closer, undetected approach and 2) reducing primary production of the favored carex (and other wetland) forage and nest-building species. Large open-water freshwater ponds, another component of the high-quality dusky goose habitat, have been greatly reduced on the Copper River delta since the earthquake, at least in the proposed RNA. The deeper incision of the drainage network on the delta after the 1964 uplift has naturally breached many of the natural levees containing the large freshwater ponds. A comparison between our results and the conditions shown on 1974 aerial photos reveals that these changes were considerably more pronounced in the 1974-84 decade than the 1964-74 decade immediately after the uplift. There has been a limited amount of plant colonization of prograded surfaces within the RNA, unlike the major new marsh being created at the mouth of the Eyak River. *G.P. Juday.*

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LEE D. ALLEN, Associate Professor of Agricultural Engineering; University of Idaho '57, B.S., '72, M.S. Mr. Allen's agricultural engineering research has included insulation and vapor barriers, cold-climate animal environment and waste disposal, soil cement and rammed earth structures, grain and hay drying, northern climatic measurements and phenology, irrigation and tillage, locally grown vegetable processing, and preservative treatment of Alaskan woods. Mr. Allen joined the AES staff in 1957. He has been Alaska's representative on ten midwest and western Regional Research Committees. His current projects concentrate on climatological measurements and energy utilization.

CATHY A. BIRKLID, Research Assistant; University of Alaska '77. A.A. Computer Information Systems, B.B.A. Management. Ms. Birklid began working for AES in 1979. Her major responsibility was development and administration of market surveys concerning statewide demand for cut roses. She has also investigated the feasibility of small-scale meat production of ducks, geese, and rabbits in a village setting for sale in Alaska markets. 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 working on applying newly developed computer software to various farm management systems in Alaska.

LEROY BEN BRUCE, Instructor 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 unusual feedstuffs such as taro. In South Dakota, he was extension specialist in feedlot nutrition, providing service to cattle feeders statewide. His work with the University of Alaska-Fairbanks is with beef cattle at the Palmer Research Center. His general areas of research interest are beef cattle nutrition and management, and will be working specifically with cow-calf and feedlot research.

ARTHUR L. BRUNDAGE, Professor of Animal Science; Cornell University '50, B.S.; University of Minnesota '52, M.S., '55, Ph.D. Dr. Brundage has been with the University of Alaska for 33 years and is now senior project leader in animal science with primary responsibility for research in dairy cattle management, production, nutrition, and breeding. He has also served as state extension dairyman, manager of the Matanuska Valley Breeders' Association (a nonprofit corporation of local dairymen operating in cooperation with the Experiment Station), and an instructor at the Matanuska-Susitna Community College. Dr. Brundage will retire in February of 1985, after which

he expects to maintain an informal relationship with the experiment station and the university.

DONALD E. CARLING, Assistant 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 the Agricultural Experiment Station in 1981 and has since concentrated a basic and applied research program on potatoes and vegetables. Applied reserach includes variety testing and studies of herbicides, seed treatments, and general cultural practices. More basic research includes the study of Rhizoctonia disease of potatoes and vegetables.

WILLIAM B. COLLINS, Assistant Professor of Range Management; Brigham Young University '74, B.S.; Utah State University '77, M.S., '79, Ph.D. Dr. Collins's research interests are: behavior of grazing animals, grazing systems, and range management. Dr. Collins has worked on problems associated with range use by reindeer, mule deer, elk, pronghorn antelope, moose, musk ox, wild horses and burros, cattle, and domestic goats.

JEFFERY S. CONN, Research Agronomist, USDA; 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 designing 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 Agricultural Experiment Station 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; 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.

JAMES V. DREW, Dean, School of Agriculture and Land Resources Management, and Director, Agricultural 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, 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.

ALAN C. EPPS, Professor of Natural Resources; Montana State University '66, B.S.; Montana State University '69, M.S. Mr. Epps's background is in natural resource allocation and management, with extensive experience in land-use planning. Before joining AES he was with the Cooperative Extension Service, University of Alaska, where he worked extensively in public policy at the national, state, and local levels, receiving the USDA Distinguished Service Award in 1978 for his policy education work on the Alaska national interest lands issue. Mr. Epps is currently conducting research on natural resource policy and is coordinator of UAF's applied reindeer research and instruction program and teaches an upper division course on the Alaska Reindeer Industry.

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 the Agricultural Experiment Station, currently researching runoff relations of boreal forest watershed management, forest systems, forest management, resource measurements, simulation and modeling, and biometeorology.

THOMAS J. GALLAGHER, Assistant Professor of Regional and Land-Use Planning; University of Oregon '69, B.L.A.; University of Michigan '74, M.S., '77, Ph.D. His research interests are in the area of rural land planning, participation methods, and use of alternative processes in plan preparation. He is presently conducting research on application to Alaska of the Joint Review Process. He currently teaches graduate courses in regional planning and an undergraduate course in land-use planning. Dr. Gallagher also serves as land resources specialist for the Cooperative Extension Service with responsibility for preparation of the "Alaska Planning Director."

ANTHONY F. GASBARRO, Extension Forestry Specialist and Instructor of Forest Management; 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 5 years with the U.S. Forest Service both in California and Alaska, 2 years with the Peace Corps in the Dominican Republic, and 2½ 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 Project and currently holds a joint appointment between SALRM and the Cooperative Extension Service.

JOSHUA A. GREENBERG, Research Associate; University of Connecticut '82, B.S.; University of Alaska '84, M.S. Mr. Greenberg's background is in resource and agricultural economics. He joined AES in 1984 where he has focused on economic research related to Alaska's reindeer industry.

MARILYN GRIFFITH, Assistant Professor of Plant Physiology; Mt. Holyoke College '75, B.A.; Yale School of Forestry '77, M.F.S.; University of Minnesota '81, Ph.D. Dr. Griffith was awarded a Killam Fellowship in 1981 to pursue independent research at the University of British Columbia and the University of Western Ontario in Canada. Her research interests are focused on growth and development of plants at low temperature using expertise in physiology, biochemistry, and anatomy. Since joining the Agricultural Experiment Station in 1984, Dr. Griffith has been involved in directing research programs in plant physiology and horticulture.

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

DOROTHY J. HELM, Plant Synecologist, Research Associate; University of Delaware '69, B.S.; University of Michigan '70, M.S.; Colorado State University '77, M.S., '81, Ph.D. Dr. Helm's background includes soil-vegetation relationships around alpine snowfields and vegetation inventory techniques in Colorado. She has been involved with the vegetation studies on the Susitna Hydroelectric Project since 1980, including studying vegetation succession along a 50-mile stretch of the river, mapping vegetation over several million acres, inventorying moose browse, and studying phenological development of plants near the potential impoundment area. She has assisted with data collection and analysis on range-related projects with Homer beef, Delta bison, Cantwell revegetation, and Beluga and Usibelli coal fields. She is also helping to streamline data collection and report generation techniques using available microcomputers and university mainframe computers.

MARY LOU HERLUGSON, Research Associate in Animal Sciences; New Mexico Institute of Mining and Technology '74, B.S. Attended graduate schools at Washington State University and University of Alaska. Ms. Herlugson joined the Agricultural Experiment Station 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; 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 the 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 an 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 the Agricultural Experiment Station in 1975, nutrition research has been conducted with swine and cattle to determine the nutritional and feeding value of marine by-products. Recommendations have been made for feeding crab waste meal to livestock and research is currently being conducted to determine chitin digestion by rumen microorganisms. Research to determine barley protein quality and the feeding value of a new hulless barley variety, 'Thual', are currently in progress. Courses in introductory animal science, livestock feeding, nutrition and graduate courses in nutrition and metabolism have been developed and offered through the Natural Resources Management degree program.

ALAN JUBENVILLE, Associate Professor of Natural Resources 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 two 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 has been an active member of W-133 Regional Hatch Project, linking economic theory with recreation management theory. Currently Dr. Jubenville is working on a textbook integrating theory into the management process.

GLENN P. JUDAY, Visiting Associate Professor of Plant Ecology; Purdue University '72, B.S.; Oregon State University '76, Ph.D. Dr. Juday's research background is in community ecology, especially composition, distribution, and structure of old-growth conifer forests. He was principal investigator, Indiana Natural Streams System in 1972. He was chairman of the Oregon Natural Areas Commission from 1973-76 and coordinator, Rosie Creek Fire Research Project, 1983-85. Dr. Juday's major program responsibilities since joining AES in 1982 have included coordination of multidiscipline research projects, especially the Alaska Ecological Reserves Program. This applied research has resulted in publications on climate change, forest fire effects, land-use planning, geomorphology, and wildlife-habitat relationships. He received a Meritorious Service Award for natural areas work from the governor of Oregon.

CARLA A. KIRTS, Assistant Professor of Agricultural Education; Virginia Polytechnical Institute and State University '76, B.S., '77, M.S.; University of Missouri-Columbia '81, Ph.D. Dr. Kirts's research background is in student-teaching management for preparation of vocational agriculture teachers and strategies to promote quality instruction. Currently, Dr. Kirts teaches technical courses in natural resources management and agriculture. 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.

LESLIE J. KLEBESADEL, Professor of Agronomy; University of Wisconsin '54, B.S., '55, M.S., '57, Ph.D. Dr. Klebesadel joined the University of Alaska in 1957. He served as the first director of Matanauska-Susitna Community College, 1958. As a member of the Plant Science Team of US/USSR Agreement on Agricultural Cooperation, he traveled extensively in the Soviet Union in 1974. He served as research leader and location leader of the US Department of Agriculture's Agricultural Research Service scientific staff in Alaska from 1968 to 1981. Dr. Klebesadel's research emphasis is in physiology and management of forage grasses and legumes; latitudinal, ecotypic, and photoperiodic aspects of adaptation, winterhardines, and seed production; development of cold hardiness and dormancy; establishment techniques; nutrition and harvest management; evaluation and utilization of indigenous Alaskan grasses and legumes; and ecological genetics as concerned with germplasm modification within introduced populations during natural selection toward subarctic adaptation.

CHARLES W. KNIGHT, Instructor of Agronomy; Kansas State University '70, B.S., '71, M.S. 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 the Agricultural Experiment Station. From 1973 until 1978 he was superintendent of the East Central Kansas Experi-

ment 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.

WINSTON M. LAUGHLIN, Soil Scientist, Agricultural Research Service, USDA; University of Minnesota '41, B.S.; Michigan State University '47, M.S., '49, Ph.D. Dr. Laughlin's background is as a farm laborer and soil surveyor in Minnesota and as a geodetic computer with 30th Engineers, U.S. Army. Since coming to Palmer in 1949, he has worked with the Agricultural Research Service in cooperation with the University of Alaska, dealing primarily with soil fertility problems and plant nutrient deficiencies.

GARY A. LAURSEN, Visiting Assistant Professor of Mycology; Western Washington State University, Bellingham '65, B.A., B.S.; University of Montana, Missoula '70, M.S.; Virginia Polytechnic Institute and State University, Blacksburg '75, Ph.D. Dr. Laursen's background includes teaching, research, and research administration in Arctic environs specifically at the Naval Arctic Reserach Laboratory in Barrow, and currently with a research appointment at the Agricultural Experiment Station. His research interests include studies of fungi in Arctic, alpine and maritime tundra sites in Alaska, Norway, Sweden, Finland, and Switzerland. Dr. Laursen's current interests emphasize continued Arctic Alaska fungal ecology and interior Alaska higher plant-fungi associations.

CAROL E. LEWIS, Associate Professor of Resources Management; University of Florida '62, B.S. Mathematics; '64, M.S. Mathematics; Georgetown University '70, Ph.D. Physics; 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 Agricultural Experiment Station research faculty since 1973, past 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, Assistant 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 the Agricultural Experiment Station in 1980 and is currently conducting research on fungal and bacterial diseases of wheat and barley plants, as well as on tree rusts, wood decays, and mycorrhizal problems. 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.

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 Sitka blacktail deer. He served as a consultant to industry on matters relating to the effects on vegetation of development activities. Dr. McKendrick has also served as a member of the National Academy of Sciences Committee on Alaskan Coal Mining and Reclamation and as a staff advisor to the National Governors' Association Range Resource Subcommittee.

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

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 the Agricultural Experiment Station in 1963 where he commenced studies on native grasses of Alaska, investigating the taxonomy, distribution, adaptation, 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 revegetative 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.

MAYO MURRAY, Editor and Publications Supervisor, attended the University of Connecticut and the University of Alaska. Mrs. Murray has been with the University of Alaska for 13 years, the last 9 of which have been in her present position. As head of publications, she oversees the production of the station's journal, *Agroborealis,* as well as a variety of other publications on a variety of topics. Mrs. Murray also serves as information officer for SALRM.

BONITA J. NEILAND, Director of Instruction and Public Service, School of Agriculture and Land Resources Management. University of Oregon '49, B.S.; Oregon State University '51, M.A.; University of Wisconsin '54, Ph.D. Dr. Neiland's research background is in plant ecology with emphasis on soil-vegetation relations and forest regeneration. She has been head of the Department of Land Resources and Agricultural Sciences at UAF. In 1952, she was a Fulbright Fellow to the University of Wales.

EDMOND C. PACKEE, Assistant Professor of Forest Management; University of Montana '62, B.S., Yale University '63, M.S., University of Minnesota '76, Ph.D. Dr. Packee's research background is in the coniferous forests of the Pacific Slope north of the redwoods, the Rocky Mountains, and interior Alaska as well as in the northern hardwood forests of the Great Lakes states. He also has forest management experience in northern Wisconsin and coastal British Columbia. He was senior silviculturist for 15 years with a forest products company in Canada. Dr. Packee joined the Agricultural Experiment Station in 1983 and has concentrated on forest growth and yield, the silviculture of tamarack, and forest products' markets. He is a technical advisor to the Governor's Timber Task Force.

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 background of research 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 the Agricultural Experiment Station in 1982 to investigate soil genesis and classification in Alaska. He also represents the experiment station by participating in the National Cooperative Soil Survey program in Alaska and supervises the Plant Tissue and Soil Analysis Laboratory in Palmer.

SIGMUND H. RESTAD, Assistant Director of the Agricultural Experiment Station, University of Minnesota '53, B.S.; University of Minnesota '54, M.S. Mr. Restad's background includes agricultural extension, research in dairy nutrition and management, administration of the Alaska Division of Agriculture,

and executive officer for the Agricultural Experiment. His present position includes management of the Palmer Research Center.

ALLEN P. RICHMOND, IV, Research Associate, Forestry; Virginia Polytechnic Institute and State University '73, B.S. University of Alaska '83, M.S. After serving 4 years as an officer in the United States Army, Mr. Richmond left the service to attend the University of Alaska. He has worked for the past 5 years on the Intensive Forest Management Project, demonstrating and evaluating various pieces of forestry equipment and silvicultural practices which may improve the productivity of interior Alaska's forest lands. Research has been directed toward determining forest management options available to forest managers.

PETER C. SCORUP, Research Associate; Colorado State University '66, B.S. Mr. Scorup was a range conservationist with the Soil Conservation Service for 3 years and an instructor of agriculture and natural resources management, at Colorado Mtn. College for 2 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.

STEPHEN D. SPARROW, JR., Assistant 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 AES 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.

MAX STARK, Superintendent, AES-Farm, Fairbanks; Montana State University '42, B.S. Mr. Stark taught vocational agriculture for 35 years. He was also a part-time dairyman and a grower of certified potato and grain seed and spent fourteen summers with the Montana Potato Improvement Association at Montana State University.

ROSCOE L. TAYLOR, Professor of Agronomy; South Dakota State University '48, B.S.; Iowa State University '50, M.S. Mr. Taylor has extensive experience in crop breeding and production research in Alaska, involving both grain and forage crops. He is responsible for the development of five barley, two oat, two wheat, and one rye varieties adapted to Alaska's growing conditions. Mr. Taylor assisted in the development and maintenance of one varie-

ty each of bluegrass, fescue, bromegrass, alfalfa, and red clover. Current research emphasis is concentrated on cereal breeding, involving the development of adapted barley varieties possessing urgently needed disease resistance, early-maturing oat varieties suitable for grain and forage, and early-maturing wheat varieties with improved grain yield and quality.

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.

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. Van Cleve 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.

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 Palmer AES Plant and Soil Analysis Laboratory supervisor. He is also currently working in soil fertility and fertilizer requirements of newly cleared Alaska soils.

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 the Agricultural Experiment Station in 1970, where

he 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; 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, Visiting Assistant Professor of Silviculture and Forest Ecology; 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 of white spruce forests to the environment and how this knowledge can be used to improve forest productivity in interior Alaska.

Financial Statement

Expenditures — July 1983-June 1984

Statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1983, and ending June 30, 1984.

		% of total
Federal:		
Hatch Regular Formula Funds	$755,439	12
Hatch Regional Formula Funds	124,571	1
USDA-Agricultural Research Service	688,900	11
McIntire-Stennis Formula Funds	173,887	3
Cooperative Agreements	210,389	4
Other Grants and Contracts	879,373	14
State Funds	$3,511,140	55
Total	$6,343,699	100