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ENERGY INDEPENDENCE FOR ALASKA VILLAGES

LOG CABIN-BUILDING WORKSHOP

GEYSER PROTECTION AREAS

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

UAF UNIVERSITY OF ALASKA FAIRBANKS

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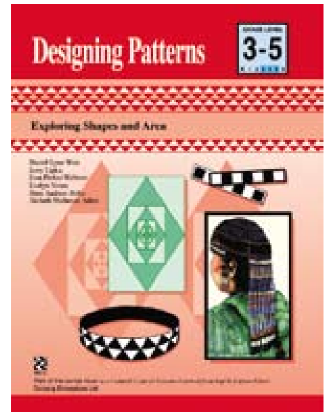

Designing Patterns: Exploring Shapes and Area, *one of the curriculum modules developed by the Math in a Cultural Context program. See page 4.*

Woody biomass may provide Alaskans with an important source of fuel, whether in the form of bio-oil or other heat sources. See page 25.
—PHOTO BY J. ANDRES SORIA

Milan Shipka serving reindeer sausage at the Kertulla Hall dedication ceremony and picnic August 29, 2008. See page 43.
—PHOTO BY NANCY TARNAI

About the cover:

Large photo: A new handicapped-accessible recreation cabin for the Starrigavan Recreation Area Campground, made with Alaska logs during a log cabin-building workshop held in Sitka and sponsored by UAF's USDA Wood Utilization Research program. See story on p. 6.
—PHOTO COURTESY THE SITKA RANGER DISTRICT

Taiga forest typical of the Interior. See stories on pages 6 and 19.
—PHOTO BY MATTHEW HELT

About this panel:

Midnight Sun-flowers growing in the field at the Fairbaknks Experiment Farm. See story on p. 15.
—PHOTO BY BOB VAN VELDHUIZEN

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UAF UNIVERSITY OF ALASKA FAIRBANKS

NEWS & PUBLICATIONS

News blog

The school now has a blog, **SNRAS Science & News**, to help keep the public apprised of breaking news, current research, events, awards, and to act as a portal for SNRAS-related sites and sites in Alaska and elsewhere that pertain to the research done at the school. Popular posts include a series on sustainability, posts on peonies, alternative energy, climate change, spruce budworms, and the new PhD program. The blog is updated one to four times a week, with posts usually written by the staff of the AFES Information Office, but with the occasional post by faculty or other guest writers. To view the blog, go to http://snras.blogspot.com.

Snapshot of the post on the SNRAS Science & News blog from December 3, 2008.

PASS to HLA

The Department of Plant, Animal, and Soil Sciences, or PASS, has a new name—the **Department of High Latitude Agriculture**. Dr. Milan Shipka, department chair, said most people did not understand what PASS meant or what activities and research were included in the disciplines contained in the department. "With the concept of global climate change looming large in Alaska, it is most appropriate to have the word *agriculture* in a department name at UAF," Shipka said. "Our faculty members are the primary force of agriculture at UAF." The new name became official Dec. 2, 2008.

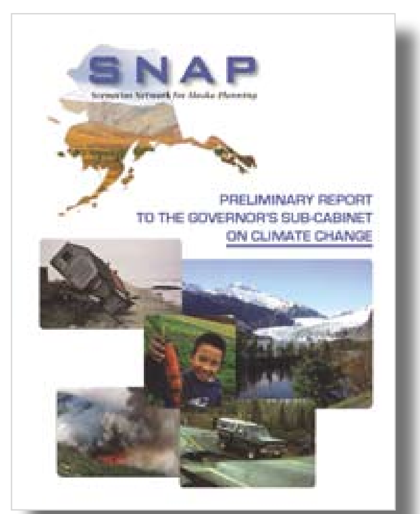
The department provides statewide education, research, and outreach in agriculture, soils, revegetation, and bioremediation through UAF at the Fairbanks Experiment Farm, Georgeson Botanical Garden, the Palmer Research and Extension Center, the Matanuska Experiment Farm, the Delta Junction Field Research Site, Nome, the Seward Peninsula, and other locations across the state. Examples of High Latitude Agriculture research include: reindeer research at Nome and Fairbanks; reproductive performance in domestic ruminants; the role of light in high latitude crop production; controlled environment plant growth; cultivar selection of vegetables in Alaska; potato disease; management practices for forage and turfgrass; peony cultivation and marketing; composting research; and analysis of arctic and subarctic soils.

The Alaska Department of Fish & Game studies moose digestion at the Matanuska Experiment Farm. This orphaned moose has been raised in captivity at the farm.
—PHOTO BY NANCY TARNAI

SNAP report to the governor

The **Scenarios Network for Alaska Planning** prepared a preliminary report for the Governor's Sub-Cabinet on Climate Change, published in November 2008. SNAP is assisting the Governor's Sub-Cabinet with the task of preparing and implementing an Alaska Climate Change Strategy. The final report will be a transparent document that deals with state policies for anticipated climate change. The Sub-Cabinet's goals include building the state's knowledge of the actual and foreseeable effects of climate warming in Alaska, developing appropriate measures and policies to prepare communities in Alaska for the anticipated impacts from climate change, and providing guidance regarding Alaska's participation in regional and national efforts addressing causes and effects of climate change.

SNAP provides climate maps and projections, temperature and precipitation scenarios, and other objective data and analyses to the public. SNAP is a collaborative network of the University of Alaska, state, federal, and local agencies, and NGOs. Currently most policy and management planning for Alaska and elsewhere assumes that future conditions will be similar to those of our recent past experience. However, there is reasonable consensus within the scientific community that future climatic, ecological, and economic conditions will likely be quite different from those of the past. We now know enough about current and likely future trajectories of climate and other variables to develop credible projections. We can also make projections for other variables that are closely correlated, such as frequency of intense storms, risk of wildfire or flooding, and habitat and wildlife changes associated with these events. For more information or to view SNAP projects and data, go to www.snap.uaf.edu.



Counting on tradition

Math in a Cultural Context adds up

> **"The program works because it fits the Yup'ik children's lifestyles."**

The formula is simple: Apply Native elders' everyday knowledge to school mathematics. From that idea Math in a Cultural Context has grown and flourished, producing nine educational modules that consist of curriculum books and accompanying storybooks, training hundreds of teachers, and reaching seventeen school districts across Alaska and beyond.

MCC, which joined SNRAS and the UA Geography Program in 2007, is led by Professor Jerry Lipka. While striving to increase the number of indigenous teachers in Dillingham in the early 1980s, Lipka met with parents and grandparents of potential educators to listen to their ideas. Immediately recognizing the value of the Yup'ik elders' knowledge, Lipka turned to the National Science Foundation for financial support. The NSF agreed to fund the project if it focused on math. "So we went to the math side," Lipka said. By 1996 he had a planning grant and by 1997 was operating under a full grant.

"The elders were crucial and fundamental to the project," Lipka said. "The elders were naturalists and they wanted to help because their children would become teachers." Over the years Lipka developed slow and steady relationships with the elders, listening, asking questions, working side by side with them. "Trust grew out of those relationships," he explained.

The program works because it fits the Yup'ik children's lifestyles. "This is a curriculum that can remove obstacles to learning," Lipka said. "It removes barriers."

While mainstream math curricula work fine for the majority of students, those further removed from mainstream society with somewhat different daily knowledge and experiences may find traditional ways of learning math difficult. So instead of math lessons about skyscrapers and supermarkets, MCC employs culturally-relevant examples such as berry-picking and salmon fishing. "Students are able to identify with the material we created. We tap into what they know."

Lipka has conducted two studies with the American Psychological Association's Robert J. Sternberg to assess the three kinds of intellect: academic, creative, and practical. Students taught in a way that uses all three areas outperform their peers, Lipka said. Sternberg's stellar research confirmed what Lipka already knew. "I know it works," he said. "But Sternberg's study added credibility."

In 1999 Lipka received an American Book Award for Transforming the Culture of Schools, a plan for how to implement Native knowledge into the classroom. Teachers have responded positively to the program. MCC Instructor Nicolle Gilsdorf was teaching in Tuluksak, a village north of Bethel, when she first heard of MCC. "I knew I could get behind it," she said. Working with sixth graders as a brand new teacher, Gilsdorf realized MCC would allow her to teach math, social studies, and science skills while connecting the children to their ancestral culture. She even noticed increased attendance when she used the curriculum. "That's a powerful indication this works," she said.

Because subsistence activities are "incredibly rich," Gilsdorf said, they are ripe for educational opportunities. Teachers learn the vocabulary associated with subsistence activities and attach this to the concepts, making math interesting and fun. "I love it and the kids respond to it," she said. "It allows them to feel competent and it's about sharing stories, which is a big part of Yup'ik culture." MCC has an expert apprentice teaching model and it has a clear structure. Plus, students are allowed to make mistakes and learn from them. "They get to explore through their culture math concepts."

Gilsdorf noted that students who had not been interested in math, including children with special needs and Alaska Native youths, began to take on leadership roles after getting familiar with MCC concepts, due in part to the project's intentional use of multiple modalities and different forms of intelligence.

The project has conducted twenty studies, finding in every instance that MCC students outperform control groups at statistically significant levels and with good effect on project tests. This occurred in all trials except for one urban subgroup. Control group curricula included *Everyday Math* and *Saxon*. Skills tested included numeration, measuring, representing data, data organization, analysis, interpretation, perimeter, area, geometrical shapes, proof and properties, and fractions. Lipka believes the following factors affect student performance:

- culturally and socially relevant materials that Alaskans can relate to
- integrated approach helps students to identify with the material
- a project-oriented approach
- students become engaged; barriers are reduced because of the relevant material, the hands-on approach, respect of the teacher and the student to explore and engage in mathematical thinking
- constructing math tools that allow students to understand math concepts, such as a Yup'ik abacus, personal rulers, geometrical pieces, and finding their own ways of organizing data
- students and teachers find MCC challenging
- students learn to think mathematically, learn to conjecture, and physically and logically prove their points

UA Geography Program Director Mike Sfraga says MCC is a natural fit for his department. "It puts science and math in a geographic context," he said. "It all works." While Western educational efforts tend to divorce the cultural context from the curriculum, Lipka found a wonderful formula that is culturally relevant, regionally applicable, and teaches mathematics in a way that makes sense to teachers and children, all the while weaving in traditional knowledge, Sfraga said. "It's probably the best example of the mother of invention to me; it is the perfect geography K-12 program. It blends a lot of traditions together and the results are fantastic."

Sfraga is particularly excited that the program appeals to young Native males who may not always find education exciting. Math that relates to such things as navigation and the mechanics of a fish wheel are appealing to Native boys, Sfraga said.

Sfraga went so far as to say MCC is one of the best stories UAF has in its efforts to assist rural schools in Alaska. "In the future people will look back and call this a legacy program." Its potential is unlimited, he said, predicting that MCC will continue to be implemented in more communities. "It is internationally replicable; it could be tweaked for Africa or the Navajo Reservation, anywhere there are strong traditional ties and knowledge. When others understand the value they will say 'me too.'"

For more about the MCC program, go to www.uaf.edu/mcc/ or contact Dr. Lipka at rfjml@uaf.edu, (907) 474-6439. The program offices are located at 2175 University Avenue South, Suite 101, Fairbanks, Alaska, 99709.

MCC GOALS

- to improve the math performance of elementary school students, especially Alaska Native students
- to provide professional development to Alaska school districts
- for school districts to adapt and adopt MCC modules
- to research the effectiveness of the modules in improving students' math performance
- study specific impacts by math subscales and by other factors
- to study contextual factors that contribute to the effectiveness of implementing MCC

AWARDS

2008, ***Annie Blue's Stories***, HAIL Award (Honoring Alaska Indigenous Literature)

2006, Best proposal from US Department of Education, Alaska Native Education

2006, MCC's grant proposal to the US Department of Education, Institute of Educational Sciences, number one in a nationwide campaign

2004, Building Engineering and Science Talent Initiative Report acknowledged MCC as notably effective in increasing math performance of under-represented pre-kindergarten through twelfth grade students

1999, American Book Award for ***Transforming the Culture of Schools: Yup'ik Eskimo Examples***

A Log Cabin Building Workshop:

From Hangar to Woods

Valerie Barber

The finished Starrigavan recreation cabin, October 2008.
—PHOTO COURTESY THE SITKA RANGER DISTRICT

"[W]orkshop participants and I would learn how to construct a log dwelling from start to finish from the experts."

About two years ago while living and working in Sitka, I received a phone call from Kent Barkhau at the USDA Forest Service. He asked me if I was interested in helping to sponsor a log cabin construction workshop in Sitka to build a recreation cabin at the Starrigavan Recreation Area Campground. Since I have always dreamed of building my own log home, I jumped at the opportunity; workshop participants and I would learn how to construct a log dwelling from start to finish from the experts. Kent said there were secondary growth logs about forty years old that they were interested in harvesting for watershed fish and wildlife habitat enhancement and forest health improvement projects. They wanted to determine if the logs were suitable for building. Harvesting old growth timber in the Tongass National Forest has become difficult as timber sales have declined due to litigation and loss of industry. The secondary growth that has resulted from the cutting of old growth forest in the past is now approaching a size that is optimal for logs suited for log cabins and other products.

I offered to see if my program, the USDA Wood Utilization Research project, could help pay for the instructors for the class. I immediately thought of Mike Musick and his son, Richard, from Fairbanks. I knew of their work and I had taken a class years earlier from Mike. Richard had studied in New Zealand under Robert Chambers, a world-renowned log cabin builder, and we ended up using the method he had learned, using green logs that "shrink to fit," caused by the compression-fit saddle notches that are used. With this method, an airtight seal is formed between the logs and the logs get tighter as they dry, shrink, and settle under the weight of successive layers of logs and the roof being added.

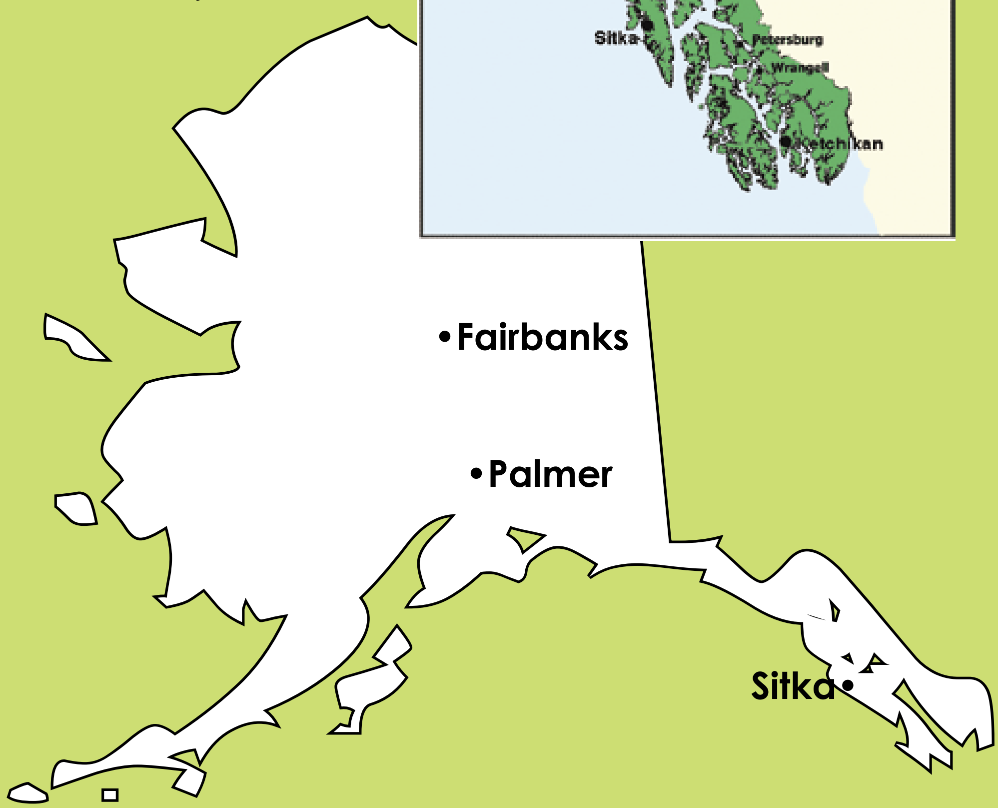
We talked to Jeff Johnson, director at UAS-Sitka campus, about using the facility to host the class. He was excited about the prospect and a cooperative agreement

Above: notched logs in the preassembly stage at the hangar on the Sitka campus.

—photo by Val Barber

Right: The Tongass National Forest (green area in inset) covers much of the Alaska Panhandle.

—map courtesy the US Forest Service



was formed between the UAF Forest Products Program, University of Alaska Southeast, Sitka campus – Community Education and Professional Development Program, and the Tongass National Forest – Sitka Ranger District. It was decided that twelve students could be accommodated and we looked for other agencies that could help sponsor the students. Cooperative Extension Service in Fairbanks, the Pacific Northwest Wood Utilization Center, Sitka Conservation Society, Safari Club International (SCI), Friends of the Tongass Cabins, and Southeast Alaska Guidance Association – Adventure Based Education and Youthbuild Program, all stepped forward to help. The class was set for two weeks in May 2008.


EXIT
STIHL

Approximately 450,000 acres of the Tongass National Forest have been harvested in the past sixty years throughout southeast Alaska and there are 225,000 acres of young-growth stands that will be ready for thinning and harvesting in future years. Some of the benefits of thinning include improved habitat for wildlife; availability of traditional forest products; potential for energy projects to replace fossil fuels; and new products for local, domestic, and export markets. The logs for the cabin building project were harvested in Sitka in late fall 2007 from an area that had been previously logged by the Nelson Logging Co. between 1968 and 1974. About 100 logs were harvested and debarked using high pressure water treatment. The logs ranged in length from 25 to 30 feet and had an average tip diameter of about 8 inches and average butt diameter of about 14 inches. The logs were laid out at the start of class.

Twelve students signed up for the class, coming from Sitka, Haines, Craig, and Juneau. I was an unofficial student, as was Kent. I hauled the necessary equipment from Palmer and Fairbanks. On the first day of class, we measured all tip and butt diameters and entered them into a spreadsheet. We used a formula from Robert Chambers' book, *The Log Construction Manual*, to figure out what size logs to start with, and what size to use as we continued the rounds. Out of the fourteen students, most had used a chainsaw and/or were carpenters. The level of skill was amazingly high and logs flew in and out

Opposite, above: participants in the log-building class watch as Kent Barkhau uses a chainsaw to notch a log.

Opposite, below: Another student, Pat Hughes of the UAS-Sitka Campus, sands the notches to create an exact fit.

Above right: scribing two logs in preparation for cutting the kerfs and w-shaped lateral grooves for each log.

—photos by Val Barber

Right: Robert Chambers' book, The Log Construction Manual, *and Tom Walker's book,* Building the Alaska Log Home, *used as textbooks for the class.*

of the hangar where construction was taking place. We learned how to pick out the appropriate log for a round and then scribe the logs to fit together. Each log needed a three-inch-deep kerf along the top and a W-shaped lateral groove on the bottom. A scarf had to be carved out of the underlying log so the upper notched log would slide onto it. We had to measure and remeasure continuously to make sure we didn't mess up. Even though we had extra logs, we didn't want to waste even one. We had nine levels to complete along with a floor for the second story and we used a total of forty-four logs. Once the logs were all notched and fitted together, they were deconstructed and wool batting was inserted into the W groove for insulation.

The shell was completed in two weeks and the logs were moved to the site for reconstruction, where a cement pad had been prepared. Several students from the class volunteered to help put the cabin together again. Once up, doors and windows were cut and various artistic touches were added.

As a result of this seminar, some of the participants are now interested in starting a log cabin business in Sitka. Another offshoot of the class is that my own cabin dream is much closer to reality. I purchased land in Palmer and with the skills and confidence I have gained I am planning to construct a cabin within the next couple of years. Another workshop is being planned in Sitka for 2009, and at the Matanuska Experiment Farm for 2010.

Meanwhile, Sitka's Starrigavan Recreation Area has a drive-up, handicapped-accessible cabin available for the public to rent. Someday I hope to return to Sitka and spend a little leisure time in the cabin I helped build.

Valerie Barber is an asistant professor of forest sciences and director of the UAF Forest Products Program, a member of the Wood Utilization Research Program.

Other participants in the course included Kenyatta Bradley, Forrest Gangle, Pat Hughes, Jud Kirkness, Marcel LaPerriere, Mike Mullin, Clayton Murral, Kim Perkins, Jay Stelzenmuller, Ben Walker, Richard Warren, Jr., and Don Wulff.

Below: stacking and fitting the cabin logs inside the hangar to ensure that they fit.
Opposite, top: Outside on a sunny day, cutting the grooves and inserting the wool batting for insulation.
Opposite, bottom: detail showing the groove with sealant and wool batting.
—photos by Val Barber

Onsite reasembly and construction.

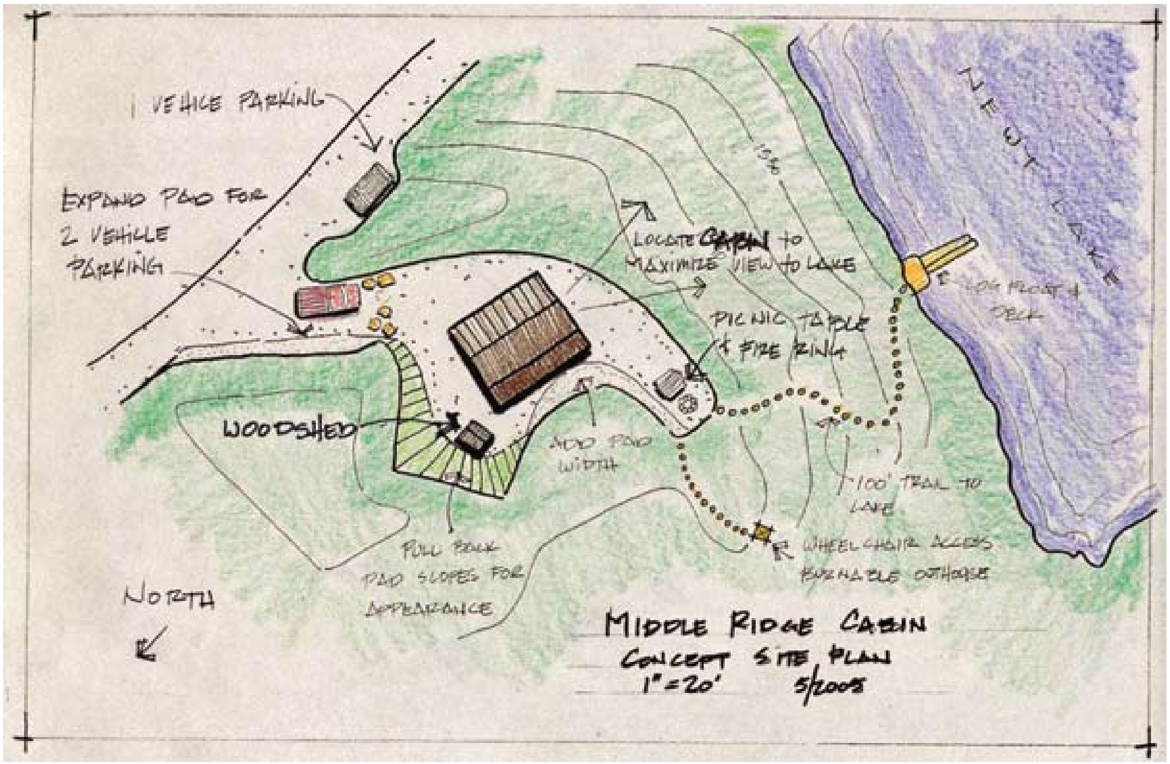
Opposite, top: class participants and Richard Musick on the floor of the cabin.

Opposite, bottome: logs stacked in preparation for reassemblling on the prepared flooring. Note that the logs are marked so that they will be stacked correctly.

Top: construction crew finishing wall assembly. At left stands Richard Musick; on the wall above him is Pat Hughes. On the wall to his right, in the pink shirt, is Marcel LaPerriere drilling a hole for a screw to pin the logs together on this round.

Right: Richard Musick cutting the doorway, using a two by four as a cutting guide.

—PHOTOS BY VAL BARBER



The cabin concept site plan for the next workshop, to be held in May. The cabin will be assembled on Middle Ridge, overlooking Newt Lake on Wrangell Island.

—drawing courtesy the Sitka Ranger District

Below: interior scenes of the newly finished Starrigavan Recreation Area cabin, showing the wood stove and the stairwell to the loft.

—photos courtesy the Sitka Ranger District

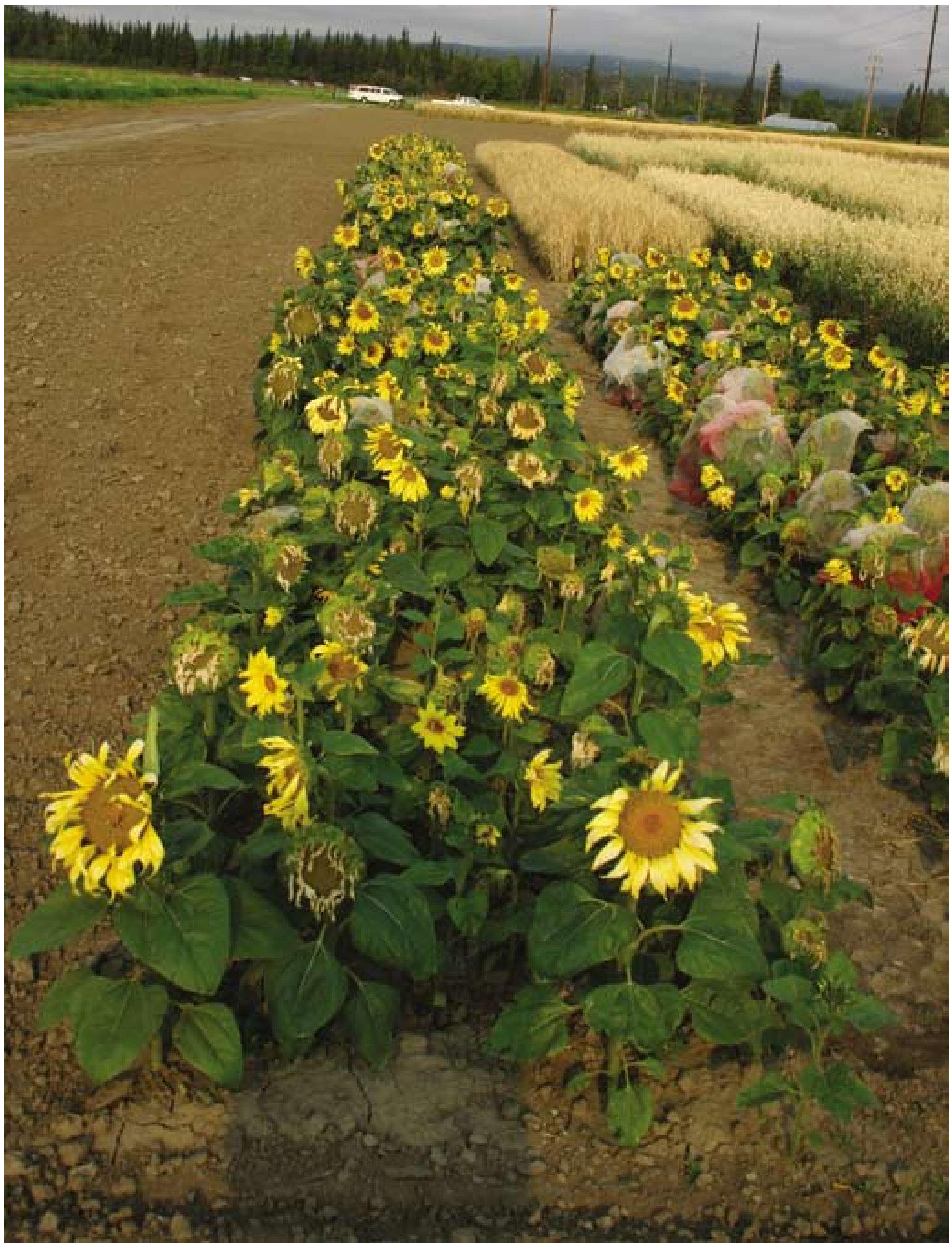
The Midnight Sun-flower: a bloom for northern birds

Bob Van Veldhuizen

The Fairbanks Experiment Farm has more than a hundred years of agricultural history, with scientists working to produce varieties and agricultural methods suited to the needs of farmers at high latitudes. The farm has produced new varieties of crops such as strawberries, cabbage, potatoes, wheat, barley, and now, after sixteen years of selection, a new oilseed sunflower variety adapted to interior Alaska growing conditions.

Midnight Sun-flower is an open pollinated selection made from a sunwheat variety (a dwarf hybrid sunflower) that was originally planted in 1993. This selection was unofficially released as 'Midnight Sun-flower' to local gardeners in spring 2008 as a potential agronomic and horticultural oilseed crop. The primary intended use is as a locally grown oilseed for the wild birdseed markets.

Sunflowers (*Helianthus annus* L.) are an annual broadleaved plant that can grow 5 to 20 feet tall. They have stout, rough, and hairy stems one to three inches in diameter topped by a seed head that is 3 to 24 inches in diameter. The heads have many small, cross-pollinated flowers surrounded by pointed scales and 40 to 80 yellow rays. Wild sunflowers or horticultural varieties may have multiple branched heads from a single stalk. There are two types of sunflowers that are grown as an agronomic crop. Those



Rows of Midnight Sun-flower growing in the fields at the Fairbanks Experiment Farm. Mesh bags are used over maturing seedheads to prevent birds from eating the seeds.
—photo by Bob Van Veldhuizen

"In Alaska, sunflowers have been grown on limited acreages off and on for many years, primarily as livestock forage and secondarily as oil and confectionary seed for the local birdseed market."

that have black or dark brown seed grown for the oil content, (45 to 55 percent oil from hulled seed), and those with white stripes on the seed grown for the confectionary market. Both the heads and the leaves of sunflowers track the sun during the day and tilt upwards at midnight. This phenomenon is called nutation and continues every day until the end of the flowering stage.

About half of the dried weight of sunflower heads is seed. The whole seed contains about 24 to 45 percent oil. However, only about 20 to 35 percent oil can actually be expressed from the whole seed. Sunflower oil is obtained by a combination of expressing and solvent extraction. The remaining oil cake meal contains about 35 percent protein, which is used as a livestock feed. Sunflower oil is mostly polyunsaturated and is used in the edible oil market. It also is a semidrying oil that is used in the manufacture of soaps and paints. Whole oil seed is used as a feed for poultry and caged and wild birds. Confectionary seeds are either eaten raw or roasted. Sunflowers have been grown as silage for livestock but are less palatable and nutritious than either grasses or legumes. In Alaska, sunflowers have been grown on limited acreages off and on for many years, primarily as livestock forage and secondarily as oil and confectionary seed for the local birdseed market.

Common sunflowers are either open pollinated or hybrid varieties. They are long-season plants that are both drought and heat resistant. Because of the large amount of biomass they produce before flowering few ever reach physiologic seed maturity in Alaska before the first killing frosts. Sunwheat varieties, on the other hand, are a dwarf hybrid sunflower similar in head size to the common sunflower but only growing 36 to 50 inches tall. They are earlier maturing (about the same as for wheat) and the seed often reach physiologic maturity in the short Alaskan growing season.

Sunwheats like Midnight Sunflower are slightly lower yielding with lower oil contents when compared with common sunflowers when grown in areas where both reach complete physiologic maturity. When grown in areas where there is not a long growing season however, sunwheats out-perform the common sunflower. Sunola is the term given to the open pollinated dwarf sunflower made from Canadian selections of the common sunflower. Sunola is as short as sunwheat, 24 to 36 inches, but with correspondingly small head size, 3 to 5 inches in diameter. It is lower yielding than the common sunflower but contains higher oil contents.

Uniform seedling germination requires a soil temperature of at least 50°F and good soil moisture. Cool soil or low soil moisture conditions delays germination and causes non-uniform stands. Young sunflower plants have a strong frost tolerance before the six leaf stage. In addition, the ripening seeds have strong frost tolerance after physiologic maturity has been reached. Light frosts after flowering do not affect seed production. Sunflowers require about an inch more soil moisture than small grains or canola for maximum seed production. Sunflowers can deplete soil moisture for the following year.

There are several fungal diseases that attack sunflowers, but only a few that are of economic importance. Sclerotinia or white mold fungus (*Sclerotina sclerotiorum*) can infect any part of the sunflower plant from the base of the plant to the head. The most important disease is wilt caused by this white mold infection at the base of the plant. It is a fast acting disease often taking only four to seven days from the appearance of the first symptoms to complete wilting. Wilted plants are noticeable just after the flowering growth stage. Cool, wet soil conditions in the spring favor development of this fungal disease. It can also be spread from root to root contact and heavy planting.

Sunflower heads are mature when the backs of the heads have turned from green to yellow and the bracts have turned brown. The seed matures from the outside of the head to the inside, and continues to ripen as the stalks dry. Average seed moisture at this time

Closeup of the Midnight Sun-flower seedhead.
—PHOTO BY BOB VAN VELDHUIZEN

Detail of Midnight Sun-flowers in the field.
—PHOTO BY BOB VAN VELDHUIZEN

is around 40 percent. Sunflower heads bend down towards the ground and curl back when mature. This shape acts like a cup catching any precipitation and holding it there providing an environment for the development of a Botrytis head rot (*Botrytis cinerea*). This gray mold works its way through the head infecting the seed before it is dry enough to harvest. If it is harvested with non-infected seed, the mold can spread while in storage. In Alaska, the harvest season is often wet, and moldy heads along with any wet stalks make direct combining of sunflowers extremely difficult. Hand harvesting, drying and threshing becomes the only option.

All sunflower varieties can be harvested two to three weeks after physiologic maturity when the seed has reached 20 to 25 percent moisture levels. The seed is dry and safe for long-term storage at between 8 and 10 percent moisture. It is often harvested before that to prevent losses due to shattering or bird damage. Supplemental drying is then required. Cleaning the seed lot to remove all green foreign material, and cracked and dehulled seeds facilitates drying and produces a more acceptable seed lot after drying.

Starting in 1993, seeds were collected from the earliest maturing heads of a sunwheat variety in the Fairbanks area. These seeds were hand threshed, cleaned, and planted in test plots the following season. This process has been repeated every year since then. Since sunwheats are hybrid varieties and all sunflowers are open pollinated, there was considerable variation in the following year's crop. However, continued selection for early maturity has resulted in a more uniform, open pollinated sunflower that closely resembles the Canadian Sunola varieties. To date, the plants are quite dwarfish, 20–24 inches tall, and with head diameters of close to 6 inches. It matures 7 to 10 days earlier (an average of 83 days from planting) than the earliest sunwheat varieties and 14–20 days earlier than common sunflower varieties. This produces acceptable yields of around 350–400 lbs/acre, much better than that of the earliest sunwheat varieties. However, because this is an open pollinated selection there is still considerable variability among plants.

Because of the Midnight Sun-flower's smaller plant size it is planted about four inches apart in rows that are only six inches apart, usually by mid May when the soil temperatures have warmed sufficiently. The seed will reach physiologic maturity sometime around mid August but it will not be ripe enough to harvest yet. The seed, however, will be attractive to birds at that time. To prevent seed loss, mesh bags are usually put over the seed head. The mesh should be small enough to prevent birds from picking seeds out of the heads while at the same time be large enough to allow moisture to escape to slow down the occurrence of gray mold in the heads. The crop is hand harvested using either a sharp knife or a pair of hand clippers to remove the head and about 10 to 12 inches of the stem. The heads are mature when the backs of the heads have turned from green to yellow and the bracts have turned brown. This occurs around late August to mid September in most years. They will require more drying after harvest to continue ripening the seeds. This can be done by tying a few of the cut stems together, or tying a couple of the mesh bags together if they were used, and hanging them upside down in a warm dry place for a couple of weeks. The seed can either be left in the heads or they can be threshed from the heads by hand. To do this, use a pair of leather gloves and just rub the seeds from the heads into an open container. The heads can then be discarded. This will result in mostly seed but it will also have a fair amount of other detritus in with the seed. Ripe, mature seed will usually be heavier than immature seed and the remaining detritus. This seed can be cleaned by using gravity and air separation. Set up a small room fan on the floor on medium speed, place a small container directly in front of the fan and slowly drop small amounts of uncleaned seed (one handful at a time) so it passes through the air flow. The heavier ripe seed will fall directly in the container and the lighter unripe seed and detritus will blow off. Dried heads as well as the cleaned seed can be placed in or near birdfeeders as a high energy feed for wild birds throughout the winter.

Limited seed will be available through the Alaska Agricultural and Forestry Experiment Station, University of Alaska Fairbanks, for future distribution in 2009. Contact Bob Van Veldhuizen for more information at fnrv@uaf.edu.

For more information on sunflower and other agronomic crop performance trials, see "Performance of Agronomic Crop Varieties in Alaska, 1978–2002," by Robert M. Van Veldhuizen and Charles W. Knight, AFES Bulletin 111 (136 pp), published October 2004 and available on line at www.uaf.edu/snras/afes/pubs/bul/B111.pdf.

For more information on ornamental sunflower performance, see Annual Flowering Plant Trials, available on line at www.uaf.edu/snras/afes/pubs/pvt/index.html.

Biomass fuels

local energy, local jobs, and community resilience

Nancy Fresco and F. Stuart Chapin III

In many rural interior Alaska communities, recent increases in fuel prices have made the cost burden of electrical generation crippling. At the same time, wildfire risk is on the rise, employment is hard to find, and environmental contamination from diesel fuel is a serious problem. Residents are concerned about the multiple potential threats posed by anthropogenic climate change, and there is increased interest in renewable energy sources. In the Interior, one renewable option is wood biomass. Converting electrical power generation systems to wood energy could play a significant role in addressing all of the above issues.

We assessed the feasibility of switching power generation from fossil fuels to wood energy in thirty-three rural Alaska communities in forested regions of interior Alaska (Figure 1) and found that the installation costs of biomass systems would be recouped within twelve years for at least thirty-two communities in the region. All but the largest remote villages in the Interior could meet all their electrical demand and some heating needs with a sustainable harvest of biomass within a radius of 8 km of the village.

Although fuel costs have risen everywhere, some rural consumers pay an effective rate of up to 35 cents per kWh, more than twice the rate paid in urban areas. Without state subsidies, this figure would be over a dollar per kWh in some communities.

Rural villages are increasingly confronted with high fire risk owing to increasing fire severity and fuels buildup, particularly mature black spruce. Fire suppression around

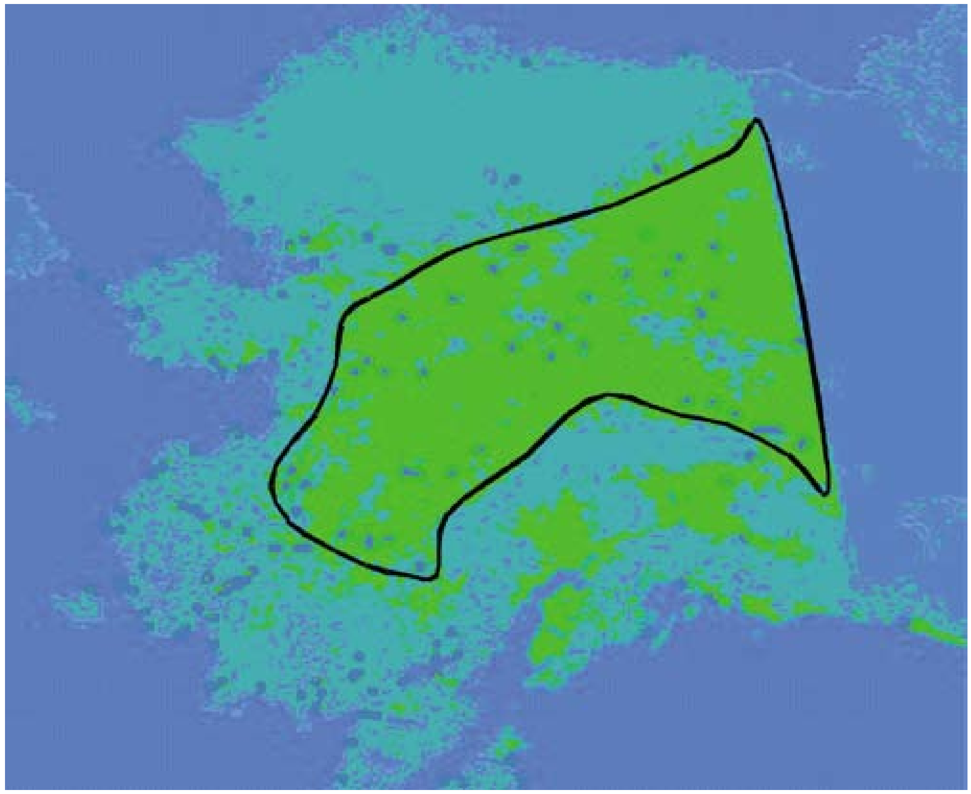


Figure 1. Remote Alaska communities. About 90 communities (represented by dots) lie in forested regions (green shaded area). Approximately half of these are in the Interior region considered in this study (roughly demarcated by black line). (adapted from Crimp, P.M. and S.V. Adamian, 2001)

> **“Residents are concerned about the multiple potential threats posed by anthropogenic climate change, and there is increased interest in renewable energy sources.”**

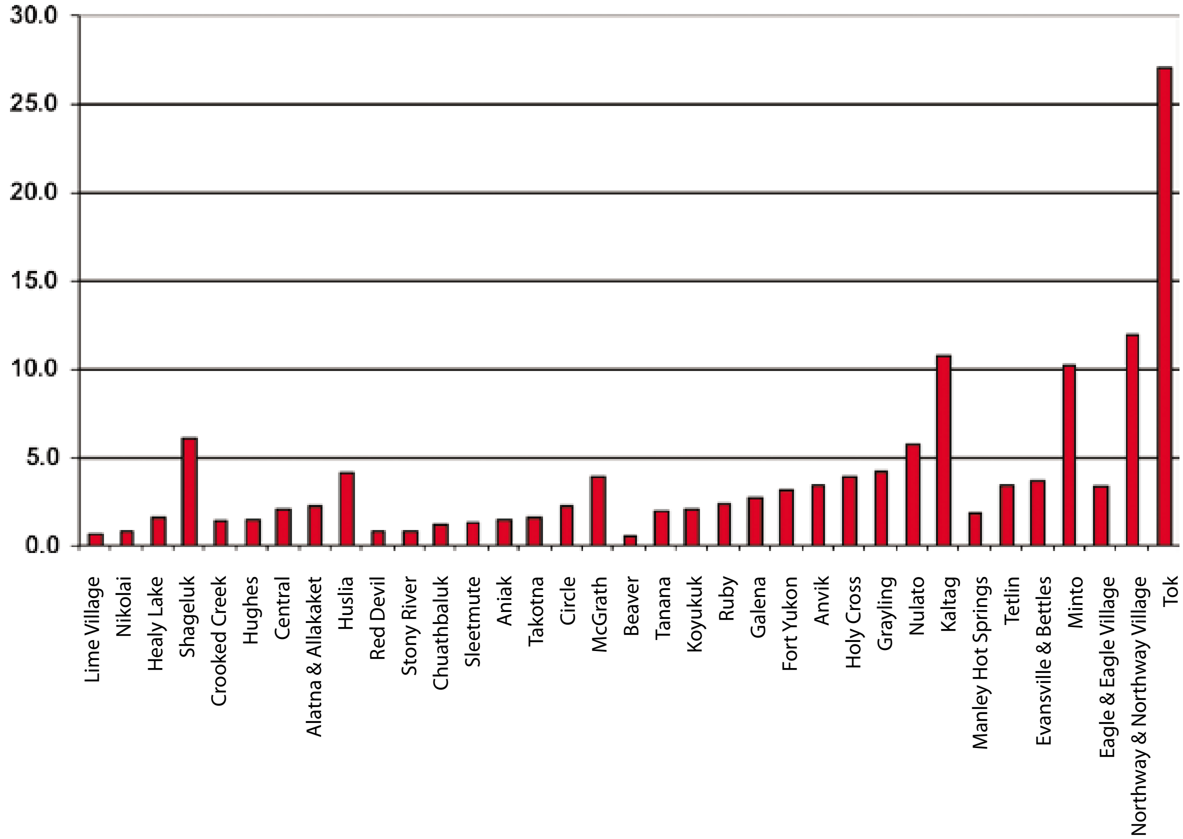


Figure 2. Years necessary to recoup an investment in wood-powered electrical generation capacity equal to mean electrical loads. Villages are shown roughly according to their accessibility, with those on the left only accessible by minor river and those on the right accessible via major road.

inhabited areas tends to decrease average annual area burned, which over time increases average forest stand age, reduces variability, and increases the risk of future fires. Although harvesting trees does not precisely replicate the effects of natural fire cycles from an ecological standpoint, it can reduce fire risk and reset vegetative succession. This, in turn, can increase subsistence opportunities by favoring berry crops and willow, birch, and aspen for moose browse.

Our focus was on use of black spruce in relatively simple, easily maintained small-scale boilers for electrical power generation. In such a system, whole-tree wood chips or chunks are oxidized with excess air circulation, either in a stoker or a fluidized bed, and the hot flue gases that are released produce steam in the heat-exchange sections of a boiler.

An existing project in Dot Lake demonstrates the feasibility of wood biomass systems and the efficacy of employing combined heat and power capabilities. A wood-fired boiler is used to heat and power eight residences and the washeteria in this thirty-seven-person community. Dot Lake is not a typical Interior village, as it is on the road system. As a result, diesel fuel in the community is far less expensive than in some villages. However, wood prices in Dot Lake are also likely to be lower than prices in more remote villages, because in Dot Lake the boiler operates on waste from nearby timber operations, which can be easily transported via road. Use of the system has been somewhat sporadic, but even so, this tiny village saves thousands of dollars in fuel costs every year using the wood-powered system.

We estimated the maximum travel distance necessary for biomass harvest for wood energy around each of the thirty-three communities studied. To calculate this distance, we took into account village population, per capita energy use, the fraction of total energy use to be replaced with biomass energy, rotation length for forest harvest, biomass density for black spruce at harvest age, wood energy density, electrical efficiency, and percentage of forest cover.

Mean population for the selected communities was 106, with a range from 21 to 1,439 people. Mean energy use was 3758 kWh per capita. Harvest rotation was set at 75 years (early maturity), moisture content of undried and air-dried wood at 60 percent and 15 percent respectively, black spruce forest cover at 44 percent, black spruce biomass at 25t/ha, and the energy value of dry wood at 8,500 btu/lb (5480 kW/t).

We assumed an efficiency of 28 percent for electrical production. This estimate was intentionally very conservative. Modern methods of wood energy generation offer relatively high combustion efficiency and low emissions of air pollutants, but considerable energy is lost in converting that energy to electricity. Typically, the overall efficiency of a system that is only used to generate electricity is a mere 25 to 30 percent. However, if heat is also a desirable product, as is the case for most of the year in interior Alaska, the boiler system can be configured for the simultaneous production of heat and electricity. Roughly 70 percent of rural Alaska communities could make cost-effective use of combined heat and power systems.

We explored the short- and long-term costs and benefits of switching from diesel energy to wood energy in these remote communities, and estimated the period needed to pay back capital investments. We considered the installed cost of a biomass power system per kilowatt of generation capacity, the total biomass capacity installed, the actual energy offset, diesel efficiency,

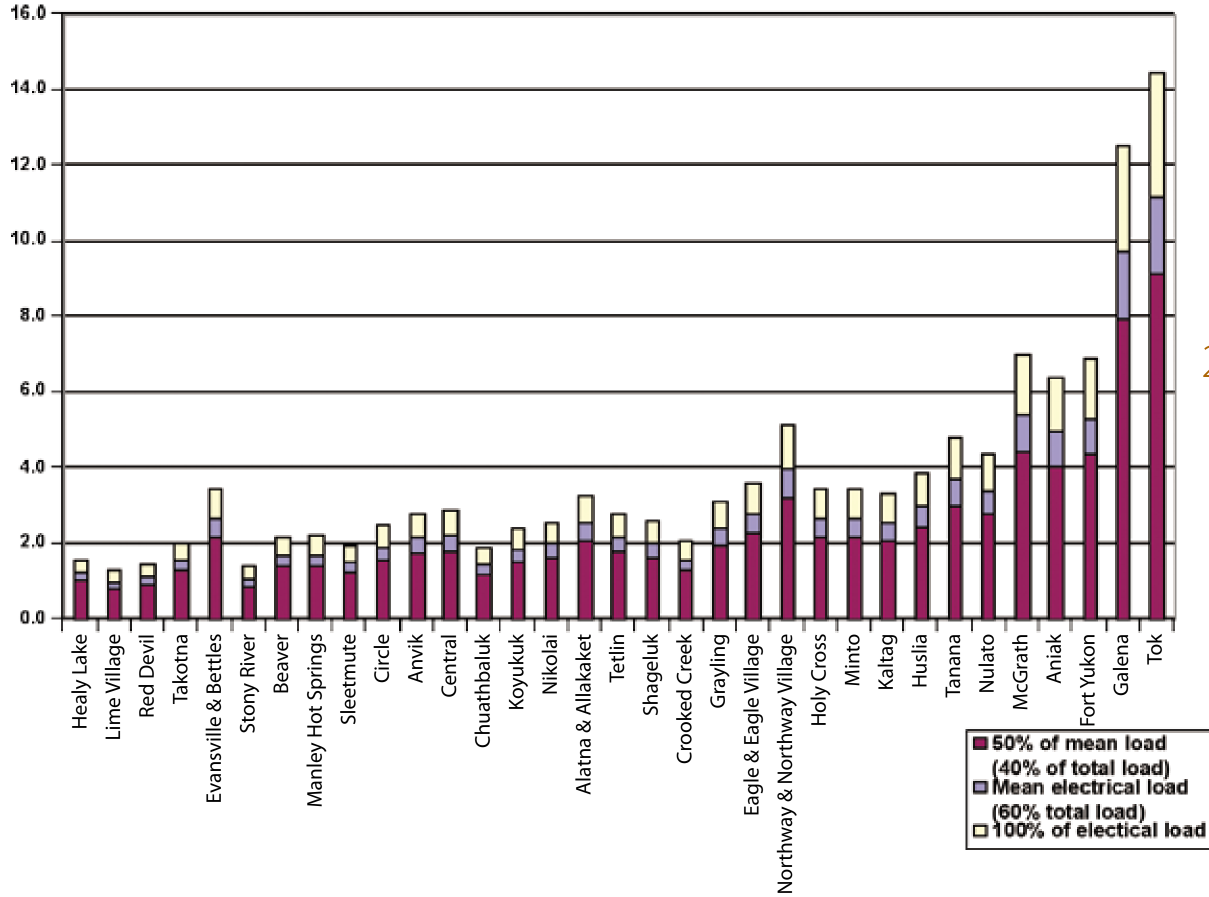


Figure 3. Maximum travel distance according to the percentage of village energy needs met by biomass fuels. Model outputs estimate sustainable harvest of black spruce for energy generation. If installed biomass generation capacity is equal to 50 percent of mean loads, approximately 40 percent of the community's electrical demand will be offset. At a capacity equal to mean loads this rises to 60 percent. All data assume 75-year forest rotations.

diesel price, the fraction of nonfuel costs offset by use of biomass, total nonfuel costs, biomass energy generated, and biomass energy costs.

We assigned biomass capacity installed in each village a value equal to the mean electrical load for that community. Under this assumption, existing diesel systems would be at least partially retained and maintained to meet peak loads, while allowing biomass systems to run at full capacity for much of the time. We used $1,849/kW as the cost of installed capacity. Since national averages for wood fuel costs seemed unrealistically low, we estimated fuel procurement costs based on actual costs of clearing and thinning projects in rural Alaska communities. In all cases, local crews were used, and the work was extremely labor-intensive and low-tech.

Social factors likely to affect the feasibility of fuel substitution included:

- Existing social infrastructure related to village electrical utility management and funding, fire prevention, and biomass harvest
- Threshold requirements (make-or-break factors needed within a particular community or at a broader scale, e.g., a minimum level of local technological expertise)
- Existing institutional barriers to change
- Potential positive social feedback (e.g., autonomy, employment)
- Potential negative social feedback (e.g., reactions to system quirks or failures)
- Lessons learned from existing biomass projects in rural Alaska

Our analysis was intentionally conservative, and so may have underestimated potential advantages of conversion to biomass fuels. Nevertheless, we found that the installation costs of biomass systems would be recouped within twelve years for thirty-two of thirty-three communities studied (Fig 2). All but the two largest remote communities studied (Tok and Galena) could meet all their electrical demand and some heating needs with a sustainable harvest of biomass within a radius of 8 km of the village (Fig 3).

Because transport and storage of diesel fuel represents a large percentage of its cost in remote areas, the greatest economic feasibility is demonstrated by villages that are not easily reached by either road or river networks. The greatest ecological feasibility occurs in communities of small to medium size, where the wood resources needed are available within a relatively small radius.

Biomass conversion also offers potential social benefits of providing local employment, retaining money locally, and reducing the risk of catastrophic wildfire near human habitation. Harvest of biomass fuels would provide local jobs, which in turn would bolster the local cash economy by recirculating money within each village. In contrast, payments for fossil fuels represent a monetary flow out of communities. Fire is linked to many aspects of community wealth, in both monetary and subsistence categories. Thus, natural forest succession, protection of life and property, local wages, and subsistence foods are all linked through the presence–or absence–of fire on the landscape.

Subsidies and grants create a large gap between the real costs of electrical power and the prices being charged to consumers. In reality, however, the discrepancy between realized costs and real costs may be even larger, owing to hidden (off-book) costs covered by transfer payments other than those made via the state Power Cost Equalization Program. These include government-funded construction and upgrades. Such off-book costs account for roughly 25 percent of the real cost of power, but are not accounted for in our economic analysis. Thus, the State of Alaska has a large stake in any potential fuel conversion project.

Biomass fuels are likely to increase the long-term social and ecological resilience of village communities to externally-driven changes, including fluctuations in fossil fuel prices related to state, national, or international policies; variability in Alaska's economic outlook, which might in turn affect subsidies; and changes in fire risk and fire management, driven by climate change and by state and federal fire budgets.

Based on the financial power wielded at higher levels of governance and the social power contained within communities, there are potential advantages and disadvantages associated with both top-down or bottom-up approaches to managing potential village biomass projects. Success of a fuel conversion project in a community is likely to depend upon the existence of local advocates and participants; sufficient local technological skills; and collaboration among communities, funders, and electrical cooperatives. In the long run, a combined approach seems likely to provide the greatest resilience to the system. Power sharing and co-management are ideas that are starting to take hold in a range of rural applications and are likely to be appropriate in an Alaska context. For example, although overarching assessments of fuel supply and demand around a village might be performed by forestry professionals, annual harvest areas might be chosen by local village councils, based on community preferences.

The transition to renewable energy sources is constrained by a number of economic, social, technological, and political factors. These include startup costs for research and new infrastructure; social inertia and risk aversion; inadequately developed technologies; lack of availability of all energy sources in all regions; and artificially low costs of existing fossil-fuel systems owing to subsidies, lack of accounting for economic externalities, and current infrastructure.

Fall foliage in the Yukon Flats National Wildlife Refuge, showing typical taiga forest.
—PHOTO BY TED HEUER, US FISH & WILDLIFE SERVICE

Despite the above limitations and constraints, conversion to biomass fuels would be economically viable and socially beneficial for many villages across interior Alaska. Pilot projects offer the next step in testing feasibility.

Further reading and information

Alaska Center for Energy and Power: www.uaf.edu/acep/

Alaska Conservation Solutions: www.alaskaconservationsolutions.com

Alaska Energy Authority: www.aidea.org/aea/

Alaska Renewable Energy and Sustainable Opportunities Network (web portal): www.akreason.org

Alaska Sustainable Energy Center: www.investfairbanks.com/Energy.htm

Biomass Energy Alternatives for a Remote Alaskan Community, by Crimp, P.M. and S.V. Adamian. 2001. Alaska Energy Authority and Ecotrade, Inc. Anchorage, Alaska and Glendale, California. Available on line at www.nrbp.org/papers/017.pdf

Biomass for Electricity Generation. Energy Information Administration. www.eia.doe.gov/oiaf/analysispaper/biomass/

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Wood Biomass for Energy. Forest Products Laboratory. Available on line at www.fpl.fs.fed.us/documnts/techline/wood-biomass-for-energy.pdfs

How to save Old Faithful

geyser protection areas

Kenneth A. Barrick

Geyser basins are rare composite resources that provide an increasingly important array of recreational, scientific, cultural, national heritage, and economic benefits. For centuries, hydrothermal recreation has supported tourism—from "geyser gazing" to the "taking of the waters" in spa thermal pools. Geyser basins are the key attraction at important national parks and reserves, including Yellowstone National Park, northwest Wyoming (US); the Whakarewarewa Thermal Reserve, Rotorua City (New Zealand); and Dolina Geizerov ("Valley of Geysers"), Kamchatka Peninsula (Russia).

Geysers are relatively fragile geologic features that are subject to irreversible damage and/or quenching from nearby human development activities. For example, geyser basins have been damaged or driven to extinction by geothermal wells used

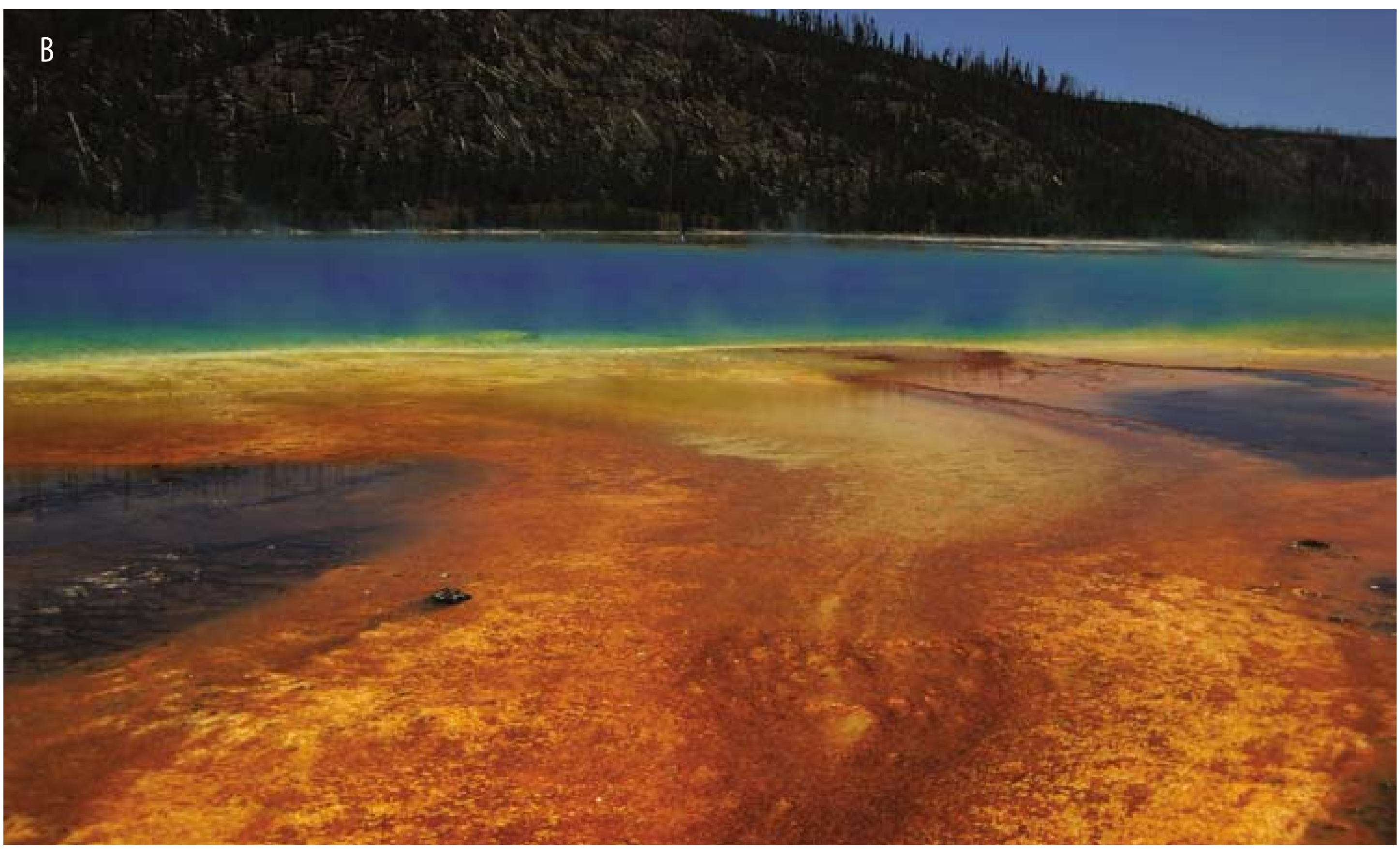
> **"The prospects for geothermal energy development are likely to increase with the search for alternatives to fossil fuels… [but] geothermal wells are incompatible with playing geysers."**

Geyser basins provide an important resource not only for tourism, but also for microbiology research, so far yielding benefits in the fields of clinical medicine, food analysis, forensics, food processing, brewing, and textile processing, with new research exploring potential application in the production of hydrogen fuel, among other promising avenues.

—PHOTO BY KEN BARRICK

Figure 1. Selected features of geyser basins. (A) Pohutu Geyser, New Zealand (a rare "grand" or tall geyser); (B) Yellowstone's Grand Prismatic Spring with colors from cyanobacteria; (C) Yellowstone's Penta Geyser (a more common "small" geyser); (D) a mud pot; (E) a fumarole.
—PHOTOS A–D BY KEN BARRICK; PHOTO E BY TIM ROSS

for home heating or industrial-scale electricity production, alteration of nearby riverbeds, filling of hydroelectric reservoirs, and exploration for the precious metals that are precipitated by hydrothermal waters. Over the past few decades, various energy development projects have permanently quenched about 260 geysers, which reduced the worldwide geyser endowment by about 23 percent (or 40 percent of all geysers located outside of national parks and reserves). About 100 geysers were quenched in New Zealand (75 percent of the local endowment), and about 46 in Iceland (75 percent of the local endowment). In the US, two geyser fields in Nevada were quickly driven to extinction by geothermal wells at Beowawe (all 30 geysers), and Steamboat Springs (all 26 geysers). Today, the world's few remaining geyser basins are exceptionally rare.



The prospects for geothermal energy development are likely to increase with the search for alternatives to fossil fuels. Therefore, it is important to raise awareness that geothermal wells are incompatible with playing geysers. The sustainability of the world's remaining geyser basins requires that environmental managers and engineers not only understand the wide range of benefits provided by geyser basins, but are also fully informed about the negative impacts that water withdrawal from geothermal wells will impose on hydrothermal watersheds that supply geysers and important hot springs. In the US, it is especially important to protect the hydrothermal resources of Yellowstone National Park, which currently harbors the world's largest concentration of geysers. The current suite of environmental regulations that protect Yellowstone's geyser basins must be strengthened before intractable geothermal resource conflicts arise.

Important features of geyser basins

Geysers almost always occur in association with other surface hydrothermal features, including hot springs, fumaroles, mud pots, and steaming ground (Figure 1). When geysers and associated hydrothermal features cluster around a common watershed and geothermal heat source, they constitute a composite resource—often referred to as a "geyser basin" (in New Zealand, "hydrothermal area"). Technically, a geyser is a hot spring that intermittently becomes unstable and erupts (usually upwards) a turbulent jet of water and steam. Each geyser eruption is followed by a quiescent recharge phase. Geysers are classified as either cone (columnar) or fountain (pool) types. Each geyser is rendered essentially unique by its characteristic eruption. Eruptions vary in terms of water and steam volume, height, length, periodicity, predictability, cyclic phases (continuous or multiple sub-eruptions separated by quiet phases), noise, and potential steam phases. Most geysers are small and barely sputter and splash to a height of about three meters. At the other end of the scale, the eruptions of "grand" geysers are much taller, and typically send water upwards of 60 meters. However, grand geysers are exceptionally rare—among Yellowstone's 500 geysers, there are only a few grand geysers that play on a predictable daily basis.

Geysers are appreciated as amenity resources for their many natural characteristics, and for the sheer spectacle of their eruptions. The sequential eruptions of a single geyser never seem to be the same—there is always the chance that the next eruption will be better than the preceding one. The complete experience of geyser viewing includes the anticipation stage, complete with contemplative waiting for the eruption, the exhilaration accompanying the eruptive stage(s), and the desire to experience similar, but always different, sightings of the same or other geysers. The uniqueness of each geyser provides an essentially infinite array of possible geyser sightings.

Geysers are often surrounded by incredible beauty. The overflow channels of geysers and hot springs can exhibit some of the most intense colors found in nature—yellows, oranges, browns, and greens (Figure 1). The colors are the product of highly pigmented cyanobacteria that thrive in hot water. The varying colors are temperature dependent. At the boiling point (about 100°C), only white-colored bacteria thrive as long filaments, then matted, yellow colonies take over when the water cools to about 71°C, orange at 63°C, dark browns at 57°C, and green at 50°C or less. On a sunny day, cyanobacteria pigmentation can be so brilliant that the reflection and scattering of light can project sympathetic colors into the plume of steam rising off the hot water.

Increasing scarcity of geyser basins

Geyser basins are truly rare. The world's natural endowment before the geyser extinctions caused by energy development projects was about 1,194 geysers. A total of about 260 geysers have permanently ceased to play as a result of nearby development activities. Today, most of the remaining geysers are found in only five major clusters, including: (1) Yellowstone National Park (about 500 geysers); (2) Dolina Geizerov, "Valley of Geysers" in Russia (about 190 geysers); (3) El Tatio in northern Chile (about 80 geysers); (4) the Taupo Volcanic Zone in New Zealand (about 30 remaining geysers); and (5) Iceland (about 16 remaining geysers, not all active).

Extinction of geyser basins by geothermal wells

The most serious concern for the future sustainability of the world's remaining geyser basins is the prospect of nearby geothermal energy development. Several factors are conspiring to increase the prospects for geothermal energy. First, the search for alternative energy resources will accelerate with the increasing cost of fossil fuels. Second, technological advancements have reduced the size of geothermal power plants to five megawatts (MW), and lowered the cost of developing geothermal fields through staged development (one MW can provide power for about 1,000 people). The next generation of technology, called "Enhanced Geothermal Systems," is expected to make large-scale "heat mining" possible through deep-drilling and reservoir stimulation techniques (1 to 50 MW). Enhanced geothermal systems will push development from the relatively restricted domain of high-temperature geothermal fields (in the US, mostly limited to the western states) to all landscapes. Third, emerging centers of expertise in geothermal engineering (like those in Iceland) are maturing into export industries.

Geothermal energy production requires wells that extract large amounts of hot water, steam, and/or heat from the hydrothermal reservoir. The water withdrawal from geothermal wells is capable of quenching natural overflow features like geysers. When geothermal wells lower reservoir pressure, the discharge can be reduced to the point where geysers cease to play. The often fatal resource competition is best understood as the "geyser paradox." The thermal energy required to trigger the eruption of a geyser (150°C or higher) indicates a shallow magmatic heat source, which is a reliable indicator of a potential geothermal energy resource. Moreover, there are engineering incentives to place power plants near geyser basins because hot water (or steam) cannot be piped great distances from the geothermal wells. The "geyser paradox" is a reminder that surface hydrothermal features are often magnets for geothermal development, but geysers and hot springs do not persist in a natural state when heat and/or water are removed from the geothermal reservoir that supplies them. There is ample evidence that geothermal wells are simply not compatible with active geysers. Moreover, geysers are nonrenewable resources—they almost never recover when quenched by geothermal wells. It is suspected that underground cooling clogs the geyser's plumbing with mineral precipitates.

The environmental history of the world's hydrothermal reservoirs is replete with multiple case studies of geyser basin extinction from geothermal wells. New Zealand lost the largest number of geysers to energy development. The Taupo Volcanic Zone on the North Island of New Zealand once contained the world's second-largest geyser endowment. However, energy development projects reduced New Zealand's endowment of more than 130 geysers to about 30. Multiple

Figure 2. New Zealand's Wairakei Geothermal Power Station project. (A) overview of the geothermal well field and piping, and (B) typical geothermal well infrastructure.
—photos by Ken Barrick

types of energy development projects quenched geysers, including the industrial-scale geothermal well withdrawal at the Wairakei Geothermal Power Plant (Figure 2), the negative impact of river modifications at the Spa Hydrothermal Area, the drowning of geysers under a hydroelectric reservoir at Orakeikorako, and the impact on the Whakarewarewa Thermal Reserve by geothermal wells used for home and commercial heating in nearby Rotorua City.

Iceland is a remote island nation in the north Atlantic with few domestic energy resources, so it has relied heavily on geothermal development. Today, about 55 percent of Iceland's energy consumption is provided by geothermal power and heating plants. Iceland was originally endowed with more than 60 geysers and 600 hot springs. Iceland is the home of the namesake of all geysers—the "Great Geysir." Before geothermal development, geysers were abundant at Reykir (about 15 geysers), Hveralvellir (12 geysers), Haukadalur (9 geysers), and Borgarfjaroarsysla (7 geysers), and a few other locations. However, today, there are only about 16 playing geysers.

In 1867 the US Army discovered the Beowawe Geyser Basin while on cavalry patrol in central Nevada, about 2.5 kilometers from the village of Beowawe. A one-kilometer-long sinter terrace contained geysers, and about 100 fumaroles and 100 hot springs. At any one time, about 12 to 27 geysers were active, and they erupted to heights of 10 to 20 meters. However, in the early 1950s, energy prospecting began when three geothermal wells were drilled. Well testing quickly dried up the natural springs. Later, in 1986, a geothermal power plant went on line, which was capable of producing about 17 MW. By

1987, all of the geysers and hot springs had been driven to extinction.

Steamboat Springs Geyser Basin included a group of hot springs and fumaroles that issued from a sinter area among the hills about 20 kilometers south of Reno, Nevada. The original geyser endowment was about twenty small geysers, although occasionally one would erupt to a height of 8 to 15 meters. Today, the Steamboat hydrothermal reservoir is developed by two geothermal well fields, and associated power plants, with a total output of about 55 MW. All of the Steamboat geysers are now extinct due to geothermal energy development.

Benefits of geyser basins

Geyser basins provide an array of important benefits that extend well beyond recreation. For example, the unique or endemic organisms that inhabit hydrothermal areas have special value, not only because of their scientific interest, but also because some of them, especially thermophilic microorganisms, have considerable commercial value. Geyser pools and hot springs have temperatures at (or near) boiling, so bacteria have evolved thermostable proteins that allow them to thrive at temperatures above 45°C. The importance of thermophilic bacteria was discovered in 1965, when Thomas Brock, a microbiologist, was conducting basic research on the cyanobacteria inhabiting the thermal pools of Yellowstone's Lower Geyser Basin. There, in a hot spring, he made a serendipitous discovery—a pink filamentous bacteria living at 82 to 88°C, which was remarkable because it was thriving at temperatures above the reputed upper limit for life. The new thermophile was named *Thermus aquaticus*. By the late 1980s, *T. aquaticus*' heat-stable enzyme "Taq" polymerase (named after *T. aquaticus*) was applied to the "hot" phase of the polymerase chain reaction (PCR). PCR is a DNA sequencing technique that rapidly amplifies specific DNA sequences by replicating a single DNA molecule into millions of identical copies. Taq made PCR processing much faster, which allowed automation and the widespread use of DNA sequencing. Today, Taq-based PCR supports a multi-billion dollar DNA sequencing industry, and provides vital testing services for clinical medicine, food analysis, and forensics.

Geyser basins offer hot water habitats with virtually unlimited possibilities for the discovery of new thermophiles with novel catalysts for industrial processes. An increasing array of biomolecules have been isolated from thermophiles, including xylanases for enzymatic treatments of paper pulp to reduce the amount of chlorine bleach needed (reducing waste and pollution); polymer-degrading enzymes like proteases for improving food processing, brewing, and detergents; and pullulanases for textile processing. Several thermophilic bacteria are considered potentially useful in microbial biomass fermentations of bioethanol. Metal-containing proteins are being studied for the potential production of hydrogen fuel. In a very real sense, the practical application of geyser basin microbiology has already assisted in the development of alternative energy sources, and the future discovery of useful applications is essentially unlimited so long as the remaining geyser basins are protected.

Geyser basins are emerging as an important part of the host country's "national heritage." For example, New Zealand's remaining hydrothermal areas are now recognized as a part of what makes the nation "different." Heritage attributes elevate hydrothermal landscapes, and the traditional communities based on them, to the status of "treasures" that require protection in the national interest. The positive benefits from national heritage status should not be underestimated. The evolving encoding of landscapes that have extraordinary natural history characteristics with importance as part of a nation's collective sense of community has the power to inspire responsibility for enduring resource stewardship. In time, geyser preservation motivations based on national spirit can by transformed through altruism into universally accepted "global public goods" held in trust for future generations.

Geyser basins provide important opportunities for scientific research. Traditionally, geological processes have dominated geyser basin studies. However, the growing list of commercial applications for heat-adapted microbes has greatly expanded biological research. Geysers also support specialized research. For example, geyser activity is of interest in mathematics and statistics, including variability in the length of intervals between geyser eruptions, and the characteristics of periodical phenomena.

Protecting the geysers of Yellowstone National Park

The pioneers of the American West described the geyser basins they found in northwest Wyoming as a "wonderland"—a landscape with such exceptional qualities that in 1872 it inspired the nation's first large-scale land reservation in the public interest—Yellowstone National Park. Today, Yellowstone spans 8,950 km^2 of Wyoming, Montana, and Idaho, and its nine geyser basins contain about 500 geysers, or half of the world's remaining geyser endowment. The Upper Geyser Basin alone has about 180 geysers, including the world famous Old Faithful Geyser. The Upper Geyser Basin also harbors most of the world's exceptionally rare "grand" or tall geysers (Figure 3).

It is a common assumption that the geyser basins at Yellowstone National Park are bestowed with permanent refuge status. However, the hydrothermal watersheds that supply Yellowstone's geysers and hot springs extend well beyond the park's borders. Two Known Geothermal Resource Areas (KGRAs) are located adjacent to the park—Island Park KGRA to the west, and Corwin Springs KGRA on the north (Figure 4). The establishment of KGRAs along Yellowstone's boundary set up an enduring resource conflict between the preservation of the park's hydrothermal features and application of geothermal energy development rights outside the park. Existing geothermal legislation,

Figure 3. The grand or tall geysers of Yellowstone National Park's Upper Geyser Basin. (A) Old Faithful Geyser (a cone type geyser), (B) Riverside Geyser; (C) Castle Geyser; (D) Daisy Geyser; (E) Beehive Geyser; and (F) Grand Geyser (a fountain type geyser).
—photos A-C, E, F by Ken Barrick; photo D by Mila Zinkova, CC Attribution ShareAlike 3.0

Figure 3, continued

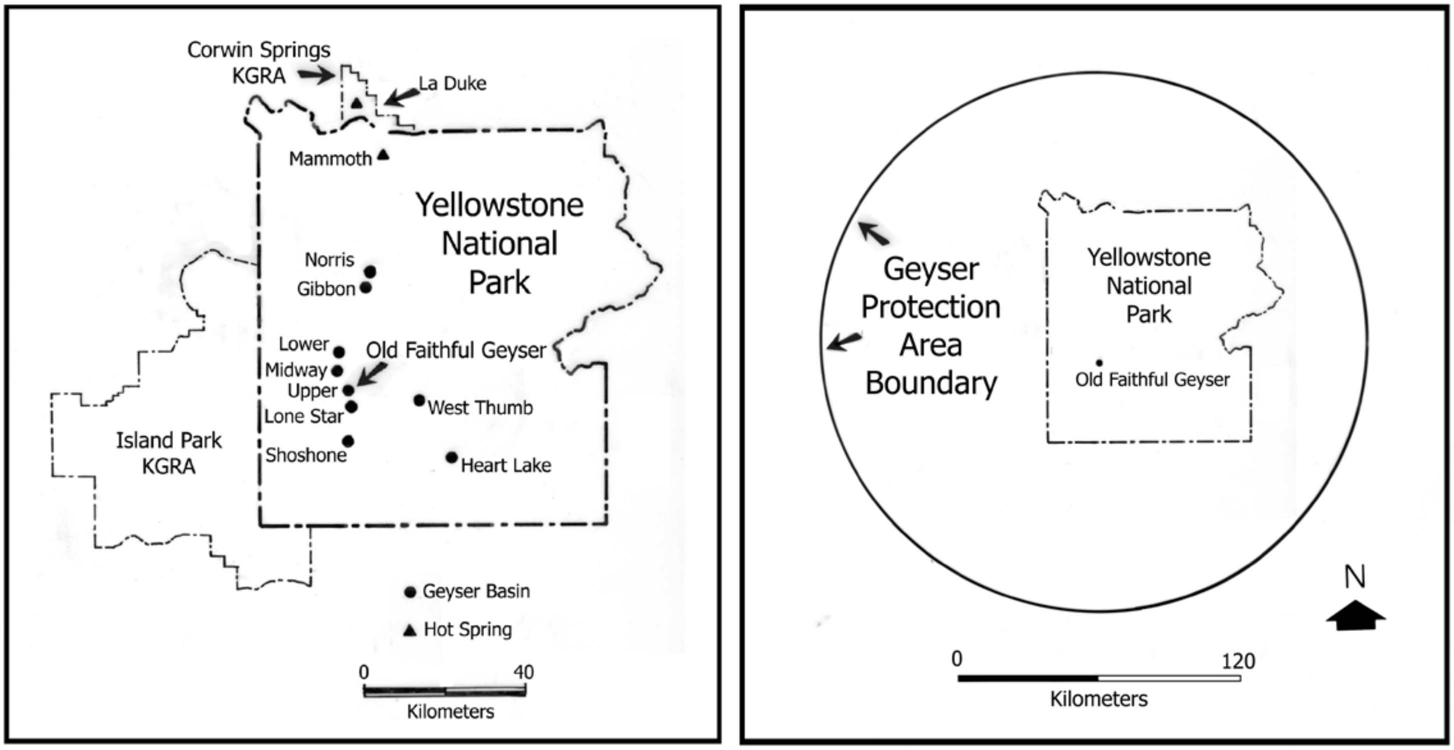


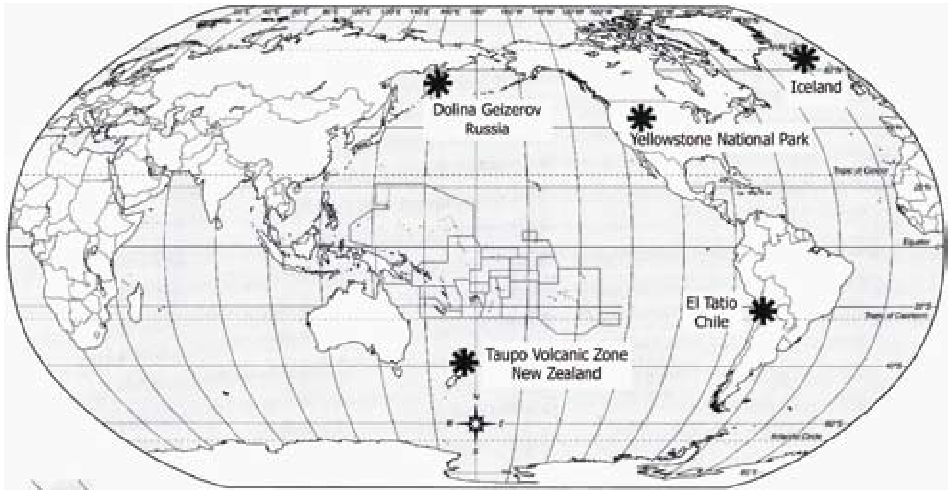
Figure 4. (Left) The Island Park and Corwin Springs KGRAs in relation to Yellowstone National Park's geyser basins, and (Right) proposed "Geyser Protection Area" (GPA) centered on Old Faithful Geyser (note the KGRAs are replaced by the GPA).

like the Geothermal Steam Act of 1970 (amended in 1988), provides some protection of the park's hydrothermal features, but offers varying limitations for geothermal development on adjacent federal, state, and private lands. The prospect of future geothermal wells on the KGRAs was always controversial, given the public knowledge about the potential for irreversible damage to Yellowstone's geysers and hot springs. Unfortunately, in the mid 1990s, the US Congress failed to approve the Old Faithful Geothermal Protection Act, which would have provided specific protections for Yellowstone's geysers and hot springs.

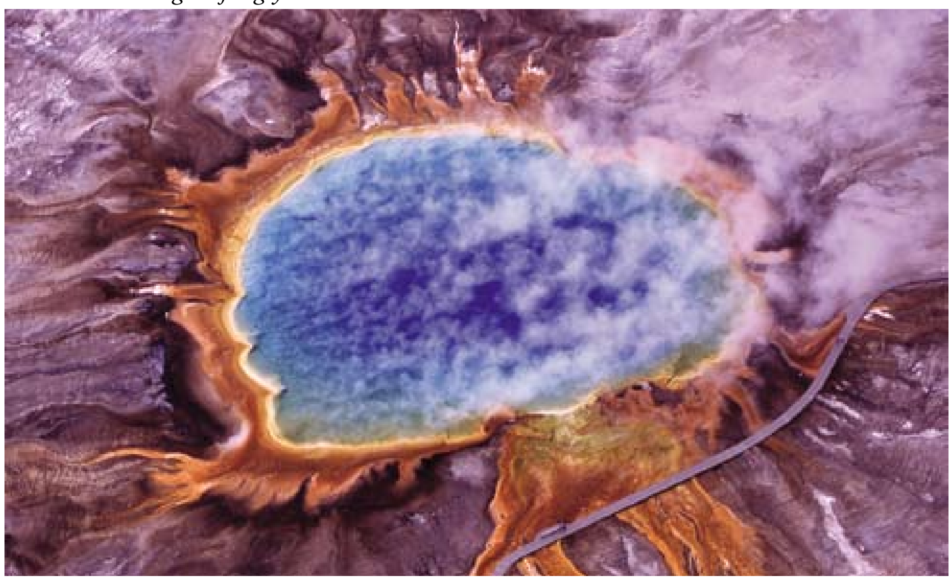
The Island Park KGRA is located in the Targhee National Forest, only about twenty kilometers west of the Upper Geyser Basin and Old Faithful Geyser. Potential geothermal energy development at Island Park represents the most immediate threat to Yellowstone's geysers. In the 1970s, the Targhee National Forest was managed to closely mirror the pro-development preferences of rural Idaho. In 1980, the US Forest Service released a Final Environmental Impact Statement (EIS) that recommended granting geothermal energy leases on about half of the Island Park KGRA. By 1986, there were 107 geothermal lease applications on the Island Park KGRA covering 70,000 ha of federal land, and 10,280 ha of state and private land.

The Corwin Springs KGRA is connected to Yellowstone's hydrothermal features in that it is the northern extremity of the "Mammoth Corridor," a 40-kilometer-long traverse of faults and hot springs that runs from Norris Geyser Basin, at Yellowstone's interior, to about 10 kilometers north of the park. Yellowstone's Mammoth Hot Springs area is famous for the world-class travertine terraces that were created by its hot springs. The Corwin Springs KGRA had a number of controversial geothermal wells constructed over the years. In 1986, the most controversial of these wells was drilled on the Royal Teton Ranch. At the time, the ranch was owned by the Church Universal and Triumphant (CUT), which was constructing a survivalist compound, complete with a large concrete bomb shelter, and plans to tap geothermal energy. Yellowstone managers viewed the CUT geothermal well as a dangerous precedent. The CUT geothermal well was eventually plugged, but not before creating considerable anxiety that other geothermal wells would be drilled on the Corwin Springs KGRA.

The two KGRAs located adjacent to Yellowstone have been in place for decades now, but they have yielded few benefits. However, these KGRAs did invite intractable resource conflicts, costly environmental investigations, contradictory scientific interpretations, and a divisive commingling of goals between federal agencies, state governments, and private property owners. In crisis mode, the US Congress did act to shore up the outdated environmental provisions of the GSA, but the current piecemeal approach to protecting Yellowstone's geysers is fraught with peril. Even small modifications to a geothermal reservoir's heat and/or water regime can cause irreversible damage to a geyser basin. A comprehensive and permanent solution is required that replaces the KGRAs adjacent to Yellowstone with a Geyser Protection Area (GPA), centered on Old Faithful. To be effective, the GPA must include: 1) the exclusion of all geothermal energy exploration and development (including water withdrawal from geothermal wells, extraction of heat by down hole heat exchangers, and/or surface diversion of hot spring discharge), 2) the termination of all existing geothermal and large-scale irrigation well development rights, and 3) application across all types of land ownership—federal, state and private. The area of Yellowstone's GPA must be sufficiently large to protect all the hydrothermal reservoirs that supply its geyser basins. A minimum effective GPA radius of 120 kilometers from Old Faithful Geyser is required, which includes the watershed of the Madison Plateau and the hydrothermal sources that are likely to supply Mammoth Hot Springs (Figure 4).



World's remaining major geyser basins.



Aerial view of Grand Prismatic Spring, Yellowstone National Park. The spring is approximately 250 by 300 feet (75 by 91 m) in size. This photo shows steam rising from hot water in the center surrounded by huge mats of brilliantly colored algae and bacteria.
—Jim Peaco, National Park Service

Conclusions

The scarcity of the world's remaining geysers has greatly increased their preservation value. The sustainability of the remaining geyser basins will require an integrated environmental management approach based on a comprehensive knowledge of the values and benefits that society derives from them; a sober accounting of the known risks of competition for heat and/or water from the hydrothermal reservoir that supplies them; and effective protection legislation. Experience demonstrates that all incompatible uses, especially those that abstract heat and/or water from a geyser basin's hydrothermal reservoir(s) (e.g. geothermal and large-scale irrigation wells) must be prohibited from the outset. The fact that most of the world's remaining geysers are located in a few clusters or geyser basins, means that geyser protection can be efficiently accomplished with delineated Geyser Protection Areas. Sustaining the world's remaining geyser basins and their multiple benefits with GPAs should be a matter of urgent national and international policy.

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TWO FOR THE PEACE CORPS

Erin Kelly with local children in El Salvador, near El Imposible National Park.
—PHOTO COURTESY ERIN KELLY

ONE: ERIN KELLY

After spending two years in a remote region of El Salvador, Peace Corps volunteer Erin Kelly has returned to Fairbanks. Along with memories and great stories to share as a result of her experiences, Kelly will also gain a master's degree from UAF.

Kelly is the first student from the School of Natural Resources and Agricultural Sciences to participate in Peace Corps Master's International, a cooperative master's degree program that allows students to integrate graduate studies with international development experience.

"This is not just a resume builder," said Tony Gasbarro, UAF professor emeritus and the campus coordinator for Master's International. "The student has to have a sincere interest in helping the poor in the underdeveloped world. They need compassion for people in the Third World."

Before departing the US, Kelly went through three months of intensive training with the Peace Corps. Technical, cultural, and language aspects were emphasized. Based nearly 5,000 miles from Fairbanks, Kelly was in a small community near El Imposible National Park where she worked with a nongovernmental agency called SalvaNatura, which manages the park. Kelly said she was surprised at how the local people welcomed her. "I knew upon leaving for the Peace Corps that I was headed for an incredible experience, filled with its ups and downs, but I never imagined the sense of home I would feel in my community and the warm acceptance I would receive," she said. In fact, she liked it so much that she had a hard time leaving El Salvador, and said she would have stayed another year if she could have.

"Volunteering in a foreign land and simultaneously working on a master's degree requires the ability to multitask, to say the least."

El Imposible park guides and guards posing with Erin Kelly during a hike through the park.
—PHOTO COURTESY ERIN KELLY

Volunteering in a foreign land and simultaneously working on a master's degree requires the ability to multitask, to say the least. The focus of each degree is geared toward the specific work the volunteer does. Kelly will earn a master of science degree in natural resources management. Essentially, her volunteerism is transformed into graduate work, but she took several courses prior to her journey, will complete a final semester, and will write a project paper. While in El Salvador she interviewed community members within El Imposible National Park to see if they were in favor of the managing nongovernmental organization's plans to develop ecotourism. She also interviewed representatives of the NGO, the Ministry of Natural Resources and the Environment, and the Ministry of Tourism. She discovered that the majority of community members were in favor of ecotourism development and would be willing to help make it a reality, but they complained of a major lack of communication between residents and SalvaNATURA, the NGO, so much so that many people felt left out.

Kelly is recommending that SalvaNATURA establish more communication and contact with the community so as to generate trust and a good working environment. "Without collaboration from the community, nothing SalvaNATURA does in the park will be successful or sustainable," Kelly noted. Through the years of interaction between the community and SalvaNATURA, conflicts had characterized the relationship and nothing of note had been done to solve the problems, she said. She will also recommend that the NGO increase its marketing efforts for El Imposible. "The more tourists that visit the park the more motivation the community will have to collaborate and take part in community-based ecotourism projects," Kelly said.

El Imposible is a dry tropical forest, named after the steep "Impossible Pass" in its boundaries, and created by governmental fiat in 1986. The park is surrounded by a 7,658-acre buffer zone, in which approximately 13,000 people live. What is known as the Region of Influence has a population of 136,194 people (as of 2006), and is defined as the area around the park that directly receives benefits from the presence of the protected area, such as water, and whose development also affects the area. This area is 145,678 acres. Of the two sectors in the park, the San Francisco Menedez sector is the least developed for ecotourism. Kelly's paper is based on interviews, participant observations, and a review of El Imposible's park management plan.

Kelly's work included creating a marketing plan for the park, and she wrote a manual of questions in English and Spanish to assist Spanish-speaking park guides in communicating with tourists. Her involvement also extended to the younger set. Kelly took children on hikes in the park after she discovered that some children living just outside the park had never been within its boundaries. Kelly kept Spanish-language children's books at her apartment so she could share story time with her young friends. Other interactions with children focused on Kelly's concern for the environment. After hosting several trash pick-up days, she noticed that the children were littering less. She even got some locals on the recycling bandwagon.

Learning to communicate with agencies, community members, and government bureaucracies helped Kelly gain valuable negotiation skills. After completing her master's she would like to work for a US company and return to a developing nation that needs her skills in ecotourism and adventure travel.

Finding herself completely immersed in the local culture, Kelly rented a small apartment and traveled to a nearby town once a week to check e-mail. She noted that the park where she worked is home to 400 species of trees, 5,000 to 6,000 species of butterflies, 282 species of birds, and 53 species of amphibians and reptiles. "Thank goodness I only saw three snakes," she remarked.

The diversity and beauty of nature aside, Kelly said it was the kindness and generosity of the people she will always remember. "Many Salvadorans live in poverty and may be unable to provide their families with basic necessities, yet they seem content with their lives because they have their family, health, and faith in the future, and they are always more than willing to give what they have to someone else in need."

Kelly found being a Peace Corps volunteer thrilling and satisfying, and said she plans to recommend it to other students. "Joining the program has been one of the best decisions I have made," she said. Combining volunteer work with the pursuit of a degree gave her opportunities to learn more about El Salvador's tourism development, the government's management of protected areas, and the role of nongovernmental organizations.

To sum up her experiences, Kelly said, "Being in the program requires a lot of flexibility and patience in that once you start your Peace Corps service things never go as you hope or plan they will, and everything moves at a much slower pace than you are used to. Also, you need to be able to take initiative and function well under little to no supervision. Having an open mind and being able to think outside the box are important elements as well."

In the end, Kelly hopes she left behind a positive legacy of some sort, but it will likely take time and reflection for her to understand the total picture of her influence. Or maybe she never will. But one thing she does know. "I have learned to let go of expectations, slow down, and that sometimes you just need to let things happen on their own," she said.

For further reading:

- "Salvadoran challenges," December 2007, by LJ Evans, www.uaf.edu/news/featured/07/peacecorps/
- "My Peace Corps site: El Salvador," by Erin Kelly, www.uaf.edu/news/featured/07/peacecorps/elimposible.html
- "Report from El Salvador," *Natural Resources News*, v. 8 n. 1, April 2008, www.uaf.edu/snras/afes/pubs/nrn/NRN%208_1.pdf

Earthen bread oven.
—PHOTO BY MATTHEW HELT

Matthew Helt, left, in Paraguay with his host family.
—PHOTO COURTESY MATTHEW HELT

TWO: MATTHEW HELT

After months of intensive Peace Corps training, SNRAS's second Peace Corps Master's International student, Matthew Helt, was assigned to a village of 150 people outside Ybycui in Paraguay. In e-mail messages, Helt expressed satisfaction that his village has a working farmers' group, youth group, and women's group. "I am truly excited to spend the next two years working on community development and empowerment," he wrote.

During his training period, Helt learned to deal with cold water showers and to request more vegetables for dinner. Even though surrounded by lettuce fields, his host family was more accustomed to serving meat dishes. Helt attended sessions on agroforestry, crops, beekeeping, and environmental education, and he went to workshops on culture, health, safety, music, religion, and learning styles. He has grafted citrus and mango, planted a garden, and worked on a tree nursery.

Helt noted that deforestation is a major problem in Paraguay, with large plantations growing cotton, soybeans, and sugar cane for export on land that used to be forests. His assignment is to work with local farmers who only have a few acres.

For the Christmas holiday, Helt and his family killed a turkey and a couple of chickens for their feast, then he visited with another family to participate in the slaughter and butchering of a pig. "Needless to say I am very thankful that generally speaking we have grocery stores that stock clean, cold, and safe meat in nice little packages. Probably not the most environmentally friendly and all that but it is an amazing convenience that I for one am very thankful to have," Helt said.

Helt found that being far from home can be a bit tough, but learned that reading helps him feel less lonely. "There is nothing like a good book to keep you going," he said. He discovered that, for the most part, Paraguayans, especially in the campo, don't read much because they don't have access to books or libraries. Rather, they tend to watch soap operas from Argentina and Brazil and listen to regatonne and polka to pass the time.

The bamboo fence in progress. Stacked slats are drying in the yard.
—photo by Matthew Helt

"When you read they think it is work or study and are generally impressed," Helt said. "I have taken up reading to an extent that anyone who knew me before Paraguay probably wouldn't believe."

Helt's time is spent working on his house and visiting with people. "Cutting bamboo and building a fence is extremely time consuming and green bamboo is very heavy. It's a huge amount of work with just a hand saw and a machete," Helt said. "We have to walk a couple of kilometers to cut the bamboo, then either haul it by hand or an ox cart to my house where I stack it to dry and split it for slats. Luckily I've had the help of a few members of the youth group. I eventually hope to work with them to help plan my vegetable garden, tree nursery, demonstration forest, and an orchard."

Helt is also working with a beekeeping volunteer to help the community learn how to manage bees, and he helped with a "tree day" for youths. "We talked about the benefits of trees, what we use them for, and planted seeds in pots with the kids," Helt said. He is getting to know as many people as possible and providing an example of how to have a garden and farm.

Fellow Peace Corps volunteers in the lettuce beds, learning technical skills in preparation for assignment in a community.
—photo by Matthew Helt

When Helt was sworn in as a Peace Corps volunteer at the US Embassy in Asunción on Dec. 5, he was elated. "It's not every day that one is able to do such a thing so it was rather exciting for most of us," he said.

Professors' Perspective

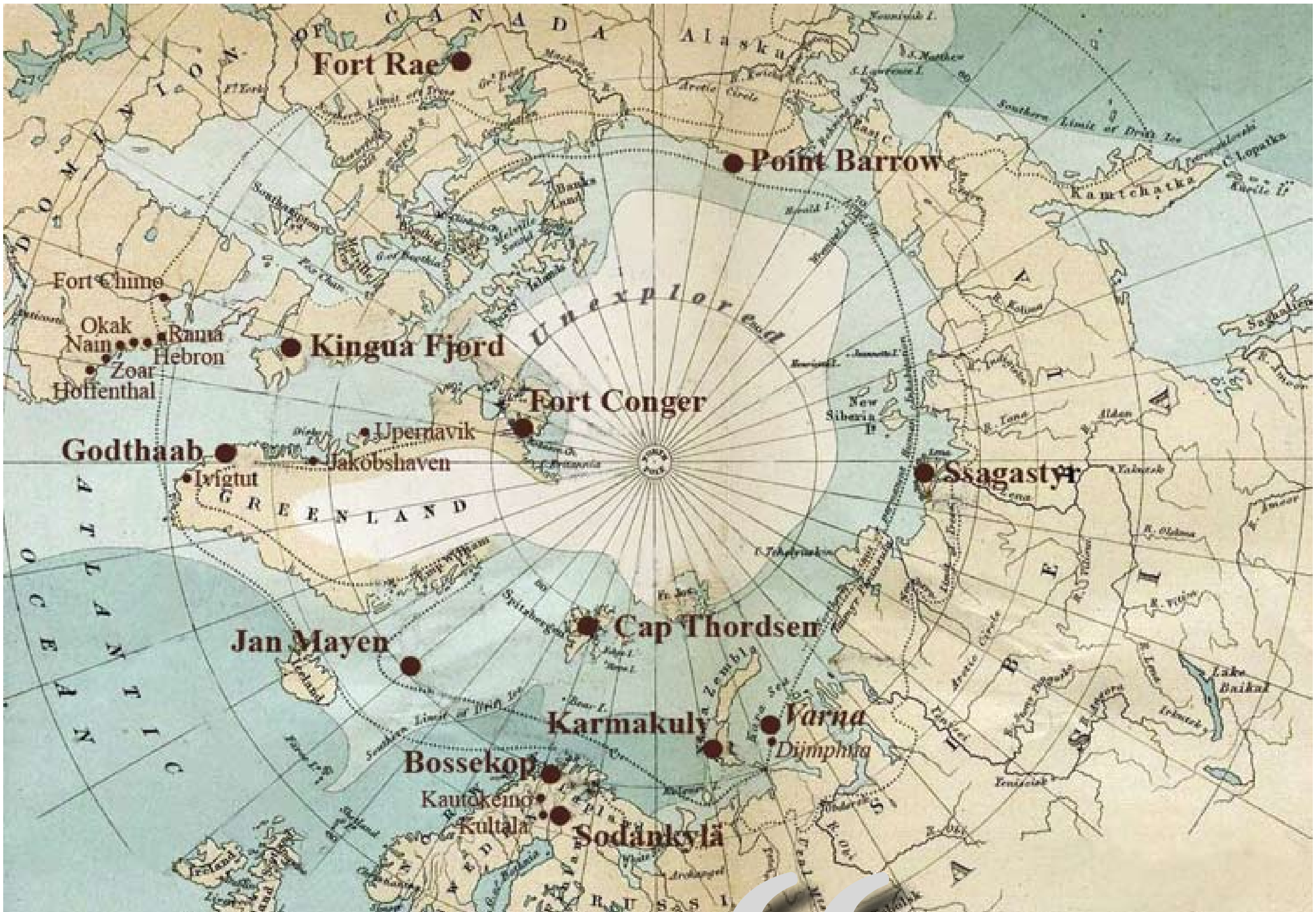
SNRAS Associate Professor Susan Todd, academic contact for the Peace Corps Master's International Program for the school, said, "Having some courses in a graduate program focused on international issues is a good thing since Americans tend to know very little about foreign countries. his program takes the coursework a step further by placing students in another country for two years. With globalization everything is connected. Even if we ignore the rest of the world it does affect us." Todd is glad that interest in the program is growing. Other students are expected for fall semester 2009.

Tony Gasbarro is also pleased. "International experience only helps students," he said. The host country gets the technical experience of graduate students, and also becomes more aware of what Americans are like. "It's a cultural interchange," Gasbarro said. Often it's outside of work that volunteers make the best connections. "They can provide so much—English courses, soccer games, community involvement, sharing other skills."

For the students, the program helps them develop skills for the global marketplace and gain job placement support, Gasbarro said.

Graduate studies and the Peace Corps Master's International program at SNRAS

Students may pursue several areas of interest within the UAF Natural Resources Management MS degree, including horticulture, soil science, agronomy, animal science, forest ecology, silviculture, resource economics, land planning, parks/recreation management, and resource policy. The university provides a six-credit tuition waiver for Peace Corps Master's International students, allowing them to maintain their active student status during their assignment. Visit www.uaf.edu/snras/pcmip/index.html for more information or contact Susan Todd at ffskt@uaf.edu or Tony Gasbarro at ffafg@uaf.edu. Contact Joshua Greenberg at j.greenberg@uaf.edu for questions on graduate studies in natural resources management.



Eleven nations established fourteen principal research stations across the circumpolar regions during the First International Polar Year. Twelve of these stations were in the Arctic, along with at least thirteen auxilary stations, manned by more than 700 researchers between 1881 and 1884.

—MAP COURTESY OF NOAA ARCTIC RESEARCH, WWW.ARCTIC.NOAA.GOV/ARO/IPY-1/

THE IPY AT UAF

The 4th International Polar Year (IPY), which kicked off in March 2007 and continued through March 2009, was a campaign of intense, internationally coordinated research to gain new knowledge about Earth's polar regions, how those regions are changing, and how the changes are affecting the health of the biosphere. The IPY is an opportunity to educate and excite the public and help train the next generation of scientists, leaders, and educators.

Besides the unprecedented research developed in this most recent worldwide collaboration, the IPY has brought lecturers, visiting authors, concerts, and new publications to UAF. Valuable outreach programs were presented to high school and elementary school students.

This IPY, organized through the International Council for Science (ICSU) and the World Meteorological Organization (WMO), is the fourth polar year, following those in 1882–83, 1932–33, and 1957–58.

> **“The key concept of the first IPY was that geophysical phenomena could not be surveyed by one nation alone.”**

Polar bear, Ursus maritimus*, on an ice flow in Wager Bay (Ukkusiksalik National Park, Nunavut, Canada) in 1996. Changes in sea ice, upon which polar bears and other marine mammals depend, is one of many climate-related research areas studied during the 2007-2009 International Polar Year.*
—photo by Ansgar Walk, Wikimedia

During each of these three periods, or "year," scientists from around the world worked together in a coordinated effort on scientific and exploration programs in the polar regions. Each polar year significantly advanced scientific knowledge and geographical exploration, expanding the understanding of geophysical phenomena that influence nature's global systems. The experience gained by scientists and governments in international cooperation set the stage for other international scientific collaboration, and also led to political cooperation.

First International Polar Year (1882–83)

The idea of International Polar Years was the inspiration of the Austrian explorer and naval officer Lt. Karl Weyprecht, who was a scientist and co-commander of the Austro-Hungarian Polar Expedition of 1872–74. From his experiences in polar regions, Weyprecht became aware that solutions to the fundamental problems of meteorology and geophysics were most likely to be found near the Earth's poles. The key concept of the first IPY was that geophysical phenomena could not be surveyed by one nation alone; rather, an undertaking of this magnitude would require a coordinated international effort. Twelve countries participated, and fifteen expeditions to the poles were completed (thirteen to the Arctic and two to the Antarctic). Beyond the advances to science and geographical exploration, a principal legacy of the First IPY was setting a precedent for international science cooperation, rather than competition. Unfortunately Weyprecht did not live to see his idea come to fruition.

Second International Polar Year (1932-33)

The International Meteorological Organization proposed and promoted the Second IPY (1932–1933) as an effort to investigate the global implications of the newly discovered Jet Stream. With forty nations participating, the Second IPY heralded advances in meteorology, magnetism, atmospheric science, and in the mapping of ionospheric phenomena that advanced radioscience and technology. Forty permanent observation stations were established in the Arctic, creating a step-function expansion in ongoing scientific Arctic research. In Antarctica, the US contribution was the second Byrd Antarctic expedition, which established a winter-long meteorological station approximately 125 miles south of Little America Station on the Ross Ice Shelf at the southern end of Roosevelt Island. This was the first research station inland from Antarctica's coast.

The International Geophysical Year (1957–58)

The International Geophysical Year (IGY) celebrated the 75th and 25th anniversaries of the first and second IPYs. The IGY was conceived by a number of post-World War II eminent physicists who realized the potential of the technology developed during the war, such as rockets and radar, and they hoped to redirect the technology and scientific momentum toward advances in research, particularly in the upper atmosphere. The IGY's research, discoveries, and vast array of synoptic observations revised or "rewrote" many notions about the Earth's geophysics. One long-disputed theory, continental drift, was confirmed. A US satellite discovered the Van Allen Radiation Belt encircling the Earth. Geophysical traverses over the Antarctic icecap yielded the first informed estimates of the total size of Antarctica's ice mass. For many disciplines, the IGY led to an increased level of research that continues to the present. The world's first satellites were launched. A notable political result founded on the IGY was ratification of the Antarctic Treaty in 1961. The success of the IGY also fostered an additional year of research through the International Geophysical Cooperation. The Special Committee for the IGY became the model on which three post-IGY scientific committees developed, for Antarctic, oceanic, and space research, and several focused research efforts including the International Year of the Quiet Sun. The scientific, institutional, and political legacies of the IGY endured for decades, many to the present day.

International Polar Year 2007–09

The current polar year involves more than 200 projects, with thousands of scientists from over sixty nations examining a wide range of physical, biological, and social research topics. It has also been an excellent opportunity to demonstrate, follow, and get involved with cutting-edge science in real time. IPY scientific findings are indicating abundant evidence of changes in snow and ice: reductions in extent and mass of glaciers and ice sheets; reductions in area, timing, and duration of snow cover; and reductions in extent and thickness of sea ice. Changes in snow cover and sea ice have immediate local consequences for terrestrial and marine ecosystems. Permafrost, an additional form of ice that influences nearly 25 percent of the northern hemisphere's landmass, also shows substantial decomposition due to warming climate. Permafrost degradation affects local ecology and hydrology as well as coastal and soil stability. The International Conference on Permafrost at the University of Alaska Fairbanks attracted 800 scientists and researchers to Fairbanks in July 2008.

The IPY is also delving into global linkages. Changes in the large ice sheets will affect global sea level, affecting coastal cities and low-lying areas. Changes in snowfall and shrinkage of glaciers will influence millions of people whose daily use of water for personal consumption or for agriculture depends on snow pack and glacial sources. Thermal degradation of permafrost will mobilize vast reserves of frozen carbon, some of which, as methane, will increase the global greenhouse effect. Changes in sea ice combined with enhanced river inputs of freshwater will lead to substantial changes in ocean circulation. Warming of polar oceans, coupled with changes in ice coverage and river runoff, will alter marine ecosystems with consequences for globally significant fisheries.

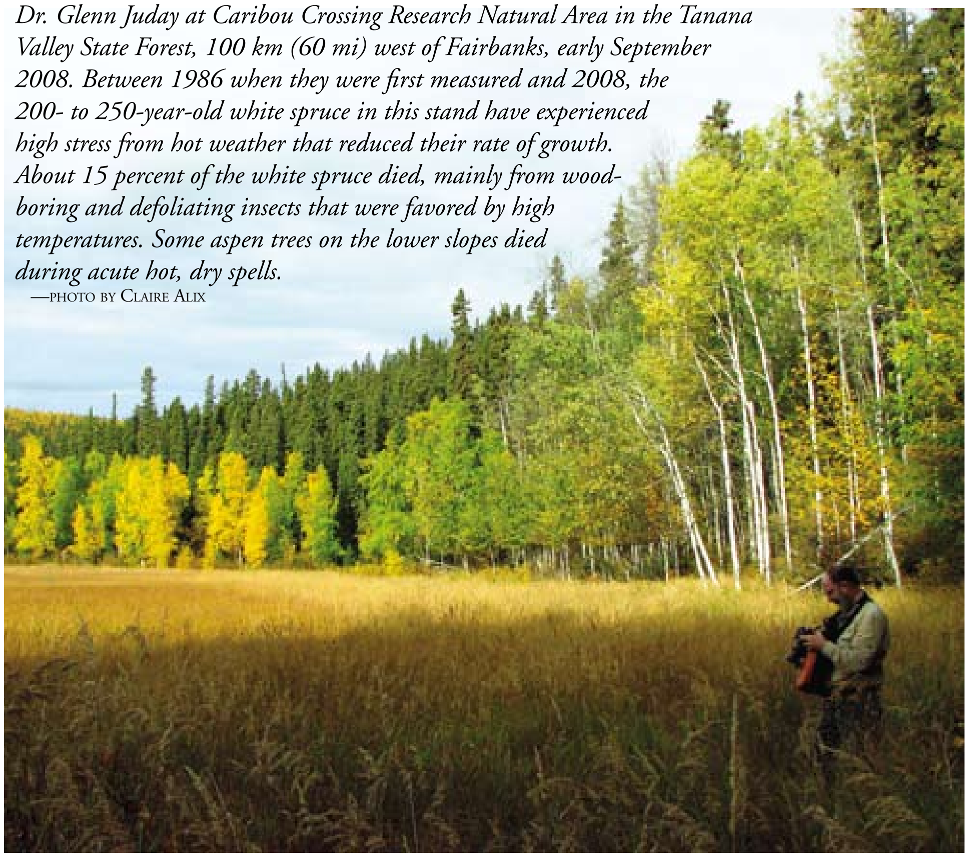
Recognizing that polar changes are occurring in the daily living environment of more than four million people, researchers involved in this IPY are studying northern communities facing changes in their natural environment and in their natural resources and food systems—changes of rapidity and magnitude beyond recent experience or traditional knowledge.

For a majority of participants, the IPY stimulates a sense of urgency and discovery. What secrets, what clues to

Coastal erosion from melting sea ice and permafrost is changing the Arctic coastline and releasing carbon into the atmosphere.
—photo by Gary Michaelson

the planet's past, lie under the ice? How does life survive extreme cold and long dark? What structural and physiological adaptations evolved in cold waters and propagated throughout the oceans? What marvels of photochemistry occur when spring's first light strikes winter snow? How do microbial communities in the upper ocean influence cloudiness in the atmosphere above? What subtle richness of behavior, language, and knowledge has allowed human communities to survive in the Arctic for thousands of years? Can ancient, solid ice hold so much history and yet change so fast?

Each IPY represents a unique opportunity to push collectively at these intellectual frontiers, to explore unseen places, to develop new concepts and theories, and to set the stage for predictions, assessments, recommendations, and future discovery through international collaboration and partnership.



Dr. Glenn Juday at Caribou Crossing Research Natural Area in the Tanana Valley State Forest, 100 km (60 mi) west of Fairbanks, early September 2008. Between 1986 when they were first measured and 2008, the 200- to 250-year-old white spruce in this stand have experienced high stress from hot weather that reduced their rate of growth. About 15 percent of the white spruce died, mainly from wood-boring and defoliating insects that were favored by high temperatures. Some aspen trees on the lower slopes died during acute hot, dry spells.
—PHOTO BY CLAIRE ALIX

Below: spruce budworm from the UAF campus, June 2008. The western portion of Fairbanks and Chena Ridge was the center of the most severe spruce budworm attack of white spruce trees in Alaska during 2007 and early 2008. This is the third or fourth instar larva which overwintered as a second stage larva. With sufficient warmth, this insect develops into an adult moth by late June, mates, and lays eggs that hatch in August.
—PHOTO BY STEVE WINSLOW

IPY work by SNRAS researchers

Watershed implications:

The Yukon River Basin Initiative is a cooperative effort involving Professor Glenn Juday and the US Geological Survey. This comprehensive study of ecosystems and how they function in relation to climate change is the prototype for many future studies across the nation, including detailed examination of water, permafrost, photosynthesis, and more. By focusing on watersheds the researchers will gain a better understanding of how climate change affects ecosystems.

K-12 outreach:

Professor Elena Sparrow offers professional development workshops to Alaska's primary and secondary teachers. K-12 teachers learn how to instruct their students about the IPY and scientific measurements in Earth system science and engage in environmental studies. For example, teachers learn how to investigate the seasons through biomes, along with ice phenology, freezeup and breakup, and frost tube protocols. Frost tube protocol is a way to measure depth and timing of freezing of the ground/soil, using an easy-to-make measuring device, the frost tube, which is, essentially, a small sealed plastic tube filled with colored water. Freezing of the ground and or soil depends on the atmospheric temperature/environmental conditions.

Forests and carbon:

Professor John Yarie is documenting log decomposition in interior Alaska, as logs represent a significant carbon and organic matter input into the forest floor in natural forest ecosystems. He also conducts experiments in drought among hardwood ecosystems in upland and floodplain locations in interior Alaska to determine the influence of summer rainfall on tree growth and has a thirty-year research project which provides long term records of tree growth and climate data in forest stands.

Effects of climate change on rural Alaska:

Associate professors Scott Rupp and Gary Kofinas are working with rural residents who have a rich knowledge of the land and animals of the region. The research focuses on fire and moose ecology, rural-urban moose hunting, and climate change scenarios. Rupp is producing climate scenarios with the SNAP team that Kofinas will then use with villagers in Wainwright, Kaktovik, and Venetie to document local interpretations of past and future ecological changes and human adaptation to those changes.

Vegetation changes:

In analyzing the Normalized Vegetation Difference Index, Professor Dave Verbyla noted a contrast in trends of 1982–2003 annual maximum NDVI, or photosynthetic biomas, with cold arctic tundra significantly increasing in NDVI and relatively warm and dry boreal forest areas of the Interior consistently decreasing in NDVI. The annual maximum NDVI from arctic tundra areas was strongly related to a summer warmth index, while there were no significant relationships in boreal areas between annual maximum NDVI and precipitation or temperature. Annual maximum NDVI was not related to spring NDVI in either arctic tundra or boreal buffers.

And much more:

- arctic coastal erosion and carbon transformation across the shoreline
- carbon cycle science in the Alaska coastal temperate rainforest
- effects of long-term simulated summer drought on key components of mid-successional boreal forest carbon balance
- impact of climatic change on boreal forest fire regimes of Alaska

North Slope Science Initiative

UAF and the Inland Northwest Research Alliance recently hosted Lessons from Continuity and Change in the Fourth International Polar Year Symposium at the UAF campus in March. The symposium focused on the lessons learned from polar research as well as those from elsewhere that can enhance studies of the Arctic. While rapid change has been amplified in the Arctic, the entire Pacific Northwest is undergoing significant changes to its social and ecological systems due to similar economic, climatic, demographic, and other forces. The responses to such external forcing have occurred across levels of governance, but rarely in a comprehensive or long range fashion.

Sessions included: Coastal and Rural Communities: Vulnerabilities and Adaptations; Oil and Gas Development: Balancing Interests and Sustainability; the Futures of Marine Ecosystems; Freshwater Systems: Hydrological Security in the Face of Rapid Change; Local, Traditional and Indigenous Knowledge; Planned Cross-Cutting Sessions: Stakeholder Participation in Complex Multi-User Systems, Questions of Scale and Knowledge in Observation from Local to Remote Sensing; and University - Community - Industry: Partnerships to Inform Policy Development.

History of the IPY adapted from an article by the IPY International Programme Office. Please visit www.ipy.org for further information.

Research contacts:

Center for Global Change & Arctic System Research: www.cgc.uaf.edu

Inland Northwest Research Alliance: www.inra.org

North Slope Science Initiative: www.northslope.org

Left: Eddie Frank of Venetie butchering a moose head. Below: house in Venetie.
—photos by Gary Kofinas

A Sustainable PhD

As Alaska and the circumpolar north face increasingly complex challenges in the use and management of natural resources, the education and training of high-level professionals skilled in the practices and policies that enhance natural resource management likewise become increasingly important. The need for skills and research in sustainable practices and management of our resources has become ever more apparent to policymakers, employers, researchers, and students, and so a new PhD program at the University of Alaska Fairbanks is generating interest and enthusiasm. Adding doctoral studies in Natural Resources and Sustainability will bring exciting new research opportunities to the campus and beyond, said Dr. Joshua Greenberg, PhD program director.

—SNRAS file photo

The School of Natural Resources and Agricultural Sciences worked with the School of Management to make the new degree possible. Applications have begun arriving and Greenberg predicts an influx of students to the program. About five or six are expected the first year, with an increase to twenty by the fourth year.

"This will allow us to train students in original research so that we can continue to help meet the needs of our state," Greenberg said.

The program aims to prepare future leaders as academic researchers, agency professionals, and analysts. Graduates will likely find work in the frontiers of science, helping to manage natural resources and the environment. Careers include university faculty, researchers, and private consultants for governmental or nonprofit agencies.

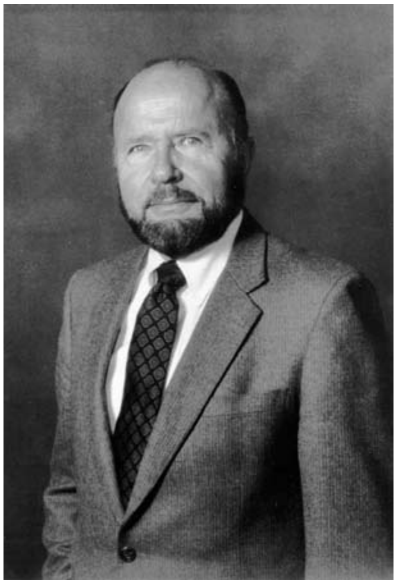
Objectives are to educate and train scholars at the PhD level with in-depth integrated knowledge in research and management of natural resources; develop leaders to direct the use and management of natural resources in Alaska and other northern latitude settings; create a nationally recognized program that contributes to scientifically informed public decision making; contribute to sustainable development of Alaska's rural and urban environments; and increase research programs addressing the Arctic and its indigenous peoples.

The PhD program builds on existing resources at UAF. Like most other PhD programs, the NRS program is centered on training students in original research. It will distinguish itself from other programs by emphasizing research focused on both disciplinary (e.g., forest ecology, resource economics) and interdisciplinary work (e.g., reaching ecological and economic objectives via adaptive management) on natural resource issues at high latitudes, focused primarily on Alaska. In so doing, the NRS program will contribute directly to the research mission of the University of Alaska, particularly with respect to the following elements of the university's vision statement in the 2006 Strategic Plan:

- Spearhead integrated research, emphasizing complex high-latitude physical, biological, and social systems;
- Link research discoveries with teaching, service, and community engagement;
- and create innovative collaborations with communities, businesses and governments that meet state, national, and global needs.

Selection of PhD applicants is based on undergraduate and post-baccalaureate grade point averages, general graduate record exam scores, letters of recommendation, a statement of intent, and, for some positions, suitable field or laboratory experience. Applicants are also evaluated on their publications, professional presentations, and previous teaching and research experience.

Interested students should visit www.uaf.edu/som/programs/nrs/or contact Dr. Greenberg at 907.474.7188 (phone), 907.474.5276 (fax), or e-mail nrgrad@uaf.edu.



Senator Jay Kerttula

Kerttula Hall Dedication

UAF's Palmer Research and Extension Center was renamed "Kerttula Hall" Aug. 29 in honor of Alaska's longest serving state legislator, Jay Kerttula. A plaque dedicating the building in honor of Senator Kerttula was presented at the ceremony, and a meal featuring Alaska-grown foods (including reindeer sausage and hamburgers made with meat from cattle raised on the Matanuska Experiment Farm and reindeer from the Fairbanks Experiment Farm, grilled by animal science professor Milan Shipka).

"This is a celebration not of a building but of a vision and a man," SNRAS Associate Dean Mike Sfraga said. He added that many of today's trendy topics, such as organic gardening, supported farming, food safety, and sustainability, were in Kerttula's vocabulary decades ago. "Jay helped make agricultural research happen."

Other speakers, including University of Alaska regents, chancellors from UAF, UAA, and UAS, the UAF Alumni Association president, and the UAF president, called Kerttula "the dean of Alaska agriculture, a statesman of the highest order, and a friend of the university."

UAF Chancellor Brian Rogers said the Board of Regents exhibited unprecedented support for renaming the research facility. "It's the right thing to do for the university and the right thing to do for Jay," Rogers said.

Dean Carol Lewis said it was fitting to name one of the most important buildings in the Matanuska Valley after Kerttula. "He made it possible for us to dream and do new things," Lewis said. "When I look at Kerttula Hall I don't see a lab; I see classrooms and new students learning. I see a place for the community to participate in outreach." She thanked Kerttula for his vision that will carry agricultural research into the future.

Jay Kerttula came to the Matanuska Valley as a small child with his family in 1935; they were one of the Matanuska Colony farming families that helped to settle the Valley in the 1930s. He was first elected to the Alaska House of Representatives in 1960. He served in both the House and Senate for thirty-four years, becoming Alaska's longest serving legislator. He is the only legislator who has served as both Speaker of the House (1968–1970) and President of the Senate (1980–1984). A lifelong interest in agriculture led Senator Kerttula to create the Alaska Division of Agriculture to assist farmers. The family farm gave Senator Kerttula the inspiration and skills to establish his own successful farm. He and his wife, Joyce Campbell Kerttula, raised their two daughters there. Beth and Anna share their father's passionate support for agriculture. The couple continue to make Palmer their home.

Members of the Kerttula family at the ceremony with a framed mockup of the bronze plaque that will later be placed on the building. From left to right: Joyce Kerttula, Representative Beth Kerttula, and Senator Jay Kerttula.

—photo by Nancy Tarnai

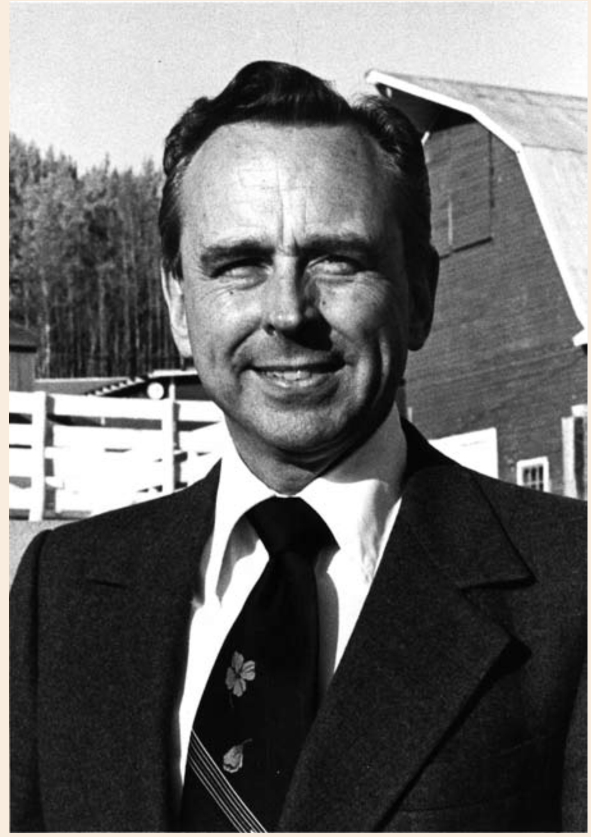
The Senator's desire to serve the agricultural industry in Alaska and in the Matanuska Valley led him to pursue funding for an agricultural laboratory. The Palmer Research Laboratory, constructed in the early 1980s, is a tribute to his understanding of the needs of the industry. The lab has served as a resource for researchers, farmers, dairy owners, ranchers, miners, the petroleum industry, and educators. It has provided analyses of soil samples to guide farmers in fertilizing their crops and of forage samples to assist animal producers in their feed and nutrition regimens. In cooperation with the Alaska Division of Agriculture's Plant Materials Center, the lab is used to analyze seeds and plant materials for market. Research and production in agriculture and natural resources have benefited from the work performed at the lab: potato and vegetable production; hay, forage, and grain production; beef and dairy cattle genetics and diets; and work on revegetation for the trans-Alaska pipeline, Prudhoe Bay oilfields, and Alaska mines.

The laboratory also supports new work in biofuels using Alaska woody and crop biomass. Wood chemist J. Andres Soria is working to discover potential biofuel and bio-based products from the chemistry of Alaska trees. A pioneer in the liquefaction of wood using supercritical fluids, Soria is building a biofuel laboratory to develop and test biofuels made from low-grade wood, woody biomass, and fire and insect-killed trees, and recently collaborated with Purdue University and the Indiana Soybean Alliance to do cold-weather tests of biodiesel. The laboratory is shared with University of Alaska and federal and state agency scientists working in animal biology, and serves as a teaching laboratory for graduate and undergraduate students. It has become an essential element in research, education, and outreach of SNRAS and the experiment station. It is a source of critical support to farmers throughout Alaska, rural communities interested in food stability, urban and suburban gardeners, and the growing community of smallholder farm owners. As Alaskans move toward a future focused on biomass for energy, climate change and food security, responsible use of resources, and the health of families and communities through modern uses of traditional botanicals, the laboratory continues to be part of the legacy of Jay Kerttula's work to further Alaska agriculture.

Above: Sen. Kerttula and Dean Carol Lewis posing in front of the newly-dedicated building. Below: view of Kerttula Hall from a distance.

The Palmer Research Laboratory, including professor Soria's biofuels lab.
—photos: top by Nancy Tarnai, middle by Norman R. Harris, bottom by J. Andres Soria

JAMES DREW: piloting agriculture



Singleminded. Accessible. Involved. Those words inevitably come up when colleagues describe the late James Drew.

Dr. Drew, who served for two decades as dean of the UAF School of Agriculture and Land Resources Management (precursor to the School of Natural Resources and Agricultural Sciences) and director of the Agricultural and Forestry Experiment Station, died at his home in Fairbanks July 9, 2008 from pancreatic cancer.

"He was a giant flag-waver for agriculture in Alaska," said Patricia Holloway, professor of horticulture and director of the Georgeson Botanical Garden. "He influenced the whole direction of this school until his retirement. He was the driving force. He got it going."

A perfect example of Drew's enthusiasm for agriculture is relayed by Holloway: "I went to him in 1989 with the idea of a botanical garden. Many people in our school were totally opposed to it. Jim Drew thought it was the best idea and he was the number one supporter from day one. The garden would not exist without him."

Drew's singleminded devotion to agriculture was also mentioned by Charles Knight, the northern region manager for the state Division of Agriculture and a former faculty member under Drew. "He did a lot," Knight said. "He expanded the school and brought in faculty. He was very oriented with the needs of Alaska and was involved in so many state agencies. He was active and aware of all that was going on."

Knight also recalled how Drew was accessible to faculty, students, and staff. Knight had left UAF for a couple of years, working at a Kansas university, where he found it frustrating that he could not easily converse with the dean. When the opportunity to work for Drew arose he was assured he would be able to see the guy in charge whenever necessary. "I appreciated the access to him," Knight said. "He had an open door policy and he always made you feel like part of a group. He always had time if you had a concern; he didn't brush you off."

Born in 1930 in Flushing, New York, Drew grew up on a small dairy farm in Cresskill, New Jersey. He earned an agriculture and forestry degree at Rutgers University. In 1952 he volunteered for the US Air Force and was selected for pilot training. After the Korean War he completed his training and joined the New Jersey Air National Guard and returned to graduate school at Rutgers, where he earned a doctorate in agronomy in 1957. For twenty-four years, Drew continued to serve in the Air Guard in New Jersey and Nebraska, retiring with the rank of lieutenant colonel.

While Drew loved flying, the land was his chosen profession and it was soil that brought him to Alaska. From 1955 to 1958, Drew spent his summers making the first soil map of Barrow, studying soils along the Jago River and was the first person to survey the soils along the Sagavanirktok River. His research followed what twenty years later would become the Prudhoe Bay pipeline route. Upon his retirement in 1995, Drew told a story about those summers. The work crew floated the Sagavanirktok River, stopping every ten miles to map the soils and vegetation. After the end of the first summer they were bringing their samples and findings back to Barrow and stopped at Umiat to have breakfast with a radio operator at his Quonset hut. The hut caught on fire while they were cooking and the men lost all their field samples and notes and had to return the next year and repeat everything again.

Drew married Marilyn Smith of Powell, Wyoming, in 1956. Drew joined the agronomy faculty at the University of Nebraska-Lincoln, where he was elected as a fellow in the American Society of Agronomy, the Soil Science Society of America, and the American Association for the Advancement of Science.

In 1975 the family headed to Alaska where Drew became director of the Agricultural Experiment Station. The next year he became dean of the School of Agriculture and Land Resources Management. In an article about his retirement in Agroborealis in 1995, Drew said the highlights of his two decades at UAF were the development of several state agriculture projects, the creation of SALRM, the incorporation of the school with the Agricultural and Forestry Experiment Station, and the integration of the teaching and research components. He also worked diligently to get the Delta Agricultural Project up and running. "He attended every farm forum, every field day; he was always supporting agriculture," Charles Knight said.

Drew was also heavily involved in the community. He served as chairman of the board for the Fairbanks Chamber of Commerce and the Tanana Valley Fair Board. He was a member of Fairbanks Rotary Club, Resource Development Council, Alaska State Chamber of Commerce, Interior Alaska Economic Development Council, and Alaska Reforestation Council. After retiring, Drew and his wife flew cross-country in his Piper Arrow, stopping to visit friends and relatives. In 2004 he received the FAA Aviation Safety Program Certified Flight Instructor of the Year Award for the Alaska Region. He received the Master Pilot Award for more than fifty years of flying. He served on eight boards and committees promoting aviation in Alaska and from 2000 to 2007 was coordinator of the Interior Alaska Flight Instructor Association.

Knight said that one of Drew's strengths was the gift of gab. "He was a great guy but people got tired because he had to give the entire history leading up to the point he was trying to make. But he could explain things on a level everyone could understand." Knight also said Drew loved young people and enjoyed helping students.

Carol Lewis, SNRAS dean, said that Drew led the school and the experiment station through, as Drew often quoted from Charles Dickens, a period when "it was the best of times; it was the worst of times."

"The best of times were exciting as the Agricultural and Forestry Experiment Station became a part of heightened state interest in developing its agricultural and forestry industries in the late 1970s and early 1980s," Lewis said. "During that time the School of Agriculture and Land Resources Management was recognized as a respected school with the University of Alaska Fairbanks system, delivering baccalaureate and advanced degree programs emphasizing natural resources, agriculture, and forestry. The worst of times, in the late 1980s and early 1990s, were marked by attempts to dismantle the school and combine the experiment station with another institute. We survived, because of the quiet, calm, yet forceful leadership of the consummate gentleman, Jim Drew."

Lewis said it was a privilege to follow Drew, who she called "an incredible leader, a master teacher, an enduring mentor, and a friend," throughout her career at UAF.

"He loved to talk about agriculture and economics," Agronomy Professor and Associate Dean Stephen Sparrow said. "He was a good talker. He gave me a lot of good advice; he had a lot of wisdom he shared with people." Sparrow also recalled Drew's love of reading and flowers. "He always had a beautiful flower garden."

Fittingly, Drew's July 21, 2008 celebration of life was held at the Georgeson Botanical Garden. The family requested that memorial donations be made to the Drew Outdoor Amphitheater. The outdoor theater, built into a hillside above the gardens, was made possible by donations from Drew's retirement gifts. It has been in use for several years, and is often a starting point for classroom tours, and a place for lectures and ceremonies. Patricia Holloway of the botanical garden said the next goal is to put a roof over the structure. "It's fitting for our first dean to survey his farm from the amphitheater," she said.

Donations may be sent to UAF Georgeson Botanical Garden, c/o UAF Development Office, P.O. Box 757530, Fairbanks, AK 99775; by phone at 474-2619; or on line at www.uaf.edu/giving.

Images of the Drew Outdoor Amphitheater, currently under construction. Right: views of the benches and gravel walkways. Below: the path leading to the amphitheater.
—photos courtesy the Geogreson Botanical Garden

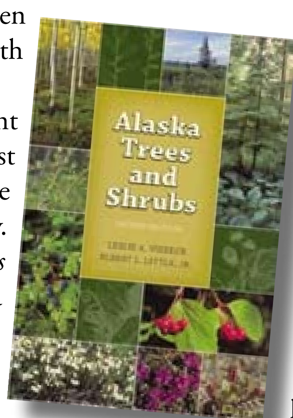
LESLIE VIERECK: infectious curiosity

While Leslie Viereck's employment with UAF was short lived, his legacy as a scientist and mentor to forestry students, staff, and faculty continued the rest of his life. He died at age 78 on Aug. 31, 2008 at his Fairbanks home after struggling with numerous health issues.

Viereck was born in 1930 in South Dartmouth, Mass., a small Atlantic fishing town. While a student at Dartmouth College, he and two friends drove a Model A Ford up the Alaska Highway. He returned to Alaska several times while he worked to finish his doctorate degree in plant ecology at the University of Colorado. In 1954 when he was serving in the Army at Fort Richardson, he and three friends ascended the South Buttress of Mount McKinley, a feat no one has been able to repeat.

In 1959, he began teaching and researching at UAF. One of his first projects was an environmental impact study of the potential use of nuclear weapons to build a harbor on Cape Thompson on the northwest coast. Along with two other scientists, he identified the potential disastrous consequences of this proposal by the Atomic Energy Commission (now the Nuclear Regulatory Commission). Because of these three outspoken scientists the plan was halted but it cost all three of them their jobs. Their story was memorialized in Dan O'Neill's book *The Firecracker Boys*, which is currently under option for a feature film to Leonardo DiCaprio's production company Appien Way, in association with HBO Films.

In 1963 Viereck went to work for the US Forest Service at the Institute of Northern Forestry. He wrote *Alaska Trees & Shrubs*, considered a definitive guide, with Elbert Little Jr. The book was recently re-published by UA Press. Viereck's research focused on fire ecology, permafrost, long-term vegetation succession, climate monitoring, vegetation classification and mapping, and invasive plant species.

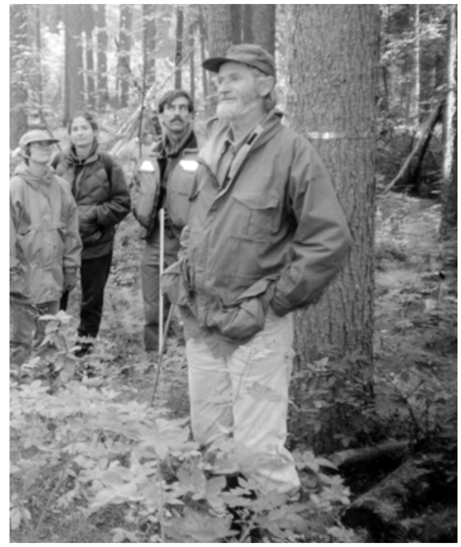


Associate Professor of Forest Soils David Valentine recalls first meeting Viereck in 1986 when the LTER was just getting started. "I was in awe," Valentine said. "I really admired him." He spent a Thanksgiving with the Viereck family and was impressed by their graciousness. "He was genuinely nice," Valentine said. "He was a decent, really brilliant guy who was a pleasure to know."

At the Viereck home that Thanksgiving Valentine said Viereck showed the guests the exacting details he had tracked on ground temperatures. "He had this curiosity like a little kid; it was infectious," Valentine said.

Years later when Valentine read *The Firecracker Boys* it became clear to him how Viereck had put his career at risk to stand up for the data he had collected. "He got fired for not bending to the administration's will," Valentine said. But throughout the years Valentine knew Viereck he never exhibited bitterness. "That's the last word I would use to describe him."

In 1993 the university presented Viereck with an honorary degree and emeritus status. He retired from the Forest Service in 1999 and continued to work with the scientists at UAF on the Long Term Ecological Research project and mentored young scientists who would continue this research effort. John Yarie, professor of silviculture at UAF, looked up to Viereck throughout his career. "He was very intelligent and easy going, very dedicated to the work he was doing," Yarie said.



Dr. Viereck (foreground) with a forestry field trip group.
—SNRAS FILE PHOTO

Viereck was instrumental in founding the Bonanza Creek Long Term Ecological Research program, located in the boreal forest near Fairbanks. Research at LTER focuses on improving understanding of the long-term consequences of changing climate and disturbance regimes in Alaska's boreal forest. The objective is to document the major controls over forest dynamics, biogeochemistry, and disturbance and their interactions in the face of a changing climate. The site was established in 1987 as part of the National Science Foundation's Long Term Ecological Research Program.

An avid nature lover, Viereck kept extensive journals noting the times of recurring natural events, such as the migration of birds, the greening of the trees, days of flowering, and high and low temperatures.

SNRAS Dean Carol Lewis said, "Les Viereck's legacy will live on through the literature, the Bonanza Creek Research site, his love for nature, and his journals."

Viereck is survived by his wife of 53 years, Teri Viereck, and their daughter and two sons. A celebration of life was held Sept. 6, 2008 at the Georgeson Botanical Garden. In December the Viereck Nature Trail, on West Ridge of the UAF campus, was dedicated to honor both Les and Teri Viereck, who have been longtime university supporters.

The family requested memorial donations to the UAF Georgeson Botanical Garden, c/o UAF Development Office, P.O. Box 757530, Fairbanks, AK; by phone at (907) 474-2691 or online at www.uaf.edu/giving.

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Susan Todd and Tony Gasbarro in Todd's office. Both are advisors for students in the Peace Corps Master's International program. See story p. 33.
—photo by Nancy Tarnai