



AgroBorealis

Agricultural and Forestry Experiment Station • Volume 25, Number 2, July 1993

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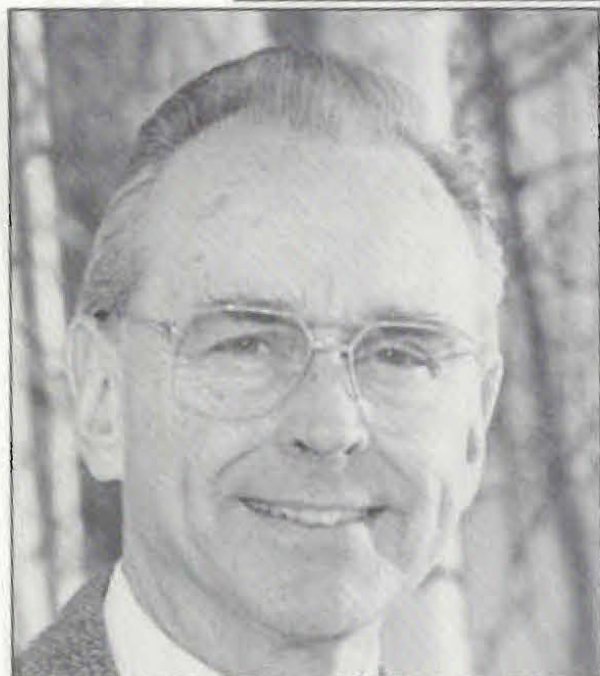
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About the Front and Back Cover:

SOUTHEAST ALASKA'S TEMPERATE RAIN FOREST: Ph.D. Candidate Robert Ott puts his camera to use while conducting research this past summer in Southeast Alaska. To learn more about the research at the School of Agriculture and Land Resources Management, please turn to page 20.



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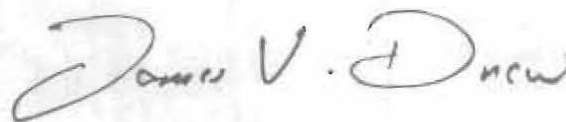
TRANSMITTAL LETTER

The Honorable Walter J. Hickel
Governor of Alaska
P.O. Box 110001
Juneau, Alaska 99811-0001

Dear Sir:

I submit herewith the annual report from the Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks, for the period ending December 31, 1992. This is done in accordance with an act of the Congress, approved March 2, 1887, entitled "An act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and also of the act of the Alaska Territorial Legislature, approved March 12, 1935, accepting the provisions of the act of Congress.

Very respectfully,



James V. Drew
Director

Fairbanks, Alaska
June 30, 1993

STATEMENT OF PURPOSE

This report summarizes research progress at the Alaska Agricultural and Forestry Experiment Station (AFES). Our research aims to solve problems related to agriculture, forestry and the environment. Specifically, the AFES research objectives are to provide new information to manage renewable resources of high latitudes, and improve technology for enhancing the economic well-being and quality of life at high latitudes.

While foresters, farmers, and land managers use our research results, all Alaskans directly benefit from the wise use of land resources. As such we remain committed to our state and communities. Our scientists regularly meet with land managers, foresters and farmers throughout the state to discuss their specific needs and problems. The scientists work directly with producers through farm forums, agricultural field days, greenhouse workshops, vegetable conferences, reindeer herder workshops, and forestry workshops, discovering additional research needs through these contacts.

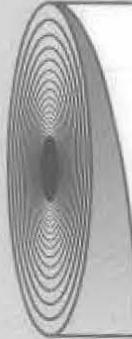
Additionally, experiment station scientists work with Cooperative Extension Service agents, establishing a two-way flow of information on research needs. Scientists also serve on advisory panels for land and resource management agencies.

Because of these contacts, most of the research projects described in the plant and animal sciences section of this report are in response to producer requests. We work with the industry, state and federal agencies to develop research projects in forest sciences and resources management.

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

Administratively, AFES is an integral part of the School of Agriculture and Land Resources Management (SALRM) at the University of Alaska Fairbanks. This association provides direct linkage between research and teaching in forestry, agriculture and natural resources. Scientists who conduct research at the experiment station also teach, sharing their expertise with both undergraduate and graduate students.

SALRM/AFES establish, meet board of advisors



the School of Agriculture and Land Resources Management (SALRM) and the Agricultural and Forestry Experiment Station (AFES) recently formed a Board of Advisors. The 10 men and women comprising the group come from diverse backgrounds and from different parts of Alaska. A common element uniting them is a sincere dedication to the effective stewardship of Alaska's natural resources.

Dr. Jim Drew, SALRM dean and AFES director, said the purpose of the board is to provide advice and guidance for the directors and focus of programs in teaching and research within the school and experiment station. The board is organized to develop a composite view representing those whom these programs are expected to benefit.

The board met July 19th and 20th on the campus of the University of Alaska Fairbanks. Faculty members from each of the departments of the school and experiment station briefed the board on current research and teachings. Included in these briefings were field trips to the Long Term Ecological Research Site in the Bonanza Experiment Forest near Fairbanks, and the Fairbanks Experiment Farm on the UAF campus for a firsthand look at research in the field. The meeting concluded with discussions by board members and faculty concerning ways to improve teaching and research related to the management of natural resources.

Board members were nominated by faculty members within SALRM and AFES and reflect the diversity of private and public sectors that use information from the school and experiment station. The next three pages highlight the members and the first group gathering.





Board members:

◆ **CHARLES "CHARLIE" BODDY**, Fairbanks; vice president of government relations for Usibelli Coal Mine, Inc.

◆ **ROSE FOSDICK**, Nome, director of the Reindeer Herders Program, Kawerak, Inc.

◆ **ROBERT FRANKLIN**, Fairbanks, owner of B-Y Farms.

◆ **HELEN HANKINS**, Fairbanks, Kobuk District Manager for the Bureau of Land Management.

◆ **JOHN "CHRIS" MAISCH**, Fairbanks, chief forester for the Tanana Chiefs Conference

◆ **MICHAEL MEEHAN**, Seward, president of Meehan By-Products, Inc.

◆ **MARSHA MELTON**, Palmer, former general manager of the Alaska State Fair in Palmer and involved in agricultural activities.

◆ **ANN ROTHE**, Eagle River, environmental policy consultant.

◆ **STEVE ULVI**, Fairbanks, subsistence manager for the Gates of the Arctic National Parks and Preserves

◆ **MARCIA WARD**, Soldotna, owner Ward Farms and Ward Landscaping Service, Inc.

① Charlie Boddy, vice president of government relations, Usibelli Coal Mine, Inc. and Dr. Allen Mitchell, Palmer Associate Dean and Director.

② Michael Meehan, Meehan By-Products president.

③ Dr. Jeff Conn, USDA-ARS; Yong Huang, research assistant; Robert Franklin, B-Y Farms; Marsha Melton, former general manager of the Alaska State Fair in Palmer; Chris Maisch, forester for Tanana Chief Conference; Helen Hankins, Bureau of Land Management; Dr. Jim Drew, SALRM Dean and AFES Director; Rose Fosdick, Reindeer Herders Program, director; and Michael Meehan.
(Photos by Donna Gindler)





① Chris Maisch.

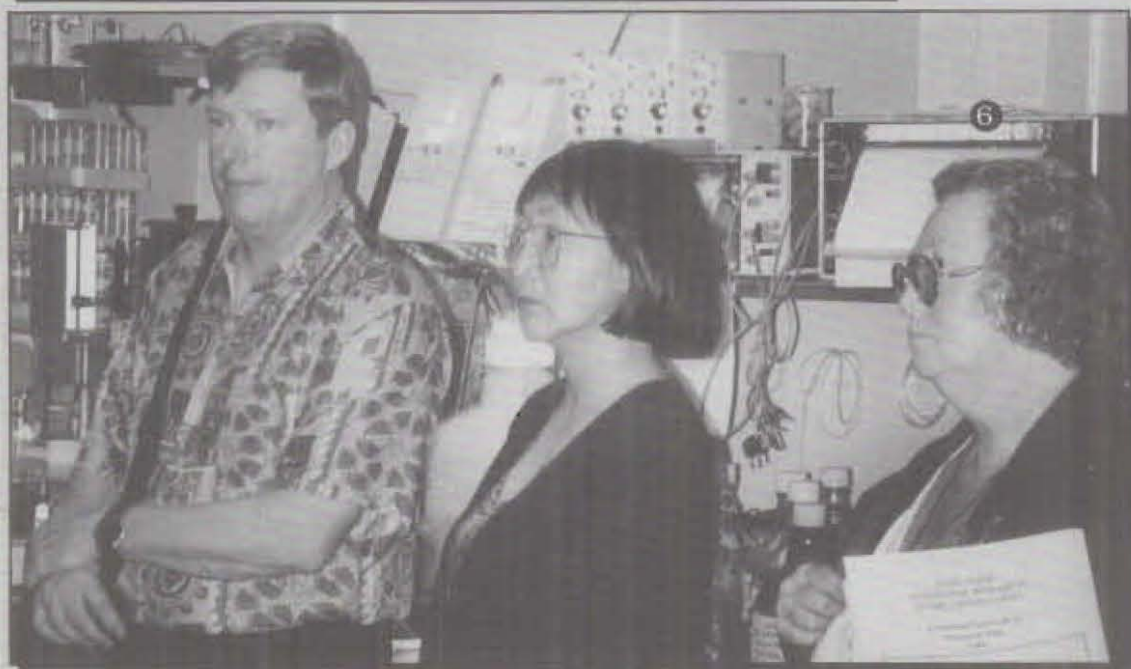
② Michael Meehan, Dr. Jim Drew and Robert Franklin.

③ Marsha Melton, Steve Ulvi, subsistence manager for the Gates of the Arctic National Parks and Preserves, Helen Harkins (looking at the map), Dr. Dan Verbyla, Ann Rothe, environmental consultant and Rose Fosdick.
(Photos by Donna Gindle)





- ④ Marsha Melton (left) and Marcia Ward, owner of Ward Farms and Ward Landscaping, Inc.
- ⑤ Dr. Leslie Viereck, Chris Maisch and Ann Rothe.
- ⑥ Charlie Boddie, Rose Fosdick and Marcia Ward.
(Photos by Donna Gindle)



Baked Alaska?

Scientist examines temperature trends

By: Dr. Glenn Patrick Juday

Greenhouse effect. By now almost everybody has heard the prediction that the earth's climate will warm because humans are altering much of the earth's system that releases and stores gasses that trap the sun's heat. This, in turn, produces a greenhouse effect (Schlesinger and Mitchell, 1987). The predicted greenhouse warming is supposed to be greatest in the far north.

If that is true, Alaskans should be the first to see and experience that warming. Is there evidence that global warming is happening in central Alaska? If there is evidence of warming, are there other explanations than the greenhouse effect for these climatic changes?

Like people everywhere, Alaskans like to talk about the weather. Unfortunately, if you ask us if it's been warming or cooling lately we'll probably respond based upon an unusual recent event that left a strong impression. Such as:

John Q. Public, "I can't believe it. On May 17 (1992) it snowed in Fairbanks. The robins were forlornly chirping in the slush. The ice on the Tanana River didn't break up until May 14 (1992), the fourth latest breakup date since records began 76 years ago in 1917. On September 12, (1992) a heavy snow fell across the Interior. Hardwood trees had hardly begun to drop their leaves and millions and millions of tree tops and branches broke under the burden of the heavy wet snow. 1992 was the shortest snow-free season on record."

Susie Q. Public, "I can't believe the great weather here in Fairbanks. From late May through mid-September (1992) we had 62 days where the temperature was 70-degrees or warmer. Since 1980 only two summers had more warmer days. This year (1993) the Tanana River in Nenana 'broke up' April 23. That's the second earliest since 1917. We also had an incredible warm spell in May and June, producing one of the warmest spring-earliest summer periods on record. We set a few daily record-high temperatures. Spring 1993 was generally one of our warmest in the 20th century and may have set the stage for a rare tree seed crop at timberline, possible insect outbreaks, etc."

These conversations emphasize the fact that human memory alone is not a reliable guide to climate. A written record of instrument-based temperatures measured in the same way at the same place going back as far as possible is better. Unfortunately, almost all our official local weather stations have breaks in record keeping and recording instruments were moved from original locations to new sites with distinctively different microclimates. Most of the current weather stations began recording at their present locations in the late 1940s and early 1950s.

The University of Alaska Fairbanks, Agricultural and Forestry Experiment Station is the site of the oldest, continuously active weather station in the Interior. The National Weather Service lists it as the "University Experiment Station (UES)." At the UES, which was moved slightly twice (but with no noticeable effect), records have only slight breaks in continuity since 1906.

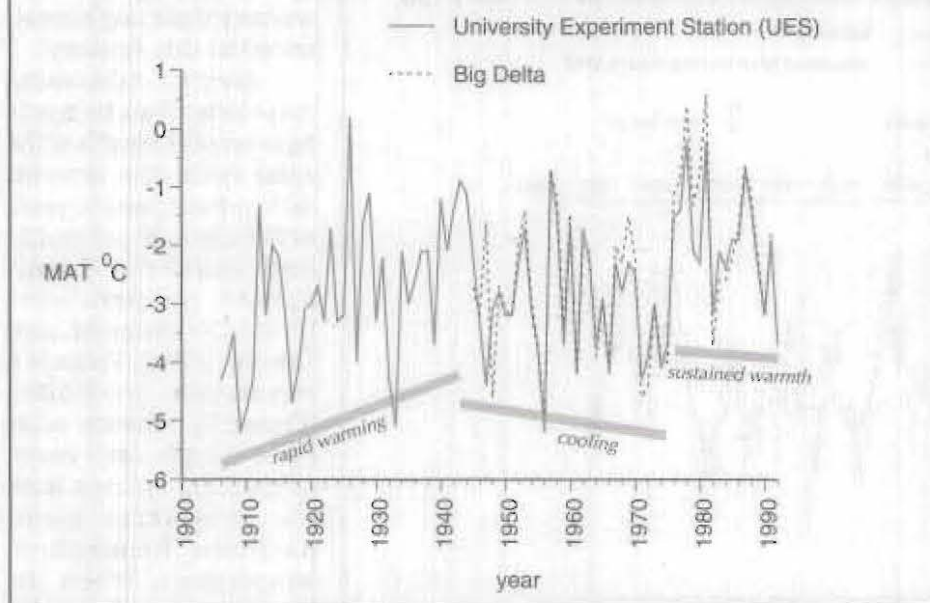
The manager of the experiment farm records weather data at UES under a cooperative reporting system with the NWS. The experiment farm fields provide a buffer from the urban "heat island." A heat island is caused when buildings and vehicles release waste heat, usually a significant influence on Alaska temperature records (Bowling and Benson, 1978). What does the UES temperature record show and is it representative of Interior Alaska?

Mean annual temperature (MAT) is the mean of the mean of the daily high and low temperature. Figure 1 shows that the UES and Big Delta MAT records are similar and track each other for the years that they overlap. This information tends to confirm that the changes recorded at UES represent and reflect changes across Interior Alaska. It also shows three trends in the UES MAT record.

Mean annual temperature at UES warmed rapidly until 1941, cooled significantly from the mid-1940s to 1975, and experienced a complete reversal, warming to previous high levels or warmer from 1976 to the present. These trends correspond to the overall temperature trends of the northern hemisphere (Hansen and Lebedeff, 1987 and 1988).

Figure 2 shows that overall, even allowing for the

Figure 1. MEAN ANNUAL TEMPERATURE IN INTERIOR ALASKA



cooling period, UES MAT warmed 1.25°C (2.25°F) during the 20th century. This warming rate is above the northern hemisphere average. By way of comparison, recent computer model estimates of the warming that would happen with a doubling of carbon dioxide in the atmosphere are less than 2°C (Mitchell, et al., 1989). The UES record is consistent with—but doesn't prove—the prediction that global warming will appear first and be of greatest magnitude at Alaska's latitude. However this simple view doesn't account for all the various, natural-background influences that could have produced the warming.

A smoothing treatment can be applied to series data to highlight trends. Figure 3 shows smoothed UES temperatures, in this case a five-year running mean, compared to the untransformed data. Regular cycles of warming and cooling are obvious, with the cycles' peaks and troughs about eight-to-14-years apart. The peaks and troughs are produced by the extreme high or extreme low untransformed MAT values as well as the uninterrupted duration of even moderately high or low MAT.

I previously noted the cycling behavior in Alaska's temperatures and hypothesized it's relation to the 11-year solar sunspot cycle. "... Assuming that the next cycle conforms to the model 11-year behavior, (the) hypothesis would

then predict that the true direction of Alaska MAT trend would be downward to the mid-'80s, and that MAT would peak again in the early-'90s." (Juday, 1984).

At this point it might be wise to consider a well-known point within the meteorological community. "The history of meteorology is littered with whitened bones of claims to have demonstrated the existence of reliable cycles in the weather." (Burroughs, 1992).

Fortunately, good correlations have recently been found between the solar cycle and northern hemisphere surface air temperature. The relationship was unclear in the past because the northern hemisphere air temperature record

has to be corrected for the biennial change in the direction of upper atmospheric winds near the equator (van Loon and Labitzke, 1988). The solar cycle also correlates well with the amount of warming or cooling of the global average sea surface temperature (Reid, 1991). With these and several other correlations now firmly established, it's interesting to check for a correlation in the updated UES record.

Figure 4 shows the match between the solar cycle (mean monthly sunspot number) and UES MAT. The correlation of the two is fairly good, especially in solar cycles 19 through 21. The warmest years of UES temperature generally fall on solar cycle

Figure 2. UNIVERSITY EXPERIMENT STATION
Rate of Warming of Mean Annual Temperature (MAT)
[linear regression]: $\text{MAT in } ^{\circ}\text{C} = (.0126) (\text{year}) - 27.2$

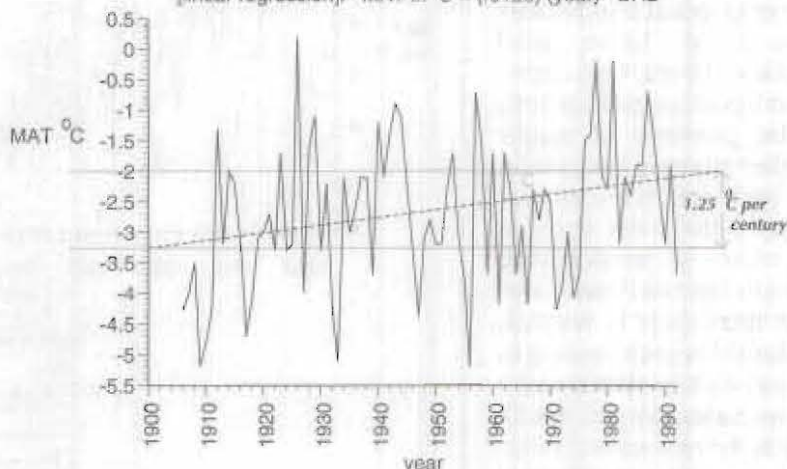
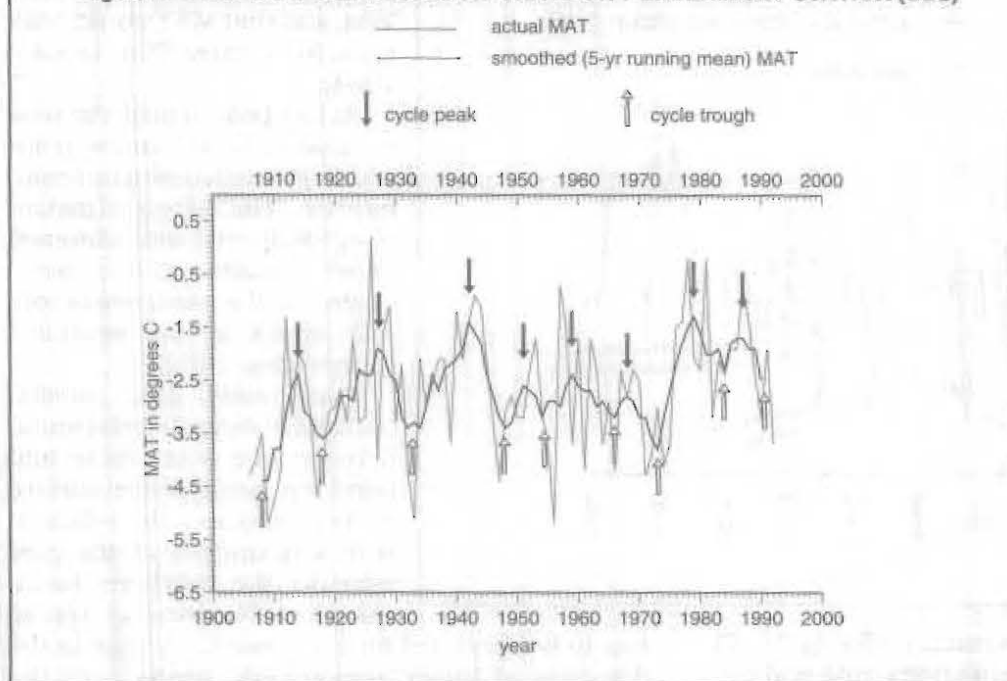


Figure 3. TEMPERATURE CYCLES AT UNIVERSITY EXPERIMENT STATION (UES)



peaks and the coldest years between the peaks generally fall near solar cycle troughs, although some misalignment is present. The predicted cooling of the mid-1980s took place and warming in the late-1980s occurred at the time of the (earlier than expected) solar cycle peak.

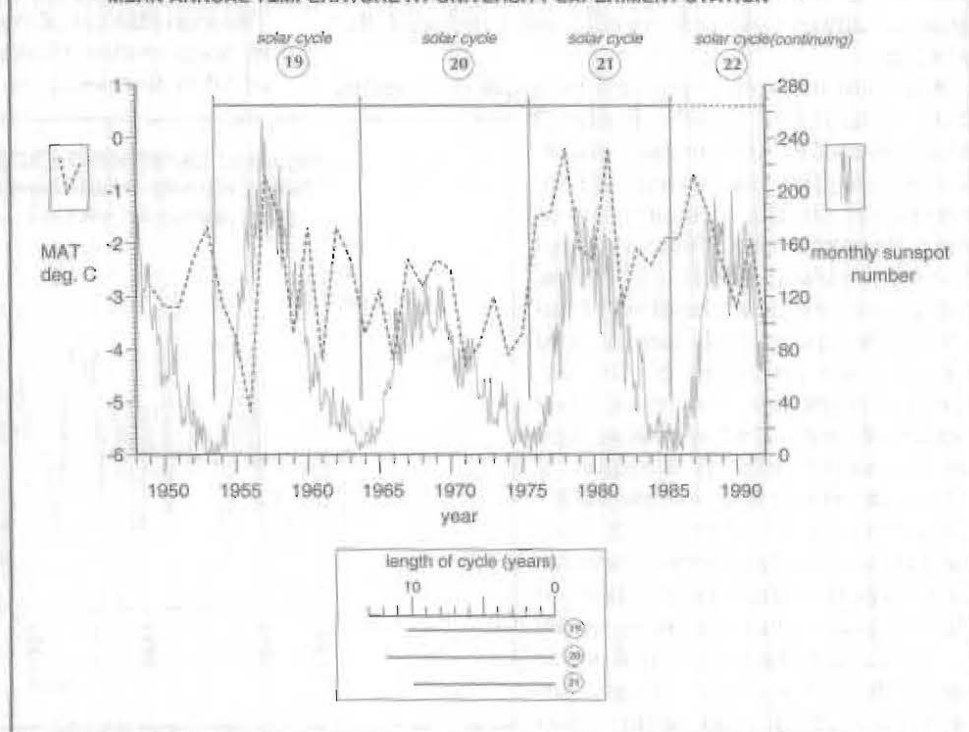
Solar energy flux (the amount of energy given off by the sun) correlates well with January and February temperatures in McGrath, Alaska but the correlation only holds about every other year during times the upper atmosphere tropical winds blew west (van Loon and Labitzke, 1988). This correlation fits an overall pattern of the position of major weather steering systems in the northern hemisphere. Again, if the solar cycle is the cause of temperature cycles in Interior Alaska and if the next cycle is normal, we should expect cooling in the mid-to-late 1990s and a new warm temperature peak early in the new millennium. If the apparent underlying warming trend continues,

and when the time between cycles is longer than 10.5 years the temperature is colder than normal. Using this guide, solar cycle 20 should have produced a cooling at UES, and cycle 21 should have produced warming. UES temperatures generally

this next peak should produce temperatures warmer than any experienced in this century.

Another interesting correlation can be made between the length of the solar cycle (the amount of time from peak to peak or from trough to trough) and northern hemisphere temperatures (Friis-Christensen and Lassen, 1991). There is a remarkable correlation (Figure 5) between solar cycle length and warm or cold departures from the long-term mean northern hemisphere temperature. When the time between solar cycles is shorter than 10.5 years the temperature is warmer than normal,

Figure 4. CORRELATION OF SOLAR CYCLE AND MEAN ANNUAL TEMPERATURE AT UNIVERSITY EXPERIMENT STATION



behaved as the cycle length predicts (Figure 4).

The actual way that solar cycling controls earth temperatures, if it actually does, is not known. Sunspot number or cycle length is a proxy record of some fundamental underlying change in the sun or possibly the earth's atmosphere. Reid (1991) claims that some changes in sea surface temperatures are due to changes in solar luminosity (amount of energy given off by the sun) during the solar cycle, and perhaps continuing changes in solar luminosity building up from cycle to cycle. Another theory is that changes in the solar wind throughout a solar cycle change the chemistry and physics of the upper atmosphere in a way that could amplify the changes in solar energy flux (Tinsley and Heelis, in press).

Scientists don't think solar cycle changes cause all variations in global temperatures. Another prominent cause of short-term climate change is the periodic movement of warm water into the

tropical east Pacific, better known as El Nino.

Alaska, because of its location at the northern margin of the vast Pacific basin, is positioned to receive pulses of warm air that move up from the central Pacific during El Nino episodes. Strong effects of the 1983 and 1987 El Ninos are particularly noticeable in the UES record. Climatologist

Jim Hansen actually forecasted the dramatic cooling of 1992 (same effect noted by John Q. Public at the beginning of this article) as an effect of the June 1991 eruption of Mount Pinatubo in the Philippines (Kerr, 1993). But the computer model that proved correct in predicting the cooling from Mount Pinatubo is also used to model warming of the earth from greenhouse gasses.

Does the new and rapidly emerging insight into cycles of warming and cooling in Interior Alaska relate to anything significant in Alaska resources? Figure 6 shows the correlation between

Figure 5. RELATIONSHIP OF SOLAR CYCLE LENGTH AND NORTHERN HEMISPHERE TEMPERATURE ANOMALIES

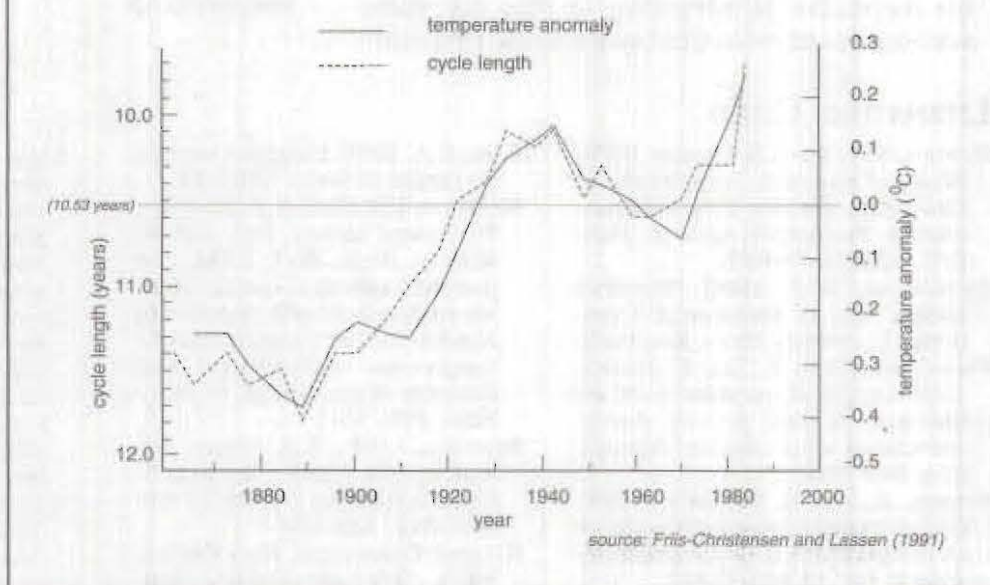
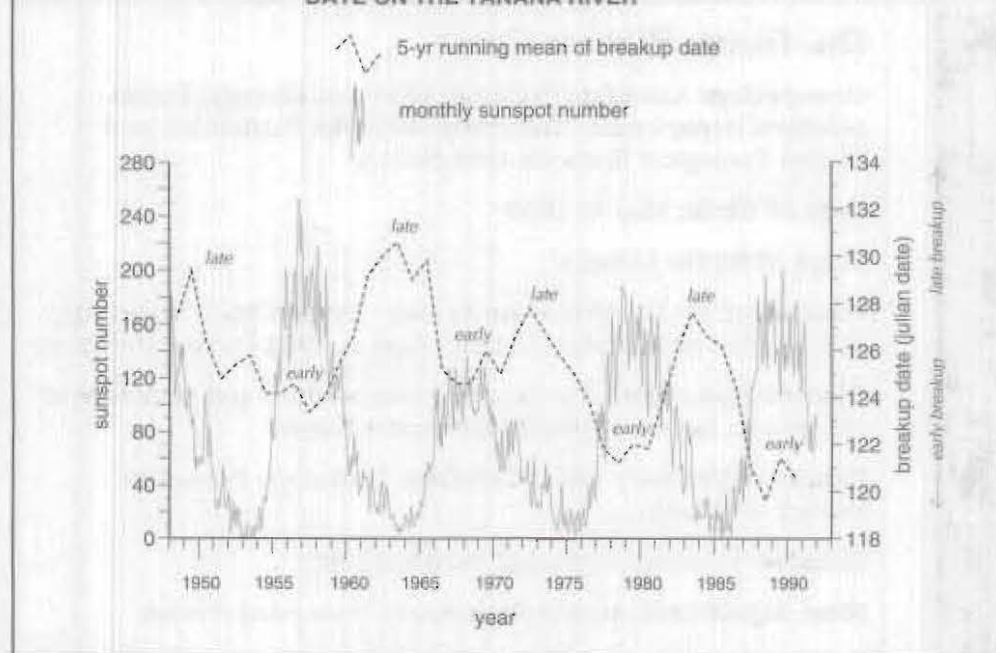


Figure 6. RELATIONSHIP OF SOLAR CYCLE AND BREAKUP DATE ON THE TANANA RIVER



the solar cycle and smoothed values of spring ice breakup dates on the Tanana River at Nenana, the subject of a lottery since 1917. Even though the correlation is intriguing, as they say, there are no guarantees in this business. Setting aside

solar cycles and volcanoes, the UES record may still contain some human-caused greenhouse warming or it may not. But that is a gamble everybody is involved in. □

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DR. GLENN PATRICK JUDAY

Occupation: Associate Professor of Forest Ecology, Forest Sciences Department, University of Alaska Fairbanks; and Alaska Ecological Reserves Coordinator

Date of Birth: May 4, 1950

Place of Birth: Indiana

Education: Ph.D. 1976, Plant Ecology, Oregon State University; B.S. summa cum laude, Phi Beta Kappa, 1972 Purdue University

Dissertation topic: The location, composition and structure of old-growth forests of the Oregon Coast Range

Family: **Wife:** Mary Beth; **Children:** Christine, Benjamin, Patrick and Colin

Hobbies: Reading, exploring, conversation

Most Significant Accomplishment: Time compression

Farewell Dr. Kirts

By: J. Stephen Lay
CITU Manager

Good-bye Professor Kirts. We'll miss you. Hello Dean Carla Kirts. Congratulations on your promotion as the new dean of student services. You earned it. You're great with students. The University of Alaska Fairbanks is better thanks to your contributions and active pro-student enthusiasm.

You assumed the position in 1981 as assistant professor of agricultural education. In the classroom, we remember you for challenging us and making us think, not just allowing us to mindlessly memorize facts and figures.

But then you wouldn't let us off easy. Oh no! You made us use it. Resource allocation sounds like a nice bureaucratic concept in a lecture. But for those of us who sat in the back of the room the day the M&M's got passed around, it quickly became real. At least some of us know it's real. Those full-cheeked M&M munchers in the first row may not yet understand, but most of us do.

Of course you gave them another chance when we played the Commons Game. Again you threw us into our own education. We didn't just discuss the environment versus personal benefit. Playing

the game, we balanced our own personal benefit against the environment. And while we now know there were no winners or losers in the game, some of our personal beliefs did win. Others lost. In the end, we learned "there's no such thing as a free lunch." Guess where we heard that one? And people don't al-

ways act on their ideals particularly when their personal benefit is at stake. That's a lesson we'll apply the rest of our lives.

Being a professor is so much more than teaching although you've earned several outstanding teaching awards including your most recent success earning the Carol Feist Award for outstanding undergraduate advising.

With you, being a professor certainly wasn't 9 a.m. to 5 p.m. employment. How many Labor Day vacations have you missed because you spent the day advising students and flipping burgers?

We did have to share you with the faculty. That faculty who relied on you for facts and advice regarding the curriculum and effective teaching methods. The faculty who rely on you and your summer to meet the deadline of a new core curriculum. The faculty who will forever benefit from your example of a professor as a teacher.

Again congratulations. But, still, in SALRM we'll miss you. Thank you and good luck. □

Drs. Carla Kirts and Jay McKendrick co-taught a course, Boreal and Tundra Rangelands during the fall of 1990. This course included an excursion from Fairbanks to Prudhoe Bay. In this photo Dr. Kirts (third from the right) poses with her class. (AFES photo)



Dr. Carla Kirts. (Photo by Stephen Lay)



People, activities, accomplishments

DISTINGUISHED TEACHERS

Dr. Jay **McKendrick**, agronomy professor, earned the Distinguished Teaching Award from the National Association of Colleges and Teachers of Agriculture. Dr. McKendrick's innovative and effective teaching techniques while bringing his research results to his students helped earn him this recognition. McKendrick is from Idaho and has been with the School of Agriculture and Land Resources Management for 21 years. He and his wife, Judy, live in Palmer, Alaska.

Dr. Keith **Van Cleve**, professor of forestry, was one of three professors who earned the 1992 Emil Usibelli Distinguished Teaching, Research and Service Awards. Van Cleve, who serves as the forest sciences department head is a native of Seattle, Wash. and has been with UAF since 1967. He and his wife, Margaret, have two daughters.

DISTINGUISHED ADVISERS

Drs. Carla **Kirts** and Meriam **Karlsson** won the Carol Feist Award as recognition by UAF for their work in undergraduate advising. Dr. Karlsson is an associate professor of horticulture. Dr. Kirts recently left SALRM to become the UAF's Dean of Student Services.

APPOINTMENT

Congratulations to Dr. Chien-Lu **Ping**, professor of agronomy, soil scientists, for his selection as a delegate at the 6th International Conference on Permafrost in Beijing, China. The National Academy of Science made the appointment.

EARNING TENURE

The following people recently earned tenure:

- Stephen **Dofing**
- Lyle **Renecker**
- Ruthann **Swanson**
- James **Walworth**

PROFESSORSHIPS

The following were recently promoted to professor:

- Carol **Lewis**
- Chien-Lu **Ping**
- Stephen **Sparrow**

The following were promoted to associate professor:

- Stephen **Dofing**
- Lyle **Renecker**
- Ruthann **Swanson**
- James **Walworth**
- John D. **Fox, Jr.**

PRINTED ABROAD

Dr. Stephen **Sparrow**, agronomy professor, and Mr. Verlan **Cochran**, USDA Agriculture Research Service soil scientist, co-authored an article with Soviet scientist, I.N. **Sharkov**. The article, "Carbon and nitrogen mineralization in soils of different natural zones," was printed in the *Siberian Biological Journal*.

RETIRING

Frank J. **Wooding** retired July 1 and received the rank of professor of agriculture, emeritus.

STUDENT AWARDS

The department faculty nominated and honored the following as Outstanding Student:

- Tim **Hammond**, Dept. of Plant, Animal and Soil Sciences
- Teresa **Dunham**, Dept. of Resources Management
- Andrew "Buzz" **Baker**, Dept. of Forest Sciences



KUDOS TO BARBARA PIERSON, STUDENT AFFAIRS COORDINATOR. ACCORDING TO DR. JIM DREW, AFES DIRECTOR, SHE HAS HELPED ALMOST DOUBLE ENROLLMENT IN THE SCHOOL OVER THE PAST FIVE YEARS. (PHOTO BY DONNA GINDLE)

COLLEGE WORK STUDY

Bruce **Hofer**, from Berea College, Berea, Ky., participated in a college work study program this summer. Hofer worked at the Georgeson Botanical Gardens to gain hands-on experience in managements aspects of subarctic horticulture. The work experience included projects in landscape construction and maintenance and crop production at high latitudes. He also assisted researchers in collecting data on research projects related to domestication of Alaska native wildflowers and berries. (Photo is on top of next page)

People, activities, accomplishments



INTER-TRIBAL YOUTH PRACTICUM

Forty-four students from throughout the state participated in the Alaska Inter-Tribal Youth Practicum this summer. The practicum, a five-day training camp, exposed Alaska Native youth to the challenges of managing resources, economic development, culture, preservation and career opportunities.

The goals and objectives of the program are for students to develop an understanding of natural resource implications and related concerns of Native and tribal government; acquaint participants with the methods, uses and traditions practiced by Natives for managing natural resources; expose Native youth to natural resources management activities, disciplines and career opportunities; acquaint Native youth to the educational processes and academic requirements for a degree in natural

resource disciplines; develop leadership, communication and problem-solving skills and experience a variety of Alaska Native cultures.

The School of Agriculture and Land Resources Management joined the Tanana Chiefs Conference and the United States Forest Service in offering this practicum. Qualified students earned one college credit in natural resources management.

OPPORTUNITIES

The School of Agriculture and Land Resources Management participates in a two youth programs: the summer youth employment program and the Resource Apprenticeship Program for Students (RAPS).

The summer youth employment program is the combined result of SALRM and the Private Industry Council teaming together to employ local high school students. These students work 35 hours per week in a variety of ag-related jobs, such as landscape construction, planting, maintenance, data collection and setting up research projects. Students employed under this program during the summer of 1993 are: Robert Shields, John Hardy, Faith Speakman and Matthew Bottorff.

The RAPS, a joint venture with the Bureau of Land Management, introduces rural students to applications of resources management. It allows them to get actual work experience. Students involved in this program are paid by BLM. 1993 RAPS participants included: Andrea Dick, Gloria Beetus, (both pictured below, left to right) Jeff Huntington and Gerry Northway.



People, activities, accomplishments



① Rodilyn "Lyn" Bundy (top left), USDA, analyzes gas samples for carbon dioxide, nitrous oxide and methane at the Delta Farm. (Photo by Donna Gindle)



②③ Bill Saari, USDA, collects gas samples on the long-term tillage study on the Delta Farm. (Photo by Donna Gindle)

④ Dr. Chien-Lu Ping gets into his work at the Usibelli Coal Mine, Inc. (Photo by Stephen Lay)

⑤ Tracey Papenfuss, student assistant, does a legume population count for the Delta Bison Project. (Photo by Donna Gindle)

1934 grad leaves a trail

by: Donna Gindle
Editor

Joseph Flakne's business card deviates from the norm. But then, so does Joseph Flakne. His card is headlined with, "Joe Flakne's two statements of fact." Those statements are:

"Sure God created man before woman, but then you always make a rough draft before the final masterpiece," and

"A woman must do twice as much as a man to be considered half as good, fortunately it isn't difficult."

While not the usual business card verbiage, it is essentially a testimony to one of the two major issues Flakne has devoted his life to: women's rights. The other issue is conservation.

Flakne, spent some time recently walking down memory lane when he revisited the University of Alaska Fairbanks to receive an honorary doctorate of law degree July 21.

At 93, his mind is razor sharp. A vibrant younger version of Joseph slips out easily when he has a listening audience. He charms and endears as he narrates one adventure after another.

He came to Alaska to attend college in 1929. Flakne earned his tuition by working for the U.S. Biological Survey, monitoring the condition of reindeer, caribou, mountain sheep and buffalo and managing the agricultural farm. After graduating in 1934 he was hired as a district agricultural agent for the colonization of the Matanuska Valley. As an agent he helped colonists from Michigan, Minnesota and Wisconsin settle into the valley. During World War II Flakne served as Alaska Specialist for the War Manpower Commission, working with the construction of the ALCAN Highway. From there he was transferred to Washington D.C. where he lobbied for Alaska statehood.

"My mother always said, 'be a good boy and the good Lord will take care of you.' I guess she was right because He sure has. I have had such a wonderful life," Flakne said.

But, what he doesn't say is that his life has been filled with causes that have resulted in increased value in the lives of many.

In an awards nomination package the Northern Virginia Soil and Water Conservation Dis-



Joseph Flakne. (UAF photo by Cal White)

trict submitted on Flakne, the district wrote, "Since retiring to Fairfax County in 1964 Joe Flakne has been a tireless force for conservation and preservation of the natural beauty and recreational opportunities in Northern Virginia.

"...Mason Neck is the area closest to the nation's capital where bald eagles nest. In 1965 this area was seriously threatened by plans for immediate commercial and residential development. Joe instantly immersed himself in battle. Perhaps this is the place he earned one of his many nicknames: 'Wilderness Warrior'."

Flakne is also involved with various youth organizations in his adopted hometown of Virginia. The conservation district's nomination package described some of the activities. In it, they wrote that Flakne told a youth group, "I am yesterday. You, the young people, are the hope for our tomorrow. What you learn now about the conservation of our natural resources will shape the future of our land."

But even referring to himself as "yesterday" Flakne has no thought of slowing down. His one bit of chagrin seems to be that his body has succumbed to that inevitable process called aging.

"Getting old is no fun, sometimes. I just don't know why my body had to get so old on me," he said as he tried to keep pace with a group half or a third his age during a tour of the Agricultural and Forestry Experiment Station. And while he did tire, he did not quit.

Flakne likes inspirational quotes and it seems appropriate to finish with a quote he has on his wall in his Virginia home:

"Do not follow where the path may lead...Go where there is no path and leave a trail."

Database management

We primarily completed software development on a prototype computer database management system. We will fine tune the system to create a user-friendly environment while providing options required by various game farm management systems. We are now compiling a user manual for the software.

•Darrell Blodgett and Lyle Renecker

Reindeer weights

From 1988 to 1992, we weighed the body and the velvet antler from known-age, free-ranging reindeer owned by Mr. Lawrence Davis of Nome. We used analysis of variance (ANOVA) to compare body and velvet antler weights with age and sex of reindeer.

In adult reindeer, body weight varied significantly ($P = 0.003$) between sexes. Mature cows weighed approximately two-thirds as much as bulls. Cows approached mature body weight earlier than bulls.

Yearling bulls and cows weighed 55 and 75% as much as four-year-old bulls and cows, respectively. Bull weights peaked at age four (121 kilograms) while cows continued to slowly, but steadily, increase in weight up to age eight.

Velvet antler weight varied significantly ($P = 0.0004$) between sexes. Mature cows produced approximately 20% as much product as mature bulls. Production from bulls peaked at age four (3.1 kilograms) while velvet antler production from cows slowly, but steadily, increased up to seven years of age. No antler weight data is available for older bulls since they are normally slaughtered or castrated when they are four to five years old.

•Darrell Blodgett, Heather McIntyre, Lyle Renecker and Robert Dieterich

Aleutian shield fern's reproduction

Research was begun in 1989 to germinate spores and establish greenhouse populations of the endangered Aleutian shield fern. We successfully grew sporophytes in vitro and transferred them to greenhouse culture. Plants continue to grow well in the greenhouse environment, but no mature sporophytes have developed. The restricted-use insecticide, Temik®, causes significant phytotoxicity on this species. Sample populations of *Polystichum aleuticum*, *P. lachenense*, *P. acrostichoides* have been established in the green-

house for future work in isozyme analysis and comparative gametophyte development. Experiments are progressing on pH effects on growth of sporophytes, effects of temperature on spore germination, and effects of spore shape on germination.

•David Boyd and Patricia Holloway

Manage cattle, maximize forage

This study seeks to maximize use of Alaskan forage for beef cattle through alternative management, to manage cattle on a fall calving scheme and to compare animal survival, health, and economic considerations with traditional spring calving methods.

The beef cattle (Angus x Hereford) at Palmer were bred in April and May so they would calve in late February and March. Through the winter these cows were often overfed because of their efficient usage of feedstuffs. The herd was shifted to fall-calving (August).

Fall-calving cows begin their maximum lactation, requiring the most energy, in August. They are in excellent condition from being on pasture and lactate during the winter to take full advantage of the nutrients in the harvested forage. The first fall calves, a 100% calf crop, were born in August 1991. Calves were weaned before going to pasture and grazed the duration of the summer. In early October they were placed in the feedlot and were ready for slaughter in December and January. This saved about 50% on grain from spring calving. The free choice hay intake by beef cows for fall and spring calving is 2.5% of body weight, but fall calving cows use winter forage more efficiently because they are also providing for calves and were not in over-condition for spring grazing.

•Leroy Bruce

Persistent herbicides

Studies in three previous years have indicated the efficacy of two chemical herbicides, linuron and metribuzin, in controlling weeds in potato fields. Linuron proved to be the least troublesome of the two, with respect to residues phytotoxic to vegetables grown in rotation with potatoes. In 1992, blends of linuron plus metribuzin, applied individually or as tank mixes were tested for efficacy and residue. Weeds were minimal in 1992, making it impossible to assess efficacy. Residue tests are progressing and the entire study will be repeated in 1993.

•Donald Carling

Potato variety comparisons

Alaska's 1992 potato production, primarily in the Matanuska Valley, was above average and similar

to 1991. Soil moisture was low early in the season; average rainfall in May, June and July sustained plants but wasn't sufficient to optimize growth. Rainfall was below average in August and probably contributed to reduced yields in the nonirrigated trials. Overall yield of US #1 tubers across 45 varieties in irrigated plots was 15.3 tons an acre, whereas in nonirrigated trials the US #1 tuber yield was 9.6 tons per acre.

Total tuber yield was 19.3 tons and 12.3 tons an acre in irrigated and nonirrigated trials, respectively. The percent of tubers in the US #1 category was 79.3 and 78 in irrigated and nonirrigated trials, respectively. These percentages are somewhat lower than in 1991.

Top-yielding cultivars in the irrigated trials included IditaRed, Red Warba, Nipigon and Kennebec, whereas Gold Coin, Kennebec, Green Mountain and Red Warba topped the nonirrigated trials.

One unusual aspect of the 1992 season was a very cold September. The average daily mean air temperature in September was approximately 4°F lower than a 57-year average. This temperature made harvesting difficult.

•Donald Carling

Soil acids may control potato scabs

In 1992 we began on-farm research to evaluate controlling potatoes' common scab by acidification of affected soils through applying elemental sulfur. The initial phase, reducing soil pH by transforming microbes of elemental sulfur to the more oxidized sulfate form, will take at least one year. In subsequent years, potato varieties with varying degrees of susceptibility to common scab will be grown in treated and untreated soils to evaluate the effectiveness of the acid treatment.

•Donald Carling and James Walworth

3-Methylhistidine excretion

Five adult female reindeer (*Rangifer tarandus*) were injected with ¹⁴C-labeled N-Methylhistidine (N-MH) to evaluate the quantitative excretion of N-MH in urine. Less than 70% of the label was recovered after five to seven days.

Renal handling of N-MH demonstrated that urine flow influences N-MH excretion. Animals with high urine flow excreted larger amounts of N-MH and had significantly lower serum levels of N-MH. Additionally, nutrition appears to affect N-MH excretion, possibly because of the effect of nutritional status on water flux.

As demonstrated in several other species, reindeer appear to metabolize N-MH. Labeled N-MH is

removed from serum faster than can be accounted for by excretion in urine. What happens to the metabolized N-MH wasn't determined, but labeled metabolites were detected in urine.

These results indicate that urinary excretion of N-MH won't reliably measure protein degradation in reindeer.

•Ray Case, Lyle Renecker and Robert Hudson

Reindeer body composition changes

Increased urinary excretion of urea nitrogen has been documented in severely undernourished wild ruminants including white-tailed deer (*Odocoileus virginianus*), moose (*Alces alces*), and wapiti (*Cervus elaphus*). This study investigated the applicability and sensitivity of this indicator in reindeer (*Rangifer tarandus*).

Six adult female reindeer were placed on each a high and low protein diet from November to May. Declines in creatinine excretion and changes in body composition based on tritiated water space (TOH), indicated that striated muscle mass declined in animals fed a low protein diet. This catabolism of striated muscle did not result in increased urinary excretion of urea filtered at the glomerulus than those fed a high protein diet.

Renal handling of urea was evaluated using the renal clearance technique. Animals on the low protein diet reabsorbed a significantly higher portion of urea filtered at the glomerulus than those fed a high protein diet.

These results indicate that, in early stages of under-nutrition, reindeer efficiently use endogenous protein reserves, such as striated muscle, and that urinary excretion is a poor indicator of early under-nutrition in reindeer.

•Ray Case, Lyle Renecker and Robert Hudson

Radio-collaring neonate reindeer

In 1991, a neonatal reindeer survival study was implemented on a commercial herd on Seward Peninsula. Two researchers, driving snowmobiles, located groups of parturient cows and recent births. When they viewed cow and calf pairs the researchers approached, pushing the group upslope. The neonate, unable to keep up, assumed a submissive posture enabling capture. During this time, the cow moved approximately 25 meters and milled.

Contact between the handlers and neonate was minimal. The neonate was sexed, weighed, and radio-collared. The weighing apparatus was a sterile, simple loop, gloves were used throughout the process, and radio-collars were sterile.

After the procedure, the crew quickly left. A

subsequent, intensive schedule of tracking flights confirmed bonding and calf survival. In 1991, seven out of 52 (13%) neonates died within 48 hours of collaring, one was abandoned. In 1992, five out of 41 (12%) neonates died within 48 hours of collaring and three were abandoned. There were no significant differences in weight, age, and sex of abandoned calves versus non-abandoned calves.

During the two years of this study, careful attention to sterile procedures, rapid processing of animals, and minimal handling likely reduced mortality, due to abandonment. This procedure should be followed when radio-collaring neonates.

•Cheryl-Lesley Chetkiewicz, Lyle Renecker and Greg Finstad

Studying reindeer calf mortality

Predation of calves in a Seward Peninsula commercial reindeer herd is purportedly high and may limit population growth. Consequently, we determined proximate perinatal (before the calf is 48 hour old) and postnatal (after the calf is 48 hours old) calf survival by tracking and observing 51 and 38 radio-collared calves in 1991 and 1992 respectively.

In 1991, perinatal mortality was 12% (n=6). Predation by foxes (*Vulpes vulpes*) (8%), and wolverine (*Gulo gulo*) (2%) were the major cause of death during perinatal (10%). Forty-two percent (n=19) of the calves died during postnatal, and causes of mortality, besides predation by grizzly bears (*Ursus arctos*) (7%), and foxes (2%), included disease (2%), drowning (2%), and unknown causes (29%).

In 1992, perinatal mortality was 5% (n=2). Predation was not a major cause of death that year. Again, 42% of the calves died during the postnatal period and causes of mortality included grizzly predation (19%), disease (6%), drowning (3%) and unknown causes (11%). It was speculated that two of the 1992 bear kills occurred because calves were injured after handling.

The average overall survival rate for 1991 and 1992 was 52% \pm 7%. We conclude that predation does not appear to be an important cause of mortality for reindeer calves. Effective herding and reindeer surveillance during calving could reduce the potential interactions between predators and prey. Injuries incurred during handlings could be reduced with attention to herding protocol and corral condition.

•Cheryl-Lesley Chetkiewicz and Lyle Renecker

Productivity in farmed reindeer

In this study, we examined five aspects of productivity, drawing on experiences from a number of herds and studies with reindeer on the Seward

Peninsula. The aspects include breeding programs and herd structure; predation factors; forage and range conditions; handling stress; and parasites and diseases.

Management decisions for enhancing animal productivity can't be made without adequate research and application. The five factors must be explored and a solution applied, to meet changing needs and goals of the herders and industry. Evaluating these factors allows herders to predict the impact of management decisions on both annual and long-term income and ensure a viable and sustainable future.

•Cheryl-Lesley Chetkiewicz, Lyle Renecker, Robert Dieterich and William Thompson

Monitoring wetsoils

This study establishes baseline data for the depth and period of saturation, redox potential and soil temperature of seasonal frost and permafrost soils, and soil water potentials of soils with seasonal frost. The data are expected to provide information leading to growing season and hydric soil criteria in Alaska; redoximorphic features and aquic conditions; and effect of global change on soil temperature and soil moisture regimes.

The monitoring sites include three soils in Delta Junction, three soils in Fairbanks and five soils in the Mat-Su Valley. We used soil temperature probe, soil water tensiometer, TDR probes, piezometer, and pt-electrode (redox potential). Cryogenic structures of permafrost soils were studied, using a permafrost auger. Dynamics of the active layer of permafrost soils were studied by using permafrost probes. In 1993 we will compile the data and report it to the user groups.

•Mark Clark, Chien-Lu Ping and Yuri Shur

Greenhouse gas flux

We are conducting cooperative studies to determine the amounts of nitrous oxide produced and the amount of methane consumed in grassland soils with and without the use of nitrogen (N) fertilizer. Three locations, Fairbanks, Alaska; Ft. Collins, Colo.; and Mayaguez, Puerto Rico, are being used to represent climatic conditions of the tropics, mid-latitudes and the subarctic.

At Fairbanks, two sites are being used. One site has no history of N fertilization, while the other site has received annual applications of urea at rates of 90 kilograms N per ha (hectare) for 10 or more years.

The results from the first season indicate that urea (90 kilograms N/ha) increases nitrous oxide efflux over the control for about 30 days, more than doubling the total amount evolved over the summer.

However, this is less than 0.1 % of the nitrogen applied and is in the range of that observed at more southerly locations. Urea applications reduced methane consumption for less than two weeks at the site with no fertilizer history. At the site with a history of nitrogen fertilization, methane consumption was inhibited for less than a week, followed by a short period of increased consumption. In both cases the urea application did not significantly change the total consumption over the summer. The site with no history of nitrogen fertilization consumed more methane throughout the summer than did the site which had been fertilized for more than 10 years. The non-fertilized site was warmer and drier than the fertilized site. Warmer soils increase microbial consumption of methane and drier soils hasten the diffusion of gases into the soil allowing more methane to reach the active microorganisms. Therefore, we attribute the greater consumption of methane at the non-fertilized site to more favorable physical conditions and not necessarily to its fertilization history.

•Verlan Cochran, Sharon Schlentner and Arvin Mosier

Nitrous oxide and methane flux

Summer fallow, green manure crops, and mineral nitrogen can all increase the availability of nitrogen to crops. These practices involve different processes in the soil and may influence the flux of nitrous oxide and methane. We conducted a study near Delta Junction during summer 1992 to compare nitrous oxide and methane flux in a barley field after summer fallow, fababeen green manure crop, fababeen forage crop, and barley crop. All treatments were split with one-half the area receiving urea at 80 kilograms N/ha and the other half no nitrogen. The previous crop had no effect on methane consumption. However, when we added urea to the plots that received green manure, methane consumption was reduced. Urea did not affect the consumption of methane in the other treatments. Cropping history had little effect on nitrous oxide efflux in the absence of applied urea. Where urea was applied, nitrous oxide efflux was in the following order: barley > green manure > forage crop > summer fallow. The cause of this order of nitrous oxide efflux appears to be related to the amount of available carbon in the soil at the time of urea application as a result of the past crop. Denitrification is a major source of nitrous oxide and the greater the supply of available carbon the greater the potential for denitrification.

•Verlan Cochran, Sharon Schlentner and Steve Sparrow

Herbicide degradation

Subarctic agriculture soils are frozen for six or seven months each year. Soil temperatures may occasionally reach 80°F at the soil surface in summer but at 15 centimeters depth, temperatures maxima usually range from 50 to 60°F. Most studies of herbicide degradations kinetics have been made at temperatures higher than normally encountered in subarctic soils.

We determined the degradation kinetics of two herbicides—metribuzin and metolachlor—at temperatures typical of the subarctic in summer. We collected soils from zero to six inches and 12 to 18 inches at Fairbanks and Delta Junction. We mixed the soils with metribuzin or metolachlor and incubated them at 40, 57 or 80°F. Samples were obtained periodically and were chemically extracted and herbicide residues quantified using gas chromatography. The metolachlor samples have been analyzed and metribuzin samples analysis is nearly complete. Half lives for metolachlor at 80°F ranged from 72 to 140 days. At 40° half lives ranged from 381 to 685 days. Degradation was faster for soils obtained from 12- to 18-inch depths than from surface soils.

Fairbanks' soils degraded faster than Delta Junction soils. Metolachlor degraded slower with increasing organic carbon levels.

•Jeffery Conn and Jeff Graham

Effects of herbicides, tillings

Herbicides used to control weeds in potatoes can persist and injure cabbage and lettuce planted in the same ground the next year. Tillage methods used before planting lettuce and cabbage could distribute herbicides in different ways and influence the amount of herbicides contacting the plants.

We performed a study to determine the effect of mold board plowing, rototilling or chisel plowing on vertical distribution of metribuzin and linuron. We applied these herbicides at rates normally used to control weeds in potatoes. We then plowed the plots using one of the three tillage methods. After obtaining soil samples at two- to eight-inch depths, we analyzed them for herbicide residues and then planted lettuce and cabbage.

The herbicides were concentrated near the soil surface in plots that were chisel plowed. The complete crop was lost. Herbicides were buried in plots that were mold board plowed and almost no crop loss occurred. Rototilling evenly distributed the herbicides but some crop injury resulted. Overall persistence wasn't affected by tillage systems.

•Jeffery Conn

Leaching potential of herbicides

We investigated the leaching potential of metribuzin and metolachlor in dryland barley and irrigated potatoes at Delta Junction and Fairbanks AFES farm sites. C_{14} -labeled metribuzin was added to the surface of ABS soil columns (10 x 90 centimeters) in the field. These were removed periodically. Soil columns were also removed for conventional extraction and residue analysis.

Analysis of C_{14} metribuzin showed that metribuzin degraded rapidly: 12% left at one month, 2% was left at 16 months. The majority of the metribuzin residue remained in the top seven centimeters: at 12 months 97 and 79% remained in the 6.4 and 3.8% organic carbon soils, respectively. Some metribuzin residues leached to 45 centimeters: 0.1 and 0.3% in the 6.4 and 3.8% soils, respectively. Metochlor samples are awaiting analysis.

•Jeffery Conn, William Koskinen and Jeff Graham

Plant breeding

Eighteen promising F_6 barley families were selected and advanced to the F_7 generation in 1992. The families were, on average, eight days earlier maturing than 'Otal', the earliest-maturing variety grown in Alaska and Canada. The barley variety 'Albright' was released jointly with Agriculture Canada. Albright is approximately 7% higher yielding than Otal but about two days later maturing.



Dr. Jeffery Conn, USDA-ARS scientist, plants potatoes needed for research. (Photo by Scott Penwell)

One research study showed that the superior northern adaptation of barley relative to wheat was due to its more rapid grain fill and maturation, rather than earlier flowering. A second study found that significant genetic variation exists for rate of grain fill in northern-adapted barley cultivars.

•Stephen Dofing, Charles Knight and Steve Blake

Portable reindeer crush design

In Alaska, reindeer are managed under both free-ranging and farm conditions. In both types of management, there is a need to efficiently and safely restrain the animal to harvest velvet antlers, provide routine health care, and to monitor weight gain.

A pneumatic crush for red deer, manufactured in New Zealand, has been used in Alaska to restrain reindeer. However, this crush is both expensive and cumbersome to transport. We designed a lightweight, portable reindeer crush built with materials that are readily available and can be assembled in eight to 12 hours with minimal welding and construction skills.

•Greg Finstad and Lyle Renecker

Handling reindeer

In June 1992 reindeer researchers monitored the incidence of, and vaccinated Seward Peninsula reindeer against, brucellosis (*Brucella suis biovar IV*). Data and samples were also collected from each herd for demographic records and other ongoing research projects.

•Greg Finstad and Lyle Renecker

Cultivar row spacing

Cultivar selection and management may affect production and storage qualities of storage cabbage. Two storage cabbage cultivars, 'Custodian' and 'Survivor' were grown with in-row spacings of 11, 14, and 16 inches. An early, hard frost terminated growth unusually early, consequently reducing crop yield. Marketable heads were produced only by Survivor at the 16-inch spacing.

•Raymond Gavlak and James Walworth

Usibelli vegetation studies

Usibelli Coal Mine, Inc. has funded several vegetation inventory and revegetation studies over the past decade. Their goal is to use the most current knowledge and plant materials to continue improving revegetation of mined sites.

We inventoried vegetation on 6,910 hectares of land in the Hoseanna Creek Basin in Interior Alaska to identify the vegetation types and plant species as



Dr. Dot Helm working at Usibelli Coal Mine. (Photo by Stephen Lay)

well as ecological relationships. We identified 26 vegetation types, ranging from young floodplain stands to mature forests and patterned ground. Topography consisted of relatively flat areas dissected by actively downcutting streams. South-facing slopes were dominated by broadleaf or mixed broadleaf-needleleaf communities. North-facing slopes were dominated by needleleaf forests with ericaceous shrub understories on permafrost soils. Vegetation on upland sites has been affected by frequent fires.

Reclamation planning also requires testing plant species for growth under disturbed conditions. Reclamation goals include stabilizing slopes and establishing self-reproducing communities suitable for postmining land use. Grasses are among the most efficient plants for slope stabilization. Part of the challenge in establishing self-reproducing communities is to reestablish nutrient cycling on nutrient-poor soils.

In 1991 we evaluated grass species on south-facing slopes for cover, nutrient absorption, and decomposition. We monitor nutrient locations of soils, roots, and above ground plant parts of selected species to identify nutrients locations. We will use litter bags containing material from several species to evaluate decomposition of different grasses.

•Dot Helm

Reestablishing woody browse

Objectives of reclamation projects vary on different parts of a disturbed site. Specific objectives may include slope stabilization, wildlife habitat development, and plant species diversification. Achieving these goals depends on careful selection of appropriate plant species and consideration of the biological, chemical, and physical properties of the soils. Seven woody plant species selected for availability, ease of propagation, and suitability for moose habitat were evaluated on four growth media selected for their biological properties.

Plant growth continued to be good after four years on three soils from paper birch-white spruce forest, upland meadow, and lowland meadow sites—but was still poor on the gravel-overburden site. Willows have achieved the best

growth while white spruce is the slowest growing species tested. Outplanted cuttings have grown sufficiently to overcome most competition from bluejoint regenerating from rhizomes. Canopies of neighboring plants expanded so that we can assess species interactions and effects of crown closure on the understory. More than 27 plant species have been included in cover estimates on plots. The most diverse community regenerated from the lowland meadow plots.

This project demonstrated that moose browse can be produced in three years on simulated mining disturbances in Southcentral Alaska.

Grass cultivars Norcoast Bering hairgrass and Nortran tufted hairgrass are still growing well after four years. Nortran reduced bluejoint cover compared with a control. Different seeding rates and ratios altered the plant community composition.

•Dot Helm

Glacial till succession

Mycorrhizal fungi may facilitate succession by helping establish plants on deglaciated land. Fungal species may change as vegetation changes. Mycorrhizae are symbioses between fungi and plants in which the fungi help the plant absorb nutrients. A series of field observations and field and indoor experiments test hypotheses concerning mycorrhizal formation by early colonizing plant species, potential transfer of mycorrhizal fungi to later arriving plants, and differences in mycorrhizal infection levels and types in different successional stages.

Seedlings of all major plant species in the chronosequence at Exit Glacier in Kenai Fjords National Park were found on the most recently disturbed sites. Preliminary analyses indicated that first year seedlings are nonmycorrhizal or are just initiating mycorrhizal development whereas most seedlings in their second or later year have some mycorrhizae.

Nurse-neighbor pairs of plant species that occur naturally during succession were outplanted on recently disturbed sites. Nurse plants were inoculated or uninoculated to evaluate nurse plant effects and to separate mycorrhizal transfer from microsite amelioration effects. Preliminary analysis of some root systems shows ectomycorrhizal infection on some inoculated plants but not all.

Isolated uninoculated plants were also located in several successional stages including the barren, isolated plant, patchy, alder, and poplar. Ectomycorrhizal fungi had colonized some of these plants by the first growing season's end.

•Dot Helm

Evaluating germplasm in the GBG

During the 1992 growing season, we evaluated 18 tree species, 35 shrubs, 197 herbaceous perennial ornamentals, 238 annual flowers, 35 herbs and 156 vegetables in the Georgeson Botanical Garden. We evaluated ornamentals for landscape potential, frost tolerance, and winter hardiness. Vegetables and herbs were screened for suitability in Alaska's home gardens.

•Patricia Holloway and Patricia Wagner

Direct-seeded mixes

We evaluated 12 commercial and experimental annual flower seed mixes for Alaskan gardens. Seed mixes included annual wildflower mixes, garden flower mixes, and mixes blended for specific purposes: fragrance and short stature. Mixes were direct seeded on June 9, and all began to bloom by July 15. Full color did not develop until the first week of August. The most popular mix was Golf Course Mix. It bloomed early, had attractive flower display until frost, and contained several frost tolerant species that continued the color until snowfall. Problems encountered with some mixes included lodging, uneven height, color stratification, late-season color development, poor seed germination of some species, and introduced weed species.

•Patricia Holloway, Patricia Wagner, Grant Matheke, Virginia Gauss and Janet Bradner

Seed germination of Nootka lupine

Nootka lupines, *Lupinus nootkatensis*, have hard seeds and benefit from acid scarification for optimum seed germination. In this experiment we identified the best acid soak treatment for the fastest, most complete germination of lupine seeds. Seeds were scarified in concentrated sulfuric acid for two-minute intervals from zero to 40 minutes. Scarified seeds were sown onto filter paper and germinated at 23°C constant temperature beneath 40-watt fluorescent lights (16-hour photoperiod). Optimum germination occurred when seeds were soaked in acid for 18 minutes or longer. The most rapid germination occurred with the 30-to-40-minute acid treatments. At least 50% of the seeds germinated within 24 hours in these treatments. Total germination was 86 to 100%.

•Patricia Holloway

Protein sources in pig diets

We conducted two studies with 58 (16.3 pounds) pigs to determine the feeding value of three fish

hydrolysates produced by the Bertullo Bio-Proteus Process (an aerobic proteolytic fermentation by a marine yeast, deboned, oil separated and dehydration) from cod processing wastes, whole pollock and halibut steaks. The products were low oil and ash with high protein contents of 73, 79 and 71% crude protein (CP) for cod, halibut, and pollock hydrolysates, respectively. Pigs were allotted to the diets for 28-day feeding period with all-barley diets, to meet National Research Council (88). Hydrolysates were included at 13.2 to 14.6% of diet (weight to weight) and were compared to controls with soybean (47% CP) and herring meal (standard of the fish meal industry). Hydrolysates from the cod waste and halibut steaks had equal growth and feeding value to the other test diets with reduced daily gains of pollock (.73 lbs.) vs. .97, 1.0 and .84 for the soybean, herring and halibut hydrolysate, respectively. The reduced daily gains were related to poorer feed to grain ration (F/G) of 2.2 (lbs./lbs.) for the pollock diet compared to 1.8 for the other three diets. Pollock dry matter (1.7%), pepsin digestibility (91.3%) and lysine (4.8%) contents were reduced and indicated excessive heating.

Equal performance in starter pigs for cod and halibut hydrolysates does not warrant extra value on the market for the Bertullo Process hydrolysates compared to standard fish meals.

•Fredric Husby

Testing reindeer for brucellosis

Researchers helped translocate 122 reindeer from Hagemester Island during November and sampled blood from 269 reindeer. Blood was centrifuged, the serum processed, and card tested for *Brucella suis biovar IV*. All reindeer tested sero negative for this disease.

•Nancy Karidis and Lyle Renecker

Monitoring brucellosis

Researchers monitored the prevalence of *Brucella suis biovar IV* in reindeer herds on the Seward Peninsula. Blood was sampled from 129 reindeer in seven herds. The blood was centrifuged, processed, and serum tested in the laboratory by the card, plate, and rivanol techniques. Of the 129 samples, 10 were found to sero positive with all three tests. Researchers will continue monitoring and vaccinating reindeer herds, ensuring the decline of the disease and limiting its potential threat to humans.

•Nancy Karidis and Lyle Renecker

Reindeer range and productivity

This was the second year National Park Service and UAF reindeer researchers jointly evaluated seasonal reindeer ranges more precisely. In June we participated in the summer handlings within the Beringia International Heritage Park to collect blood and fecal samples for animal serum mineral and food habit analysis. In August, 10 people traveled to three different sites and evaluated the plants available for reindeer. A total of 89 transects (10 plots per transect) were established. Plant composition, percent cover, and biomass were determined. We assessed plant succession in areas that burned in August 1991. We'll input this data into a computer database and then automate it in a Geographical Information System (GIS). The data will be combined with automated topographical and ecosite information from the same areas compiled through cooperative agreements between us and the National Park Service, Soil Conservation Service, and Bureau of Land Management. Further analyses should improve range and animal management decisions.

•Nancy Karidis, Lyle Renecker and Dale Taylor

Primula seedling development

Efforts are made to accelerate and improve primula plant development by providing supplemental lighting for a limited time during seedling development. Seedlings of *Primula malacoides* 'Prima Carmine Red', *Primula vulgaris* 'Danova Lemon Yellow' and *Primula X polyantha* 'Pacific Giant Red' receive supplemental irradiance from high-pressure sodium lamps for two weeks initiated at germination, 14 days after germination or 28 days after germination. The plants are grown at 16°C, 16 hours photoperiod and except during treatment, 5.8 mol day⁻¹m⁻². The irradiance levels during treatment are 11.5 or 17.3 mol day⁻¹m⁻². There were no significant effects of supplemental irradiance on rate of flowering for *P. malacoides* plants, although the leaf number on the main shoot increased from 22 ± 4 leaves for control plants to 30 ± 3 leaves for plants receiving 17.3 mol day⁻¹m⁻². Flowering of *P. malacoides* plants averaged 100 ± 4 days from germination.

•Meriam Karlsson and Jan Hanscom

Root temperature and flowering

Plants of *Primula malacoides* 'Prima Carmine Red' and *Primula vulgaris* 'Danova Lemon Yellow' are grown for five weeks after transplant in root

growth chambers maintained at 16, 20 or 24°C. Germination and seedling development occurred at 16°C, 16-hour photoperiod and 5.8 mol day⁻¹m⁻². The location for the root growth chambers and the continued plant development after the root temperature treatment is a greenhouse at 16°C and 16 hours at an average 5.8 mol day⁻¹m⁻². Both flower initiation and flowering were first recorded for *P. malacoides* plants grown in the root growth chambers at 16°C. The observed time from transplant to flower initiation was 28 days and to the first open flower 76 ± 5 days for the *P. malacoides* plants grown with 16°C root zone temperature. The number of leaves and shoots of *P. malacoides* plants showed an increasing nonsignificant trend with increasing root temperature.

•Meriam Karlsson and Jan Hanscom

Osmotic primula seed priming

Primula seed germination is often slow and sporadic. Germination improves in many plants when the seed is primed with a solution of polyethylene glycol (PEG). Seeds of *Primula vulgaris* 'Danova Lemon Yellow' and *Primula malacoides* 'Prima Carmine Red' were primed for zero, two, four, or six days in solutions of 320, 360 or 400 grams/liter PEG. The temperature during the priming process were maintained at 16°C. The seeds were rinsed and planted in seed flats and germination rates determined at 12, 16, 20 or 24°C. Seedlings were transplanted four weeks after germination and grown to flower in a greenhouse maintained at 16°C and 16-hour photoperiod.

•Meriam Karlsson and Jeffrey Werner

Gold extraction solutions

Solutions resulting from the hydrometallurgical extraction of gold from ore contain several ions in various concentrations. A project was initiated in collaboration with the UAF Department of Mining and Geological Engineering and Citigold Alaska, Inc. to determine the effects of treated industrial gold extraction solutions on plant growth. The effects of the solutions are determined on fast-growing plants to establish guidelines for large-scale land applications without causing adverse effects on the forest or other vegetation.

•Meriam Karlsson and Michael Nelson

Nitrogen, phosphorus effects

We evaluated the effects of nitrogen (N) and phosphorus (P) fertilization rates on 'Otal' barley yield and rate of maturity near Delta Junction. All combinations of seven rates of N and seven rates of P were applied either in a band in the seed row or broadcast and incorporated prior to seeding. Plant

populations were greatly reduced when band applications of N exceeded 60 pounds per acre. Grain yields showed little response to fertilizer applications greater than 70 pounds N and 40 pounds P_2O_5 per acre.

•Charles Knight

Fertilization rate effects on barley

Nitrogen (N) and phosphorus (P) fertilizer application rates greatly affect the yield and rate of maturity of barley. We grew the varieties of 'Otal,' 'Eero,' and 'Harrington' at Fairbanks and Palmer in 1991 and 1992 and fertilized them with three N rates and two P rates. Tillers per plant were counted weekly, and fully extended heads were tagged daily. Observations included the effects of fertilization rates on number of tillers per plant, date of heading, rate of ripening, success rate of tillers producing mature seed, and yield components (heads per square foot, kernels per head, and kernel weights).

•Charles Knight and Stephen Dofing

Biological control of plant diseases

We evaluated *Trichoderma atroviride* isolates—CHS 861, CHS 901, biotype 603 and biotype 453—for effectiveness in controlling pre-emergence damping off of pea plants caused by *Pythium dissotocum*, *P. oligandrum*, *P. violae*, and *P. ultimum* at 10 and 23°C.

T. atroviride isolates reduced the damping off disease incidence by 22 to 52% at 10°C and by 23 to 62% at 23°C. Although all four isolates can control the disease effectively, certain *T. atroviride* isolates better control particular *Pythium* sp. at certain temperatures. The disease incidence of pea treated with *T. atroviride* isolates wasn't significantly different from fungicide Captan treatment. In the medium uninfested by *Pythium* spp., seed treatment with *T. atroviride* isolates had no significant effect on seed emergence percentage but Captan significantly reduced the seedling emergence percentages, both at 10 and 23°C.

•Chao Chen and Jenifer McBeath

Bacterial ring rot of potatoes

Potato cultivar BakeKing seed pieces were inoculated (10^9 cfu/tuber) with *Clavibacter michiganensis* subsp. *sepedonicus* (CMS), the cause of bacterial ring rot, and planted at Fairbanks. We sampled the plants intensively throughout the growing season. After surface sterilization, samples were cut to sections, weighed, macerated and diluted with 0.05 M phosphate buffer and plated on NCP-88 semiselective medium and nutrient broth yeast medium. We detected CMS in stolons and lower stems 45 days

after planting. The viable CMS ranged from 10^{9-11} cfu/g of stem tissue to 10^{3-6} cfu/g of stolon tissue. After the symptoms appeared in 65–70 days, CMS was detected systemically but it seemed to be confined to stem and stolon. No detectable CMS was found in the mesophyll and roots. Disease development seems to be closely correlated to environmental conditions.

•Ming Di and Jenifer McBeath

Plant disease resistance

Plasmid pUCD620 carrying promoterless *Lux* genes was used to deliver Tn4431 to *P. solanacearum* strain K60 by electroporation. Transformants expressing the *Lux* genes directed by a heterologous promoter of *P. solanacearum* were selected and used to inoculate potato and tobacco plants. For both stem and leaf inoculation, bacteria rapidly moved toward the stem and roots through vascular bundles as detected by x-ray film. However, in *avrD*-transformed tobacco plants, bacterial multiplication was dramatically reduced and their movement was severely suppressed in the vascular tissue.

•Yong Huang, Ming Di, Thomas Keen and Jenifer McBeath

Controlling potato black scurf

Four isolates of a wide spectrum, cold tolerant, mycoparasitic *Trichoderma atroviride* were evaluated under commercial field conditions for their efficacy in controlling potato black scurf, caused by *Rhizoctonia solani*. Six treatments were tested in a randomized complete block design with three replications. Results from 1991 indicated that under high tuberborne *R. solani* inoculum levels, *T. atroviride* isolates CHS 861, CHS 901, Biotype 453 and Biotype 603—could protect a highly susceptible potato locally known as 'Peanut' against *R. solani* equal to or better than fungicide (PCNB). In 1992, tuberborne and soilborne inoculum levels were low. Cultivar 'BakeKing' was moderately resistant to *R. solani*. In the plants treated with *T. atroviride*, yield wasn't significantly different from that of the control. A significant reduction in yield was noticed in plants treated with PCNB.

•Jenifer McBeath, Chao Chen and Jan Bittner

Serum progesterone levels

We collected blood serum samples from female reindeer (*Rangifer tarandus*) held at the University of Alaska Large Animal Research Station from February 1991 to March 1992. Twelve pregnant and four non-pregnant animals were monitored during the 13 months. Radioimmunoassay was

used to determine differing serum progesterone levels between the two groups. Non-pregnant females had a maximum serum progesterone level of 3.2 ng/ml in December with levels dropping below 1 ng/ml by February and March. Pregnant females had progesterone levels greater than 5.8 ng/ml by January. We used a threshold level of less than 3.5 ng/ml in December or January to distinguish between the females in a free-ranging herd on the Seward Peninsula.

•Heather McIntyre, Lyle Renecker and Marsha Sousa

Reindeer breeding & age fecundity

We collected blood serum from known-age, free-ranging female reindeer (*Rangifer tarandus*) owned by Lawrence Davis of Nome in December or January from 1986 to 1990. One hundred and thirty-three serum samples from 38 different reindeer varying in age from 1.5 to 9.5 years old were analyzed between 1991 and 1992 for progesterone using radioimmunoassay. Pregnancy was evaluated using a threshold level of 3.5 ng/ml as determined in a companion study. All females older than 1.5 years tested positive for pregnancy at the December/January sampling. A larger sample size of females in age groups older than 9.5 will be needed to determine at what age fecundity begins to decline for reindeer.

•Heather McIntyre, Lyle Renecker and Marsha Sousa

Age specific calving success

We estimated age specific calving success using the subjective evaluation of presence or absence of udder during the June handling of the Lawrence Davis reindeer (*Rangifer tarandus*) herd on the Seward Peninsula. Approximately 2,600 to 3,600 females, from one-to eight-years old, were examined annually from 1988 to 1992. Percent calving success for each age class was calculated for each year. To determine the effect of year and female age on calving success we used a two-way analysis of variance (ANOVA).

Calving success increased for females up to three years old and then did not vary with age for three-to eight-year olds. The effects of year were highly significant ($P < 0.0001$) on calving success. Between 1988 and 1992 calving success varied from 54 to 76%.

•Heather McIntyre, Darrell Blodgett and Lyle Renecker

Reindeer blood mineral levels

One hundred and seventy-five whole blood and serum samples from 10 Alaskan reindeer herds

(*Rangifer tarandus*) were collected in 1991 and 1992. We analyzed samples for selenium, copper, zinc, sodium, potassium, phosphorus, calcium, magnesium, and iron. Two-way ANOVA will be used to determine differences between years and herds. These values will provide a baseline for comparison of blood mineral status of individual reindeer.

•Heather McIntyre, Lyle Renecker, Gary Mather and Patricia Talcott

Reindeer diets and milk production

We assessed milk production of lactating reindeer on high and low protein diets in May using a radiotracer technique. Simultaneous injection of tritiated water (HTO) into the lactating females and an oral dose of deuterated water (DDO) to the nursing offspring was used to determine milk-water intake rate. Data will be analyzed using a Simulation, Analysis and Modeling (SAAM) program.

•Heather McIntyre, Ray Case, Dan Holleman, Robert White and Lyle Renecker

Reindeer calf weights

During the 1991 and 1992 summer reindeer (*Rangifer tarandus*) handlings on the Seward Peninsula, we weighed 3,669 calves from seven different herds. Calves from the Lawrence Davis herd were weighed periodically throughout a three-week period to calculate an average daily weight gain for the period. Calves from the other herds were weighed once and their weights compared to the prediction interval around the regression line generated from the Davis herd data. Even though there was no significant difference between calf weights from the Davis and the other six herds there was a trend toward higher weights for calves from the James Noyakuk herd and a trend toward lower body weights from the Merlin Henry and Nathan Hadley herds. We will monitor calf body weights during the 1993 summer handlings to determine if the trends are consistent over time.

•Heather McIntyre, Darrell Blodgett and Lyle Renecker



Greg Finstad and Cheryl Lesley Chetkiewicz working with the reindeer.
(Photo by Stephen Lay)

Gravel pad vegetation experiments

This research includes an array of studies aimed at identifying soil treatments and plant species useful in vegetating abandoned gravel fill in the Arctic tundra regions of northern Alaska. Gravel fill used for the BP Put River No. 1 wellsite was restructured during the winter of 1989–90 to develop test plots. The design provided for five, 4-foot-by-8-foot plots in each of 144 experimental units. One plot in each unit was seeded to a mixture of native plant seeds in June 1990 and another in 1991. The final planting was to have occurred in June 1992. However, the growing season in 1991 was very cold. Only one-fourth as many positive degree hours air temperature were recorded in 1991 as in 1989, at Prudhoe Bay, Alaska. This caused seed production to fail, leaving us without a supply for the 1992 planting.

The 1992 growing season was adequate for seed production. We collected seed from 64 indigenous vascular plant species: 28 forb and half-shrubs, 23 grasses, nine shrubs, and four grasslike (mostly sedges). The final planting occurs in June 1993. Recording instruments were installed in 1992 to monitor air and gravel temperatures on the plots.

Snow depths of four feet slowed the spring growth of plants. Consequently, in the summer of 1992, snow fences were cut in half to reduce the winter accumulations to a two-foot maximum. We began a snow gradient (four feet to near zero) study in 1992 to measure effects of various winter snow depths on plant survival and growth. A total of 16 species was planted: 10 grasses, four forb and half-shrubs, and two shrubs. By September 5, five grass species had emerged from the June 26 and July 21 plantings.

Gravel pads abandoned for a known period of time can provide valuable insight into the time required for plant colonization in this region. The National Petroleum Reserve in Alaska (NPRA) contains several of these types of gravel fill, representing sites abandoned approximately 10 years. In 1984, a preliminary evaluation of vascular plant colonization on the gravel fill in NPRA was begun. The second evaluation of four exploratory gravel pads in NPRA was conducted in 1991–92. One drilling pad, Umiat No. 5, used during the first exploration of the reserve, was added to the study in July 1992, representing sites abandoned approximately 40 years.

We have identified more than 125 vascular plant species colonizing gravel fill in the Alaska Arctic. Approximately 100 are worthy of closer examination for revegetation potentials. Sixty-four indig-

enous vascular plant species were planted in rows at the botanical garden at BP Put River No. 1. This array includes 28 forb and half-shrubs, 23 grasses, nine shrubs, and four grasslike species, planted over three years. Some grass specimens of the earliest planting developed sufficiently to begin sexual reproduction by summer 1992. Most of the forb and half-shrub specimens are quite small because of the slow development in the arctic. The planting will provide material for phenological and seed production evaluations in a uniform garden for perhaps the largest collection of indigenous arctic plants in Alaska.

•Jay McKendrick, Peter Scorup, Warren Fiscus and Gwendolyn Turner

Red clover companion crops

Red clover is a promising legume in areas of Alaska where protective snow cover is not removed by winter winds. The objective is to determine the value of companion crops in controlling weeds and the effect of companion crops on clover establishment. Four treatments of Altaswede red clover were planted at Point MacKenzie in 1991 and in 1992: clover, clover plus oats, clover plus fodder rape, and clover plus annual ryegrass. All companion crops were planted at slightly lower seeding rates than would be used for pure stands. During the planting year, companion crops improved weed control, but red clover yields were also reduced by competition from the companion crops. Red clover produced 1.5 tons per acre when seeded alone and only 1.1 tons per acre with companion crops. Companion crops added significantly to the total crop yield, however, more than making up for the reduction in clover. Total crop yields were 2.4 tons per acre with companion crops. The year after establishment, first cutting yields of clover were not different (1.9 tons per acre). Continuing research will determine the long term effectiveness of companion crops.

•Michael Panciera and Beth Tillman

Red clover establishment

Three varieties of red clover were studied to determine the differences in seeding year growth between adapted and non-adapted varieties. 'Alaskland' (Alaska), 'Altaswede' (Alberta), and 'FL MTC' (Florida) were spring planted at Point MacKenzie in 1991 and 1992. Alaskland grew slowly and produced very little top growth (0.42 tons an acre) by the end of the seeding year. Altaswede, which is moderately well-adapted to Alaska conditions, produced 1.3 tons an acre and

the nonadapted FL MTC produced 1.7 tons an acre. The most adapted variety, Alaskland, allocated 25% of total dry matter to the root system, while Altaswede was intermediate (21%) and FL MTC was the lowest (16%). High mortality was observed for FL MTC plants after the winter of 1991–92 despite the fact that early snow cover prevented the soil from freezing for the entire winter. Forage yields on the first sampling date (June 23) during the year after planting were higher for the adapted varieties (1.6 tons an acre) than for FL MTC (0.3 tons an acre). By July 13, yields had nearly doubled (Alaskland and Altaswede 3.6 tons, FL MTC 0.6 tons).

Well-adapted varieties are necessary to obtain high yields of perennial forages, but non-adapted varieties may also be useful. The high yields and vigorous growth of FL MTC during the seeding year suggest that non-adapted varieties would be useful as a green manure crop.

•Michael Panciera and Beth Tillman

Turnip growth rates

We studied forage turnip and turnip hybrids during 1991 and 1992 to define differences in distribution of dry matter between tops and roots and to describe yield accumulation. In 1991, four varieties were studied: 'Civasto R', 'Forage Star', 'Purpletop', and 'Tyfon'. 'Fresia' and 'Rondo' were added to the study in 1992. Dry matter yields were markedly different for the two years. In 1991, yields increased from 1.5 tons an acre (eight weeks) to 4.5 tons an acre (15 weeks). Dry matter yields were much lower during 1992 averaging 0.5 tons an acre (eight-and-a-half weeks) and increasing to 2.1 tons an acre (14.5 weeks). Drought and insect damage were responsible for the lower yields in 1992.

Early in the growing season most of the dry matter yield is in the top growth (75 to 90%), but roots increase throughout the season. Civasto R had the highest proportion of roots (62%) and Tyfon had the lowest (26%) at the end of the growing season. Some of the uses of these varieties will be determined by the distribution of yield between tops and roots. A high proportion of roots is desirable if the forage is going to be stockpiled for autumn grazing because the roots will be less damaged by frosts than will the tops. A variety such as Tyfon would be favored for pasture during the growing season since it is predominantly leaf and it will rapidly recover from grazing. Research with turnips will continue to determine the yields that can be expected over the long term. The feed

value of turnips is equivalent to corn grain, so even at the lowest yield levels that we observed, the feed production was equivalent to 66 bushels of corn grain per acre.

•Michael Panciera and Beth Tillman

Fodder rape silage

Brassica crops, such as fodder rape, grow well in Alaska and have extremely high feeding values. Fodder rape is normally used as a pasture crop because it is high in moisture content and, thus, difficult to ensile. In this study, we blended chopped dry brome grass hay with chopped 'Emerald' rape to make silage mixtures that ranged from 65 to 85% moisture. The mixed forage was ensiled in laboratory silos. The pH declined from 5.7 at the start of the study to 4.0 after four weeks of fermentation. Mixtures with the highest proportion of rape fermented the fastest, but after four days of ensiling, the maximum difference among treatments was 0.3 pH units. Lactic acid and acetic acid reached their highest levels by day seven (12.7 and 4.2 parts per million, respectively). As the proportion of rape increased in the silage, lactic acid levels rose and acetic acid declined. The forage quality of the silages was related to the amount of rape in the mixture. Acid detergent fiber declined from 34 to 25% as the proportion of rape was increased. Digestibility (IVDMD) was highest for the 100% rape treatment (77% IVDMD) and IVDMD declined as the proportion of brome grass increased in the mixtures (58% IVDMD for pure brome). The IVDMD and ADF changed little over the four weeks that we monitored fermentation. In preliminary studies, rape silages proved highly palatable to dairy cattle. More research needs to be done to overcome the practical problems of blending rape with drier forages at harvest or during silo filling.

•Michael Panciera and Paul Windschitl

Permafrost soils classification

In the current U.S. soil classification system, Soil Taxonomy, nearly 65% of the soils in the Arctic Slope and Interior Alaska are covered by only two subgroups, either Pergelic Cryaquepts or Ruptic-Histic Pergelic Cryaquepts. This oversimplification is not adequate to aid the transfer of soil knowledge. Through the cooperative effort of the USDA–Soil Conservation Service, Agriculture Canada, the University of Alaska and the University of Wisconsin, a Gelisol order is proposed for the permafrost soils. In this new order, soils with features such as patterned ground, cryoturbation, polar-desert, wetness, and organic matter will be differentiated. The 1993 goal

is to field test the proposal through a circumpolar cooperation.

•Chien-Lu Ping

Fractionation and carbon balance

The total carbon balance of soil interstitial water and alkali extracts of the bulk soils were achieved by applying the tandem XAD-8/XAD-4 resin isolation procedure. Fulvic acids are the dominant fraction of the dissolved organic carbon in soil interstitial water ranging from 48 to 71%. This supports the fact that fulvic acids are the primary complexing agent and translocating agent for weathered products such as aluminum (Al) and iron (Fe). The XAD-4 acids or the low-molecular-weight organic acids account for 10 to 13%. The hydrophobic neutrals and hydrophilic neutrals account for 12 to 36%. The Bhs horizon of the Kachemak soil, a grassland Spodosol, has only a trace amount of humic acids but more than 50% nonhumic substances in the soil interstitial water, suggesting most likely the products of the active biological activities in the overlying horizons.

The relatively small proportions of the nonhumic substances in the alkali extracts of the bulk soil suggest the faster turnover rate of these compounds. The higher portions of XAD-4 soils in soil interstitial water than in the bulk soil suggest that the XAD-4 acids may play an important role in Al- and Fe-complexing but biologically less stable than fulvic acids.

The proportions of humic and fulvic acids in the bulk soils vary widely among the three soils. This wide variability reflects the soil-forming processes or the genetic environments of the three soils. Further investigations are needed to compare the composition of humic and nonhumic substances in the overlying and underlying horizons to access the carbon transformation in the soil system.

Chien-Lu Ping, Gary Michaelson and Ronald Malcolm

Nenana Valley archaeological sites

This study identifies soil genetic horizons in each major deposit, investigates the morphological and chemical properties, and relates these properties to past environments in which the soils formed on the archaeological sites in the Nenana Valley. Soil genetic horizons are identified by morphological properties which are based on Munsell color, field texture, presence of coarse fragments, structure, consistency, root distribution, soil horizon boundaries, and other features such as charcoal particles. Throughout the profile, fine to medium plates are the dominating structure which reflect

the aeolian deposition process and the lenticular microstructure reflects the frost action caused by seasonal frost and especially syngenetic permafrost formation. The redoximorphic features throughout the profile except the most recent bluff sand deposit suggest the gradual rising of permafrost table which created a temporary saturated zone and induced anaerobic conditions. The oxidation process occurred during fluctuating water table due to improved drainage either seasonally or by fire and connected with postcryogenic structure. Aeolian deposition, accumulation of organic matter, transformation of iron minerals due to natural fire and reduction-oxidation reactions, frost action and cryoturbation are major processes contributing to the morphological properties of different soil sequences in the Paleosols associated with archaeological sites in the Nenana Valley.

•Chien-Lu Ping and Yuri Shur

Soil classification, climatic zones

Approximately 80 percent of Alaska is underlain by permafrost which controls the soil temperature regime and often the soil moisture regime. Three soil climatic zones in Alaska roughly correspond to the three established permafrost zones. The cryic climatic zone corresponds to the zone that is free of permafrost and has a maritime climate. Soils in this zone have mean annual soil temperature (MAST) measured at 50 centimeters depth of >0 to 8°C , and mean annual precipitation (MAP) of 40 to 500 cm. The cryic-pergelic climatic zone corresponds to the zone of discontinuous permafrost, with a strong continental climate. This zone is composed of a complex mosaic of permafrost soils and permafrost-free soils with MAST of >-4 to 2°C , and MAP of 30 to 45 cm. The pergelic climatic zone corresponds to the zone of continuous permafrost, and has MAST from -4 to -10°C , with MAP of 12 to 50 cm.

•Chien-Lu Ping and Joseph Moore

Arctic tundra soils study

The study was a cooperative effort involving the AFES, USDA-Soil Conservation Service, USDA-Forest Service, Agriculture Canada, Russian Academy of Science, Institute of Soil Science and Photosynthesis in Pushchino, Moscow, Institute of Biological Problems of the North in Magadan, and Dokuchayev Institute of Soil Science in Moscow. The joint team studied the alpine tundra and taiga forest soils in the Upper Kolyma of Magadan Region and the arctic tundra and taiga forest in the Kolyma Lowland of the Yakutia Region. The joint team compared the soil classification systems of Canada, Russia, and the United States and agreed that a comprehensive

classification system would benefit land-based technology transfer in the circumpolar regions.

•Chien-Lu Ping

Resource data automation

This joint project between the UAF – Reindeer Research Program, USDA – Soil Conservation Service, USFS – Bureau of Land Management, and the National Park Service automated vegetation, soil, topographic, land ownership, and seasonal reindeer (and potentially other animal use patterns) range information onto a computer Geographical Information System (GIS). After baseline information was compiled and the overlays edited, range management decisions can be made easily through analysis of the database.

Currently, ecosite and ownership information have been digitized and edited. In 1993 we will incorporate digital elevation maps, reindeer ranges, updated vegetation information, historical fire information, and animal location data.

•Lyle Renecker, Mike Searcy and Ted Cox

Reducing death in relocated reindeer

This study tests the use of probiotics to reduce death in relocated reindeer. When ruminant animals experience dramatic shifts in diet or are stressed in shipment, substantial environmental changes occur in their rumen. The changes result in a reduced ability to digest forage that can have a debilitating effect on the animals' condition. Probiotics (stable form of *Lactobacillus* spp. bacteria) repopulate the rumen with microbes necessary for cellulose digestion. As a result animals should remain less stressed because of a more favorable nutritional status. We have prepared facilities and ration for shipment of stock.

•Lyle Renecker, Raphaela Stimmelmayer and Marsha Sousa

Molecular genetics of AK reindeer

The study, a pilot project investigating the genetic variability of reindeer in Alaska, will first examine the molecular genetics of reindeer tissue samples collected from animals on Hagemester Island, Alaska during November 1992. We will analyze samples in 1993 and compare results to other ungulate species. The project will expand to include more diverse reindeer populations.

•Lyle Renecker and Matt Cronin

Wildflower seed mixes for Alaska

This is the first year of a five-year project where we will evaluate indigenous and non-indigenous

perennial wildflower seed mixes. Preliminary results confirm that irrigation is important in establishing wildflower meadows, but several species have been identified that will become established on non-irrigated sites including fleabane, *Erigeron glabellus*; strawberry spinach, *Chenopodium capitatum*; wild camomile, *Tripleurospermum inodorum*; aster, *Aster sibiricus*; and arnica, *Arnica alpina*. These species probably hold the most promise for future research in roadside revegetation. The experiment comparing sowing rates of Nauriaq Gardens Wildflower Mix revealed no advantage during the first year to doubling or tripling the sowing rate on the irrigated plots. Species emergence and cover were similar among plots primarily because the most common and abundant component was the non-native California poppy (*Eschscholzia californica*). This species is an annual, and it is not expected to self seed. The second year will be critical to the establishment of the native Alaska wildflowers on these plots.

•Oulina Rutledge and Patricia Holloway

Soil management and temperature effect on C, N and P mineralization

This study's objective was to compare soil carbon, nitrogen and phosphorus mineralization rates in conventional tillage and no-tillage plots (with and without crop residue) under continuous barley. At the end of the eighth growing season, we collected soils from surface to 15 centimeters soil depth and incubated at five, 15 and 25°C. After 16 weeks incubation, potential net C and P mineralization and nitrification rates were highest in soils taken at zero to five centimeters depth and incubated at 25°C. Also rates of cumulative carbon dioxide evolved, net mineral nitrogen and inorganic phosphorus released were higher in soils from the no-tillage than in the tillage plots. This indicated the presence of larger amounts of organic material which, under field conditions, decomposed slower in the no-tillage plots.

•Elena Sparrow and William Karidis

Methane consumption

Oxidation or consumption of methane, CH₄, is a positive control on increases in greenhouse gases which are involved in global climate change. Several studies have been initiated to document CH₄ uptake in subarctic agricultural soils and assess the effects of different soil and crop management practices. We found no long-term inhibition of methane consumption by a one-time application of urea fertilizer to soils planted to grass. Methane uptake in surface to 30 centimeters soil depth was

highest at 25°C while that in 30 to 50 centimeters soil depth was highest at 5°C.

•Elena Sparrow and Verlan Cochran

Delta Bison Range N-fixing plants

This project determines the potential for using nitrogen-fixing plants to improve forage quality of the Delta Bison Range. Eventually we will develop a management plan for the bison range which will include the use of N-fixing plants. Several N-fixing plant species were planted on small plots at several range locations in 1991. We monitor these plots primarily for survival under different environmental conditions.

In 1992, larger plots at fewer locations and with fewer N-fixing species were planted for a more detailed study of long-term potential forage production and quality. Several species in the 1991-seeded plots showed good winter survival at the more protected locations; survival was poor to fair at the more exposed locations. The 1992-seeded plots were completely destroyed by grasshoppers, therefore producing no data. We will continue monitoring the 1991-seeded plots and will reestablish the large plots in 1993.

•Stephen Sparrow and Michael Panciera

Perennial legumes study

Legumes are valuable in agriculture because they produce high-quality animal feed and because they are able to "fix" atmospheric nitrogen into forms which plants can use. Thus, good yields of high quality forage can often be produced by legumes without the use of N fertilizer. Some legume species are perennials and under good conditions can produce good forage yields for many years. This project seeks to determine N-fixation, herbage yield, and persistence of several legume species over four years at three locations with different soil and climate conditions. Plots were planted in 1992 at Delta Junction, Fairbanks, and Point MacKenzie. Flooding and insect damage resulted in total loss of plots at Delta Junction and Fairbanks; they will be replanted in 1993. At Point MacKenzie, first-year forage yields ranged from about 1.25 tons per acre for bird's-foot trefoil to more than three tons per acre for alsike clover. We are currently completing plant N analyses and then will calculate amounts of N-fixed.

•Stephen Sparrow and Michael Panciera

Investigating reindeer death

We conducted a cursory investigation on the consequences of a winter 1991-92 die-off of reindeer (*Rangifer tarandus*) (primarily males) on

Hagemeister Island. Results indicated that starvation ultimately caused the over-winter mortality. A combination of environmental factors, such as severe weather conditions and a delayed entry of females into the rut may have led to the precarious body condition of mature bulls. To further elucidate the Hagemeister Island scenario, additional data was collected during November 1992 and is being analyzed.

•Raphaella Stimmelmayer and Lyle Renecker

Game farming

Over the past two decades, the game production industry has emerged as an alternative to conventional farm agriculture. Promising species include reindeer (*Rangifer tarandus*) and pronghorn antelope (*Antilocapra americana*), however, their use is dependent on adaptability to intensive management. Until recently, information regarding long-term observation of disease processes in farmed game was not available. Experience with deer



Dr. Steve Sparrow, agronomy professor, and Don Quarberg, CES agent, inspect crops at Delta (Photo by Donna Gindler).

farming, primarily in New Zealand, indicated that higher herd densities encountered in intensively managed operations may cause an increase in the incidence of health problems. A proper management program, including preventive medicine, should provide better disease resistance. This study provided information on economic considerations, disease prevention protocols, and medical management protocols for on-farm use.

•*Raphaella Stimmelmayer and Lyle Renecker*

Reindeer meat study

An increase in consumer demand for leaner, healthier meats has attracted more attention to the commercial game industry. The objective of this study was to determine the optimal slaughter weight and age of reindeer (*Rangifer tarandus*) in relation to desirable carcass characteristics, minimal slaughter stress, and optimal meat yields. The criteria necessary for the development of a grading system for reindeer meat will also be explored. We initiated a pilot study in February. We obtained a sample of 24 reindeer carcasses, balanced for sex and age (three groups), from Bering Sea Reindeer Products. Each carcass was split dorsally and the left half of the carcass was cut into primal cuts and then further into retail meat cuts in order to obtain a yield test. Sensory panel analysis was conducted on the left loin from each carcass to evaluate quality criteria. The second half of the carcass was dissected into bone, muscle, and fat components. Each muscle group was weighed and measured and then related to body size, age, and animal condition. Fatty acid and chemical composition analysis was conducted on samples of both meat and fat. The study will ultimately provide recommendations to aid the Alaskan reindeer industry in the production of high quality, inspected meat products necessary to access the internationally emerging specialty meat market.

•*Teresa Tomany, Lyle Renecker and Ken Kreig*

Fertilizer for transplanted lettuce

Varying rates of nitrogen (NH_4NO_3) and phosphorus (triple superphosphate) were applied as broadcast or band treatments to transplanted 'Salinas' head lettuce in 1992, the first year of this study. Data collected at the end of the growing season suggest no benefit to banding nitrogen, and a significant risk of crop damage. Banding phosphorus increased fertilizer efficiency and resulted in greater lettuce yields with lower rates of triple superphosphate, although the rate of crop maturation was delayed slightly.

•*James Walworth, Raymond Gavlak and Donald Carling*

Chloride, sulfate potato tests

Study of the effects of chloride and sulfate salts on potato tuber production continued for the third year. All nitrogen, potassium, and phosphorus were applied in forms containing neither chloride nor sulphate. Varying rates of calcium sulfate and calcium chloride were applied in a factorial design. Measurements indicated that neither salt affected potato tuber yield. Increasing rates of chloride application reduced tuber specific gravity (indicating reduced levels of tuber solids), however sulfate had no influence.

•*James Walworth and Raymond Gavlak*

Lettuce nitrogen usage

Head lettuce fertilized with either an ammonium (urea) or a nitrate ($\text{Ca}(\text{NO}_3)_2$) nitrogen source was treated with a foliar application of molybdenum ($(\text{NH}_4)_2\text{MoO}_4$) to investigate whether lack of molybdenum reduces the ability of lettuce to assimilate nitrate-nitrogen in Southcentral Alaskan soils. First-year results indicate that head lettuce responded to molybdenum application regardless of nitrogen source. Lettuce growth was greater with calcium nitrate than with urea, whether or not molybdenum was applied.

•*James Walworth, Raymond Gavlak, and Donald Carling*

Fish by-products used as fertilizers

Two fish processing by-products, salmon bone meal (SBM) and white cod bone meal (WCBM), were evaluated for effectiveness as nutrient sources in potato production. Each by-product was applied at 1,000, 2,000, and 3,000 pounds per acre to plots containing four potato varieties. Inorganic sources of nitrogen and phosphorus (ammonium nitrate and triple superphosphate) were added to control plots at rates equivalent to the amount of each nutrient added in the SBM treatments. All plots received identical rates of KCl, since the fish processing by-products contain very low levels of this nutrient. Nitrogen and phosphorus use was less efficient when SBM or WCBM were the sources, however at high application rates, tuber yield and quality were equivalent to that obtained with the inorganic nutrient sources. Inorganic nitrate-nitrogen remaining in the soil profile at the conclusion of the growing season was significantly less where the fish processing by-products were applied.

•*James Walworth, Raymond Gavlak and Donald Carling*



- ① Pat Wagner, (top left) -ag lab assistant, is working in the Georges Botanical Garden. (Photo by Stephen Lay)
- ② Cheryl-Lesley Chetkiewicz and Ray Case (above) notch a reindeer's ear for tagging. The tagging designates herd ownership. ((Photo by Stephen Lay)
- ③ Ming Di (bottom left) explains research programs to a tour group. (Photo by Donna Gindler)
- ④ Sharon Schlentner (below), USDA-ARS lab technician, works in the research plot. (Photo by Scott Penwell)



LTER: an overview of activities

The principal focus of the Bonanza Creek Experimental Forest (BNZ) long-term ecological research (LTER) program is to study the taiga ecosystem structure and function. The program emphasizes the pattern and rate of successional change and the controls over these processes during primary succession along the floodplain of the Tanana River and during secondary succession following fire in the adjacent uplands. During the first phase we initiated a series of long-term experiments to document the changing nature of ecosystem controls. We examined:

- (1) vegetation change and demographic controls over successional processes,
- (2) vegetation-induced modifications in resources and standing crops of biomass and nutrients,
- (3) controls over nutrient supply, and
- (4) influences of herbivores on ecosystem structure and function.

Most of the research will be evaluated over extended time intervals, five to 10 years minimum. Ecosystem structure and process control observations and experiments established during phase one continued into early phases of LTER II.

1992 is characterized by unusual climatic conditions. Record late snow in May and early snow in September resulted in a shortened growing season. The September snow fell prior to normal leaf abscission in deciduous tree species and normal hardening off for many introduced horticultural plants. These events emphasized the importance of long-term records of controls of ecosystem structure and function. We are following the impact on vegetation growth and nutrition as part of our long-term monitoring program.

The 1991 and 1992 tree growth records for the soil carbon manipulation experiment indicate significant effects on tree basal area increment. The consequences of these treatments for tree element supply and nutrition require further examination. Work with root observation tubes, nitrogen fixation, denitrification and the rhizosphere is providing insight to the importance of the below-ground ecosystem as a mediator of successional processes.

Decomposition research is helping unravel the significance of successional change in controls of element supply for tree growth. Secondary plant chemicals may play an important role in controlling decomposition and element supply. The importance of the physical, chemical and biological environment in which these process occur will be our focus for decomposition research during the coming year.

Small and large mammal browsing plays a major role in control of ecosystem structure and function especially early in succession. Large exclosures established during LTER I are a valuable resource for understanding the consequence of herbivory to control ecosystem dynamics. The implications of herbivory to forest floor decomposition and element cycling are a focus for the coming year.

Data and information management are crucial to the short- and long-term success of the LTER program. Recently acquired hardware and software will help us establish a data archiving and information management system to integrate our research program, convey research results to the scientific community, and successfully interact across the LTER network.

The information base on ecosystem structure and function at the BNZ LTER has been used in stand level modeling activities. New efforts are underway to link stand level models with Geographical Information System to expand our understanding of process controls at a landscape level.

The BNZ LTER is a \$3.9 million federally-funded program. It is designed to promote research on the structure and function of the northern boreal forests of Interior Alaska. Graduate and undergraduate student instruction and cooperation with other universities and government renewable resources management agencies are important additional features of the program.

Related research progress reports immediately follow.

White spruce forest tree-ring studies

I analyzed the tree ring radial growth of 67 200-year-old white spruce trees previously measured at the Reserve West location in BNZ LTER site. I also measured tree rings on 101 readable stems from a reconstructed 25 meter by 25 meter (1/16th hectare) portion of the Timber Bench stand (three kilometers east of the BNZ LTER).

The ages of these trees indicate they originated from seed crops in only two or three specific years following a stand-replacing forest fire. The Reserve West stand experienced a major snow breakage event in 1877 or 1878 that changed the relative performance of more than half the trees in the stand. Analysis of the original stand location showed no systematic pattern in the location of winners (trees that grew slower before 1878 and best in their second century, 42%), losers (trees that grew best before 1878 in their first century of life and poorly afterward in their second century, 16%), or normal (trees that grew roughly at the same rate in both halves of their lives, 42%).

The radial growth record of the Reserve West white spruce was compared with the longest instrument-based climate record in Interior Alaska, the University Experiment Station (UES) located 34 kilometers east of the LTER site. Contrary to expectations, the stand as a whole grew best in the cooler not the warmer years, suggesting that moisture limitations may be more important than temperature. A comparison of UES annual precipitation with stand radial growth reveals an interesting one-to-four year, positive lagged response, again suggesting that soil moisture is a limiting factor. White spruce are determinate growers and their current year's growth primarily reflects the previous season's carbon gain which is stored as winter reserves.

•Glenn Juday

White spruce adaption

Productive white spruce forest occupies about 2.7 million hectare or about 5.8% of the total Alaska boreal forest of 46.2 million hectare (total of productive and marginal forest). Research on the BNZ LTER is aimed at understanding the life-history strategies of upland white spruce that produce these stands and synthesizing a framework for results from several studies that are currently underway.

White spruce, the potential terminal species in upland succession, is confined to reproduction

from seed and is markedly less efficient and flexible in reproduction compared to its hardwood tree competitors.

Reproductive requirements are contradictory to some degree. It requires intense stand-replacing fire but parent trees must survive nearby to allow seed production and dispersal. White spruce is a superior competitor against its hardwood associates later in its life cycle by producing refractory litter that inhibits element cycling and lowers soil temperatures.

Much of Interior Alaska experiences a semi-arid climate and is characterized by complex topography and varied landforms in a largely unglaciated region. In the Interior it appears that white spruce reproductive effort is periodic and timed to place seeds into upland environments produced by stand-replacing fires. Burned sites support a favorable seedbed characterized by warmed soil, reduced organic layer thickness, and low vegetative competition.

•Glenn Juday

Nitrogen cycling

The transition from alder to poplar is a critical turning point in primary succession in the Alaskan taiga. Most of the nitrogen that accumulates in the ecosystem does so during the alder stage. In alder, N-fixation, nitrification, and N-loss are all rapid. As poplar takes over, the N-cycle closes, with both fixation and nitrification decreasing. We are analyzing the mechanisms behind this.

In lab studies we extracted different groups of secondary chemicals from poplar litter and applied them to alder soil to determine the effects of these compounds. Ether extracts, absorbed onto silica gel, acted as a carbon source and increased immobilization, which reduced NH_4^+ supply to nitrifiers but was not toxic to them. Experiments using tannins and phenolics are underway now.

Field experiments include two reciprocal soil transplants between an alder site and a poplar site. One is a long-term study in which 1 m² sections of soil were transplanted. We established a factorial combination of treatments: litter transplants, forest floor transplants, and trenching. Thus we can examine the effects of the different foliar, leachate, and root inputs on N-cycling in soils from the two systems.

A second shorter-term study uses soils in five-centimeter diameter cores made of coarse plastic mesh to allow root ingrowth. After one month in the field, poplar soil in the poplar stand did not nitrify, while poplar soil in alder nitrified as rapidly as alder soil. Alder soil transplanted to the poplar stand had reduced nitrification activity. These results suggest that some soluble compound(s)

present in poplar sites are responsible for maintaining low nitrification rates and that this compound must be continually resupplied. Preliminary data from both transplants suggest that N-availability probably controls nitrification rather than toxic effects.

•Josh Schimel, Keith Van Cleve, Joy Clein and Rex Cates

Litter decomposition

We have litter bags in the field in every replicate plot containing litter from that plot. These are now in their fourth year in the field. At each sampling we measure: mass loss, litter chemistry (lignin, cellulose, N), respiration potential (an index of microbial activity), and mesofauna. We also measure mesofauna from a core immediately below the bag.

Analyses are proceeding on the samples, but several assays show interesting results. The drop in labile C was apparent in the litter respiration potential measurements, which dropped substantially from the first to the second year. These measurements also indicated a major change in the microbial community on the litter between the first two years in the field. In the first year there was a strong positive correlation between field moisture at sampling and respiration potential, while second year litter showed a negative correlation.

•Keith Van Cleve, Josh Schimel and Mitch Wagener

Environmental monitoring

Because of the two major topographic subdivisions within the BNZ, two permanent weather stations have been established—one on the floodplain of the Tanana River at 120 meter elevation and the other on a broad ridge about midway in an elevation transect at an elevation of 290 meters. Environmental parameters have been measured and recorded by electronic data loggers since 1988. This year we installed Eppley total UV radiometers at each site, and will monitor UV radiation (in a bandwidth of 295 to 385 nanometers) during the snow free season.

In addition to the two main weather stations, selected environmental parameters are monitored at the eight prime (A) sites of each of the successional stages. Additionally, we monitor frost depth and volumetric soil moisture weekly.

Record (36 cm) and exceptionally late snow fall in May and record early snow and cold temperatures in September resulted in an unusually short summer in 1992, the snow-free period being from May 26 to September 10. However the average air temperatures for June, July, and August were very close to the five year average for BNZ.

The record early and continuous cold froze the green leaves on the trees before the abscission layer was formed, resulting in leaves remaining on the trees throughout much of the winter. The September snow fall of 62 centimeters was three times that of the previous September record. We will be assessing the effects of this weather on the LTER plots during the summer of 1993.

•Leslie Viereck, Phyllis Adams and Cynthia Williams

Forest ecosystem modeling

A major thrust in the last year has been in the area of forest disturbance modeling. Initially we described the distribution of lightning across the state, and looked at the influence of large fires on subsequent mesoscale climate and the distribution of lightning in the years following large fires. We are developing a prediction system for the occurrence of fires resulting from lightning on a statewide basis. A project was completed at Colorado State University on the influence of large fires on the mesoscale climate in the immediate months following the fire. This last study primarily looked at the effect of a major change in the albedo as a result of the fire and its influence on mesoscale climate.

We began modifying the boreal forest version of a stand level computer growth model (LINKAGES) to include the nitrogen productivity concept and to implement it as a spatial model in a Geographic Information Systems (GIS) grid package.

•John Yarie

ADDITIONAL FOREST SCIENCES RESEARCH PROJECTS:

Moose browsing impacts hardwood

Moose strongly impact hardwood growth in the northern forest. During 1991, we completed sampling of birch, aspen, and balsam poplar-western black cottonwood. For each species, we sampled 20 seedling-sapling stands in the Susitna Valley. In each stand, 20 individual plots were assessed. Collected data included: height and stem diameter (six-inches above ground) of crop tree, height class of other woody vegetation, and browsing intensity. Attempts to find "escape" trees on the same sites for comparative measurements were largely unsuccessful; in most heavily browsed stands, all trees were severely damaged. This unexpected, consistent lack of trees for comparison required a different approach to the statistical analysis. We have completed preliminary analyses and have found that no correlation exists between browsed tree height and age. Evidence questions the ability to

have completed preliminary analyses and have found that no correlation exists between browsed tree height and age. Evidence questions the ability to manage forests for hardwoods where moose populations are apparently high. The issues revolve around: forest management practices involving small (under 20 acres) and limited number of clearcuts, carrying capacity of the winter range, and density management of moose. Data analyses continue and the final report will contain management considerations.

•Jonathan Andrews and Edmond Packee

Weather simulator

Progress has been made toward developing a stochastic weather simulator from the daily climatological data for Fairbanks. The development and application of forest hydrologic models will embrace rather than deny the uncertainty that characterizes resource management systems. The model works by generating a value for daily sky cover randomly based on the historical distribution of sky cover given the previous day's sky cover. Clear sky solar radiation is calculated using a sinusoidal seasonal variation of atmospheric turbidity and then modified by the randomly generated sky cover to give daily global radiation. Next, depending upon current day sky cover and whether the previous day was wet or dry, a determination is made as to whether the current day is wet or dry based on transition probabilities. If the current day is wet, the amount of precipitation is randomly generated from the monthly distribution of "precipitation per wet day." Daily maximum and minimum temperatures are generated from knowledge of previous day temperature and current and previous day's sky cover. Daily dew point temperature is calculated based on current day's minimum temperature and current day's precipitation. Finally, daily average wind speed is generated independently as a function of the observed monthly distributions of daily wind speed values. We are refining the mathematical/statistical relationships and completing professional and user-oriented products.

•John D. Fox, Jr.

Forest growth and yield

We used stem analysis to determine height-growth patterns for four (dominant or codominant) trees in 64 plots located in natural birch stands that were more than 50 years old. We grouped plots, treated as individual samples, into five families of curves; these families of curves are the basis for five site quality classes. Each family of curves has a unique height growth pattern (polymorphism); differences in curve shapes are more pronounced at ages in excess of 50 years. Comparing polymorphic site index curves of this study with previously published anamorphic curves demonstrates significant differences. The new curves represent a more accurate pattern of height growth for paper birch in Alaska. The polymorphic site index curves should be used for productivity assessment in place of existing anamorphic curves.

•Michael Hoyt and Edmond Packee



Dr. John D. Fox Jr. explains soil-plant relations in permafrost terrain to students during a summer field trip up the "Haul Road." (Photo by Stephen Lay)

AK Boreal Forest natural diversity

Around the circumpolar boreal forest major programs of timber harvest have been conducted or are planned with the assumption that (A) these ecosystems are able to withstand the disturbances associated with forest management while continuing to produce wood products at high levels, and (B) few, if any, boreal species are at risk from intensive forest management programs. However, recent research and assessments suggest that production of repeated forest crops at rotations less than half the age of typical mature or old-growth stands create conditions that place several elements of natural diversity at risk. Changes in traditional forest management practices may help lower significantly the risk of eliminating species and compromising beneficial ecosystem processes.

To begin, I have launched an assessment program in Alaska. I gathered information from Swedish, Norwegian, and Finnish researchers and we started an exchange program.

Most forest management treatments tend to reduce the patchy distribution of tree stems and tree species, make age structure more even-aged, and eliminate multilayered tree canopies. Ecological processes that are different in repeatedly harvested boreal forests than in natural forests include post-fire successional pathways, succession with tree species replacement, self-thinning, canopy gap formation, and, snag and log formation. The species receiving little attention but most immediately at risk in boreal forests are wood-rotting fungi, root mound bryophytes, and arboreal lichens, especially pendant and crustose lichens.

Strategies for dealing with these effects include reserve placement, coarse woody debris management, prescribed fire management, and partial harvest systems.

•Glenn Juday

Influencing vegetation, diversity

This study examines the nature and effects of small-scale disturbances (the death of one to a dozen trees) in the coastal forest of northern Southeast Alaska. Two intensive study sites are located in the Juneau-Douglas Island area and one is outside Sitka; reconnaissance study sites are on northwest Baranof Island, Douglas Island, and the vicinity of Juneau.

At the Sitka site, 52.9% of the gapmakers fell into existing canopy gaps regardless of slope position, 52.6% of the gapmakers fell downslope regardless of the presence of a canopy gap. However, only 7.9% of the gapmakers fell upslope into existing

gaps, and no gapmakers fell upslope if gaps were not present. Results at the Lemon Creek (Juneau) site were similar.

The importance of coarse woody debris on the forest floor as a rooting medium for understory Sitka spruce and western hemlock appears to be site dependent. Stilted trees (indicating germination on a log that subsequently rotted away) at the Outer Point site (Douglas Island) are much more likely to reach the overstory canopy compared to trees that are not stilted. Stilted trees at the Sitka site are much less likely to reach the overstory canopy than trees rooted in the forest floor. At the Lemon Creek site (Juneau) trees that are established on organic substrates are neither favored nor harmed compared to trees established on the forest floor.

•Robert Ott and Glenn Juday

Reforestation stocking standards

Adequate initial forest stocking is essential for long term yields. The literature is replete with data that show, within reasonable limits, final merchantable yields to be directly correlated with stems or basal area per acre. Currently accepted reforestation stocking levels can result in under stocked stands with final yields being more than 25 percent less than fully stocked stands. A fully stocked stand is considered to be one in which all growing space is occupied at the time of harvest with vigorous, live trees. Initial stocking must take into account seedling survival. Planting or establishment stresses and stresses associated with competing vegetation contribute to mortality. We are refining established preliminary guidelines. The evidence strongly suggests stocking standards higher than what is acceptable in current prescriptions and regulations.

•Edmond Packee

AK northern forest silvicultural

A silvicultural system is a planned program of treatments by which crops constituting a forest are tended (grown and protected), removed, and replaced by new crops. Emphasis is on the word "crops" which can include, in addition to trees, animals, other plants, and fungi. The northern forest consists of three distinct biological units: boreal (north of the Alaska Range), transition (south of the Alaska Range), and maritime (portions of the Kenai Peninsula). The tree species are similar, but understory species are dissimilar between units. Removal and replacement of the existing forest crop is referred to as the reproductive method and is paramount to maintaining site productivity. A

concern in recommending reproductive methods is the impact on biodiversity: genetic, species, ecosystem, and landscape levels. There are 13 basic forest cover types in the northern forest; reproductive method options depend on the cover type and the objectives of the managers; however, species are often a controlling factor. Reproduction methods suitable to northern forest cover types have been identified. First approximation recommendations are being finalized for each forest cover type and desired species. We are addressing reproduction method impacts on wildlife species such as song birds and game animals through a review of the literature. Preliminary implications for managing the northern forest in Alaska include: reproduction methods that encourage presence of early successional hardwoods; necessity to manage on the basis of landscape diversity; reproduction method can vary for the same forest cover type and is strongly tied to organizational goals and perceptions.

•Edmond Packee

Forest growth and yield

We remeasured the tamarack and two white spruce installations at the Bonanza Creek Experimental Forest. Both were heavily infested with aphids in the summer of 1992; aphids may be responsible for tamarack mortality. Through the cooperative effort of the Alaska Division of Forestry we completed the Tok installation. Under our supervision, people from the Tok office cleared and burned brush, completed the scarification with a disk trencher, and planted the seedlings. Four species (white spruce, black spruce, tamarack, and lodgepole pine [selected Yukon provenance]) were planted at 4 X 4, 6 X 6, 8 X 8, 10 X 10, and 12 X 12 foot spacings. Early snow prevented establishment height measurements; these will be obtained in spring 1993. The installation is also being used as the core of a community research forest that will provide educational opportunities for local grade and high school students.

•Edmond Packee

Summary of AK forest inventories

No summary exists concerning the amount of timber available for harvest in Alaska. Yet, responsible industrial development of any timber resource requires accurate estimates of the amount and type of fiber available in a given area. The first part of this review addresses federal (USDA Forest Service and USDI Bureau of Indian Affairs) inventories in Alaska. We are preparing one page summaries and including descriptions of the areas and:

- Net growing stock volume in cubic feet by species;
- Net volume of annual growth of growing stock in cubic feet by species;
- Net volume of annual mortality of growing stock in cubic feet by species;
- Reliability of the area and net growing stock volume estimates.

Unfortunately, data are not presented in the same way in each publication; thus extracted data are not always comparable from one block or unit to another. Design and achieved sampling errors are presented. Critical to the use of inventories is terminology which has changed over the period of time that the inventories have been published; this can lead to confusion. Hence, definitions are presented before any block or unit inventory summaries; following each definition are the references in which it is used. Inventories summarized to date include those for Interior, Southcentral, and Southcentral Coastal Alaska.

•Edmond Packee

Individual tree volume tables

We continued collecting bark thickness and outside bark diameter measurements (with emphasis on white spruce) during 1992. Sample size for white spruce now exceeds 600 trees with a reasonably good number of trees having a breast-high diameter greater than 18 inches. Maximum tree height is 126 feet. Time to sample trees was originally estimated at four-to five-per person hours; freshly felled trees more than 100 feet long take about one hour to sample. Large trees are essential for a robust sample, but negatively impact productivity. Limited data sets were provided to cooperators. Current data suggest that existing published tables overestimate substantially the volume of large trees and underestimate volume of smaller trees. Balsam poplar-western black cottonwood volume tables are being constructed as part of the unit "site index and growth characteristics of balsam poplar in Alaska"

•Edmond Packee and Tom Malone

Balsam poplar developments

We continued developing growth and yield tables and equations for balsam poplar and western black cottonwood. For purposes of this study, western black cottonwood is considered a subspecies of balsam poplar. An advantage to this approach is that the species and hybrid questions can be ignored. However, appropriate samples (seed capsules) collected from most questionable sites will permit separation into three categories, if analyses warrant. The sample consists of 260 trees from 65 natural stands

that are more than 50 years old. We are refining draft site-index curves, based on stem analysis. Some plots in the Susitna drainage have growth patterns substantially different from all other plots; curves of these unique plots intersect the curves of the other plots. Approximately, two-thirds of the plots now have soil descriptions and analyses.

Evidence suggests the previously mentioned unique curves are due to soil characteristics. In addition to site-index curves, we are using the stem analysis data to develop new individual tree volume tables and form tables. No published site index curves have been found for balsam poplar, existing volume tables for balsam poplar in Alaska are a composite of poplar and birch and must be replaced.

•John Shaw and Edmond Packee



Torre Jorgenson, Trudy Heffernan and Dr. Edmond Packee, associate professor of forest management, collect information for the Birch Site Index. (AFES file photo)



Dr. John Yarie (above), associate professor of silviculture, explains aspects of the Long Term Ecological Research program. Dr. Keith Van Cleave (right) professor of forestry and Dr. Leslie Viereck, plant ecologist, listen to Dr. Yarie. (Photos by Donna Gindie)



Wilderness management typology

This project is developing a typology based on the Recreation Opportunity Spectrum (ROS), dividing the roadless portion of the continuum into segments and then developing appropriate guidelines for each segment. We have completed the detailed methodology.

We are using the Hendee wilderness scale to segregate respondents into five wilderness types (along the roadless portion of the ROS continuum). Then respondents will rate the appropriateness of approximately 50 management strategies. Those strategies that contribute to the overall management score will be retained. We'll run statistical tests to determine if adjacent wilderness types differ significantly in appropriate management strategies. Those that do not can be clustered into a typology of wilderness management. A pilot project involving a sample of interior residents will be conducted in fall 1993.

•Alan Jubenville

Watchable wildlife

This project focuses on developing the criteria for selecting watchable wildlife sites in Alaska and the appropriate management strategies after selection. We used a statewide steering committee as our panel of experts and a modified Delphi technique to select the appropriate variables.

Initially each committee member submitted a list of variables in choosing roadside watchable wildlife sites. These lists were consolidated and resubmitted to each member, who then rated the importance of each variable on a scale of one to nine. We developed a field evaluation form based on the important variables the committee identified, we are currently field testing it.

Using the same technique, we surveyed the steering committee to determine the appropriate minimum management program, regardless of the agency. The results were then incorporated into a master memorandum of understanding between federal and state agencies and the Alaska Department of Fish and Game.

•Alan Jubenville and Will Lentz

Agriculture in the circumpolar north

A historical overview of agricultural activities in selected areas of the circumpolar north provides a background for a development model set in the post-industrial period. Past research has focused

on Alaska and is now expanding to include the clay belts of southeastern Canada; the Yukon Territory in Canada's northwest, and Siberia and the Russian Far East. The core/periphery model of Friedmann (1966) augmented by the transportation model of Toaff, Morrill, and Gould (1963) established a framework for viewing agriculture in circumpolar resource frontiers. Resource frontiers are remotely located in difficult environments and are within political boundaries of core government and trade centers. The model proposes frontier agriculture begins in disconnected nodes (Stage I: subsistence). As activity increases the nodes expand (Stage II: commercial/local) and eventually interconnect (Stage III: regional product movement). Finally, regional production and international trade develop (Stage IV: regional/international agriculture). In Stage IV, there is a reciprocal transport of products from the frontier to the core. None of the areas studied have an agriculture in Stage IV. Agricultural development in the circumpolar north has not been supported by post-industrial core governments. Cores have not required frontier agricultural resources to augment their economic base. To move into Stage IV, frontier regions must depend on their own resources.

•Carol Lewis and Roger Pearson



Resource management faculty work with the vendors and managers of the Tanana Valley Farmers Market as part of their agriculture marketing effort. (Photo by Stephen Lay).

Rural AK regional economic model

We began developing a mathematical framework for a comprehensive regional economic model of rural Alaskan communities. The critical component of the model will be the linkage of the cash and non-cash sectors, both important in rural areas. Household production theory developed to address market value of non-wage production in the home is being modified to develop production functions characterizing non-cash activities such as subsistence. The production functions provide a means to calculate coefficients for IMPLAN, a regional input/output model developed by the U.S. Forest Service and extensively used in the western United States. IMPLAN generates multipliers which may be used to analyze the viability of the non-cash and cash components of regional rural economies. The matrices of IMPLAN will be modified to include non-cash activities in the production as well as the consumption components. The affect of bringing a new industry into a rural community can then be evaluated as a perturbation of the existing economy using the modified IMPLAN. The most critical component of the model is the data base. There are existing data bases which can be used. The reliability of additional information which will be needed is enhanced through cooperation with the Tanana Chiefs Conference, the non-profit

arm of Doyon Ltd., the largest of the 12 Native corporations in Alaska.

•Carol Lewis and Joshua Greenberg

Russian, American exchange

Activities in joint research and student exchange are continuing under the five-year exchange program between the Agricultural and Forestry Experiment Station (AFES) and Russian Academy of Agricultural Science, Siberian Branch (RAAS/SB). A manuscript titled "Agriculture and Economic Reform in Russia" was co-authored by AFES and RAAS researchers. It will be published in *Agribusiness: An International Journal* in 1993. Faculty of the two institutes are cooperating in potato disease work, horticultural plant material exchange, and small grain and forage seed exchange.

The student exchange component of the program is expanding. One student from RAAS/SB and the State University of the Russian Academy of Sciences in Novosibirsk is pursuing Ph.D. work in resource economics within the School of Agricultural and Land Resources Management. His research considers salmon return and escapement in the Yukon River drainage. One SALRM M.S. student will be traveling to Novosibirsk on a new exchange program in the fall of 1994. His research concerns biodiversity in the circumpolar north. A



Faculty with the Agricultural and Forestry Experiment Station meet with their colleagues from the Russian Academy of Agricultural Science, Siberian Branch. This photo is taken in front of the only Buddhist temple located on the shores of Lake Baikal. AFES participants were Mr. Verlan Cochran (fourth from the left), Dr. Charlie Knight, (11th from left) and Dr. Carol Lewis (12th from left). (Courtesy photo).

new program has been initiated to include undergraduate students in the exchange.

•Carol Lewis

Perception of organic produce

We examined direct market (farmers' markets and roadside stands) patrons' attitudes about organic produce through mail survey (N=417). We tabulated the frequency of response and relationships were delineated using chi-square analysis.

We found that consumers, when selecting fresh produce, were most concerned about the health and quality of the food.

Preference for organic produce was related primarily to health safety and environmental concerns. More than half (64.5%) of the consumers had purchased organic produce from supermarkets or direct markets within the past year. Although they didn't buy organic exclusively, previous purchase was associated with an increased likelihood of future organic purchase.

The majority of consumers—those who bought organic food and those who didn't—wanted a certification process. Of those desiring a certification process, 55% of the respondents preferred a government certifying agent; 27.3% preferred both public and private sector certifying agents. Both purchasers and nonpurchasers of organic produce had misconceptions about the produce. Additional information is probably necessary for consumers to make informed decisions in the marketplace.

•Ruthann Swanson and Carol Lewis

Reindeer steaks

Restructured steaks were made from forequarters of field-slaughtered Alaskan reindeer. I made steaks with (0.01 and 0.02% of the fat) and without antioxidant, using a 1-to-1 mixture of BHA and TBHQ with a propylene glycol carrier. The steaks were vacuum-packaged and stored at -18°C, and sensory tested after two-weeks of storage and then after every four weeks until the 22nd week.

I found minimal effects to textural characteristics (such as moistness, greasiness, softness and chewiness) on steaks with antioxidant and storage. The gamy flavor decreased and off-flavor intensity fluctuated. Steaks without antioxidant appeared more well done when cooked after they had been stored. Frozen storage of restructured steaks may improve flavor.

•Ruthann Swanson

Dispute negotiating teams

During the past 15 years, as public planning has become increasingly complex and controversial,

consensus-building approaches have met with increasing success in settling many types of disputes. Now consensus-building approaches, and the more narrowly-defined field of environmental dispute settlement (EDS), are receiving attention.

Success of an EDS team depends to a large extent on the representatives chosen to be part of the citizen group. Who is chosen, how they are chosen, and what they are expected to do will have a profound effect on the negotiations. While there is general agreement that choosing representatives is important, there has been no empirical research focused explicitly on this critical element of the negotiation process.

The study examines three team structures for negotiating disputes over wolf management in Alaska, British Columbia and the Yukon Territory. Faced with a complete impasse over the issue, each of the three areas decided to form citizen teams to try to reach a consensus on wolf management and each took slightly different approaches to structuring the teams. Two of the teams (Alaska and British Columbia) were unable to develop stable agreements, while the third (Yukon Territory) produced an agreement which has been partially implemented. Because each of these cases faced the same basic issue and had many of the same interest groups involved and because one was more successful than the others, they offer a unique opportunity to isolate some of the variables to see if changes in team structure may affect the ultimate success of the negotiations.

•Susan Todd



Dr. Susan Todd is a visiting assistant professor of regional and land use planning. (File photo).

Financial Statement

Expenditures — July 1991 through June 1992

The following is a statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1991 and ending June 30, 1992 (FY 92).

FEDERAL		(% of total)
Hatch General Formula Funds	\$ 597,715	8.8
Hatch Regional Formula Funds	147,956	2.2
USDA-Agricultural Research Service	122,976	1.8
McIntire-Stennis Formula Funds	338,970	5.0
Other Grants and Contracts	1,025,744	15.2
STATE FUNDS	4,538,974	67.0
TOTAL	\$ 6,772,335	100.0%

'92 research funding

Grants and Special Funds; July 1, 1991 - June 30, 1992

NATIONAL SCIENCE FOUNDATION

Dot Helm	Patch Formation, Mycorrhizal Colonization During Succession on Glacial Till
Keith Van Cleave	LTER: Successional Processes in Taiga Forests of Interior Alaska
Keith Van Cleave	Inter-Site Climate Database for Agricultural and Ecological Research

UNITED STATES DEPARTMENT OF AGRICULTURE

James Drew	Morrill-Nelson Funds for Food and Agricultural Higher Education
Glenn Juday	1990 Alaska Research Natural Areas: Monitoring and Publications; <i>(USFS funding also)</i>
Donald Carling	Persistence in AK Soils of Herbicides Used for Controlling Weeds in Potatoes; <i>(CSRS funding also)</i>
Jenifer McBeath	Cooperative Agriculture Pest Survey; <i>(APHIS funding also)</i>
Chien-Lu Ping	Wet Soils Monitoring Studies in Alaska; <i>(SCS funding also)</i>
Verlan Cochran	Research Support Agreement; <i>(ARS funding also)</i>
Tricia Wurtz	Domestic Geese to Control Weeds for Ag. and Forestry Applications in AK; <i>(w/Univ. of Calif funding)</i>

ALASKA DEPARTMENT OF NATURAL RESOURCES

G. Allen Mitchell	FY92 AG Development / Statistical Reporting
Patricia Holloway	Demonstration Conservation Windbreak
Stephen Sparrow	Legume Plant Material Trials in Interior Alaska
Jenifer McBeath	Hard Red Winter Wheat Development

Anthony Gasbarro	Forest Research Program FY92
Ruthann Swanson	Direct Marketing: Consumer Marketing Survey FY 92
Charles Hartman	Mental Health Trust Lands (Northern Region)

ALASKA DEPARTMENT OF ADMINISTRATION

G. Allen Mitchell	Senior Community Service Employment Program
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ALASKA SCIENCE AND TECHNOLOGY FOUNDATION

Edmond Packee	Forest Products from Alaska Native Trees
Stephen Dofing	Development of a Malting Barley Industry for Alaska
Lyle Renecker	Techniques to Reduce Death Loss in Relocated Reindeer
Stephen Sparrow	Use of N-Fixing Plants to Improve Forage Quality of Delta Bison Range
Stephen Dofing	Use of Alaska-Grown Canola in Dairy Cattle Diets (<i>Dennis Green & Sons funding also</i>)
Patricia Holloway	Evaluation of Wildflower Seed Mixes for Interior Alaska

USIBELLI COAL MINE, INC.

Dot Helm	Usibelli Vegetation Studies
Chien-Lu Ping	Soil Resource Baseline Study in the Hoseanna / Lignite Valley
Dot Helm	Revegetation Studies on Two Bull Ridge

NATIONAL PARK SERVICE

Harry Bader	Study of Subsistence Use in Wiseman, Alaska
Dot Helm	Vegetation Succession Near Exit Glacier
Lyle Renecker	Automation of Resource Data on the Seward Peninsula (<i>BLM and SCS funding also</i>)

BP EXPLORATION (ALASKA), INC.

Jay McKendrick	Gravel Vegetation Studies
Jay McKendrick	Arctophila Revegetation

FRED C. GLDECKNER FOUNDATION, INC.

Meriam Karlsson	Controlling Flower Formation in <i>Primula vulgaris</i> by Environmental Factors
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IDEMITSU ALASKA, INC.

Dot Helm	Continuation of Moose Browse and Grass Revegetation Studies
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ALASKA DEPARTMENT OF FISH AND GAME

Joshua Greenberg	Economic Impacts of Alternative Pot Limits in King and Tanner Crab Fisheries
Joshua Greenberg	Economic Analysis of the Alaska <i>C. Opilio</i> Industry

AMERICAN FLORAL ENDOWMENT

Meriam Karlsson	Growth Regulator Effects in Seed Propagated <i>Begonia x Tuberhybrida</i>
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ALASKA FISHERIES DEVELOPMENT FOUNDATION, INC.

Fredric Husby	Nutritional /Feeding Value of Powdered Cod, Halibut & Pollock Bio-Proteus Protein for Weanling Pigs
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UNIVERSITY OF ALASKA PRESIDENTS SPECIAL PROJECTS FUND

Patricia Holloway	Botanical Garden
Chien-Lu Ping	Comparative Study of Arctic Tundra Soils in the Magadan and Chukotsk, USSR and Alaska, USA

UNIVERSITY OF ALASKA NATURAL RESOURCES FUND

Jenifer McBeath	Biotechnology of Biological Controls for Plant Diseases
Stephen Dofing	Continuation of a Program in Plant Breeding and Genetics

INTERNATIONAL PLANT PROPAGATOR'S SOCIETY

Patricia Holloway	Vegetative Propagation of the Lingonberry
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McKINLEY MINING CONSULTANTS, INC.

Dot Helm Premining Vegetation Inventory Wishbone Hill Project

UNIVERSITY OF ALASKA FOUNDATION

Patricia Holloway Georgeson Botanical Garden

Formula Funds; July 1, 1991 – June 30, 1992**Hatch General; USDA**

Donald Carling	Potato Variety Comparisons and Evaluations of Rhizoctonia Disease on Potato
Leroy Bruce	Management of Alaska Beef Cattle to Maximize Forage Use
Ruthann Swanson	Quality Assessment of Alaskan Reindeer
Michael Panciera	Maximizing Forage Quality at Northern Latitudes
Patricia Holloway	Propagation and Cultivation of Alaska Native Plants
Meriam Karlsson	Effects of Irradiance and Temperature of Growth and Development of Greenhouse Produced Plants
Jay McKendrick	Vegetating Man-made Gravel Structures within Arctic Wetland Plant Communities
Paul Windschitl	The Effect of Fish Meal in Ruminant Lactation Diets on Milk Production and Composition
Chien-Lu Ping	Classification and Interpretation of Permafrost Soils in Alaska
James Walworth	Improving Soil Fertility for Potatoes and Lettuce in Alaska
Stephen Sparrow	Nitrogen Fixation, Herbage Yield and Persistence of Perennial Legumes in Interior Alaska
Carol Lewis	Alaska's Agricultural Industry: A Microsystem of the Circumpolar North
G. Allen Mitchell	Palmer Administration

Hatch Regional; USDA

Fredric Husby	Characteristics and Feed Value of Barley and Western Protein Supplements for Swine
Alan Jubenville	Benefits and Costs in Natural Resource Planning
Stephen Dofing	Plant Genetic Resource Conservation and Utilization
James Drew	Regional Research Planning and Coordination, Western Region
Jenifer McBeath	Biological Suppression of Soil-Borne Plant Pathogens

McIntire-Stennis; USDA

John D. Fox, Jr.	Simulation of Climatological Input to Forest Hydrologic Models
Keith Van Cleve	Forest Floor Organic Matter Chemistry as a Control of Plant Element Supply in Interior AK Forests
John Yarie	Prediction of Landscape Level Effects of Global Change on the Alaskan Boreal Forest
Edmond Packee	Determination of the Growth and Yield Potential of Northern Forest Species in Alaska

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