Alaska EPSCoR
Fall 2005

From the Director
George Happ

Science begins with curiosity. We wonder about natural phenomena, observe closely, pose hypotheses, do experiments, and continue on a cycle of observation, analysis, and experimentation. The scientific revolution that accelerated in the past century allows us to observe at many levels, often using cutting-edge technologies. Modern ecology often requires molecular biology. When we do science, we blend training and acquiring of new knowledge. In this issue, we describe Alaska EPSCoR investments, from acquisition of shared instrumentation for our new UA DNA Core lab to application of basic physical and engineering principles in constructing roads across permafrost. At every opportunity, getting students involved in research is an EPSCoR goal and the stories of student research on marine biodiversity, the response of seals to global climate change, and the use of genetics to help understand seasonal affective disorder illustrate the breadth of research experiences possible for students at UA.

DNA Core Lab Vital To Genetics Research In Alaska

By Theresa Bakker

Tucked into the West Ridge Research Building on the University of Alaska Fairbanks campus is a powerful laboratory capable of providing molecular analysis to solve questions related to evolutionary and molecular biology, wildlife and fisheries management and much more.

The Core Facility for Nucleic Acid Analysis was established in 1995 with a grant from the National Science Foundation. George Happ is the State Program Director for EPSCoR, which has continued to invest in the facility, also known as the DNA Core Lab. He said its roots were planted along with the university's long term interest in evolution and ecology. "Somewhere in the early 1990s, we invested in an instrument to sequence DNA so people could do evolutionary studies," he said. "That was fundamentally what the core lab was. With the arrival of EPSCoR we had the money to expand the lab and get instruments to do other things."

Happ said EPSCoR was interested in a genetics lab to collect data for everything from fungus to caribou. Other programs such as CANHR (Center for Alaska Native Health Research) needed the equipment to study human genetics for research into obesity and diabetes in Alaska Natives. INBRE (Idea Network of Biomedical Research Excellence) investigators wanted to look for genes in other ways. "From all those sources, of funding we began adding instruments," he said.

Initially the "lab" was scattered throughout the campus. When plans were made to expand the university's research space, the DNA Core Lab was included in the design. The current facility opened in the summer of 2004 and features two ABI 3100 automated sequencers, a Transge-

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Lab Supports Diverse Projects

The Core Facility for Nucleic Acid Analysis Lab on the University of Alaska Fairbanks campus has been hard at work, providing genetic data collection for countless studies. Heather (Cox) Huson has been a mentor in the EPSCoR Outreach effort, Alaska Rural Research Partnership. She uses the lab to process genetic data for her students from rural Alaska.

"The core lab is vital," she said. "You can't get to the end product without the lab. We get all our genetics information up to a certain point then submit it to the Core Lab where it's run through the sequencer. There are commercial labs available, but it's more convenient for us to have it done in house."

Carrie Topp is the DNA Core Lab's Technician/ Coordinator. She knows how important it is to get good data from these samples. "When I was a grad student working with an advisor at the Museum, I helped prepare genetic specimens," she said. "It's amazing to think that hundreds of years from now people could be studying

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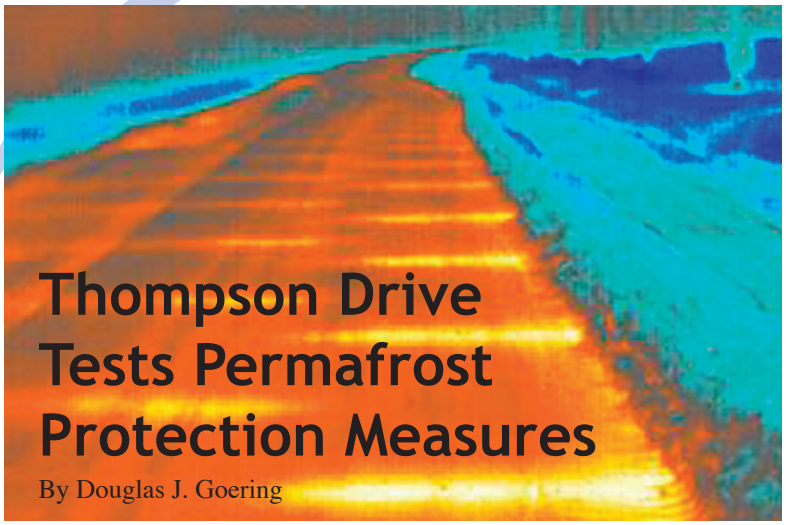
Research Focus Area Spotlight on –

Cold Regions Engineering



Thompson Drive Tests Permafrost Protection Measures

By Douglas J. Goering

Alaska's harsh climate often has adverse effects on roads, buildings, railways or pipelines. Innovative solutions have been developed such as the thermosyphon cooling devices of the trans- Alaska oil pipeline that keep the vertical support members permanently frozen into the permafrost. The unique design was an outgrowth of developments in the field of arctic engineering combined with a careful design process.

A short drive on the highways of Interior Alaska makes it clear that challenges remain. Roadways and permafrost don't get along, at least not in the large portion of Alaska that is underlain by ice-rich permafrost. Clearing vegetation and constructing roadway embankments often warms the local ground, thawing the permafrost. If the permafrost has a high ice content, the thawing results in settling of the ground (thaw settlement) and damage to structures. In the case of highways, thawing permafrost results in rough, distorted roadways.

In 2001, the Alaska Department of Transportation began the design of Morris Thompson Drive, near the University of Alaska Fairbanks, as a new entrance to the campus. The half mile section of road includes a bridge over the Alaska Railroad, and concrete curbs, gutters and sidewalks. The project area includes two sections of previously undisturbed permafrost. The concrete improvements made the consequences of thaw settlement more serious than usual. Re-leveling distorted sidewalks, curbs and gutters is expensive! To avoid these difficulties, advanced cooling technology was used in the project. Construction began in March 2003 and was completed in August 2005.

Hairpin thermosyphon evaporators being installed in Thompson Drive in September 2003. Infrared imagery (left) shows the evaporators at work in winter.

Keep It Cool Times Two

Two types of cooling technology are incorporated into Thompson Drive. The first uses the same principle as the thermosyphons on the trans-Alaska oil pipeline but in a new configuration. The devices, known as hairpin thermosyphons, are buried beneath the roadway and do not have exposed fins like those used on the pipeline. They pull heat from the permafrost beneath the roadway during the winter. The heat evaporates a refrigerant in the lower portion of the thermosyphon. Refrigerant vapor then travels to the upper portion of the hairpin where it condenses, releasing heat just beneath the roadway surface, where it dissipates in the cold winter air. The enhanced winter cooling lowers the permafrost temperature to keep it from thawing during subsequent summers. Arctic Foundations Inc. of Anchorage made the 150 thermosyphons for the project.

A second cooling technology, an air convection embankment (ACE), is also part of Thompson Drive. ACE embankments are constructed of 6 to 12 inch rocks. Ideally, all fines are excluded from the ACE material resulting in highly porous layers that allow air to circulate freely. ACE layers can be put in the center beneath the asphalt or on the side slopes. The layers promote air circulation during winter when the pore air tends to be cold and heavy in the upper layers and relatively warm and light below. The warm air rises, carrying heat with it, while cold air from above sinks and cools the underlying permafrost to provide the same type of enhanced winter cooling as thermosyphons.

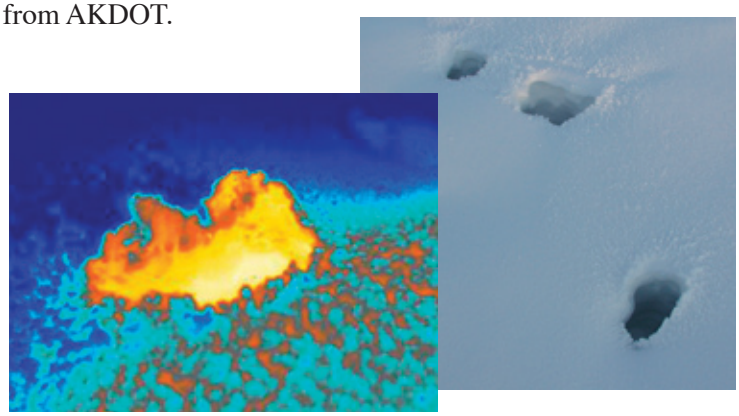
Two types of ACE systems are used on Thompson Drive. The first, a ventilated shoulder, uses ACE material only on the side-slope of the embankment. Cold ambient air is drawn into the lower portion of the ACE side-slope layer and warms as it travels upwards through the ACE rock. During January 2004, evidence of ACE air circulation was seen. Holes were formed in the snow layer by the warm air exiting the upper portion of the ACE side slope. Intense vapor plumes were observed exiting these holes as the warm moist air flowed upward into the cold January air. In the other ACE system the pavement is directly on the top of the ACE layer. A fabric separator keeps the fine material below

the asphalt out of the ACE rock. In this system, air circulates beneath the asphalt, cooling the underlying permafrost which allows it to survive through the summer without thawing.

Winter Work

The construction schedule was another unique feature of the Thompson Drive project. Some portions of the project were scheduled for winter construction to ensure that the lower portions of the embankment structure were frozen. Thawed material was placed in thin layers and allowed to freeze after compaction. A temperature- monitoring system ensured that each layer was completely frozen before the next layer was placed. Constructing the embankment in this fashion avoided introduction of heat into the permafrost layer, a common problem with summer construction activities.

Professors from the Cold Regions Research Focus Area of Alaska EPSCoR worked closely with AKDOT to carry out thermal design calculations for both the ACE and Hairpin Thermosyphon design features. Numerical modeling ensured that each system could accomplish its goal of chilling and protecting the permafrost layer year-round. An extensive measurement and instrumentation system is installed at three locations to monitor the thermal performance. The data allows researchers to improve their ability to predict the performance of these systems. Installation costs for the ACE and thermosyphons were covered by the Experimental Features in Construction program of the Federal Highway Administration. Design and data monitoring is being covered by research funds from AKDOT.



Infrared imagery (left) shows heat venting through the snow. Vent holes along the embankment in winter are a visual reminder of the successful cooling of the permafrost.

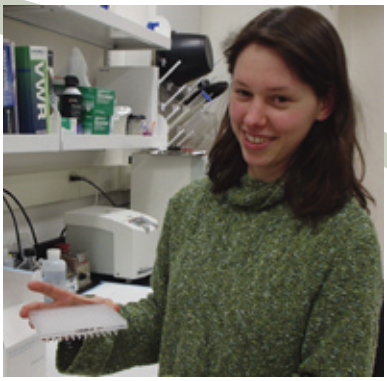
Research on interactions between infrastructure and Alaska's harsh climate has been one of the central themes of one of the research focus areas in Alaska EPSCoR, Phase II. Collaborative research programs such as this, combined with real-world application, will lead to future advances in the state of the art when it comes to dealing with Alaska's permafrost challenges.

Douglas J. Goering is a professor in the Department of Mechanical Engineering at the University of Alaska Fairbanks.

Lab Supports Diverse Projects

Continued from the cover

those same samples and discovering something new from them.

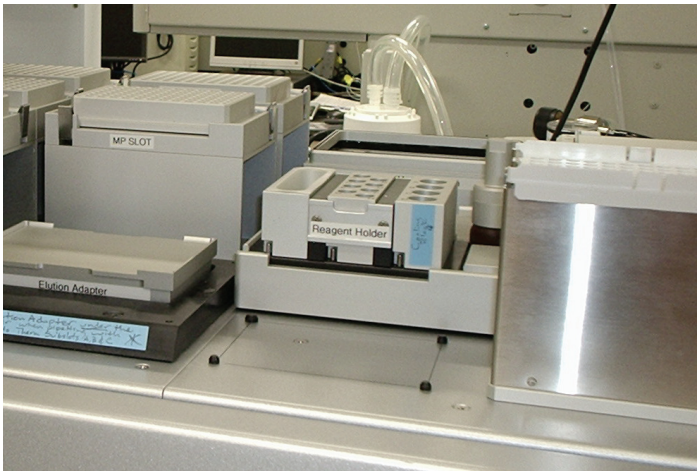


Carrie Topp

Link Olson is the Curator of Mammals at the University of Alaska Museum and an Assistant Professor of Systematic Biology in the Department of Biology and Wildlife at UAF. He's involved in several projects that all use DNA sequence data to infer evolutionary relationships among mammals from various parts of the world.

"He" uses the lab everyday. "Most of us (faculty) are a lab, rather than a single person. I have undergraduate and graduate students working on various projects involving mammals from Madagascar, Southeast Asia, and right here in Alaska. Everyday one of my students is in there or I am in there, using it."

Olson said it's handy to have the lab on the UAF campus, but the single biggest benefit is that there are so many programs in it working together. "As opposed to every other lab I've worked in, this one is uniquely configured so that all of us are in there working together in a single shared facility," he said. "It creates a synergistic effect in that we are able to troubleshoot collectively and with greater efficiency than if we were isolated in eight or nine separate labs. This is particularly true for the students, who benefit tremendously from this type of arrangement. It's a new model for us, and it required some exciting and challenging new infrastructure, but the payoff is immediately clear when you walk through the new lab. "



DNA sequencer in the Core Lab.

UnderGrad Student Spotlight –

Dominic Hondolero

Undergrad Explores the Stars

Sea stars that is, along with other marine organisms. Biology junior Dominic Hondolero spent the summer working with the Alaska part of an international marine biodiversity project, NaGISA (Natural Geography of Inshore Areas, http://www.westnurc.uaf.edu/anagisa.html). "The information we collected will be compiled with other sites from around the world and used to generate a database of the world's intertidal ecosystems," says Hondolero.

Marine scientists Katrin Iken and Brenda Konar of the University of Alaska Fairbanks School of Fisheries and Ocean Sciences (SFOS) are organizers of the project and Hondolero's mentors. NaGISA is part of a multi-year Census of Marine Life survey of marine biodiversity from the Arctic to the Antarctic.

Hondolero's summer internship, funded through an Alaska EPSCoR — ANSEP (Alaska Native Science and Engineering Program) partnership, began with a six week Marine Biology and Ecology field course at the SFOS Kasitsna Bay Marine Lab, in Seldovia, across Kachemak Bay from Homer, AK. "We learned about the main macroalgal and invertebrate species in Kachemak Bay and their roles in the ecosystem. As part of an ongoing baseline ecological study, we observed and recorded algal cover and the presence of invertebrates from several sites. We did a group project looking at the settlement of benthic invertebrates," said Hondolero.

Now he's working in the lab sorting samples collected from NaGISA sites in Prince William Sound, Kodiak Island and Kachemak Bay in previous years. Using a digital microscope and camera, he began a photographic catalog of samples for future posting on the NaGISA website.

"This has been a great opportunity for me as an undergraduate student. I plan to pursue a career in marine ecology. I plan to enroll in the Scientific Diving course at UAF and return to Kasitsna Bay next spring to see the sub-tidal ecosystem. I also plan on enrolling in the Kelp Forest Ecology field course next summer after being certified as a scientific diver," he said.

For more first-hand undergraduate research stories, go to www.alaska.edu/epscor.

Dominic Hondolero (above) examines a kelp sample at the SFOS Kasitsna Bay Marine Lab. Beate Litz, a SFOS grad student from the Seward Sea Life Center and Dominic count seagrass shoots. (left). Photos by B. Konar and K. Iken.

Faculty Spotlight – Jennifer Burns lab

International Networking Aids Seal Research

Most scientists thrive on field work, the more remote the better. For two researchers from the University of Alaska Anchorage, a spring trip into the "field" meant looking for seals on a moving, shifting series of ice floes off the coast of Eastern Canada.

Jennifer Burns is an Assistant Professor of Biology at UAA, hired under Phase I of Alaska EPSCoR. She and master's student Keri C. Lestyk spent most of March 2005 on the pack ice off the Magdalen Islands in the Gulf of Saint Lawrence, north of Prince Edward Island.

"Pack ice is not attached to land, so it's moving all the time, but you can't tell," Burns said. "You're surrounded by ice and the whole section is moving with the current, so you can't actually see anything move. "We would get dropped off and then we would drift for miles in the time it took for the helicopter to get back. We spent our time on ice bigger than football fields, surrounded by other pieces of ice bigger than football fields."

The two researchers joined a team led by Dr. Mike Hammill, the head of the Marine Mammal Section of the Canadian Department of Fisheries and Oceans. He was on the thesis committee for Burns' previous graduate student, EPSCoR grad fellow Cheryl Clark, who was supported by EPSCoR and now works for the Alaska Department of Fish and Game.

This project looks at development in both hooded and harp seals. Hooded seals are one of the deepest divers, but have the shortest lactation period: four days. In that time, pups gain about 15 pounds a day. Harp seal pups are born at the same time and are about the same size, but those harp pups nurse for about two weeks and the adults are shallow divers.

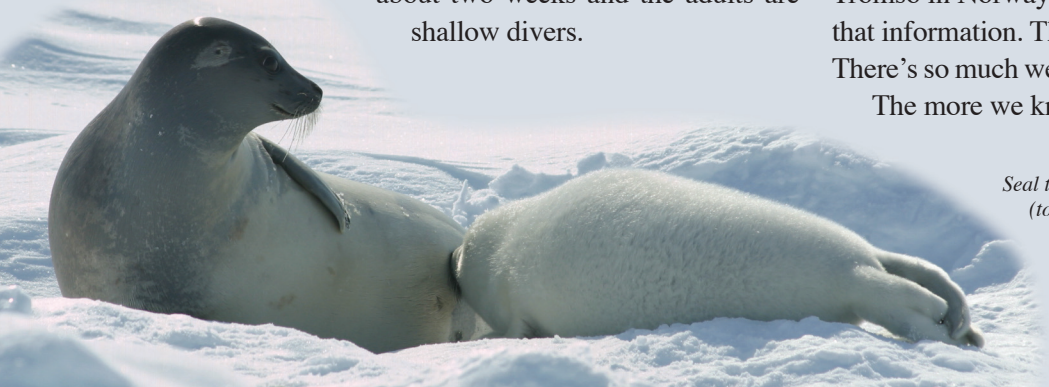
Lestyk said the two species are a good comparison, since they have the same habitat, but very different reproductive and foraging strategies. "The best thing is that one is a shallow and one is a deep diver," she said. "The deep divers need to have more oxygen, so we're expecting to see differences in the development of the structure of their muscles."

After the lactation period the pups continue to mature on their own. For the next month they enter a period of fasting. As the global climate changes and sea ice becomes less permanent and less expansive, Burns said it's going to affect the seals' ability to develop without getting in the water.

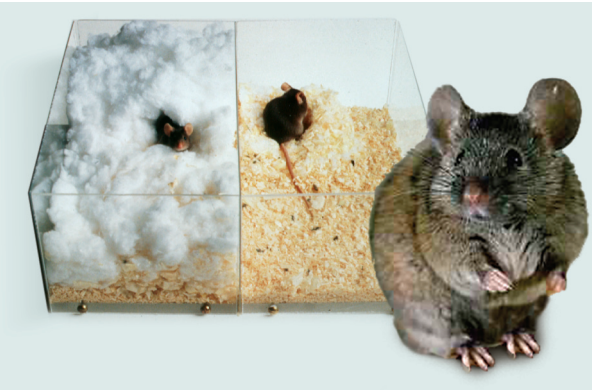
"We're interested in why the pups go through this fast," she said. "After they've gained fifteen pounds a day, why do they spend the next month losing weight without even trying to forage?

"We think it has to do with completing development without having to dive in the cold water. The tie-in is how important is that period. What takes place, and if it's shortened, what impact that may have. We're hoping to analyze the samples, and then put together a larger project to look at the changes in their behavior as the ice changes."

The Canadian government supported the project, with helicopter transportation provided by the Canadian Coast Guard. Lestyk said that kind of collaboration gives people opportunities they wouldn't normally have. "My whole project is a partnership between researchers in Norway, Canada and here," she said. "Samples were taken in 1999 and 2000 when Dr. Burns worked with Dr. Arnoldus Blix and Dr. Lars Folkow from the University of Tromso in Norway. My data set from Canada is going to enhance that information. The more I get into it, the more questions I have. There's so much we don't know. That's the best part about science. The more we know, the more we realize we don't know."



Seal tracks in the snow (top left), Keri Lestyk and a hooded seal (top center), Samples are taken from a captured hooded seal by Mike Hammill and Jennifer Burns (top right). Harp seal female and pup (left). Photos by J. Burns and K. Lestyk.



Compulsive Mice Assist Researchers

Two University of Alaska researchers are observing mice behaviors to learn more about how the brain regulates both obsessive compulsive and seasonal affective disorders. Dana Greene and Marina Castillo presented their findings at the first University of Alaska Biomedical Research Conference in May, 2005.

Obsessive Compulsive Disorder (OCD) occurs when there's an impairment in the brain's feedback loop, causing it to cycle over and over again. When a person is having these obsessions, s/he doesn't have the same sense of completion as a healthy person would. "Usually, the compulsions have to do with the obsessions," Greene said. "So if you are obsessed with germs, hand washing would be the related compulsion."

Greene is an EPSCoR Graduate Fellow and Ph.D. student in UAF Associate Professor Abel Bult-Ito's lab. She's working to validate an animal model of OCD that will be used to represent the human condition. "Hopefully we'll be able to use this model to investigate the neural pathways of OCD in humans," Greene said. "Eventually it could be used to test new drugs, other antidepressants, to see if they would be promising. Any pharmaceutical company that wanted to test a new drug could use these models."

Bult-Ito said the work is very exciting. "We've got a lot of supportive data. The key thing is that there is no spontaneous animal model available. Most projects get results by having the animal do something or giving them drugs. Those models are not suitable for looking at mechanisms because they're already manipulating something."

"We can manipulate these mice by knocking out serotonin and associated pathways that could be involved in the behavior," Bult-Ito said. "This could help identify which brain regions are involved. When we know which cellular pathway is involved, that might lead to treatment or a cure, but that's way in the future."

Top left: Nest-building of compulsive-like mice and non-compulsive-like mice after 24 hours of cotton access.
Top: Castillo performing specific serotonergic brain lesions on mice.
Middle: Mouse in running wheel to test locomotor behavior.
Bottom: Experimental set-up for measuring circadian and locomotor behavior in mice.

The mice lines used in Greene's research were started by Dr. Carol Lynch at Wesleyan University in Connecticut, where Bult-Ito earned his Ph.D. "She crossed eight different inbred mouse strains to create genetic variability and used the resulting offspring for the selection experiment. The mice were selected for big and small nest builders. In the end, we had a set of breeding animals with a thirty-fold difference in the amount of cotton used in building nests."

Then Bult-Ito went even further. "I did some quantitative genetic analysis. I crossed the two big nest builder lines, because the individual lines had reached a plateau, meaning they wouldn't build larger nest. By combining the lines, we created additional genetic variability. With that I was able to get a forty-fold difference between the big and small nest builders."

Bult-Ito also found a variation in the expression of a neurotransmitter used in the mice's circadian clocks. "We found a difference between big and small nest builders. That led to looking at circadian rhythms of mice with different wheel-running habits."

Castillo is a Research Associate in Abel Bult-Ito's lab. She's looking at how the circadian rhythms in the mice are related to depression. "There's a connection between the two," she said. "It's flipped when someone's depressed. They can't sleep at night and feel lethargic during the day. The disruption of circadian rhythms is a main symptoms in depression."

Castillo said that means there are implications for understanding seasonal affective disorder (SAD). And she said Alaska is a

Compulsive Mice Assist Researchers

Continued from page 6

good location to do that kind of work. "The location is good since we go through a period of darkness and there's a high incidence of depression both in Native and non-Native Alaskans," she said. "If somebody can figure out how to improve circadian disruption during depression, people would be able to stick to their work schedules better."

Bult-Ito said Castillo's study showed that there are some dynamics going on in the brain that have not been reported. "Marina's work shows that different dynamics are not necessarily under circadian control. We show there's an important neurotransmitter in the brain's clock, not related to circadian rhythms."

There are some promising fronts for both lines of research. "We have several grant proposals pending with private foundations, but we still need to do a little more work, which is what happens when you come up with something new," he said.

Meanwhile, EPSCoR has supported Bult-Ito's work by funding several grad students in his lab. "We have had some undergrads from the Office of Sponsored Programs and INBRE, too. And we have a large multi-investigator NIH grant aimed at creating a specialized neuroscience research program for minority institutions (SNRP). That grant is worth $7.6 million over five years. And we're hoping to renew it for another five years."

DNA Core Lab Vital To Genetics Research In Alaska

Continued from the cover

nomic WAVE, a microarray reader, robotics for liquid handling, several thermal cyclers and other instrumentation.

Now two full-time technicians are on staff to aid a myriad of users, including the Institute of Arctic Biology, the Institute of Marine Science, the Biochemistry and Molecular Biology Program, the University of Alaska Museum, the Department of Biology and Wildlife, the Alaska Cooperative Fish and Wildlife Research Unit and the State Virology Laboratory.

Carrie Topp is the Lab's Technician/ Coordinator. She runs the sequencers and instructs graduate students and other users on how to use the equipment. "We get samples from all types of species, mammals, birds, plants, fungi and even bacteria," she said. "First, the researchers extract the DNA. Then they have to amplify the sample with a thermal cycler using the polymerase chain reaction. Eventually you get lots of copies. Then a dye is added to each base pair. Once you've added the dye, you can put the sample on the sequencer. At that point, they would bring it to us."

The DNA Core Lab also features a liquid-handling robot to serve a vital part of the genetic sample process. "It handles the kind of task that could lead to human error if it's done by hand," Topp said. "This way you avoid the error and increase the speed and output of the samples. You can actually leave the room and let the robot do it while you go off and do something else."

The Lab charges for its services, but it's not set up to make a profit. "The lab charges for some services and also gets money for certain machines through individuals and their research grants," Topp said. "The idea is to buy a piece of equipment that can be used by many scientists and keep it in a lab where it's easy to maintain."

Happ said there's nothing quite like the DNA Core Lab in the rest of the state. "There is some genetics capacity on the Native health campus in Anchorage, but we've got more toys. For example, we have two sequencers that can run 16 sequences at once. The Alaska Native Hospital has one and it can only run one sequence at a time." The thirst for knowledge means that the DNA Core Lab is always in danger of becoming obsolete. "The critical thing to do now is to have it facilitate the growth of the faculty's programs," Happ said. "They have to use it now to better define their research goals and get results that build a platform for new questions. It's just an enabling facility, nowhere near an end to itself."

Schweitzer named to head Phase 3

Phase 2 of the Alaska EPSCOR program runs through August 2007 under the continuing guidance of Program Director George Happ. But planning has begun for Phase 3. When Happ announced that he would not

continue for Phase 3, UA Statewide VP for Research Craig Dorman began the search for his replacement. "George has done a superb service to UA in initiating our participation in NSF EPSCOR, and I'm delighted he will continue to oversee our NIH INBRE Program while turning over the responsibility for the Phase 3 NSF proposal to Peter" said Dorman.

Peter Schweitzer, professor in UAF's Department of Anthropology, will begin the planning for Phase 3 in fall 2005 when concept papers will be invited for consideration. The Phase 3 proposal must be completed for submission in September 2006.

"I am honored to have been selected as director for Phase 3 of the Alaska EPSCoR program. My predecessor, George Happ, has done a tremendous job during the first two phases of the program and his accomplishments will guide my way. As a social scientist, I see my job in stimulating competitive research across all science and engineering disciplines, while making sure that this research benefits the people of Alaska" said Schweitzer.

EPSCOR Program Announcements

This year, seven Alaska EPSCoR programs will offer research and travel support for University of Alaska faculty and students. Please see the EPSCoR web site (www.alaska.edu/epscor) for full details and deadlines.

For Faculty:

Young Investigator First Awards (YIFA): Annual, for recently appointed tenure track faculty, to help them become competitive for funding from the research directorates of the National Science Foundation (NSF). Deadline October 17.

DoD DEPSCoR: Annual peer reviewed competition for funds to support research critical to national defense. Beginning this year the Alaska EPSCoR office is requesting Preliminary Proposals, due on September 1, 2005. Five finalists (announced September 9) will be asked to develop full proposals due in the Alaska EPSCoR office by October 21.

Faculty/postdoc Travel awards: Ongoing program for attending meetings, conferences, training, or scientific collaboration. $500 for in-state travel, $1500 for US travel, $2000 for international travel.

For Graduate students:

Graduate fellowships: annual competition for 1 or 2 years of stipend and tuition support in the 3 Research Focus Areas. Deadline March.

Student travel awards: See faculty travel awards.

For Undergraduates:

Spring semester research project support: annual, for research projects in the 3 Research Focus Areas, funds for stipend and supplies. Deadline late October.

Summer research experience awards: annual, for research projects in the 3 Research Focus Areas, funds for stipend and supplies. Deadline February.

Student travel awards: See faculty travel awards.

Also see web page for Employment Opportunities for Postdocs, professional and student lab positions.

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