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Inside:

B.O.B.
Constructed wetlands
A quarter-century of crops

Fire research & management

School of Natural Resources and Agricultural Sciences
Agricultural and Forestry Experiment Station

University of Alaska Fairbanks

— U.S. Fish and Wildlife Service

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— Photo courtesy family of Mike Hoyt

About the cover: *Fire at Pine Creek, Brightwood, Washington, showing the oven-like conditions of wildfire.*
— Photo by Tom Iraci, courtesy National Interagency Fire Center Image Portal

Siberian crabapple, Malus baccata *(L.) Borkh, a recommended variety for firewise landscaping.*
— photo courtesy USDA-NRCS PLANTS Database / Herman, D.E. et al. 1996. *North Dakota tree handbook.* USDA NRCS ND State Soil Conservation Committee; NDSU Extension and Western Area Power Admin., Bismarck, ND

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UAF UNIVERSITY OF ALASKA FAIRBANKS

letter from the dean and the associate director:

Agricultural production today involves a broad range of environmental and natural resource sciences as they relate to food, feed and fiber production, forestry, wildlife, fisheries, and acquaculture. Worldwide, agriculture reflects the multiple and integrated use of lands to sustain growing populations with changing demands. Today we recognize that viable natural resource solutions must be both effective and sustainable, and we know that their achievement requires the collaboration of researchers, managers, policy makers, and land users.

Affecting the sustainability of ecological systems requires good communication between researchers, managers, consumers, educators, and students. This issue of *Agroborealis* illustrates how we are working to maintain the flow of information we generate. Faculty and their undergraduate and graduate students are working with all aspects of the fire-driven ecosystems of interior and southeast Alaska. Recently some undergraduates served as recorders at public meetings, while graduate students and their faculty mentors are providing information about forest regrowth, the wildland-urban interface, fuel loading, and the interactions between fire and climate, as well as humans and fire. One of our PhD graduates is working with structured wetlands as a relatively inexpensive alternative for sanitation problems in rural Alaska. Continuous information over several decades has helped potato, vegetable, and agronomic crop producers supply Alaska's food needs, and some of the crops produced for research supply the needs of food banks and food kitchens in the Fairbanks and Anchorage areas.

Just as we work toward sustainable solutions in the natural resource arena, we are challenged as well to sustain our teaching, research, and outreach efforts. On behalf of our students, faculty, and staff, I thank the many people who have consistently supported our efforts to maintain, improve, and expand our services to the state of Alaska and its people.

This year we lost one of our own, and in this issue we celebrate the life of Mike Hoyt, the student, the researcher, the forest manager, and the man. He had a passion for resource stewardship and science-based management of the land he loved. We miss him and hope the scholarship established in his honor will help carry on Mike's deeply held principles.

Sincerely,
Carol E. Lewis
Dean and Director

G. Allen Mitchell
Associate Director

Forest, fire, people, money:
A balancing act for managers

Doreen Fitzgerald

When the smoke clears and the snow falls, wildfire management usually gets little public attention, but after Alaska's severe 2004 fire season, which was more threatening than usual to human life and property, many Alaskans wanted to question and comment on wildfire issues. Some were upset about fires that were not attacked at their onset and later became hazardous to populated areas.

Although wilderness fires are a normal part of the Alaska summer, the average acres burned during 1994–2003 was 782,582. In 2004, during the state's warmest and third-driest summer on record, 696 fires burned over 6.52 million acres, according Rick DuPuis of the Alaska Department of Natural Resources (ADNR) Division of Forestry. DuPuis is the forestry division's coordinator at the Alaska Interagency Coordination Center on Fort Wainwright. The season set a state record for firefighting costs, about $106 million, but the most salient fact for the public is that many of the fires were in close proximity to Interior communities and resulted in smoke-filled days, the evacuation of several subdivisions, and disruptions for residents and tourists alike.

"Most of us associated with wildland fire in Alaska look at 2004 as the 'once in a career' season. But since wildfires are so dramatically influenced by something as unpredictable as weather, nobody discounts the chance of another 'extreme' season in the immediate future," DuPuis said. How climate warming may affect the frequency and severity of wildland fire is a research question in Alaska and elsewhere.

Sometime between mid-July or early August, the Interior's rainy season usually marks the end of the fire season, but last summer people were still waiting for heavy rains well into September. The previous record wildfire season was in 1957, when 4.94 million acres burned. That was nearly a half-century ago. Today Alaska has nearly three times the population, and many more people live in areas known as the Wildland Urban Interface, where lives and property can be threatened by fire. DuPuis said that three of the 2004 fires were declared emergency incidents by the Federal Emergency Management Agency (FEMA). "The only other FEMA declarations [for fire] in Alaska were for the Tok River fire in 1990 and the Millers Reach fire in 1996."

In Alaska initial fire management decisions are based on the "Alaska Interagency Wildland Fire Management Plan," which provides guidelines for initial attack based on the risk to human values, such as life and property. "Fire managers have discretion to deviate from the plans, but usually will not do so without concurrence from the land manager," said DuPuis.

Managers must balance the need to protect human values against the cost and risk of fighting a fire, and sometimes the higher priority need for firefighting resources elsewhere in the state. Sometimes firefighters try to suppress new fires as quickly as possible; other times, a fire is fought only to prevent it from encroaching on structures or communities, rather that with the goal of extinguishing it. Whatever the scenario, when wildfire occurs fire managers have to consider the values at risk for damage, current conditions such as weather, and their finite resources.

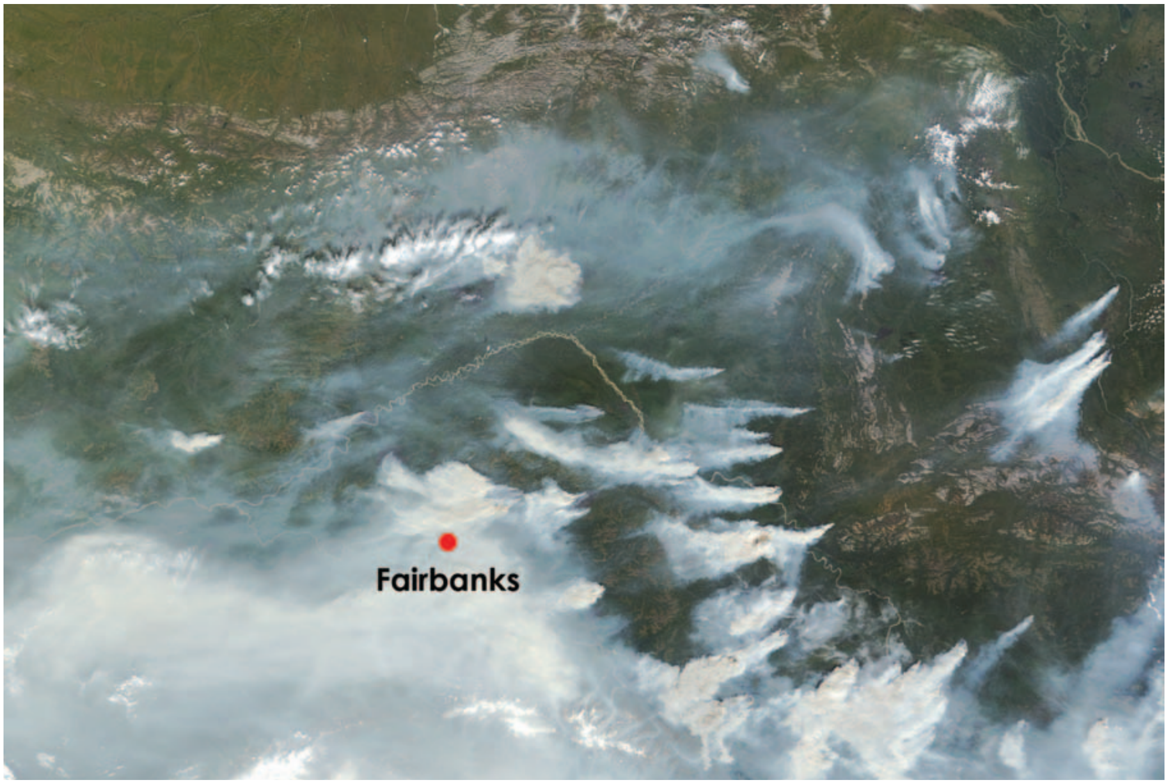
What is not possible from a cost perspective, and not desirable from a forest ecology perspective, is the suppression of all wildland fire. In fact, the forest is a little like a bonfire that builds itself—the longer it goes without fire, the greater its fuel load, and the more likely it is to ignite, either through human error or a natural cause, such as a lightning strike. In the long run, suppressing all fire can result in more intense burns (amount of heat released) or more severe burns (how deep it consumes soil duff), unless the continuity of fuels is broken up through thinning and other measures. This is of course not practical in immense stretches of forested wildland.

In November the Alaska Wildland Fire Coordinating Group held a series of community meetings to review the 2004 fire season, discuss the wildfire management plan, and take public comment, which was also accepted by mail. Meetings in the Interior, where most of the 2004 fires occurred, were held at Two Rivers, Central, Circle, Fairbanks, Venetie, Fort Yukon, Delta Junction, Eagle, Dot Lake, Tanacross, Northway, Chatanika/Poker Flats, and Tok; a meeting also was held in Anchorage. At these sessions managers briefed the public on the wildland fire management plan and its annual review process. A summary of comments and responses will be made available to the public, and is expected to be finished this spring.

Students in professor Susan Todd's natural resource management classes served as recorders at three Fairbanks area meetings. Their participation was arranged by Chris Maisch, who is the northern regional forester for the Alaska Department of Natural Resources (ADNR), Division of Forestry and a member of the advisory board for the School of Natural Resources and Agricultural Sciences (SNRAS).

The Alaska Wildland Fire Coordinating Group is responsible for statewide fire planning and coordinates Alaska's fire management effort. Because wildland fires occur on state, federal, and private land, it is composed of representatives from federal and state agencies, and Alaska Native organizations. Representing the state are the ADNR, and the departments of Fish and Game (ADFG), and Environmental Conservation (ADEC); the federal agencies are the Fish and Wildlife Service (USFWS), Bureau of Land Management (USBLM), National Park Service (USNPS), Forest Service (USFS), and Bureau of Indian Affairs (USBIA). Various Alaska Native organizations are also represented.

For management purposes, Alaska was split into thirteen different geographic areas and a separate "Area Specific



Right: Smoke from 2004 wildfires in interior Alaska is shown in this 250-meter natural color composite of MODIS data received at the University of Alaska Fairbanks by the Geographic Information Network of Alaska. The dense smoke plumes and thick haze caused an increase in the incidence of respiratory problems for many Interior residents, hampered summer tourism, and dramatically reduced summertime visibility.
— Published courtesy of the Geographic Information Network of Alaska, www.gina.alaska.edu

Alaska Interagency Wildfire Management Plan" was developed for each. In 1998 the coordinating group completed a long-term project to amend these into one plan, making it possible to understand the state's wildland fire operations without having to refer to thirteen documents. The amended plan provides one guide for management options, responsibilities, and operations, making it easier for fire suppression organizations to deploy their limited resources during active fire seasons. The amendment contains the common elements of the area-specific plans, but does not change their intent, the option selections for managers, or any fire protection option boundaries. It does not change the landowner or land manager's responsibilities and their ability to determine how fire will be managed on their lands.

The wildland fire plan establishes four options for determining initial attack priorities and responses. The goals are to provide, using available resources, the appropriate level of protection for human life, private property, and identified resources; to ensure that fire suppression costs are commensurate with values identified for protection; and to optimize the ability of landowner managers to achieve their individual management objectives. When fire occurs, the agencies jointly responsible for providing fire suppression services are the Alaska Fire Service (sponsored by USBLM), the ADNR Division of Forestry, and USFS. Although the plan options are followed whenever possible, they remain a plan; during extreme fire seasons, all fires may not be fought at their designated level due to lack of manpower or funding.

The **Critical Management** option is the highest priority for suppression action on wildland fires and pertains to areas where fire threatens human life, inhabited property, designated physical developments, and to structural resources designated as National Historic Landmarks. Fires occurring in or that immediately threaten areas with this designation are given the "highest priority for protection from wildland fires by immediate and continuing aggressive actions dependent on the availability of suppression resources."

The **Full Management** option is meant to protect cultural and historic sites, uninhabited private property, natural resource high-value areas, and other high-value areas that do not involve the protection of human life and inhabited property. Fires occurring within this designation or that immediately threaten it "receive aggressive initial attack depending on the availability of suppression resources."

The most flexible option, **Modified Management**, is intended to provide a higher level of protection when fire danger or risks are high, and a lower level of protection when fire danger or risks are low. fires within this category are evaluated on a conversion date, generally July 15, at which point, if managers concur, they would convert to limited suppression status. The intent is not to minimize acres burned, but to balance acres burned with suppression costs and to accomplish land and resource management objectives. Depending on fire danger or risk, fires in these areas may receive initial attack or periodic surveillance. Lands under Modified receive initial attack early in the fire season, but are treated as Limited (see next section) after a conversion date, typically in mid-July, when changes toward cooler, wetter weather reduce risk of developing large fires.

The **Limited Management** option is for areas where the cost of suppression may exceed the value of the resources to be protected, where fire suppression activities may have more negative effects than the fire itself, or where the exclusion of fire may be detrimental to the fire-dependent ecosystem. Fires in these areas receive periodic surveillance. Also, within the confines of land-manager policy, individual sites may receive protection. If necessary, additional suppression actions may be taken to keep a fire within the boundary of the area under this management option or to protect identified higher-value areas or sites.

State, federal, and other landowners determine the options for various sites on their lands. A digital file of the Alaska Interagency Wildland Management Plan is available at http://www.dnr.state.ak.us/forestry/pdfs/98AIFMP.pdf. A map of Alaska lands fire supression status is available at http://www.myfirecommunity.net/documetns/Appendix_B.pdf.

How wildland fire behaves

Three of the most important factors affecting fire ignition and behavior are fuel load, weather, and topography. "Obviously!" you might say, if you've ever tried to light a campfire using large pieces of wet fuel in a clearing at the top of a hill on a rainy day. But what exactly does this mean in terms of a fire's behavior?

Fuel Load. What kind and how much fuel surrounds a fire affects its spread. The fuel load (number and size of fuel pieces per area) depends on the forest's age, succession stage and species, and how much time has passed since the area's last burn. Human activities can affect the fuel load as grass replaces trees or homes are built. Small fuel loads result in low intensity fires that spread slowly. Higher fuel loads result in more intense fires that spread faster or have a longer residence time on a site, thus burning more severely. Dry fuels create fires that are harder to contain. Flashy fuels (dry grass, pine needles, dry leaves, or twigs and other dead brush) burn faster than large logs or stumps. Ease of ignition is related to the relationship of fuel surface to volume. A tree has high volume relative to its surface area; twigs ignite more easily because they have a low volume relative to their surface area (thus can dry more rapidly after rain). The spacing of fuels is also a factor. Fuels spaced slightly apart will dry out more easily and receive more oxygen; packed fuels retain more moisture, and are harder for a fire to dry. The creation of a fuel break with little or no fuel can significantly slow a fire, and combined with suppression activities, can stop one.

In an wildland-urban interface like parts of the Tanana Valley, the fire plan calls for aggressive initial attack of wildfire starts, because of the potential threat to human life and property. To counter the buildup of fuel loads in such areas, prescribed burns and various forestry practices can be used to gain the beneficial effects of wildfire: reducing fuel loads or fuel continuity and enhancing wildlife habitat. However, resources to apply these treatments are limited. On the other hand, fires may be allowed to burn on land with a limited-suppression status. When these areas are relatively close to populated ones, the possibility exists that under certain conditions a fire may become a problem fire, threatening people, which was the case with the 2004 Boundary Fire. The problems created by that fire were well reported, but there is another side of the story: from a fuels management perspective, it was a good fire, because it removed a large amount of very hazardous fuel from the interface.

Also related to fuels is vegetation type. The thesis research of SNRAS MS graduate Justin Epting, "How do vegetation types and topography affect burn severity?" has confirmed at a landscape scale the general hypothesis that a broadleaf shrub or broadleaf forest stand can act as an effective fire break, whereas black spruce stands typically have higher burn severity values. Elevation also influenced burn severity, presumably due to its control on vegetation composition. David Verbyla, professor of geographic information systems, was his major professor. Epting used remote sensing methods to investigate the study questions. Areas vegetated with spruce forest had higher burn severity than broadleaf forests and unforested areas. Higher density spruce, with its greater fuel load, had the highest burn severity values.

Weather. Moisture in the form of precipitation and humidity reduces the probability of wildfire, slows fire growth, reduces its intensity, and may extinguish it. Moisture absorbs the heat in potential fuels, so they're harder to ignite when their moisture level is high. Fires are less likely to start or grow when the humidity is high, which keeps fuels from drying out. Low rainfall creates favorable conditions for wildfires. Temperature directly affects wildfire ignition because heat, along with oxygen and fuel, are what it requires. Radiant heat from the sun heats and dries potential fuels: trees, brush, and vegetation debris. After ignition, warmer temperatures will cause a fire to burn and spread faster. During the wildland fire season, you will notice that wildfires tend to rage in the afternoon, when temperatures are highest. Researchers project that if Alaska's current climate warming trend continues, more and/or larger wildland fires are likely.

After ignition, wind affects fire behavior the most, and it is the least predictable and most problematic factor. It can cause the fire to spread faster and grow larger, and can make firefighting more difficult. Wind increases the oxygen supply to the fire and can further dry out potential fuels. A fire also generates its own wind, which can be more intense than the wind surrounding the fire. Fire spotting occurs when wind throws embers ahead of the primary fire and ignites more fires, significantly increasing the rate of spread. Wind can change a fire's direction, and crown fires occur when wind gusts raise the fire into the treetops.

Topography. The stable factor in wildland fires is topography, which can promote or retard a fire's progression; slope is the most important land feature. Usually fire travels much faster uphill than downhill, and faster up steeper slopes. The ambient wind usually flows uphill, and because the fire preheats the fuel upslope from it as the heat and smoke rise in that direction, the fire also moves upward. On a hilltop, the fire can't preheat the downhill fuel as well, so traveling downhill is more difficult, and a fire may burn out once it reaches the top of the slope.

Benefits of fire

The forest fire prevention and Smokey Bear campaign that began over 60 years ago has in some ways been too successful, promoting the idea that all wildland fire is bad. While human-error fires are not viewed as desirable, there is increasing acceptance of the positive role of fire in forest health and the idea that managing fires, rather than total suppression, is an important tool. Although last summer's largest fires were caused by lightning, humans ignite the majority of wildland fires in Alaska. In 2003, only 18 of the 357 fires on state-protected lands were sparked by lightning; the rest were ignited by people. On state lands, 80 percent of fires are human caused.

Not all fires burn everything as they move across the land, and how fire affects vegetation varies considerably depending on vegetation type and other factors. Because of this, wildland fire often creates a mosaic pattern, as it thoroughly burns some areas (high severity) and hardly touches others. This creates natural breaks in the vegetation (fuel), and this discontinuous fuel will prevent or slow the spread of future wildfires. It also diversifies habitat, which results in wildlife diversity.

Wildfire can benefit plant growth by reducing disease spread, releasing nutrients from burned plants into the ground, removing the insulating duff layer over permafrost, and exposing mineral soil to encourage new growth. Because of the way wildfires move across the landscape, they often don't burn deeply enough into the soil to kill roots of existing plants; lush new vegetation often sprouts soon after a fire, which benefits many animals.

The boreal forest has evolved and adapted to a cycle of burn, regeneration, and species succession. In the Interior, depending on location, this cycle varies from about 90 to 150 years on average. Fire, the major disturbance in the forest, maintains diverse vegetation and wildlife populations, both of which contribute to the ecosystem's overall productivity. Typically, fire creates a forest that has a mosaic pattern of single-aged stands of trees. Without fire, forest succession would result in atypical all-aged stands.

Black spruce *(Picea mariana)* forests are relatively susceptible to fire. With thin bark and shallow roots, the tree is easily killed by fire. Immediately following fire, large quantities of seeds commonly are released because the cones store some seeds until heat causes them to open fully. White spruce *(Picea glauca)* is also easily killed by fire, but it does not store seeds in its cones for more than a year. It relies on wind-dispersed seed from nearby surviving trees to colonize burned sites. For more on white spruce regeneration, see page 8. Hardwoods such as birch *(Betula neoalaskana)* or aspen *(Populus tremuloides)* can colonize a burned site by seed or sprouting.

In 2004, four of the largest wildland fires were caused by lightning strikes and cost more than $62 million to control: the 119,500-acre Solstice Complex fire (6/24–7/21); the 614,974-acre Eagle Complex fire (6/29–7/24); the 537,098-acre Boundary Fire (6/13–9/2); and the 451,152-acre Central Complex fire (7/13–9/3). DuPuis said that at the peak of the 2004 firefighting efforts, there were 2,711 people in the field, and Alaska had support coming from 46 states, two Canadian provinces and two U.S. territories. A great many of them had to be supplied off-road, which added to the expense.

Aerial view of BLM field camp at Innoko National Wildlife Refuge, showing fuel reduction burn in the background.
— photo by Leslie Kerr, courtesy U.S. Fish and Wildlife Service

The boreal forest of North America covers 1.4 billion acres. Natural resource managers who deal with wildland fire in Alaska's boreal forest have to assess and act on how it can best be managed for human values while providing the forest with the natural burns with which it has evolved. People living in the Wildland Urban Interface areas, or in any rural development, can contribute to their own wellbeing by creating a defensible space around homes and villages before wildland fire threatens (See Preparing for Wildfire on page 26).

For More Information

U.S. Bureau of Land Management Alaska Fire Service: http://fire.ak.blm.gov/

U.S. Fish and Wildlife Service, Alaska Region: http://alaska.fws.gov/

National Interagency Fire Center: http://www.nifc.gov/

USDA Forest Service: http://alaska.fws.gov/fire/

Frostfire website: http://www.fs.fed.us/pnw/fera/frostfire/

"Western Forests, Fire Risk, and Climate Change:" http://www.fs.fed.us/pnw/pubs/science-update-6.pdf

UAF research on human-fire interactions in the Alaska and Yukon Territory regional system: http://www.hfi.uaf.edu/.

Climate warming and fire, Canadian research: http://fire.cfs.nrcan.gc.ca/research/climate_change/factsheets/factsheet1_e.htm

For information about fire ecology or the ADFG habitat enhancement program, contact Dale Haggstrom (dale_haggstrom@fishgame.state.ak.us) or Thomas Paragi (tom_paragi@fishgame.state.ak.us).

Watching the trees return

Natural regeneration of the boreal forest after fire literally has made the forests that are managed today in Alaska. In the SNRAS forest sciences department, a long-term study monitoring the actual individual performance of a large population of white spruce seedlings is giving new insight into the mechanisms that govern this process of forest renewal. The Rosie Creek Fire Research Project began in 1983 following a 8,600-acre wildfire in the Bonanza Creek Experimental Forest, now also the

Top: Seven growing seasons following the fire, in October 1989, nearly all fire-killed snags are still standing and the forest floor is a dense mat of bluejoint grass, fireweed, and horsetail. White spruce regeneration is sparse and the white spruce seedlings are too small to locate.

Middle: In October 2002, nineteen growing seasons following the fire, individual broadleaf tree stems have begun to dominate. The 1983 and 1987 seed crop white spruce seedlings have emerged above the height of fallen logs, and the 1990 seed crop seedlings have become visible.

Bottom: By October 2003, the white spruce have greatly expanded following exceptionally favorable (cool and moist) summer weather. There is a large green needle mass in the white spruce from abundant moisture. Birch and aspen trees have added significant diameter growth.

— Photos by Glenn Juday

Bonanza Creek Long Term Ecological Research (LTER) site. It is currently led by forest ecology professor Glenn Juday. From 1989 through 2003, research technician Robert Solomon was responsible for measurements and the study database. Along with the white spruce study, work has been done comparing regeneration of paper birch, aspen, and spruce in burned stands. Research installations in the fire area are permanently marked and available for monitoring and integration into the expanded range of studies underway in the LTER site.

Since 1988, all white spruce seedlings in the 2.47-acre plot have been mapped and the annual survival and height growth measured. All seedlings belong to the 1983, 1987, or 1990 seed crops. The study will yield the first predictive equations of white spruce height growth as it relates to climate, seed-crop year following fire, and other factors. These numbers may be useful in setting natural reforestation standards, in calibrating models of forest growth, and in predicting forest growth under different climate scenarios. The data provides the probability that trees will reach height benchmarks in a given year and shows the very great advantage of immediate seed crops following forest disturbance. The study identifies the factors that promote and hinder white spruce establishment and early growth.

This is the longest continuing and most detailed look at the exact amount of tree regeneration and what conditions are associated with tree success in boreal Alaska. The Reserve West hectare plot used in the study is typical of highly productive upland forest sites, and the trends reported here should have wide applicability to sites managed for the production of wood products. The diary of the regeneration of the white spruce in the research plot is summarized below, along with some information on the burned stands of aspen, paper birch, and white spruce.

(1988) Although all trees were killed in the fire and these dead trees have been standing for five years, no snagfall has occurred in the burned birch stand. The burned aspen stand has experienced only a minor amount of snagfall, but has a dense understory of four-meter tall aspen suckers. The suckers have been grazed to the snowline at least once by moose.

(1989) An intensive effort resulted in location and mapping of 305 white spruce seedlings, all of which belong to two age classes, 1983 seed crop and 1987 seed crop. The project has been incorporated into the LTER database and monitoring program.

Natural regeneration mapping and measurements also have been completed on three burned hectares for aspen, white spruce, and paper birch. All seedling trees have been mapped and measured on the burned paper birch and white spruce hectares and on a subsample of two plots in the burned aspen stand. The burned white spruce stand was poorly stocked with seedling white spruce, totaling only 305 in the hectare. White spruce seedlings were patchily distributed; 35% of the study cells had no white spruce seedlings, 15% had only one, and 11% had two. On the other hand, 7% of the cells had ten or more white spruce seedlings, mainly along the northern edge of the hectare that lies within the critical 200-meter effective dispersal radius of surviving mature white spruce trees that serve as propagule sources.

In contrast, aspen reproduced about ten times more vigorously (3,000 stems in the hectare) than white spruce. Although aspen was a minor component of the stand before the fire, 56 percent of the cells had aspen stems, which in most cells were wind-borne seedlings. In portions of the stand that supported aspen before the fire, aspen sprouting was especially vigorous. Thirteen percent of the cells had 50 or more aspen, and four cells had 400 or more aspen stems. The burned birch hectare supported nearly equal numbers of aspen and paper birch stems at a low density (1,126 and 1,087 respectively), probably because of high fire severity in that portion of the burn. Paper birch stems were distributed more evenly than aspen; 74% of the cells supported paper birch; 71% had no aspen or only one; 6% of the cells had 50 or more aspen stems but no cell had 50 or more paper birch stems. Stem densities in the burned aspen stand were especially high; six cells (48% of the total cells in the subsample) were stocked with 600 or more aspen stems, a projected rate of 60,000 per hectare.

Snagfall was monitored in all burned stands. Six years after the fire, the only material that has fallen to the ground in the burned paper birch and white spruce stands has been treetops, limbs, and a very few snags. By contrast, snagfall was very dynamic in the burned aspen stand, where there was a 197 aspen snag and log population in 1988, and 48 new snagfalls this year. This year 66 white spruce trees fell; large primary falling trees, especially white spruce, often knocked down other trees. Most snagfall was associated with the gradual enlargement of one major and two minor canopy gaps, probably because of the ragged edge the gaps presented to the wind.

(1990) To date, 581 white spruce seedlings have been mapped. Work focused on locating and mapping; the additional seedlings all belong to the 1987 seed crop and their growth made them significantly more visible during the year. They face severe competition from grass and forbs, but the 1983 seed crop seedlings have reached heights of 50 centimeters or more and will soon overtop the competing vegetation. The major challenge to the near-term survival of the established spruce seedlings is snagfall. The large dead trees from the stand that burned in 1983 will begin to fall soon and may cover or affect five to ten percent of the reference stand surface area.

(1991) There are now 921 seedlings, which appear to be all the remaining ones.

(1992) Natural regeneration of white spruce depends on the conjunction of different chance events (fire, seedbed conditions, timing of seed crops).

(1993) Work focused on relocating and mapping white spruce seedlings in the reference stand, which belong to two age classes, 1983 and 1987 seed crops. The 1991 survey did not account for all seedlings; this year the count increased by 46%, apparently because 1987 seed crop seedlings grew enough during 1992 to finally become significantly more visible. Only 7 out of 100 cells in the reference plot had no seedlings, compared to 13 cells in 1990. Only 18 out of 921 seedlings measured in 1991 have died, suggesting that the seedling density is below the level at which intra-specific competition is a significant mortality factor, at least for these early years of stand development. During 1992-1993, about half of the standing snags from 1983 fell to the forest floor, many during a period of high winds in May 1993. Several of the larger seedlings were crushed by falling snags.

(1995) Mapped and measured spruce seedlings now number 1,678, including 1,459 alive and 219 that have died during the study. There are 148 new seedlings and only 16 seedling deaths during the previous year. Seedlings have germinated from 1983, 1987, and 1991 seed crops. White spruce regeneration surveys are not likely to be accurate before the fifth year; nearly all in this study have been discovered in the third through fifth years following the seed crop. The greatest risk to spruce seedlings (5.8% of all seedlings encountered) is from falling snags of the mature trees killed in the 1983 fire. About 300 (20 percent) of the seedlings alive in 1995 have lost their terminal buds or leaders, primarily due to animal (moose and snowshoe hare) browsing, but also due to mechanical damage from falling dead trees. The average height growth of 1983 seed-crop seedlings in 1994 (measured in 1995) was 11.9 centimeters, which is equal to or below 1991–1993 height growth. This reduced growth correlates with high drought-stress levels.

(1999) In the database now are 2,389 spruce, including 2,126 alive in October 1999 and 262 that died since monitoring began. Most 1983 seed crop white spruce now have excellent position and many will become new canopy trees. Only some 1987 seedlings are positioned well enough to emerge into the canopy. Hardly any 1990 seed crop seedlings will emerge until the death of overtopping vegetation, which may take a century. The spring survey measured height elongation of all spruce and a fall survey measured 1999 height growth. Spruce seedlings nearly all originated from the 1983, 1987, or 1990 seed crop. Mean spruce height growth was 6.1 cm and mean total height was 48.9 cm in 1998; corresponding figures were 8.6 cm annual growth and 55.8 cm total height in 1999. The best-performing seedlings are the 1983 seed crop, with 1998 mean height growth of 15.4 cm and 18.7 cm during 1999 for total heights of 122.6 cm and 138.6 cm in 1998 and 1999 respectively. Height growth was significantly below predictions from the 1997 trend line, probably because of drought in 1997 and 1998. Data from this stand are being used in large spatially explicit computer models of forest regeneration. This year all hardwoods (aspen and paper birch) with stem diameter greater than two centimeters were mapped and measured in one-fourth of the plot.

(2000) There are now 2,402 white spruce seedlings in the database, including 2,120 currently alive and 282 that have died. Apparently, at the low-to-moderate density of stems in the monitored portion of the stand, mortality of seedlings over the twelve-year monitoring period has been low (11.7%). In 2000, the mean height growth of all white spruce seedlings was 12.5 cm, a 146.7% increase over 1999 and the highest measured in the series. Only 17.4% (368) of seedlings alive now are from the 1983 seed crop; their mean height growth in 2000 was 24.8 cm, a 133.5% increase over 1999, for a mean total height of 161.7 cm. The 1983 seed crop seedlings are the best positioned for eventual dominance of the site, and are in transition between the ground-layer of vegetation and an emerging forest canopy. The acceleration in height growth in 2000 is correlated with significantly cooler summer temperatures in 1999 and 2000 than in the previous 25 years, and the occurrence of relatively abundant and well-timed rain in the summers of 1999 and 2000.

(2001) Mean 2001 growth of 1983 seed crop seedlings was nearly identical to growth in the 2000 season, which was the greatest of all years measured. Continued cool, and relatively moist summer climate appears to be responsible for the excellent growth. A re-evaluation of the assignments to age classes was completed.

(2002) The germination year in the database for all seedlings was reviewed and corrected. Mean 2002 growth of 1983 seed crop seedlings was the greatest yet (26 cm) reflecting the third year of optimum cool and moist summer weather. Average height of 1983 seedlings was 192 cm (76 in) and 71% of 1983 seedlings were greater than breast height (137 cm or 4.5 ft), a height that serves as a benchmark for likely future success in becoming part of the dominant tree canopy. Average height of 1987 seedlings was 66.5 cm (26 in), and 6% were taller than breast height, the first significant numbers to reach that height.

(2003) All seedlings were mapped and measured at the end of the growing season (year 15), and growth of a subsample was measured weekly. Mean height growth of 1983 seed crop seedlings (19.4 cm) was less than the previous year for the first time since 1998. Hot, dry weather stopped height growth by early to mid June. Despite the wettest July in the last century, height growth did not resume. For the 1983 seed crop, 84% of seedlings were taller than 100 cm and mean total height was 207 cm. For 1987 seeds, 34% were taller than 100 cm and mean total height was 84 cm. For the 1990 crop, 5% were taller than 100 cm and mean total height was 42 cm. Seedlings taller than 100 cm in the early years of regeneration have overtopped shrubs and herbs and have good potential to become part of the canopy if they are not overtopped in turn by hardwood trees. The best-positioned 1983 seedlings accomplished about 40% of their total height in the three climatically favorable cool and moist years of 2000-2002, demonstrating that there is not a typical seedling height growth following fire, but highly variable growth depending on the weather that is actually experienced.

(2004) Seedlings were measured in October 2004; the information is being incorporated into the database.

Modeling fuels and fire to improve management

A black spruce stand after a fire near Poor Man, Alaska, south of Ruby.
— PHOTO BY SCOTT RUPP

Forestry professor Scott Rupp and others are developing computer models to improve the information available to those who must plan for wildfire on the millions of burnable acres in Alaska and elsewhere.

Fire-mediated changes in the Arctic System: Interactions of changing climate and human activities

As human populations progressively expand into wildland areas, fire management issues are increasingly important. The same natural fire regimes (fire frequency, intensity, and size) that underlie the structure and function of many wildland areas also threaten human life and property. An understanding of the processes that control fuel accumulation, including the role of socioeconomic activities, is crucial for designing sound, effective management policies.

The National Science Foundation (NSF) has awarded Rupp and several other principal investigators a $1.35 million grant for interdisciplinary research that will examine, from a regional system perspective, the limits to resilience as directional changes are induced by biophysical and social drivers. The project will document and model how fire affects the Arctic climate system and its human residents, and particularly how human activities affect the fire regime. F. Stuart Chapin III, IAB professor of biology and wildlife, is the lead principal investigator for the work. Rupp received his PhD from UAF in 1998.

The research team will quantify how sensitive the region's boreal forest is to human perturbations of the natural fire regime and will identify how human activities affect the short- and long-term frequency and extent of fire. The proposed modeling approach aims to develop plausible scenarios of future changes in Alaska's fire regime and the consequences to society. This whole-system model will serve as an integrative and adaptive planning tool. It will provide an overarching research framework and will be a synthesis tool for applying understanding of the system to management and decision analysis issues.

The project will modify and test the ALFRESCO model so that it has the capability to consider human effects on the fire regime. The investigators will use these models to assess climate feedbacks associated with plausible scenarios of future climate and fire regime that the project will develop. The study will build on the research of Rupp and A. David McGuire of the UAF Institute of Arctic Biology (IAB): "Modeling the role of high latitude terrestrial ecosystems in the Arctic System: a retrospective analysis of Alaska as a regional system."(NSF OPP-0095024). Seed money to develop the successful proposal was provided in 2003 by the UAF EPSCoR Program (Experimental Program to Stimulate Competitive Research), a joint program of NSF and several U.S. states and territories. For more on this research, visit the website Human-Fire Interactions, http://www.hfi.uaf.edu/.

Cooperating with Rupp, Chapin, and McGuire on the new project are Amy Lovecraft, UAF professor of political science and northern studies, David Natcher of St. John's College, Newfoundland (formerly of the UAA anthropology department), and IAB postdoctoral student Sarah Trainor. (NSF 0096-0328282).

A computer model for management of fuels, human-fire interactions, and wildland fires in Alaska's boreal forest

Interior Alaska contains 140 million burnable acres and the largest national parks and wildlife refuges in the country. On average, wildland fires annually burn one million acres in the Interior and threaten the lives, property, and timber resources of Alaska's sparse but growing population. Although wildland fires threaten human values, they also are crucial for the maintenance of forest ecosystems. This work aims to provide information for wildland fire management that is mutually beneficial for both humans and natural ecosystems.

This model will integrate fuel buildup, vegetation, climate, and fire-management policy with real geography over time scales of years, decades, and centuries. It will produce mapped depictions of changes in wildland fuels, fire risk, and vegetation under multiple future scenarios of fire management, climate change, and human development. It will serve as an integrative and adaptive planning tool for land managers designing fire-management plans that can safeguard both human and natural values.

Recently this model was used to investigate how changing fire frequencies might affect the winter habitat of caribou, specifically the Nelchina caribou herd in eastern interior Alaska. This work incorporates results from a previous study, "evaluating influences of varied wildland fire regimes on caribou forage lichen abundance through state and transition models." Because caribou wintering in boreal forest ecosystems forage primarily on climax-stage fruticose lichens, and wildland fire can reduce their availability for decades, factors affecting fire regime on winter range could influence the animals' nutritional and population status. This preliminary research involved developing a spatially explicit succession model to evaluate specific objectives relative to influences of various fire and climatic regimes on abundance and distribution of caribou forage lichens. A paper on this work has been submitted to the journal Ecological Applications.

Currently working on the management computer model with Rupp are SNRAS graduate students Tom Kurkowski (MS candidate) and Paul Duffy (PhD candidate). Duffy's first thesis chapter was accepted for publication by Ecological Applications (in press). Other participating researchers are Daniel Mann, IAB research associate; Randi Jandt of the Alaska Fire Service (U.S. Bureau of Land Management); Karen Murphy of the U.S. Fish and Wildlife Service; Layne Adams of the Alaska Biological Science Center (U.S. Geological Survey); and Bruce Dale of the Alaska Department of Fish and Game. The project was highlighted by the Joint Fire Science Council in their 2003 annual summary to Congress. It is funded through 2005 by the federal Joint Fire Science Program.

Modeling fire risk for management decisions

Rupp has been working with Robert Haight of the U.S. Forest Service and Rich Howard of Assisi Software Corporation to assess the vulnerability of human populations to wildfire in the lake states of Minnesota, Wisconsin, and Michigan, where wildfire risk is high. This region has large numbers of fire ignitions and areas of fire-prone forest types. Past fire suppression and forest management has led to uncharacteristically expansive tracts of fire-susceptible ecosystems with altered age-class distributions of short-lived species (e.g., jack pine and balsam fir), changes that have produced serious forest health concerns, including insect infestations and natural senescence, resulting in increased fuel loadings and their attendant fire risk.

This research aimed to develop new approaches to regional fire risk assessment that couple ecological and social factors into a fire risk and consequence model, with an emphasis on reducing the potential for loss of life and property. The overall goal is to provide managers with a scientifically based decision-support tool for prioritizing fire risk reduction activities in a regional, landscape, and local context. The study was reported in the *Journal of Forestry*, Vol. 2, No. 7, October–November 2004.

An analysis of community vulnerability to wildfire will produce spatial data sets of current vulnerability based on biophysical-based fire risk, human settlement patterns, and suppression resources. Spatial data sets of community vulnerability to wildfire will provide critical current fire risk information to fire management personnel, as well as long-term information to both fire managers and planners. This project was extended in 2003. A spatial model has been developed for evaluating fuel treatment plans using genetic algorithms (a technique developed for spatial optimization) as a novel optimization strategy. Another peer-reviewed journal article will be submitted in February. This work was funded by the U.S. Forest Service.

Fuel load analysis and fire risk assessment for the Municipality of Anchorage

Research has demonstrated that fuel management practices will reduce fire behavior or severity. The goal of this research is to model the expected fire behavior in the Anchorage wildland-urban interface and to identify fuel inputs that can be proactively managed so as to minimize Anchorage's risk and exposure to any such fire. This research should immediately benefit Anchorage fire managers, who can use the results for that purpose. Extreme fire behavior can be reduced by selective thinning and other fuel-reduction actions.

Rupp, David Valentine, and Dan Cheyette of SNRAS and Sue Rodman of the Anchorage Fire Department cooperated on this project to inventory the fuels present in Anchorage's wildland-urban interface, create custom fuel models that accurately describe the fuels inventoried, model the expected fire behavior were a wildfire to occur in the wildland-urban interface under current forest conditions, and identify fuel conditions that should, according to our model, lessen either or both of the predicted fires extent and intensity.

MS student Dan Cheyette completed custom fuel models for the Anchorage Fire Department and Alaska Division of Forestry for the 2004 fire season. Cheyette graduated in July 2004. This project was funded by grant funds from the Anchorage Fire Department.

— Photo of smoke from the 2004 Boundary Fire, courtesy Alaska Fire Service, Bureau of Land Management

Wetlands and Wastewater Treatment in Alaska

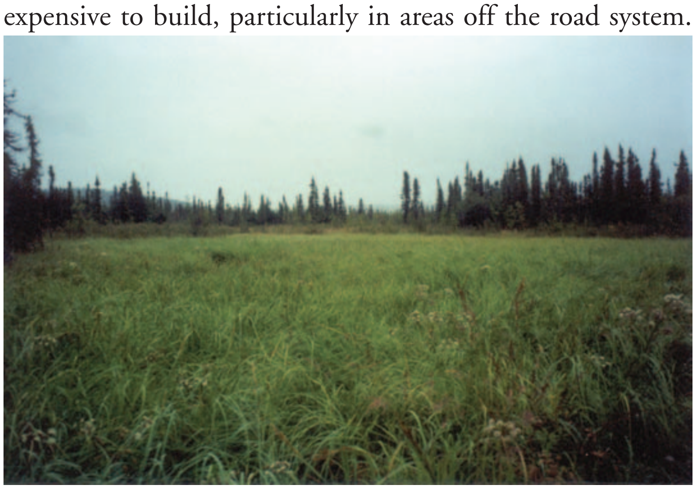
Deirdre Helfferich

Why would anyone want to construct a marsh? Dave Maddux has created a business to do just that. Swamps and marshes, it turns out, are useful for more than wilderness habitat. Because wetlands act as biological filters they are great for cleaning up wastewater, even in subarctic Alaska, Maddux explained in a recent interview. As a SNRAS graduate student, Maddux earned his PhD at UAF studying the feasibilty of using constructed wetlands for sewage wastewater treatment in a subarctic environment. His work earned him an Arctic Research Consortium of the U.S. Award for Arctic Research Excellence in 2002.

A constructed wetland is essentially a manmade swamp or marsh designed to mimic natural wetlands, but for human use as a tool to treat wastewater or runoff, attract wildlife, or to rehabilitate disturbed lands. Artificial wetlands can also be part of flood control systems. Constructed wetlands are used in low-maintenance, low-technology systems throughout the world, primarily in areas with mild winters.

Maddux explained that his research showed that these systems, if constructed properly, can be used successfully in subarctic conditions as well. "Because they're simple to maintain and relatively inexpensive to build," he said, "they may be suitable for villages and small towns in Alaska that are unable to afford or do not need conventional water treatment plants."

Conventional sewage treatment facilities can be very expensive to build, particularly in areas off the road system.



The Nulato Wastewater Treatment Facility, featuring use of a natural wetland near the town of Nulato, Alaska. This photo shows the wetland's vegetation downstream from the holding lagoons. The wetland eventually discharges into the Nulato River.
— photo by Dave Maddux

Natural wetland: a sedge marsh in the Yukon Delta National Wildlife Refuge.
—photo courtesy U.S. Fish and Wildlife Service

In rural villages, the issue of sanitation facilities is very important, and has been a political hot button for many years. Constructed wetlands may offer a relatively inexpensive and easy-to-maintain alternative for rural areas and so more such artificial marshes may be in Alaska's future.

Types of wetland

To understand how a constructed wetland works, it helps to have an idea of the different kinds of natural wetlands, and also of conventional water treatment systems.

A wetland is an *ecotone*, or bridge between two ecosystems: a dryland world and an aquatic one. This transitional environment may vary seasonally, going from dry to wet, or may consistently maintain some characteristics of both ecosytems. Wetlands are characterized by hydric soils, where free oxygen is used up by microbial action at least part of the time. Thus, plants living in wetlands must be tolerant of an absence of soil oxygen—and, of course, soggy conditions. Wetlands are recognized for their importance as wildlife habitat, particularly for waterfowl; for their capacity to protect terrestrial areas from the force of floods, storms, and tides; and for their ability to filter sediments from water. Wetlands can be an important source of fuel (peat), food, or other products, such as sedges used for thatching.

different wetland types:

bayou or **slough**: tributary stream, swamp, or shallow lake system, featuring trees and bushes (sometimes the term slough is applied to the channels in a river delta).

bog (also known as a **muskeg** or **moor**): a wetland fed primarily by precipitation, featuring peat from moss or lichen.

fen: a wetland midway between a bog and a marsh, fed by groundwater and runoff or flooding, often containing peat.

mangal, or mangrove swamp: saltwater shore forest, important as fish breeding habitat and protection of shorelines from tidal and storm erosion. (Alaska, despite its huge coastline, has no mangals, but does have saltwater marshes.)

marsh: features shallow water (fresh, brackish, or saline) with grasses, sedges, rushes, typhas such as cattails, or other herbaceous plants.

swamp: a permanently inundated area with woody vegetation such as trees or shrubs, featuring slow-moving water and often with dryland islets or hummocks.

Conventional sewage treatment: activated sludge

Conventional municipal or agricultural wastewater and sewage treatment involves three stages: primary treatment to reduce solids and oils, secondary treatment to reduce biodegradable contaminants, and tertiary fine filtration and disinfection. In conventional treatment facilities, these processes are often mechanized, although secondary treatment requires biologic processes and uses bacteria, fungi, and protozoa to break down organic matter. Sewage and wastewater or runoff are increasingly treated separately in municipal facilities. Equipment used in conventional treatment systems includes storage and aeration tanks, aerators, air separators, agitators, pumps, and sterilizing equipment such as lamps or chlorine storage tanks.

In the first stage of treatment, grit and stones that could damage equipment are removed using a channel, followed by screening to remove light solids. Sometimes these are macerated for further treatment. Then the sewage is allowed to settle in tanks or ponds. Floating material such as oil or plastic is skimmed off. The main purpose of this first stage is to create a homogenous liquid or slurry that can be treated biologically in the second stage, along with a sludge that can also be treated.

In sludge treatment, either aerobic (employing oxygen) or anaerobic (without oxygen) digestion may be used to break down the solids and to reduce the amount of pathogens present. According to Wayne Urban of Utilities Services, Inc., the company treating Fairbanks' sewage, anaerobic digestion systems are usually used for large cities because they can reduce the percentage of solids 50–60 percent, compared with 30–40 percent for aerobic systems. The greater amount of sewage in a large city also enables a treatment plant to produce recoverable quantities of methane. Methane-producing digesters are also used in agriculture, to treat manure and to produce electricity.

In the secondary stage, aerobic processes are encouraged in the sewage by using air or oxygen and biota growing on a substrate to create an environment suitable for digestion of organic materials in the wastewater or sewage. Air or oxygen, used by the digesting microorganisms, is forced through the liquid or allowed to percolate up through the filter beds from drains at their base. Urban said that his company uses a 90 percent oxygen mixture, which, although more expensive than compressed air, enables the microbes to digest the sewage much more rapidly. The microbes break down the soluble organics such as fats, sugars, short-chain organic molecules, and so on, into carbon dioxide and water; and, to some extent, they also convert ammonia to nitrate. After the sewage is aerated and decomposed, another settling stage, clarification, produces an effluent with minimal solids at the top and a flocculated or thickened sludge. This is composed of particle aggregates of up to a millimeter or more in diameter (flocs) that are created by floc-forming organisms adhering to filamentous organisms. This process of aggregation is called bioflocculation.

Flocs are living microbial communities. This biologically active sludge, or activated sludge, is sludge with a mixed community of microorganisms thriving in an aerobic, aquatic environment. Some of the sludge is returned to the filter beds or aeration tanks to seed incoming sewage with the helpful microbes, which compete with or prey upon dangerous ones, such as *Escherichia coli* bacteria. The presence and population density of these protozoans indicates the condition of the activated sludge, and ciliated species are especially instrumental in removing *E. coli* from the sewage. Even viruses (to a large extent) are removed by activated sludge. Microbes used in this secondary stage are mesophilic (preferring temperatures between 0–40˚C).

During the third treatment stage, the clarified effluent is filtered (using sand, lagooning, or reed beds) and detoxified. Nutrients, such as nitrogen and phosphorus that in high concentrations can be toxic to fish or produce algae blooms, are removed. This is done with either chemical precipitation or by using living organisms to convert nitrogen to nitrate and then to nitrogen gas. These thermophilic bacteria require a higher pH and higher temperature (40–60˚C).

Compost pile and conveyor belt at Utilities Services in Fairbanks, Alaska.
—PHOTO BY STERLING MUTH

Above: An active pile with PCV piping blowing air into the compost every ten feet. The pipe is unperforated outside of the pile, but perforated in the portion under the pile to ensure good oxygenation.
Below: Trucks and other equipment used to convey compost at various stages.
— PHOTOS BY STERLING MUTH

If required, the wastewater is then disinfected with ozone, chlorine, or ultraviolet light. Because chlorine disinfection can produce carcinogenic or other harmful chemicals that then have to be removed, many treatment plants use ozone. This can be produced as needed using oxygen and electricity, although it may be more expensive than chlorine disinfection. From here, the treated water is discharged into waterways or allowed to percolate through the ground into the water table.

Compost it!

Composting is another method of sludge treatment. Composting can produce significant heat, which helps to sterilize the sludge. The resultant product, if properly digested and composted, can be safely used for agriculture. In the Fairbanks area, composted sludge is available for sale to the public. Michele Hébert of the Cooperative Extension Service (CES) teaches in the master gardener program at University of Alaska Fairbanks, and works with CES programs on invasive plants, sustainable agriculture, and composting in Alaska. She said that even in her master gardener classes, many people are unaware that composting is possible this far north, so she shows them the composting operation at Utilities Services, one of the nation's premier examples of sludge composting.

The composting program began only six years ago. Dave Dean of Utilities Services said that the Environmental Protection Agency rated the quality of their compost as "exceptional," which means it is safe for use in vegetable gardens. The company tests for heavy metals and pathogens to ensure its safety and uses temperature probes to assure that the compost gets hot enough. It is proving so popular, Dean said, that this summer the company actually ran out. (The University of Alaska, which was doing landscaping in summer 2004, proved to be one of the largest customers.)

The treated sludge is pressed to remove excess water, mixed with wood chips (to provide carbon) and piled in large trapezoidal pyramids with air lines in it to keep it oxygenated. The compost piles are outside, and are covered with a layer of wood chips to keep them insulated from the winter cold. Utilities Services purchases the wood chips from a local supplier, Northland Wood. The wood chips must be purchased because they need to be made large enough for good air flow, according to Hébert. They are much larger than sawdust (which might be available for free from local sawmills) or the small sawdust-like chips from a shredder. The mixture composts for several months, at minimum 60 days, and then the chips are screened out of the resultant compost and reused. After another 30 days for curing, the compost is tested for pathogens. While the sludge is treated year round, the finished compost is stockpiled during the winter and sold only during the summer, as the water content of the material freezes the conveyor.

Although there are several commercial and municipal composting programs in Alaska, composting everything from dog yard wastes to lawn clippings to seafood processing wastes, the Fairbanks plant has the only sewage composting program in the state. Yet, several Alaska communities now have constructed wetlands to biodegrade their wastewater and sewage in a natural environment.

Constructed wetlands: what they are, how they work

Natural wetlands have long been used for wastewater dumping and clarification. Constructed wetlands were first used for wastewater treatment in Australia in 1904, according to a report by Fujita Research, but they didn't begin to gain in popularity for another 60 years or so. In the early 1970s, the United States increasingly began using the technology.

When constructed wetlands are used for wastewater or sewage treatment, they use treatment stages similar to conventional methods, but rely upon plants instead of filter beds to provide a substrate for the biota, and rely upon natural oxygenation and aeration instead of artificial mixing. Biological oxygen demand is a measure of how much oxygen microbes need to decompose organic matter, and is used as a parameter by regulatory agencies to indicate whether wastewater is appropriately treated and ready for discharge into the environment. Since there is usually a very large air surface to water volume ratio in wetlands, they are very good at providing sufficient oxygen to meet this demand. Maddox said that artificial sterilization is generally not needed because the process is slower than conventional treatment and harmful microbes (fecal coliforms) die out before they can reach a human host.

Maddux described two types of wetlands constructed for pollutant removal: surface-flow and subsurface-flow. In a surface-flow wetland, the effluent flows on top of the soil through the plants, as it would in a natural wetland such as a marsh. The wetland is landscaped, often with berms that create cells to control the wastewater flow rate and direction. These wetlands tend to look and function like natural wetlands. This type is the one Maddux recommends for use in subarctic regions.

In a subsurface-flow wetland, the effluent moves through a constructed medium of gravel or sand topped with plants that send their roots into the filtration bed and further remove pollutants and waste. The direction of effluent flow may be either horizontal, through and beneath the planted layer, or vertical, from the planted layer down through layers of gravel and sand and out. Subsurface flow wetlands take less area to treat the same output of wastewater. Maddux said that this type is not practical in the far north, because the medium freezes during the wintertime. Although the subsurface flow wetland thaws in summer, the gravel medium takes longer to thaw than does the surface water and the top soil layer of the surface-flow wetland.

Storage tanks or lagoons may be used in northern regions to hold wastewater until spring, when the winter's accumulation is pumped or allowed to flow into the wetland. On his company website, Maddux explains that although our summers are short, Alaska's longer days "allow for almost continuous photosynthetic production, which in turn drives microbial transformations of pollutants and gaseous exchange between the rhizosphere and the atmosphere."

A typical wetland constructed for sewage or wastewater treatment has three main sections: first, lagoons or tanks to hold and help settle out the solids; second, cells of marshes (often lined to prevent seepage) through which the effluent slowly filters; and third, a final filtration through sand and rocks before the end product is released into nearby waterways or allowed to percolate into the soil. The wetland has to be big enough to accommodate the winter's waste accumulation without being overwhelmed. Maddux found in his research that pollutant reduction appeared to be limited by the size of the wetland, and not by the extreme climatic conditions.

In the first stage, the effluent is directed into the constructed wetland. Because the water moves slowly, suspended

Left: Talkeetna constructed wetland: cell #1 with Typha latifolia *just planted prior to flooding of cell, mid-June 2003.*

Center oval: Cell #1 in the same system, showing the growth of Typha latifolia *midway through first treatment season, July 1, 2004. Note the fence: this is to prevent animals and people from wandering through the system. In particular, it helps keep moose from devouring the cattails, and prevents them from puncturing the liner with their hooves. The white PVC piping is the discharge header that distributes the effluent evenly from one side of the cell to the other. The gravel supports the discharge header, rather than soil which would turn muddy and unstable for support purposes when wet.*
—photos by Dave Maddux

Above: Camp Li-Wa constructed wetland, showing cell #1 with Typha latifolia *just planted, prior to flooding of cell, July 8, 1999.*
Below, same location: midway through the 2000 treatment season, showing one year's growth.
Bottom: same location: midway through the 2002 treatment season. Note the increased density of Typha.
—photos by Dave Maddux

solids settle out, creating sediment at the bottom of the constructed wetland, just as in a natural marsh. Many pollutants, such as phosphorus, attach to these suspended particles, and thus end up in the mud or substrate of the wetland. Microbes in the sediment help remove and transform nitrogen compounds to less harmful and more biologically available forms, breaking down ammonia and releasing nitrogen to the atmosphere. As the effluent moves past the stems and other parts of the plants, more minerals, nitrogen, and phosphorus are removed as they are absorbed by the plants.

In many areas of the United States and Canada, wetland plant nurseries cater to the needs of commercial landscapers, nonprofit and governmental agencies, or others requiring aquatic and emergent plants. In Alaska, however, there are as yet no commercial nurseries specializing in wetland flora, so Maddux relies on some local gathering from the wild and on providers from outside the state to supply him with enough for the initial plantings in his constructed wetlands. As the system becomes established, the plants reproduce and other plants seed themselves, creating a varied community suited to the characteristics of the site and the nutrients from the effluent flowing through the wetland.

Sandhill crane, Grus canadensis, *in the Yukon Delta National Wildlife Refuge. Marshes and other wetlands, artificial or natural, offer habitat to a wide variety of bird and animal life.*
— U.S. Fish and Wildlife Service

Maddux uses a variety of native Alaska plants for his constructed wetlands: buckbean *(Menyanthes trifoliata)*, bulrush *(Scirpus validus)*, carex (a type of sedge, a grasslike plant), cattail *(Typha latifolia)*, and pendant grass *(Arctophila fulva)*. In his experiments, Maddux chose the local plants mainly because of their availability. Bulrushes, sedges, and cattails are used in constructed wetlands worldwide for a broad range of wastewater treatment applications, ranging from tannery to mining to petroleum to meat packing plant wastewater and runoff, so he naturally chose to include those. Maddux found no indication that buckbean or pendant grass had been used before, but decided to try them out since they were local. They worked well in a greenhouse experiment he conducted, where the controlled conditions allowed him to determine which pollutants were introduced and how much of each type the plants took in. Bulrush did well at heavy metals uptake, as did the cattails and buckbean; in fact, Maddux said, buckbean was surprisingly good at it. In a sewage treatment situation, the important measure for the user is how clean the resultant water is, not necessarily the exact means whereby the pollutants are removed. "You're trying to remove the target pollutant from the wastewater stream," he explained, so that is what is measured at the end of the process.

Microorganisms living on the tangle of underwater vegetation feed on the nutrients and pathogens in the wastewater, as in conventional activated sludge treatment systems. This "consortium of microbes," as Maddux puts it, is termed the periphyton. "The plants' main purpose is to provide a substrate for the periphyton to attach to. They provide a carbon source, which is also important." When the plants die and decay in the fall, carbon, along with minerals or heavy metals, is released and made available to the microbial community in the wetland's sediment and water. The plants, he adds, are "only a storage place for the pollutants in the summertime." They remove about 7–10 percent of the pollutants; the rest is removed by microorganisms and natural chemical processes. For example, if the wetland bottom is oxygenated phosphorus will settle out and remain in the sediments.

In an anoxic environment, phosphorus will be released. This is why algae blooms in highly polluted lakes or streams can be so dangerous: they will use up oxygen, releasing more phosphorus and other nutrients, which in turn feed more oxygen-reducing biological cycles, which releases more phosphorus, and so on. It can take a long time for a polluted, anoxic wetland environment to return to a healthy, oxygenated one. A properly designed constructed wetland, with its controlled intake of organic matter and wastewater, and its maintainenance of an oxygenated environment, avoids this problem.

The water moving through the wetland can take anywhere from three days to three weeks to flow through the system. The longer the better, as the lower the pollutant load will be. Near Nulato, for example, there are 350 acres of natural wetland with no outlet that the village uses for wastewater and sewage treatment. Maddux helped the village create the system, the first in Alaska. Lagoons are used to store and settle the waste during the winter, and in spring and summer they empty into the wetlands. The village discharges about 72,000 gallons of waste per day into the wetland. After the water has passed through seven acres of the wetland, it can't be distinguished from the clean background water. The hydraulic retention time (hrt, or time required for water to move through the system) of most constructed wetlands is five to seven days. Nulato, with its huge acreage of wetland, has an hrt of 46 days or so, plenty of time for thorough reclamation.

In Talkeetna, where Maddux contracted with the town to create a constructed wetland for their water treatment, there is limited property available. The resulting wetland is only 3/4 acre, but processes 105,000 gallons per day. The hrt is only 3.2 days, yet the resulting water is cleaner than required by the Environmental Protection Agency, and is released into a nearby stream.

At Camp Li-Wa, a small, summer youth camp off Chena Hot Springs Road near Fairbanks, Maddux built a small wetland system designed to treat the 1100–1200 gallons of wastewater generated per day. The constructed wetland is small, only 35 by 45 feet, and takes seven days to produce treated water. Yet, this is not the smallest system Maddux has designed: home systems with primary treatment in septic tanks are quite feasible. For water usage of around 1000 gallons a month, the wetland need only be approximately 12 by 16 feet or so: a backyard marsh.

Side effects: mosquitoes and that swampy smell

Constructed wetlands don't generally produce unpleasant odors, although the primary stage lagoons may be a bit pungent during spring and fall effluent turnover. In conventional treatment the sewage is in an enclosed space, whereas wetlands and lagoons are in the open air, and this helps disperse odors. The aerobic environment and water movement of a healthy wetland is important for limiting odor. In anaerobic digestion of sewage, methane, which is very stinky indeed, can be a desired byproduct of conventional treatment, but constructed wetlands rely on aerobic processes and so there is none of this distinctive odor in a properly functioning wetland.

Mosquitoes, on the other hand, can be a significant problem in warmer areas or in places where previously there were no wetlands. The control over a constructed wetland's design, however, enables the builder to reduce its favorableness as mosquito habitat. Situating it in an open or windy area, away from the community, and the lack of stagnant water helps reduce mosquito populations. Stocking the wetland with native predators such as fish and frogs can also help. Subsurface-flow wetlands are much less suitable for mosquitoes, as there is no or little water surface available for them. Maddux wryly comments on his website, "In Alaska, where the mosquito is ubiquitous no matter where you go, the increase in the mosquito population is neglible."

The future of constructed wetlands in Alaska

The construction of wetlands for wastewater treatment, land reclamation, and creation of wildlife habitat has been growing in popularity, particularly in Australia, Europe, and the United States. By 1999, there were a thousand wetland treatment systems in operation in North America, but the technology was thought to be unfeasible in Alaska until the research conducted by Maddux and others, such as William Schnabel of the University of Alaska Anchorage, showed that the technology could be practical here. In the state's rural areas and most villages without sewage treatment facilities, disposal of sewage has been problematic. A few places, like Nulato, are near natural wetlands that might be adapted for sewage treatment. Elsewhere, when high water tables prevent the use of outhouses, sewage is dealt with using the "honey bucket method" by which domestic wastes are collected and hauled to a collection lagoon. This can result in spillage and the spread of disease. Snow melt and flooding in river plains can bring sewage-contaminated water into the community, also contributing to outbreaks of disease, such as hepatitis. Home septic systems are also common, but still result in wastes that must be removed periodically, and too many in an area can contaminate the local water table. In areas of limited drainage or permafrost (much of Alaska, in other words), septic tanks may be unfeasible.

At present, very few treatment systems using constructed wetlands have been built in Alaska: there are less than ten in the state, according to Maddux. Only three of these are for secondary sewage treatment, all designed by Maddux; the rest are used for landfill drainage (Kodiak), roadway runoff (Soldotna), and stormwater runoff (Anchorage). Yet, their relative simplicity and low cost may answer a longstanding and urgent problem for rural Alaska.

Web resources on constructed wetlands and alternative water treatment

Alaska Science Forum, "If You Build It (a Wetland), They (Pollutants) Will Stay." Ned Rozell, September 6, 1996, article #1301. Available on line at: http://www.gi.alaska.edu/ScienceForum/ASF13/1301.html.

Alternative Wetlands Technologies. Dave Maddux. www.wetlandsoptions.com

Anchorage Press, "Do Tony and Lisa Give a Crap?" Kyle Hopkins. Vol. 13, Ed. 42 October 21–October 27, 2004, cover story. Available on line at: http://www.anchoragepress.com/archives-2004/coverstoryvol13ed42.shtml

Arroyo, "Constructed Wetlands: Using Human Ingenuity, Natural Processes to Treat Water, Build Habitat." Joe Gelt. March 1997, Volume 9, No. 4. Available on line at: http://ag.arizona.edu/AZWATER/arroyo/094wet.html.

Cooperative Extension Service. Michele Hébert is an extension agent involved with the Master Gardener Program, the Sustainable Agriculture Program, and the Composting Program of the service, as well as the Alaska Committee for Noxious and Invasive Plants Management. For more information, go to: http://www.uaf.edu/coop-ext/michele/index.html.

Ecological Engineering Group. A private firm specializing in water systems and landscaping, their website provides useful background on alternative water treatment and definitions of concepts at: http://www.ecological-engineering.com/defs.html.

Environmental Science & Technology, "The Emergence of Treatment Wetlands," Stephen Cole. May 1, 1998. Volume 32, Issue 9, pp. 218 A A -223 A. Available on line at: http://pubs.acs.org/hotartcl/est/98/may/emer.html.

Fujita Research. This company provides several reports on wastewater treatment, sustainable construction, renewable energy, and urban planning. "Constructed Wetlands for wastewater treatment." January 1998. Available on line at: http://www.fujitaresearch.com/reports/wetlands.html.

Juneau Empire, "Engineered swamps could help village treat waste," Associated Press. September 29, 1999. Available on line at: http://www.juneauempire.com/stories/112999/Loc_swamps.html.

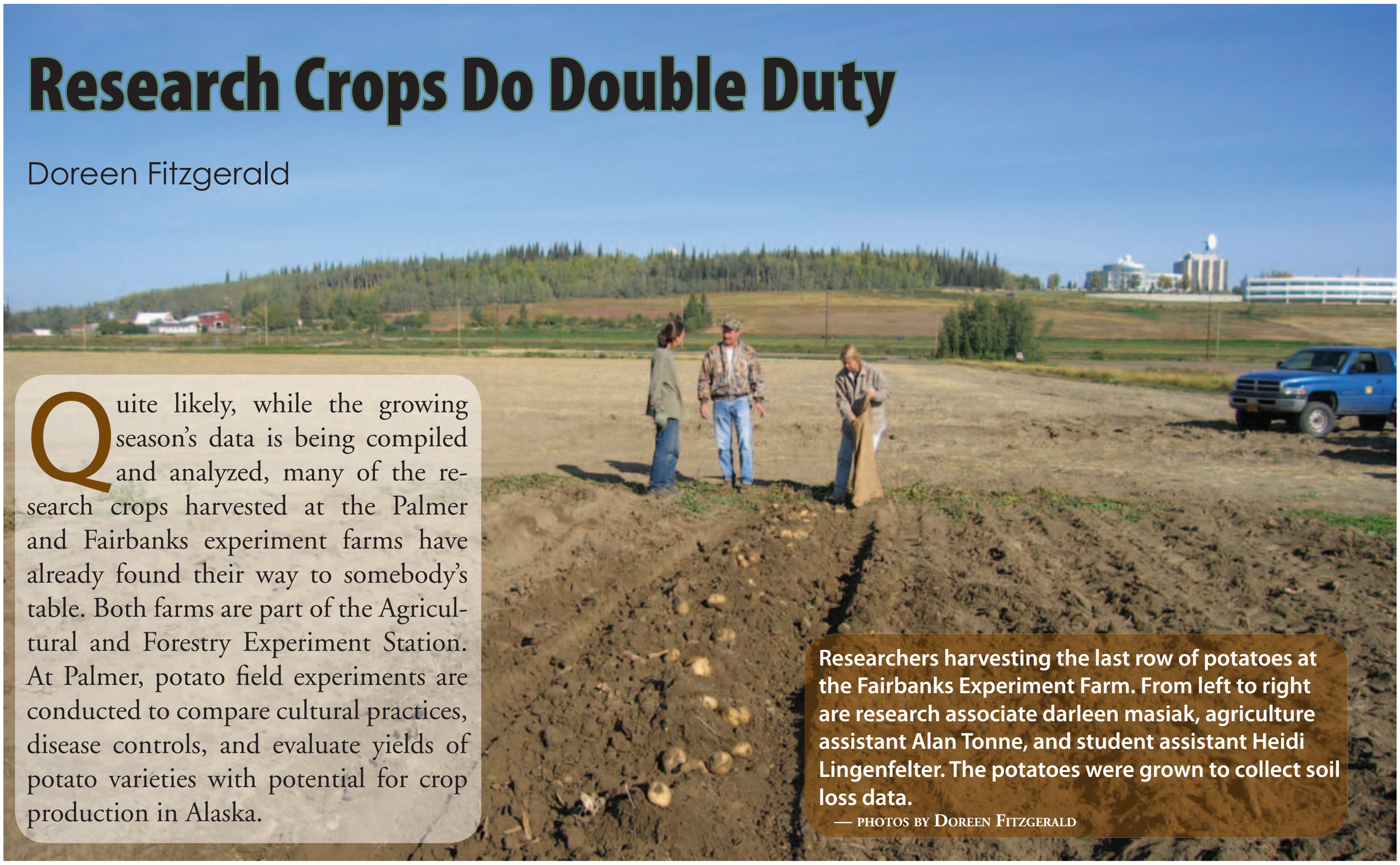
Wikipedia.org. This online cooperatively edited encyclopedia provides an ever-expanding and continuously (if idiosyncratically) updated overview of a broad range of subjects. Searches on sewage treatment, wetlands, and related topics will provide background information for interested readers.

Back ground image: Cattail, Typha latifolia *sp.*
— USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada.* Vol. 1: 68.

Research Crops Do Double Duty

Doreen Fitzgerald

Quite likely, while the growing season's data is being compiled and analyzed, many of the research crops harvested at the Palmer and Fairbanks experiment farms have already found their way to somebody's table. Both farms are part of the Agricultural and Forestry Experiment Station. At Palmer, potato field experiments are conducted to compare cultural practices, disease controls, and evaluate yields of potato varieties with potential for crop production in Alaska.



Researchers harvesting the last row of potatoes at the Fairbanks Experiment Farm. From left to right are research associate darleen masiak, agriculture assistant Alan Tonne, and student assistant Heidi Lingenfelter. The potatoes were grown to collect soil loss data.
— PHOTOS BY DOREEN FITZGERALD

"After the potatoes are graded to obtain data from the different experiments, the majority of them are donated to the Food Bank of Alaska," said Gregg Terry, agricultural assistant at the Matanuska Experiment Farm. Food Bank of Alaska distributes to about fifty food pantries and other nonprofit programs. "We are also able to donate 500 pounds of potatoes bi-weekly to Wasilla Food Pantry and occasionally to a nonprofit for a special event, such as for Thanksgiving baskets that are distributed by American Legion." The total donated from the 2004 harvest will be about 18.5 tons.

The AFES Matanuska Farm potato experiments for 2004 included a yield trial with seventeen potato varieties and demonstration plots with forty varieties. The varieties Cal White, BakeKing, Cherry Red, Russet Norkotah, Shepody, and Dark Red Noland were included in management trials. The yield of each variety was obtained for three different seed piece spacing and three different fertilization rates. The yields were compared within varieties for the different treatments and between varieties. In eight 2003 field experiments, Dark Red Norland and Red Pontiac had the highest total yield in a trial of red-skinned potato varieties. In a trial of twenty-three white and russet potato varieties, Cal-White and BakeKing had the highest total yields. The effects of seed size and seed cutting on yield was found to be small when evaluated for Russet Norkotah and Shepody. Another experiment compared seed treatments on Russet Norkotah, in the presence and absence of Rhizoctonia, a fungus that can damage potato sprouts. The yield of plants inoculated with Rhizoctonia was markedly reduced, despite the presence of fungicide seed treatments.

In 2003, Don Carling, now professor emeritus, designed the experiments. Terry conducted the experiments and collected the data. The data was analyzed by Jeff Smeenk and Roseann Leiner, both assistant professors and commercial horticulture specialists with the UAF Cooperative Extension Service. In 2004, Leiner and Smeenk designed and analyzed the experiments with Terry overseeing the planting, maintenance, and harvesting of the potato plots along with help from the farm crew.

At Fairbanks for the last three years, potatoes were among the plants grown to get interior Alaska data for the Revised Universal Soil Loss Equation (RUSLE). This information is

Left: Fairbanks Community Food Bank worker Kathy Seim (foreground) receives a potato delivery from darleen masiak and Marie Klingman.

Below left: Klingman washes dirt from roots, while student assistant Heide Lingenfelter prepares washed roots for bagging as part of a root decomposition study.

Right: Lingenfelter prepares a tray of roots to be reburied at the potato growing site.

— photos by Doreen Fitzgerald

distributed to farmers and other land managers by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture and other agencies. Data required for RUSLE include various soil properties, climate data, crop growth and cover, and crop residue cover, information that is largely lacking for Alaska crops. It is used for developing management practices that minimize soil erosion. Various crops have been grown at the Fairbanks Experiment Farm to obtain this data for interior Alaska.

At weekly intervals during the growing season, plant growth and cover parameters have been measured on barley, broccoli, potatoes, and Alaska wheatgrass (a potential revegetation crop for interior Alaska). The resulting data is incorporated into RUSLE by NRCS. Working on this project under the direction of professor Stephen Sparrow were Nikki Davis of AFES in 2003, research associate darleen masiak of SNRAS in 2003 and 2004, student Brin Spors in 2004, and SNRAS graduate Marie Klingman, who worked under Ann Rippy, of NRCS, in summer 2004.

After this year's Fairbanks potato crop was harvested, about 800 pounds were delivered to the Fairbanks Community Food Bank. In the hallway at the O'Neill building, a few bags were distributed to students and others. The research continued as potato roots were collected and washed in the lab, then put in mesh bags and reburied. They are dug up again at one-month intervals in September and October of the planting year and April through September of the following year to determine decomposition rate. This indicates how long residual plant material remains in cold soils, and hence how it might affect erosion.

"Nearly all of our leftover produce, from artichokes to zucchinis, goes to the food bank," said professor Pat Holloway at the Fairbanks Experiment Farm's Georgeson Botanical Garden. "One Extension nutrition educator, Marsha Munsel, comes in every fall and does a classroom exercise in 'where does our food come from,' and we provide the vegies and whole plants; the kids are agog over brussels sprouts!" she said, "and we often supply the Cooperative Extension Service home economists with berries and vegetables for testing recipes."

The garden's produce has other educational uses. "This year, someone in biology harvested corn plants for a classroom demonstration, and plants were used for other university classes in horticulture, ecology, and botany," Holloway said. Wade Stoddard, a Lathrop High School student, used plants from the garden to complete his science project for this year's Statewide High School Science Symposium. Plants have also been collected for classes in natural dyes. Botanical gardens and universities often request seeds of Alaska native plants, and Holloway said they even granted a Canadian request for some of our dandelion seeds. The botanical garden also has a policy whereby small amounts of seeds, rooted cuttings, and plants can be provided to local horticulture businesses to help them get started when they're interested in propagating plants for commercial production.

Agronomic crops for Alaska

Deirdre Helfferich

The search for field crops that can be successfully produced in Alaska began in territorial days, and basic research has continued since that time. At the Rampart Agricultural Experiment Station grains were grown from the year of its establishment in 1900. The first grain variety developed specifically for and in Alaska was Trapmar barley, released in 1920, and others followed: Gasser wheat, Toral oats, Lidal barley, Yukon Chief corn, Vidal wheat, Otal barley, Finaska barley, and more. Research on agronomic crops has focused on finding varieties that succeed in Alaska's climate and soils, and on developing varieties that are adapted to the state's growing conditions.

A recent publication, *Performance of Agronomic Crop Varieties in Alaska, 1978–2002,* by Robert M. Van Veldhuizen and Charles W. Knight, provides an overview of research at the Agricultural and Forestry Research Station into grains and other agronomic crops over the last quarter-century. This research bulletin (Bulletin 111) is dedicated to Frank J. Wooding, who worked for 23 years at the University of Alaska Fairbanks as an agronomist, and whose recommendations on cereal grain and turfgrass varieties, fertilizer management practices, and other crop and soil management practices are still widely used. Information in a series of circulars, *Performance of Cereal Crops in the Tanana River Valley of Alaska,* published annually from 1979 to 1986 and authored by Wooding and other researchers, is not repeated in this new publication, except for listing the varieties tested, but may provide further detail of value to farmers.

The new bulletin covers research at test sites in Fairbanks, Eielson, Delta Junction, and Palmer, where trials have been conducted on barley, oats, wheat, spelt, rye, triticale (a hybrid of wheat and rye), wild rice, canarygrass, millet, buckwheat, amaranth, field pea, canola (rapeseed), flax, safflower, meadowfoam, sunflower, and Jerusalem artichoke (sunchoke). The detailed information in the 136-page book provides farmers and researchers with a good overview of the crops that grew well—and those that did not—with appendices detailing seed suppliers and varieties tested. While the bulletin is not a crop production manual, it does give producers basic information on small grain and oilseed variety testing, information on successful cultural practices identified by the research, descriptions of the test site characteristics, and general cultural information on fertilization, tillage, pest control, harvest, and storage. The bulletin also identifies problems of infrastructure and marketing that make some crops viable only for on-farm consumption. For example, although field peas grow well, there are currently no processing facilities or elevators in Alaska set up to accept them.

Barley

Barley is the most important grain crop grown in Alaska, well adapted to the long day length and short growing season. It is primarily grown for animal feed, but malting and hulless varieties could fill niche markets. Overviews of research on spring feed barley, winter feed barley, hulless barley, and malting barley varieties are included in the bulletin.

Oats

Oats are the second most important grain crop in Alaska after barley, and are also well adapted to the state's growing conditions. Oats mature seven to ten days later than barley, germinate well in cold and wet soils, and can better tolerate acidic soils than barley or wheat. The bulletin includes overviews of research on spring feed oats and hulless oats.

Wheat and spelt

Because wheat requires a long growing season, it is of limited importance as a grain crop in Alaska. Wheat takes much longer to mature than barley or oats, and maturity is highly dependent on climate. The main uses in Alaska are in niche markets for human consumption and, secondarily, as nonruminant animal feeds. Early maturing hard red spring wheat varieties are best adapted for the state's growing conditions, but are considered somewhat marginal. Overviews included in the bulletin are of spring wheat, winter wheat, and spelt.

Rye and triticale

Rye is even less suitable for Alaska than wheat, due to its long growing season requirement and lower yield. Other problems include its susceptibility to head shatter and to ergot, which is the most prevalent fungal disease that has been found on rye in Alaska. The bulletin includes overviews of spring rye, winter rye, spring triticale, and winter triticale.

Wild rice

There are several problems with production of wild rice in Alaska: lack of privately owned lakes or ponds in which to grow the crop; cold water temperatures that reduce the already short growing season; poor competitiveness with native aquatic plants; consumption by migratory waterfowl, moose, and muskrat; and the labor-intensive nature of cultivation. There is a small niche market for wild rice and it commands a high price, but the high cost of production tends to make it an economically unviable crop for Alaska producers.

Canarygrass

Annual canarygrass or canaryseed is used for commercial feed mixes for birds and is a relatively new niche crop in Alaska. No serious diseases have yet been found on Alaska canarygrass. There are no birdseed processing facilities in the state yet, but there is a large niche market that is now supplied with imported prepackaged birdseed mix.

Millet

Proso, Foxtail, and Japanese millet were tested. Millet grows well under drought conditions and has a shallow but widespread root system, but does not germinate when soil temperatures are below 65°F. It is easily killed by light frost, doesn't compete well with spring weeds, is difficult to harvest, and losses due to head shatter and predation by migratory waterfowl are high.

Buckwheat

This crop has a limited market in Alaska, where it is primarily used as a green manure crop, with limited secondary use by honey producers for a dark, strong-flavored specialty honey. There are few disease or insect pests that attack buckwheat.

Amaranth

Amaranth is grown as a grain, leafy vegetable, or forage crop. It is a warm-season plant requiring warm soil and a long growing season, does not compete well with spring weeds, and is difficult to harvest due to thick plant material and tiny seed size. There is a small health food niche market that commands a high price for producers, but the high production costs and the difficulty of consistently producing a high-quality, high-value crop make it economically unviable for Alaska.

Field pea

Green and yellow dry peas have been grown successfully for many years in Alaska as a forage crop. Although there is a small health food niche market in Alaska for processed whole or split peas, there are at present no processing facilities or elevators in the state set up to accept field peas.

Canola

This crop is still considered marginal for Alaska. Grown primarily for its oil, it is susceptible to weeds, insect pests, and several fungal diseases. Although it can be produced, there are no facilities to process the oil, nor are there any elevators set up to take the seed. Polish and Argentine varieties were tested.

Flax

Both oilseed and fiber flax varieties were tested. Flax is still considered a marginal crop for Alaska. It competes poorly with weeds, and there are no oil-processing facilities or elevators for flax in Alaska. However, in good years, the oilseed variety 'Norlin' produced acceptable yields. Fiber flax is later maturing than oilseed flax, and no fiber varieties consistently produced acceptable yields.

Safflower

Safflower is relatively free of disease in Alaska, but its late maturity requires harvest before the optimal seed moisture content for long-term storage, so supplemental drying is required. Safflower is a marginal crop for Alaska; no varieties tested consistently produced a viable crop.

Meadowfoam

This crop, grown for the industrial oil market, is considered marginal for Alaska. No varieties tested produced a viable crop.

Sunflower

Both common and sunwheat varieties of sunflower were tested. No common sunflower varieties consistently produced a viable crop, but selection since 1993 for an early maturing dwarf sunwheat variety shows some promise of developing a crop for Alaska.

Jerusalem artichoke

Producing sunchokes for tubers in Alaska is problematic: because this is a long-season crop that requires short days with a dark period to produce tubers, killing frosts often occur before the tubers are set. Harvest is difficult due to thick plant material and small tuber size. Due to the high production cost and the unlikelihood of consistently producing a high-quality, high-value crop, it is not economically viable for Alaska.

As the authors note in their introduction, "There is no such thing as the perfect variety for Alaska. Some varieties are adapted to a wide range of climatic and geographic locations, while others are more specific in their adaptation. The change in elevation of a few hundred feet or a move of a few miles can have a considerable effect on the performance of any variety." Variations in cultural practices and the photoperiod sensitivity of a given crop affect the success of a selected cultivar or species in the far northern environment of Alaska. The authors for this reason caution that a crop failure of a specific variety may not mean that the crop is unsuitable anywhere in the state; it may mean that another location might work better. Still, test varieties with crops that have failed are probably less likely to do well.

Bulletin 111 is available on line at: http://www.uaf.edu/snras/afes/pubs/bul/index.html, or you can request a PDF file of the publication. If you cannot access the digital version and need a copy, contact the Agricultural and Forestry Experiment Station Publications Office.

Background image, this page: Jerusalem artichoke, Helianthus tuberosus *L.*

— USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada.* Vol. 3: 486.

Remembering Mike

Alaska forester and sportsman Mike Hoyt is remembered by many as a good friend, a widely respected professional, and an enthusiastic supporter of natural resource education. In late July, Hoyt died unexpectedly of a severe cerebral aneurysm. He was 45.

Michael John Hoyt was born in Grand Rapids, Michigan, to Kenneth and Eloise (Lockin) Hoyt on May 10, 1959. After moving to Alaska in 1980, he earned a bachelor's degree in natural resource management (1985) at the University of Alaska Fairbanks. He later earned a master of science degree in forest sciences (1992) from UAF. At the time of his death, Hoyt was vice chairman of the advisory board for the School of Natural Resources and Agricultural Sciences (SNRAS). He had served on the board since 2001.

"I knew Mike when he was an undergraduate in natural resources management and later was a member of his MS graduate committee," said John Fox, professor of land resources management. "He had that combination of no-nonsense savvy, intelligence, and perseverance that makes for a great forestry student and a fun person to be around. I know some of his friends called him Iron Mike, ostensibly because he insisted on lugging cast iron cookware on hunting and fishing trips. But I think we all saw that label as appropriate for his strength of character and unwavering loyalty to his friends, including the institutions he was affiliated with, such as the Society of American Foresters and SNRAS. Mike, above all, was one of the 'good guys.' It was an honor to have known him."

After college Mike lived and worked in Homer, Fairbanks, and elsewhere in Alaska. He was employed by Tanana Chiefs Conference 1989 to 1994, Hedstrom Lumber Co. (Minnesota) 1994 to 1996, and was a lands and resource specialist at Chugach Alaska Corporation 1997 to 2004. He also worked as a commercial fisherman out of Homer and Bristol Bay, and held various other jobs in high school and college.

Rick Rogers of Chugach Alaska Corporation describes himself as Mike's "friend, co-worker, and technically his 'boss.'" "I always respected Mike's land stewardship ethic," he said. "He was able to apply a kind of 'pragmatic idealism' to the everyday challenges of land and resource management issues in Alaska. He helped people figure out how to get things done in a way that leaves a legacy to be proud of. He was passionate that the bounties of Alaska's rich resources were to be used, but with care. Polarized either-or natural resource policy disputes frustrated Mike because he firmly believed in multiple use as the best way to optimize human benefits from the land. I really miss him," Rogers said, "as a colleague, but even more as a friend."

In recent communications, several of Mike's friends talked about his enthusiasm for life. "Mike lived life with gusto and really had a passion for great adventures in the outdoors," Rogers said. "I'm grateful I shared a few adventures with him, and it gives me some comfort to know that on his final day he was truly in his element, floating the Kenai River on a bluebird day with lots of fish on, all in the company of both new and long-time friends."

"My heart is still heavy with Mike's passing," said Steve Ulvi, who described Hoyt as his best friend. "I know that if we were hearing these accolades together, we would be laughing heartily. I met Mike while he was cooking up copious quantities of halibut and moose ribs one frosty winter night in 1990 in a cabin on the outskirts of Fairbanks. I learned that he labored to finish crunching field data on birch growth for his forestry masters. Over the years, our conversations ranged widely and continued until his death, as we elbowed up to many a riverside campfire or diner counter.

"Mike was a trusted family friend and real Alaskan by any measure," Ulvi said. "He cared deeply and kept an open mind in debating the use of Alaska's natural resources and protection of diverse values. He sought collaborative solutions in land and forestry management issues and understood the value of sustainable uses. He knew the wild nature of the north from direct experience. He could comfortably don a tie and sport coat to meet with other land managers over GIS maps, or sweat profusely while cruising timber in a well-worn Filson vest and corks."

After Hoyt was stricken, he was flown from Soldotna to Providence Medical Center in Anchorage, where he died July 26, 2004. In accordance with his wishes, an organ donation was made to Life Alaska. A July 31 memorial service in Anchorage was followed by a gathering at Chugach Alaska Corporation. Hoyt is survived by his mother, Eloise Hoyt of Michigan; sisters Laurie Huffman and family of Oregon; Amy Powers and family of Michigan, brothers Ken (Duff) Hoyt and family of Homer, Alaska; Steve Hoyt and family of Montana; former wife Mara Kimmel of Anchorage; six nephews and four nieces. He was preceded in death by his father, Ken.

Rogers remembers Hoyt as someone to whom people really mattered. "You always sensed that he really cared about you. He was constantly talking about his friends and his family, and he loved kids. He told tales of his nephews and nieces, and took a sincere interest in the interests, hobbies, and new experiences of my children."

In recognition of Hoyt's many contributions to natural resources in Alaska, an existing Cook Inlet Chapter of the Society of American Foresters scholarship at UAF was renamed the Mike Hoyt SAF Scholarship. It incorporates existing funds and ongoing memorial donations from Hoyt's family, friends, and colleagues.

"I think the scholarship is a fitting legacy," said Rogers. "Mike cared about the university because he knew it takes well-educated resource professionals to guide resource management decisions for Alaska. I hope the future students receiving financial help from the Mike Hoyt scholarship appreciate the passion for resource stewardship and science-based management that Mike held so dear."

Continued on the next page

“Beyond the pitfalls of politics and greed in modern issues,” said Ulvi, “Mike and those like him carry forth in the best traditions of Pinchot and Leopold, and this school, to focus on the inseparable relationships of humans and nature on the Last Frontier. We hope that this scholarship helps others deeply inspired by Alaska to carry on where Mike had to leave off.” Ulvi is park ranger and management assistant for the National Park Service, Gates of the Arctic National Park and Preserve.

The Hoyt scholarship is awarded to students in natural resources management who have chosen the forestry option. Scholarship details are available from UAF Financial Aid. Donations to the fund may be made through the UAF Advancement Services office, P.O. Box 757530, Fairbanks, AK 99775 (907.474.6402, or 1.800.UAF.GIVE) or on line at http://www.uaf.edu/giving/).

— story by Doreen Fitzgerald

Mike Hoyt at Chug Bay.
— PHOTO COURTESY FAMILY OF MIKE HOYT

Wilmking and his dog Flocke.
— PHOTO BY GABY WILMKING

Wilmking wins prize

UAF graduate Martin Wilmking has received the prestigious Sofja Kovalevskaja award for outstanding young researchers. The award, one of the most highly endowed German scientific prizes, is granted by the Alexander von Humboldt Foundation in Germany and funded by Germany’s Federal Ministry for Education and Research. The 2004 recipients will receive funding of up to €1.2 million during the period 2004 to 2007. This year’s prize winners represent the United States, Belgium, China, Germany, Italy, and Poland.

At UAF Wilmking earned an interdisciplinary PhD in forest ecology in 2003. His research committee was directed by professor Glenn Juday of the forest sciences department in the School of Natural Resources and Agricultural Sciences.

“The Alexander von Humboldt Foundation has made a really good selection,” said Juday. “During his time in Alaska, Martin was always a great explorer, always anxious to push on into the unknown and never satisfied with the obvious. He did his Alaska project in a cooperative framework, and I never met anyone who wasn’t really glad to be working with him. It’s always a pleasure to mentor people like that.”

Wilmking was born in Germany in 1972 and studied at Potsdam University before attending UAF. He currently holds a postdoctoral fellowship at Columbia University that is sponsored by the National Oceanic and Atmospheric Administration Postdoctoral Program in Climate and Global Change.

The intent of the Kovalevskaja award is to internationalize German research while supporting scientists and scholars in the early stages of their careers. It enables young scientists to conduct research they choose, finance their own work groups at German research institutions, and cover their living expenses. Along with Wilmking, ten others received the award for projects involving such diverse subjects as particle physics, astrophysics, biochemistry, and Egyptology.

Wilmking’s proposal, the only one in ecology, concerns carbon exchange and balance in the peat lands of northern Europe and Siberia and their role in the global climate system and climate change. Although northern peat lands cover a large region of the earth, they have been investigated far less than forests. The major questions are how climate warming is affecting the large amounts of carbon bound in the peat lands and how these areas are interacting with the atmosphere. Wilmking previously has investigated regional sequences of global processes in arctic Alaska, Russia, and Mongolia. His project will both strengthen existing collaboration and create new, supra-regional cooperation and contacts. While in Germany, Wilmking will be hosted by the Institute of Botany at Greifswald University.

— story by Doreen Fitzgerald

Preparing for Wildfire!

a short guide for homeowners

The following advice was adapted from information at http://www.firewise.org, the Firewise Alaska publication of the Alaska Wildfire Coordinating Group, the *Homeowner's Firewise Guide*, Anchorage Fire Dept. Wildfire Mitigation Office (www.muni.org/fire1/wildfire.cfm); the California Dept. of Forestry and Fire Protection, and the *FireSmart Home Owners Manual* published by the British Columbia Forest Service Protection Program. These tips will variously apply, depending on whether your home is in an urban or wilderness setting, or within the wilderness-urban interface. The Firewise Alaska publication covers fire-wise landscaping, construction, emergency water supply, access and signs, home planning, and what to do when wildfire threatens.

Control vegetation and fuel load before confronted with wildfire

Create a defensible space around your home. For homes on a slope of greater than 30 percent, on the downhill side increase the distances for these defensible space guidelines.

• From 30 to 100 feet of the structure thin conifers to 15 feet between extending branches; prune limbs of remaining conifers to at least 8 feet above the ground; remove shrubs underneath trees; if possible, water trees at dripline; thin regenerating conifers and prune lower branches; remove all downed woody fuels greater than 3 inches in diameter.

• From 10 to 30 feet of the structure thin conifers to 15 feet between extending branches; prune limbs of mature conifers to at least 8 feet above the ground, remove shrubs underneath trees; water trees at drip line; thin regenerating conifers and prune lower branches; maintain lawn at 3 inches high or less and keep well watered; remove all dry, downed woody fuels.

• Prune tree limbs so the lowest is between 6 to 10 feet from the ground (15 feet on large trees with understory ladder fuels.

• Within 10 feet of structure remove all trees and dry, downed woody fuels; maintain lawn at 3 inches high or less and keep well watered.

• Immediately adjacent to the house, create three-foot-wide break of noncombustible or low-combustible materials: fire resistant plants, gravel or mineral soil, etc. Use no bark or wood-chip mulch in this area.

• Create fuel breaks: driveways, gravel walkways, or lawns.

• When planting trees, space them carefully and choose fire-resistant species.

• Eliminate small trees and plants growing under trees. These "ladder fuels" allow ground fires to jump into tree crowns.

• Stack firewood at least 15 feet away from your house and other buildings; provide clearance around wood piles.

• Remove leaf clutter from your roof and yard; keep rain gutters clear of debris at all times; keep roof surfaces clear of pine needles, leaves, and debris at all times.

• Mow regularly and dispose of cuttings and debris promptly, according to local regulations.

• Keep trees adjacent to buildings free of dead, dying, or overhanging branches; Keep all trees and shrub limbs trimmed to prevent them from contacting electrical wires or overhanging your chimney. Hire a professional to trim around live power lines.

• Vegetation should be cleared well back from power lines, propane tanks and other fuel supplies.

• Make trellises of nonflammable metal.

Follow building and maintenance guidelines

• Adhere to all local fire and building codes and weed abatement ordinances. Observe local regulations regarding vegetative clearances and fire safety equipment requirements.

• Wherever possible, use approved fire-resistant or non-combustible materials when building, renovating, or retrofitting structures (this is **extremely important for roofing** materials).

• Have at least two ground-level doors as safety exits.

• Maintain at least two means of escape (doors/egress-size windows) in each room.

• Prevent sparks from entering your house by covering vents with wire mesh no larger than 1/8 inch.

• Install spark arresters for each chimney. Clean chimneys and check and maintain spark arresters twice a year.

• Remove any combustible materials that are stored under decks or other elevated structures.

• Store combustible or flammable materials in approved containers and use flammable liquids properly.

• Label and locate liquefied petroleum gas (LPG) or propane tanks or any fuel storage containers at least 30 feet from a structure. Use stone or iron instead of wood for cribs under tanks. If you store gasoline, label it.

• Clear flammable vegetation at least 10 feet around all such tanks.

• Park all-terrain vehicles, snowmobiles, and other machinery away from the house.

• Locate burn barrels on mineral soil well away from buildings and other combustible items. The barrel should have proper ventilation, screens and should never be left burning unattended. For safer disposal, bring your debris to a landfill or dumpster site.

• Regularly maintain your irrigation system. In rural areas, a homemade water tank can be made and kept filled during the fire season.

• Keep vegetation well-watered, especially during periods of high fire danger.

• Regularly maintain garden equipment and refuel it carefully.

• Check your generator and hose, as applicable and keep in good repair.

• Make evacuation plans with family members that include several options, an outside meeting place, and a contact person. Practice regularly.

• Keep battery-operated radios, flashlights, and extra fresh batteries on hand.

• Store all important papers in a fireproof container or keep copies at another location.

When wildfire threatens:

• Listen to the radio for the latest emergency information.

• If you have a ladder, prop it against the house so you and firefighters have access to roof.

• If hoses and adequate water are available, set them up. Fill buckets with water.

• Remove combustible materials from the area surrounding your house (lawn chairs, tables, etc.)

• Turn a light on in each room for visibility in case of smoke.

• Close all doors and windows; do **not** lock them.

• Open or take down flammable drapes and curtains.

• Close all blinds and nonflammable window coverings.

• Move upholstered furniture away from windows and sliding glass doors.

• Be ready to evacuate all family members and pets when requested to do so. Secure other animals if possible.

• Turn off air conditioning and air circulation systems.

• If you have electrical garage doors, open and deactivate or detach them, back your car in, and leave the keys in the ignition.

After a fire:

• Check with fire officials before attempting to return to your home.

• Use caution when re-entering a burned area; flare-ups can occur.

• Check grounds for hot spots (smoldering stumps and vegetation). Use your buckets of water.

• Check the roof and exterior areas for sparks and embers.

• Check the attic and throughout the house for hidden burning sparks and embers.

• Continue to check for problem areas for several days and contact 911 if any danger is perceived.

• If the burn was extensive, watch for soil erosion around your home. Consult local experts ways to restore and replant your land with fire-wise landscaping.

Fire-resistant landscaping

Along with building and maintenance care, thoughtful plantings will help you reduce the fuel available to any fire approaching your property to reduce fire risk and provide a safety zone should firefighters need to protect it. The type of landscape vegetation near your home is important, as are the arrangement, spacing, and maintenance of vegetation. Plant to avoid fuel buildup near structures, and water plantings during dry periods.

Landscape with low volumes of vegetation: sparse, deciduous trees rather than dense forest or shrubs. In heavily wooded areas, remove some of the trees to decrease the fire hazard and improve growing conditions. Remove dead, weak, or diseased trees. Neighbors can work together to clear common areas between houses and prune areas of heavy vegetation that are a threat to homes and other structures.

Although any type of vegetation is combustible under the right circumstances, some plants are more fire resistant than others. Of plants that grow naturally on Alaska property, many are highly flammable during the summer and can actually fuel a wildland fire, causing it to spread rapidly through a neighborhood. One of the easiest and most effective ways to create a defensible space is get rid of the more flammable vegetation within 30 feet of your home. Replace it with low-growing, fire-resistant plants. Base plant selection on fire resistance and ease of maintenance as well as looks. In general, fire-resistant plants grow close to the ground, have a low sap or resin content, grow without accumulating dead branches, needles, or leaves; are easily maintained and pruned; and may be drought tolerant. The condition of the plants around your home (growth form) and water status is also important. Plants with open growth forms, no dead wood, and well watered are much less likely to burn.

Plants that ignite readily and burn intensely include: resinous plants such as spruce, pine, juniper, and fir; plants that contain waxes, terpenes, or oils; blade-leaved or needle-leaved evergreens; plants with stiff and leathery or fine and lacy leaves; plants with leaves that are aromatic when crushed; plants with gummy, resinous sap with a strong odor.

Properly placed and maintained, the plants listed below will contribute a fire-wise landscape. Note that these plants may not be appropriate for all locations; check horticultural references and your local Cooperative Extension Service (CES) for information on growing requirements. Plants marked with an asterisk are native to Alaska. Contact the Alaska Division of Forestry's Alaska Community Forestry Program or CES Service for more information on plant selection for your area and plant maintenance. The list below was adapted by professor Patricia Holloway for interior Alaska from the publication *Firewise Alaska*.

Shrubs

Currant *(Ribes alpinum, R. triste*, R. nigrum*)*
Flowering almond *(Prunus triloba)*
Peking cotoneaster *(Cotoneaster acutifolius)*
Lilac (*Syringa villosa*, 'Preston' and other hybrids)
Honeysuckle *(Lonicera tatarica)*
Potentilla *Potentilla fruticosa**
Rose (*Rosa rugosa, R. acicularis*,* and hybrids)
Serviceberry *(Amelanchier alnifolia*)*
Silverberry *(Eleagnus comutata*)*
Spirea (*Spirea* x *vanhouttei*, *S. billiardi, S. chamaedryfolia, S. douglasii, S. stevenii**)
Viburnum *(Viburnum edule,* V. trilobum)*
Amur maple (*Acer tatarica* spp. Ginnala)
Mountain ash *(Sorbus scopulina,* S. aucuparia)*

Trees

Amur chokecherry *(Prunus maackii)*
Apple and crabapple (*Malus* spp.)
Siberian crabapple *(Malus baccata)*
Birch *(Betula papyrifera*)*
Chokecherry *(Prunus virginiana)*
Siberian elm *(Ulmus sibirica)*
Larch *(Larix sibirica, L. laricina*)*
Mayday tree, European birdcherry *(Prunus padus)*
Quaking aspen *(Populus tremuloides*)*

Ground covers and perennials

Bearberry, Kinnikinnick *(Arctostaphylos uva-ursi*)*
Bergenia *(Bergenia cordifolia)*
Bleeding heart *(Dicentra spectabilis)*
Chocolate lily *(Fritillaria camschatcensis*)*
Bunchberry *(Cornus canadensis,* C. suecica*)*
Ferns, native and non-native
Goutweed *(Aegopodium podagraria)*
Iris *(Iris setosa*)*
Jacob's ladder *(Polemonium acutiflorum*)*
Beautiful jacob's ladder *(Polemonium pulcherrimum*)*
Johnny-jump-up *(Viola tricolor)*
Lily of the valley (Convallaria majalis)
Nagoonberry (*Rubus arcticus**, 'Kenai Carpet')
Rhubarb *(Rheum rhabarbarum)*
Spike Speedwell *(Veronica spicata)*
Yarrow *(Achillea millefolium, Achillea ptarmica* 'The Pearl')
Tulip *(Tulipa tarda)*
Wild strawberry *(Fragaria virginiana*)*
Arnica *(Arnica frigida* A. alpina*)*
Siberian aster *(Aster sibiricus*)*
Bluebell *(Campanula lasiocarpa*, C. rotundifolia*)*
Asiatic hybrid lilies (*Lilium* spp.)
Peony (*Paeonia* spp.)
Columbine (*Aquilegia* sp. hybrids)
Eastern daylily *(Hemerocallis fulva)*
Maltese cross *(Lychnis chalcedonica)*
Globeflower *(Trollius europaeus, T. chinensis)*

Top: Viola tricolor / *Johnny-jump-up*
— photo © 1999 Dean Wm. Taylor

Above: red amur maple
— photo courtesy USDA-NRCS PLANTS Database / Herman, D.E. et al. 1996. *North Dakota tree handbook*. USDA NRCS ND State Soil Conservation Committee; NDSU Extension and Western Area Power Admin., Bismarck, ND.

Below left: Athyrium filix-femina *(L.) Roth ssp.* cyclosorum *(Rupr.) C. Christens / subarctic ladyfern*
— photo courtesy J.S. Peterson @ USDA-NRCS PLANTS Database

Below middle: green amur maple (siberian maple)
— photo courtesy USDA-NRCS PLANTS Database / Herman, D.E. et al. 1996. *North Dakota tree handbook*. USDA NRCS ND State Soil Conservation Committee; NDSU Extension and Western Area Power Admin., Bismarck, ND.

Below right: Cornus canadensis *L. / Siberian dogwood, bunchberry dogwood*
— photo courtesy Gary A. Monroe @ USDA-NRCS PLANTS Database

Who is B.O.B.?

Connie Harris with Deirdre Helfferich

The latest high visibility addition to research at SNRAS has been nicknamed B.O.B. The initals stand for Bi-camera Observation Blimp, and it is used for aerial photography. The blimp has a new trailer to accommodate assignments away from its home at the experiment farm in Palmer. Dr. Norman R. Harris is responsible for developing the current incarnation of this new technology and bringing it to the state of Alaska.

B.O.B.'s specifications include one digital camera, one 35mm camera for use with infrared film, and remote control trigger, all attached to a gondola that hangs from the bottom of the blimp. Controlled by the wind direction and the person holding onto the tether lines, it has a limit of 600 feet (per FAA regulations). It is 15 feet long, approximately six feet wide, and when filled with helium is capable of lifting 9.5 pounds.

The gondola, carrying two cameras. The most visible camera is a Canon Rebel 2000 film camera that is usually loaded with color-infrared film. The film is scanned into the computer to create a 30MB file with a typical ground resolution of about 3 cm. The other camera (partially hidden) is an Olympus C-5050 (5 megapixel) digital camera. The image is 15MB in size with a typical round resolution of about 5 cm. The digital camera broadcasts a live-video picture to a 5-inch monitor so the operator can see what it is imaging. The cameras are triggered by small aircraft-style radio-controlled servos.
— PHOTO COURTESY NORMAN R. HARRIS

B.O.B. the blimp, sporting the UAF logo and carrying a lightweight gondola full of cameras used by SNRAS scientists in their research.
— PHOTO COURTESY NORMAN R. HARRIS

B.O.B. has a history with Harris dating back to 1993,with its first incarnation at Oregon State University. The earliest B.O.B. was used for studying forage production in agroforests to determine growth patterns around trees. It was then used to study sagebrush/grass communities in eastern Oregon and invasive plants along the Oregon coast. Once other researchers and students saw the results from this technology, the demands for B.O.B. increased, resulting in a class teaching use of blimps for monitoring riparian ecosystems using GIS remote sensing. B.O.B.'s pictures were used for the analysis, and ground truthing, or comparative sampling at ground level, was done to verify the information in the photos. After too many close encounters with prickly gorse, the next version was purchased. Fine tuning continues to improve the technology with new lenses for infrared, a smaller gondola, and video links to see the scene the digital camera is viewing.

Using low-level aerial photography the resolution and detail is tremendous, opening up a wide range of uses. The most recent has been for studying plant colonization by *Salix setchellania* (willow), *Populus trichocarpa* (cottonwood), and *Epilobium latifolia* (fireweed) along the Matanuska River, using one-meter-square white PVC and metal targets, which are recorded with a global positioning system or GPS. The points are used to mosaic the different photos together with a matching scale. When the blimp is pulled across the landscape the target points are used to line up multiple images that can be analyzed in a variety of ways. Timing the photography during the flowering of the subject plant species makes it easier to pull that species out of the images to measure the area of coverage.

Harris has applied this technology to agroforestry canopy cover, stream morphology, and archeological documentation. Once the images have been scanned into a computer for analysis and manipulation, they provide remote sensing specialists with low-level data that can be used to monitor plant cover, plant population dynamics, and spatial relationships among vegetative components. To have the same amount of information that is gained by photography would involve a tremendous amount of time and labor to document the coverage of an area with 'ground truthing.' This involves using statistics to predict the actual coverage of plants, given an approximate number of plants in a particular area, which leaves a variable of error greater than that of the photos taken by B.O.B.

B.O.B. has been involved with studies of forage production in haylage fields and cattle pastures at the experimental farm in Palmer. Pictures taken by B.O.B. were used for building and facilities inventory at the Matanuska Farm, as well as to create maps of the buildings, pastures, and forested area. B.O.B. was taken on Chien-lu Ping's soil fieldtrip to the North Slope, and, said Harris, "We got beautiful imagery on the tundra range along the Dalton Highway."

Ned Rozell, in an "Alaska Science Forum" article on research conducted with the blimp, described how Harris, Jeff Conn of the USDA, and Trish Wurtz of the Boreal Ecology Cooperative Research Unit have been working together to study white sweet clover *(Melitolus alba)*, "Alaska's most widespread invasive plant." Harris used the blimp to study the Matanuska River floodplain infestation of clover, identified by Conn and others, and Wurtz will be conducting experiments on the ability of native shrubs and trees to withstand competition from the clover. Whether the sweet clover is a danger to native plants is unknown, but the fact that it is not native is considered problematic by some agencies.

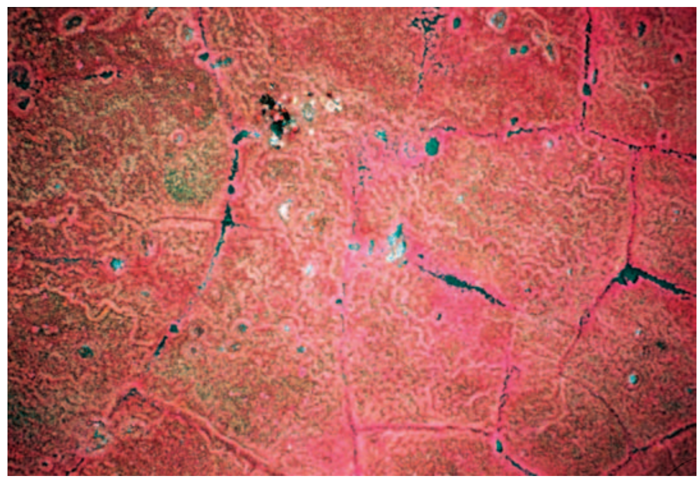
In the near future, these scientists will be expanding the white sweet clover study to include areas along the Tanana River and will work on long-term plant population dynamics using the study site on the Matanuska River. They hope to develop a long-term study of the vegetation changes on the tundra range associated with climate change. Harris plans on using it in Fairbanks and on the North Slope, and is sure it will be fun to keep track of the road miles along with the pictured miles that B.O.B. logs. Said Harris, "We would like to take it to Nome and do some studies associated with the Reindeer Research Program. There are so many studies that can use this technology, you are only limited by your imagination."

Every time it goes up in the air, people stop and point, and airplane pilots seem to be attracted too, and fly by to check it out. With the identifying UAF logo on the side of the trailer and the blimp, it's a distinctive sight: university research in flight.

The Melilotus *study site on the Matanuska River, August 3, 2004. White sweet clover is a pinkish color at this time of the year and is thus easily mapped.*
— PHOTO BY B.O.B., COURTESY NORMAN R. HARRIS

The blimp above the Matanuska River white sweet clover study site. Standing on the riverbank are Norm Harris, left, and agricultural technician Beth Hall, right. The gondola is clearly visible.
— photo courtesy Norman R. Harris

Below: Shot from digital camera of upland tundra site near Galbraith Lake. Visible in the picture are typical features of permafrost soils including permafrost polygons, a thermokarst lake, numerous thaw ponds, and a pingo. A permanent weather station and a square-meter quadrat are also visible at middle left as tiny white motes.
— photo by B.O.B., courtesy Norman R. Harris



Above: Scanned color-infrared shot of the acidic, wet tundra 27 miles south of Deadhorse. Chien-lu Ping and Ed Packee's NRM soils fieldtrip class is digging a soils pit to collect samples, top middle of photo.
— photo by B.O.B., courtesy Norman R. Harris

For more information:

"Invasive plants creeping into Alaska," Ned Rozell. Alaska Science Forum, *Heartland*, Nov. 14, 2004, p. H-7.

"Invasive Plants in Alaska: assessment of research priorities," Jeff Conn, Ruth Gronquist, Marta Mueller. *Agroborealis* (35:2)13–18.

Norman R. Harris is assistant professor of range science and management and may be reached at the Palmer Research and Extension Center, pfnrh@uaa.alaska.edu, or (907) 746-9467.

Right: Norm Harris is standing next to B.O.B.'s bright yellow mobile trailer, custom fabricated at the Matanuska Experiment Farm by Mike Swanson. It carries the fully inflated blimp, which can be rigged, deployed, shots acquired, and stowed away in as little as 20 minutes. This shot was taken on the way to the North Slope.
— photo by Connie Harris

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Denali potatoes, one of many varieties tested at the Agricultural and Forestry Experiment Station farms. After crops like these are grown in the fields, the harvests become charitable donations.
See story on page 20.

— AFES file photo

Rye in flower. Rye is even less adapted to Alaska growing conditions than is wheat, but several varieties were recommended by AFES researchers for their potential in Alaska niche markets.
See story on page 22.

— photo by Flavio Gassen

Norm Harris, left, and Beth Hall, right, preparing to release the SNRAS research blimp over the Matanuska River floodplain. Harris is making last-minute adjustments to the camera equipment in the blimp's gondola.
See story on page 29.

— photo courtesy Norman R. Harris