UNIVERSITY OF ALASKA FAIRBANKS™

LEADER IN ARCTIC RESEARCH

forces at work

UAF™

For the past 100 years, researchers at the University of Alaska Fairbanks have addressed challenges of great significance to the people of Alaska, our nation and global societies. It is important to consider the impacts of our research endeavors and the resulting benefits that accrue to society, not just in the immediate aftermath but also in the decades that follow.

Alexander Fleming accidentally discovered a mold that could act as an antibiotic, which led to the manufacture of penicillin, a life-saving drug used to treat infections in people since 1942. Similarly, innovations from UAF scientists have improved Alaskans' lives, government efficiencies, community health, infrastructure resilience, military preparedness and national security.

Our engineers have developed better designs for road and building construction in permafrost terrain. UAF researchers have reduced incidence of diabetes and hepatitis and improved diets and individual well-being. Agricultural and forestry researchers have bred plants that are better adapted to be productive in this environment and developed markets for local products. Our volcano researchers and atmospheric modelers created a tool to route aircraft away from volcano plumes. Our hydrologists have helped build safer bridges and ice roads. Our earthquake researchers have ensured that our building standards are adequate to protect life and property. Our fishery and wildlife scientists quantify populations and safe harvest limits. Our climate scientists provide analyses on future environmental conditions so infrastructure may be constructed to remain functional for many decades. And now, UAF researchers have joined the battle to protect individuals and communities from the effects of the coronavirus pandemic.

I hope you will enjoy reading in this report about some of these efforts, as well as similar research occurring today at UAF.

UAF researchers have made our communities more resilient, our homes more comfortable, our investments less risky and our resources more sustainable. UAF research helped our grandparents, it will enhance the lives of our grandchildren, and it will benefit our society today.

Larry Hinzman

Vice chancellor for research
University of Alaska Fairbanks

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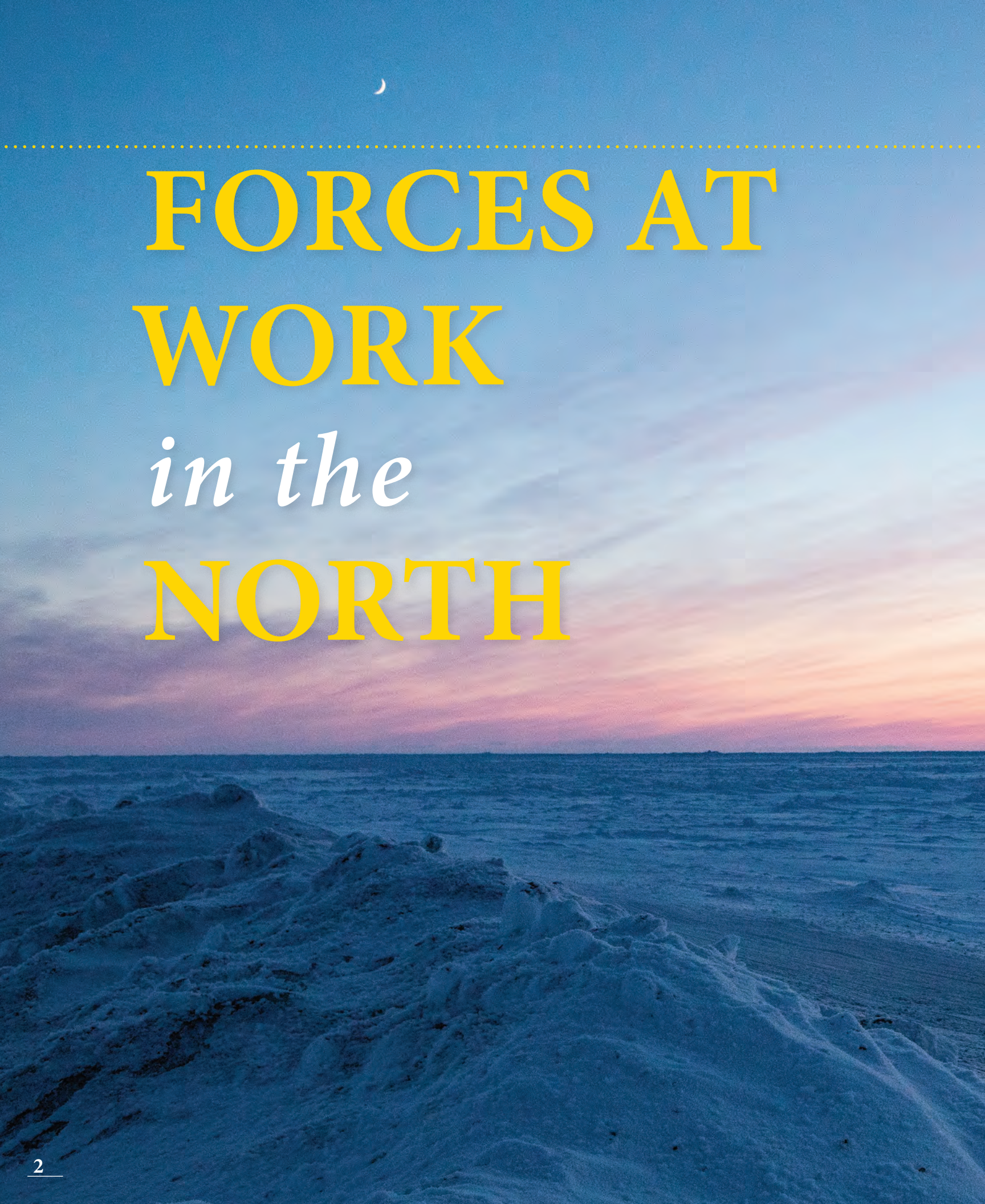
Cover: UAF College of Fisheries and Ocean Sciences Ph.D. student Rachel Lekanoff demonstrates how to take an ice core sample near Utqiaġvik, Alaska. Lekanoff helped train scientists for the Multidisciplinary Drifting Observatory for the Study of Arctic Climate, or MOSAiC. The expedition took scientists on the research vessel Polarstern into the Arctic pack ice for a year starting in September 2019.



FORCES AT WORK *in the* NORTH

Forces push and pull our world. Under these forces, the world constantly changes — in cycles, on linear tracks and through random turns.

Research at the University of Alaska Fairbanks focuses on the forces affecting the circumpolar North. This report samples that work, which is conducted by hundreds of experts working in world-class facilities hosted by our multiple research units. We've grouped these examples by the types of forces they chiefly investigate: biological, physical, or economic and social.

UAF leads the world's research institutes in the number of Arctic-related publications and citations.*

Our success comes in part from our location in Fairbanks, where visionary leaders founded Alaska's first university more than 100 years ago. But our people make everything happen. They come from across the world, drawn by Alaska and the spirit of openness and ingenuity found here.

They're working to understand and sometimes influence the forces affecting all of us. Everyone from policymakers to ordinary citizens can use this knowledge when making decisions for themselves, their communities and their nations.

*Elsevier http://bit.ly/2hvnJZB

BOOSTING COVID-19 TESTING AT ALASKA'S VIROLOGY LAB

University of Alaska Fairbanks student Jennifer Purkiss holds a tray of negative COVID-19 samples at the Alaska State Virology Laboratory on the Fairbanks campus April 8, 2020.

Alaska State Virology Laboratory technician Diana Puhak checks data on samples from Alaskans tested for COVID-19 in April 2020. The lab, located on the University of Alaska Fairbanks campus, can test up to 1,000 samples a day.

Faced with an approaching flood of COVID-19 tests, the Alaska State Virology Laboratory didn't need to look far when it had to rapidly double its staff in early 2020.

The facility, operated by the Alaska Department of Health and Social Services, is located at the University of Alaska Fairbanks' main campus. By tapping into UAF's nearby reservoir of lab technicians and microbiologists, the virology lab was able to quickly boost its staff by about 10 employees.

The addition allowed the facility to begin operating continuously, increasing its testing capability from 300 daily COVID-19 tests to roughly 1,000.

"UAF had an enormous presence," said Jayme Parker, the lab's manager. "They offered me a long list of people, and I was able to bring them right in."

That infusion of talent is part of an ongoing partnership between UAF and the facility, which is the only public health virology laboratory in Alaska. Jack Chen has split his time between UAF and the virology lab since 2012, serving as an associate professor at the Institute of Arctic Biology and the deputy director of Alaska State Public Health Laboratories.

A special fund through the Alaska IDeA Network of Biomedical Research Excellence supported efforts to genetically sequence coronaviruses from all positive COVID-19 cases in Alaska. That research will provide valuable information about how the virus spread and mutated as it moved across the state.

Such efforts, which also include work with the Centers for Disease Control, state agencies and the health care system, have allowed the Alaska State Virology Laboratory to become a "first line of defense in the rapid recognition of the spread of communicable diseases" in the state, Chen said.

WORKING TO MAKE PARALYTIC SHELLFISH POISONING LESS LIKELY

Mussels and kelp populate a tide pool at Fort Abercrombie State Park on Kodiak Island.

Paralytic shellfish poisoning is a serious health risk in Alaska, where many residents harvest and eat untested shellfish like clams and mussels.

Subsistence harvesters in southwestern Alaska are exposed to high PSP risk due to their cultural traditions and dependence on shellfish. They are particularly at risk in the Kodiak region, where levels of toxicity are often high and illness caused by PSP is prevalent.

Alaska Sea Grant's Marine Advisory agent for Kodiak, Julie Matweyou, is spearheading efforts to develop a safe-harvest program through PSP toxin monitoring, development of low-cost testing tools and continued public education about the risks of personal shellfish harvest.

Matweyou and Kodiak-area partners gather PSP toxin data at three popular shellfish harvest sites. They're improving the ability of local people to monitor not only the toxins but also the environmental drivers of the harmful algae responsible for them.

Monitoring of butter clams in the Kodiak region has found elevated toxins year-round and that toxin levels vary by location. This further demonstrates the need for beach-specific testing and low-cost screening tools that harvesters can use.

Matweyou and other experts have substantially improved an antibody-based test for saxitoxin and other toxins that cause PSP. They are also trying to develop a quick-test field kit that harvesters could use on the beach or in their communities to detect PSP in shellfish.

Matweyou has also investigated the distribution of PSP toxins in butter clam tissues and analyzed traditional cleaning methods. Results are being synthesized for public dissemination with the goal of increasing safer harvest of shellfish.

Matweyou continues to respond to community inquiries about PSP. She visits K-12 and undergraduate university classes, engaging students on the topic with age-appropriate, hands-on learning.

These edible and nonedible tissues of butter clams were segregated as part of a study comparing cleaning methods used by Kodiak subsistence harvesters to prepare the shellfish for consumption. The study evaluated the effects on PSP risk.

HIBERNATION RESEARCH POINTS TOWARD NEW WAY TO TREAT INJURED HUMANS

Kelly Drew works in her lab in the Murie Building at UAF in spring 2019.

Many animal species have adapted to Alaska's cold, so UAF's researchers naturally have been curious about these creatures since the institution's earliest days. Their research now forms the foundation for promising new biomedical innovations.

For example, Professor Kelly Drew, while studying hibernation in arctic ground squirrels, hit upon a way to mimic the phenomenon in other animals. Her drug combination could allow people resuscitated from cardiac arrest to be cooled — an important part of treatment — without causing them to shiver.

UAF patented the method, and Drew created a company to develop the technology. They signed an agreement in January 2020 that allows Drew to seek approval to use the method to help people. The agreement could also return royalties to the university in the future.

In fact, hibernation research has such broad potential that the National Institutes of Health awarded Alaska scientists a renewable five-year grant in 2019 to help them translate their knowledge into treatments that advance human health. The UAF Institute of Arctic Biology leads the newly formed Transformative Research in Metabolism program.

Three Fairbanks biotech companies already are poised to commercialize technology developed through TRiM research.

The program builds on the university's long history of research into northern animals that hibernate through Alaska's winters.

"We're going to understand the novel insights that they provide and be able to translate that into human applications," Drew said.

Knowing more about hibernating animals may point to new treatments for metabolic diseases in humans, according to IAB Director Brian Barnes, a UAF professor who has studied arctic ground squirrels for more than three decades.

"This is a big deal since it shows NIH's recognition of hibernation as a deserving model for investment in biomedical research, and UAF as a national and international center of expertise in hibernation and medical applications," he said.

LONG-TERM GULF OF ALASKA RESEARCH GETS A TWOFOLD BOOST

With a modern ship and new funding stream, UAF researchers are studying the Gulf of Alaska like never before.

Sikuliaq, a 261-foot research vessel operated by UAF's College of Fisheries and Ocean Sciences, arrived in Alaska in 2015. Cruises with the newly funded Northern Gulf of Alaska Long-Term Ecological Research program, led by UAF's Russ Hopcroft, began in 2018.

The NGA LTER builds on two decades of research previously associated with the Seward Line, a series of transects extending far into the gulf. With the new LTER funding and *Sikuliaq*, the scope of this fieldwork has greatly expanded.

The researchers can now look in more detail at biological and physical processes that drive environmental variability, which can in turn affect the gulf's fisheries. During the May process cruises, for example, researchers conduct extensive microscope work and incubation experiments, and map the ocean floor at a resolution not possible using prior research platforms.

"It's like we have moved from working out of a camper van to working out of an entire house," said Hopcroft. "The ship we have been using in the past could fit on the back deck of *Sikuliaq*."

Sikuliaq pulls into Seward before departing for the Northern Gulf of Alaska Long-Term Ecological Research cruise in May 2018.

TAKING A COMPREHENSIVE LOOK AT WILDFIRE IN ALASKA

The boreal forest is the world's largest ecosystem and covers almost half of Alaska, including the environs of both Anchorage and Fairbanks. It's also becoming more of a tinderbox, as warming summers appear to be increasing both the frequency and extent of boreal wildfires.

"Fire and Ice," a five-year project funded by the National Science Foundation, will improve Alaskans' ability to both prepare for and respond to wildfires in the boreal forest. The effort is led by the Alaska NSF Established Program to Stimulate Competitive Research, part of the University of Alaska.

Scientists are using remote sensing, fieldwork, and enhanced climate and biophysical data to improve the suite of products available to fire managers, and to better evaluate the behavior of fires and their impacts on homeowners and communities.

One group of researchers is using modeling and remote sensing approaches to generate new data on lightning storms, on fire fuels such as trees and shrubs, and on the kind of climatic conditions that contribute to hot and dry "fire weather." This will be used to improve seasonal "fire outlooks" used for planning by resource managers.

Another set of researchers will fly over active fires and recent fire sites with a hyperspectral camera and compare this information to data gathered on the ground. This will generate more precise data about the ways fires spread and how severely they impact vegetation and soil.

A third group is working with rural villages and agencies in Interior Alaska to study the impacts of fire on salmon spawning habitat and moose harvest, as well as the utility of rural wildfire fuel breaks. They'll also model the costs of various fire prevention and suppression strategies in settled areas like the Kenai Peninsula.

The research will present a clearer picture of what conditions contribute to fire starts, how fires behave, and what actions people can take to minimize their effects.

UAF graduate student Chris Smith, right, and UA Anchorage undergraduate Robert Haan check their GPS sensor while surveying 10-by-10-foot vegetation plots on the UAF North Campus trails. They're testing their field data against hyperspectral imagery of the same area as part of a project to improve remote sensing of fire fuels.

RESEARCHER USES SCIENCE, HISTORY TO UNDERSTAND COD CRASHES

Researchers prepare to release a Pacific cod with a satellite tag.

"It's all about sustainability and what's happening down the road."

When the Pacific cod population plummeted in the Gulf of Alaska in the late 2010s, it wasn't the first time fishermen had seen it happen. Cod stocks have crashed so often through the millennia that "atxidan," their name in the Unangan language, translates to "the fish that stops."

The latest population dip coincided with the arrival of "the blob," a vast pool of warm water that formed in 2015 in the North Pacific Ocean. Within a few years, 70 percent of Pacific cod had vanished from the gulf.

Nicole Misarti, a research professor at UAF's Water and Environmental Research Center, is using isotope analysis, fish size and historic records to determine how much of the cod's volatile history can be tied to such shifts in ocean temperature.

By studying Pacific cod bones from 4,000 years ago to the present, she gauges the ocean temperatures those fish experienced during their lifetimes. Isotopes also provide a snapshot of what those fish ate, where they ate it and their place in the food chain.

Understanding that history is important, Misarti said. Knowing how cod reacted to previous ocean temperature shifts will help us better understand their fate as climate change rapidly reshapes the Arctic.

"It's all about sustainability and what's happening down the road," she said. "We need to see this from a long-term perspective so we can manage for the long term."

Underwater images of Pacific cod in the Aleutian Islands showing the wide variety of habitats they frequent: Sandy bottom (top left); high relief bedrock (right); and scattered boulders (bottom left).

BEFORE THE WAVE: PLANNING AHEAD FOR TSUNAMI HAZARDS IN ALASKA

People along the coast in Alaska live with the most serious tsunami risk in the United States. Knowing where to go during an evacuation is crucial to survival, but how do emergency managers and planners decide where that is?

The Alaska Earthquake Center at the UAF Geophysical Institute has been working for years in partnership with state and federal agencies to evaluate and map tsunami inundation in Alaska.

These maps show the maximum estimated extent of flooding following a tsunami and help communities plan evacuation zones and the best routes to get there.

Elena Suleimani, a tsunami modeler with AEC, explained that residents of Alaska coastal communities need to evacuate as soon as they feel an earthquake. In Alaska, tsunamis generated by nearby earthquakes represent "near-field" hazards. In other words, people have minutes rather than hours to reach safety.

"What you need to do at 4 a.m. when the tsunami sirens start, you need to grab your things and run uphill or wherever your community decided to go," she said.

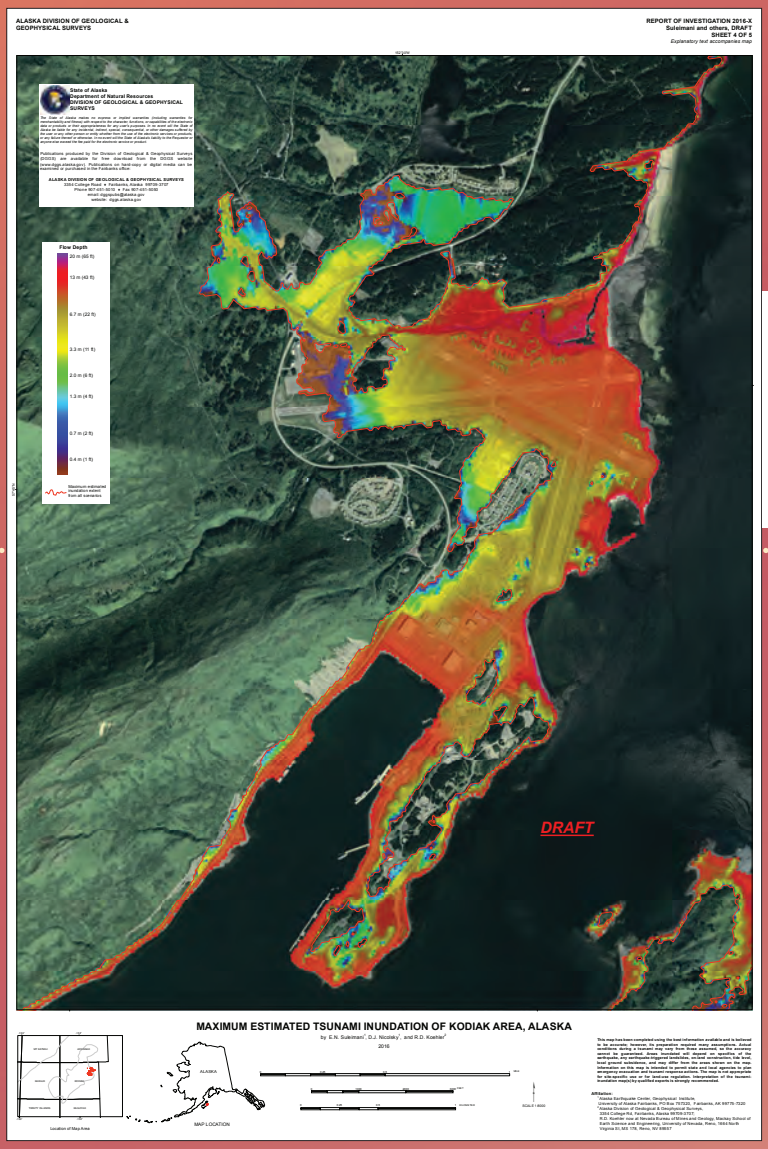
The earthquake center helps communities decide, well before an emergency, where that safe place is and the best way to respond.

The inundation map is an initial stage in helping at-risk coastal residents. A significant component of tsunami risk reduction is educating residents about potential tsunamis and helping them prepare for such events.

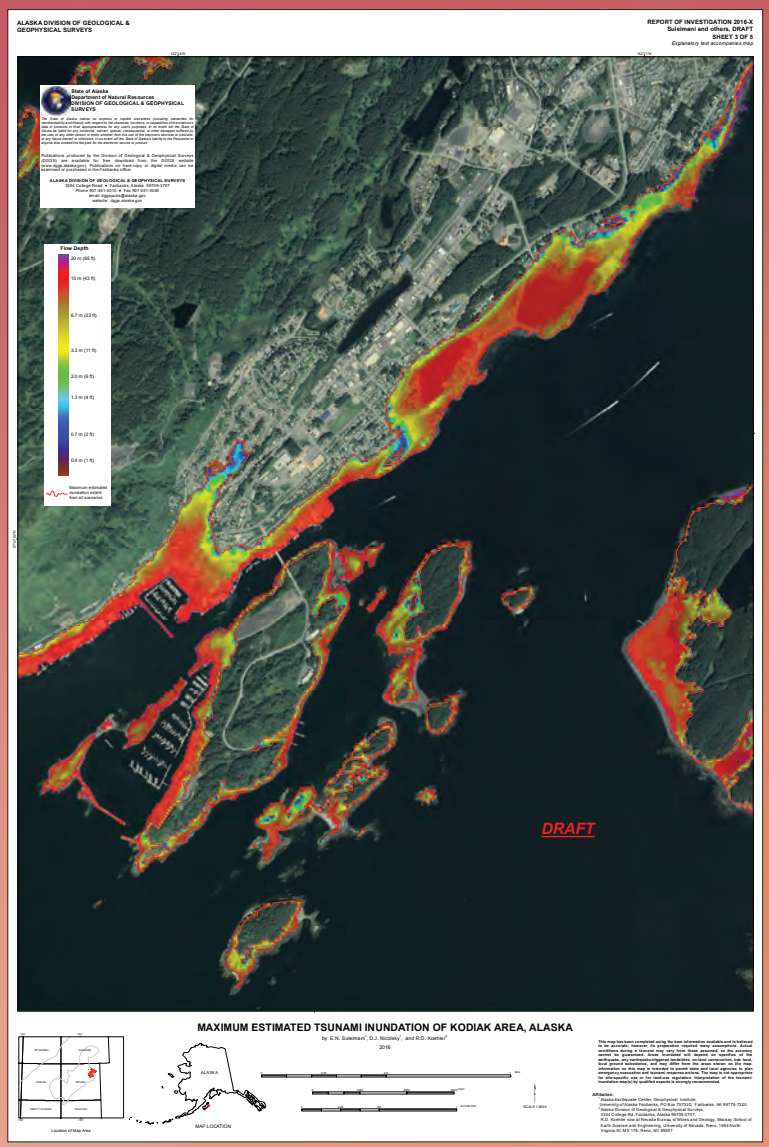
This not only requires understanding the hazards but also how residents are likely to be affected. This can be difficult to estimate because each situation is unique. Some residents may be more vulnerable because of mobility issues, language or cultural limitations, or how well they have prepared for a possible evacuation.

So, what's next? Action.

"The inundation map is just the first step. Now we know the safe area," Suleimani said. "Then we go to the community and we ask them, 'Where will you put your shelter?'"



These maps show the worst flooding expected under all tsunami scenarios at Kodiak, Alaska. The Alaska Earthquake Center at the UAF Geophysical Institute works with government agencies to create such information so communities can plan evacuations.



"Now we know the safe area. Then we go to the community and we ask them, 'Where will you put your shelter?'"

PREDICTING THE WINDOW TO REACH AN OIL-PRODUCING ISLAND

Northern Alaska oil and gas development is taking place at ground zero for climate change. Shifting sea ice conditions, eroding coastlines, thawing permafrost and increased storm activity are just a few of the threats infrastructure and planning now must consider to safely operate in these environments.

University of Alaska researchers are working to provide the best available climate data and forecasts to support these efforts.

Six miles off Alaska's northern coast is the projected site of Liberty Island. The facility will produce oil from an artificial gravel island sitting in 19 feet of water. The outcome could be 80-150 million barrels of oil, jobs for Alaskans and a stronger energy future.

However, logistically the project is challenging. Trucks will need to transport huge amounts of gravel across ice roads built over the frozen Arctic Ocean.

Peter Bieniek, a UAF climate modeler at the International Arctic Research Center, and his sea ice team are using their expertise to help forecast the window for safe travel across the ice roads.

To produce these valuable forecasts, the team starts with buoys that measure ice thickness for an entire ice season. These data help us understand ice dynamics in the region and inform a sea ice model which combines temperature, precipitation and wind to "melt and freeze" the modeled ice. Using this experimental technique, Bieniek will produce outlooks of sea ice thickness for the next few days to the next six months.

These seasonal sea ice forecasts, which have not been produced at this scale before, meet critical operational needs as Liberty Island personnel respond to changing conditions and plan for the season ahead. The outcome is a safer working environment and savings in time, resources and money.

An aerial view of sea ice in the Arctic.

Professor Margaret Darrow hikes down a frozen debris lobe in the Dietrich River valley in the southern Brooks Range about 225 miles north of Fairbanks. Darrow and state geologists are investigating ways to slow down or stop such lobes, some of which are moving toward the Dalton Highway and nearby trans-Alaska oil pipeline.

SEEKING THE CLUES TO SLOW FROZEN DEBRIS LOBES

Enormous frozen blobs of mixed rock, soil and organic debris slowly slide toward the trans-Alaska pipeline and the nearby Dalton Highway in the Brooks Range. One such frozen debris lobe recently prompted an expensive reroute of the highway.

Researchers are studying the situation for insights about how to deal with the phenomenon.

The most worrisome lobe, dubbed FDL-A, was 136 feet from the highway embankment in August 2014. Five years later, it was just 57 feet.

No one has a way to stop it. So the State of Alaska moved the Dalton Highway down the slope in 2018, expecting to buy another 20 years.

Since then, FDL-A's downhill creep has grown faster, to almost 31 feet per year. It's now projected to hit the new road in just 13 years.

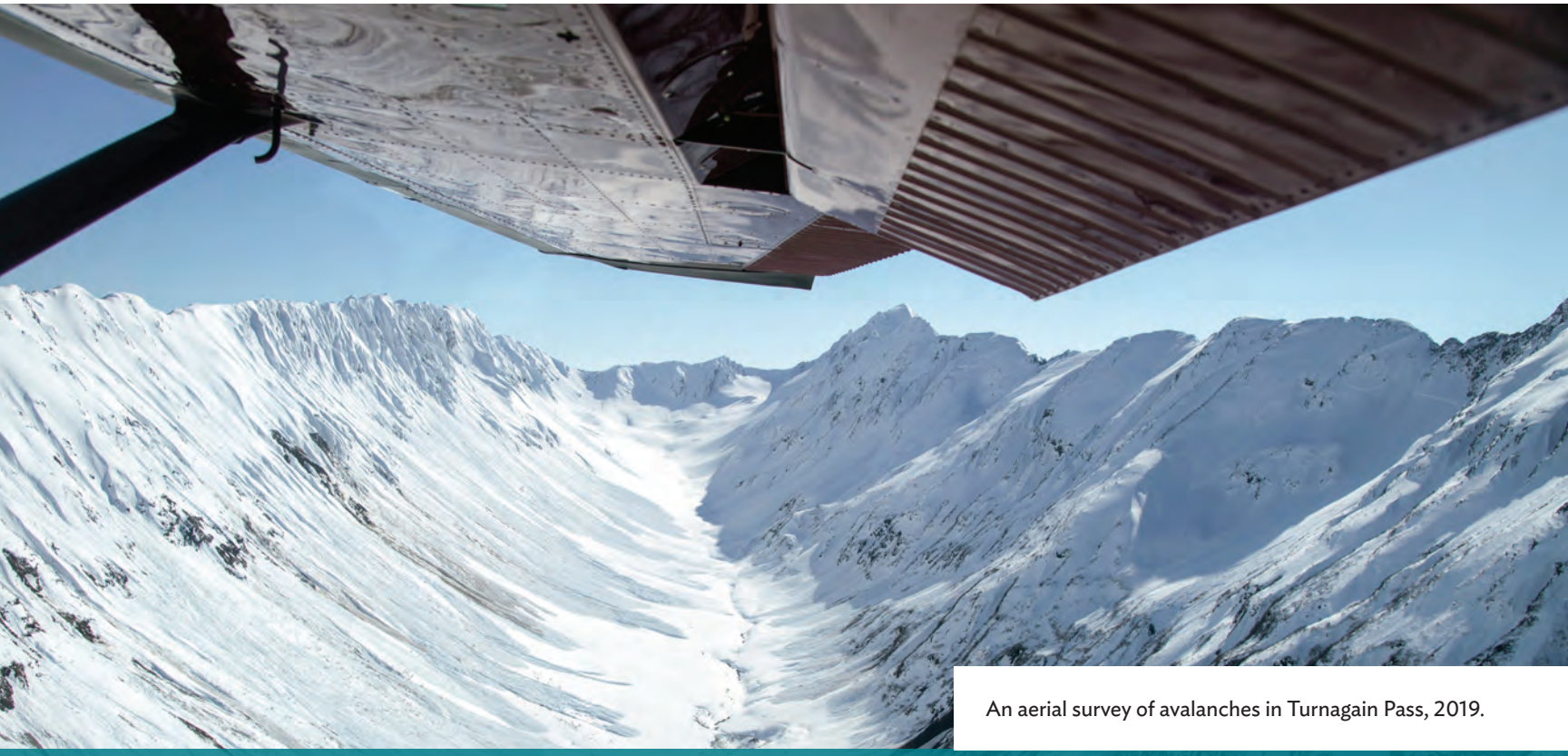
In the meantime, the lobe probably will overrun the old roadbed by summer 2021. Researchers from UAF and the state are watching to see what happens.

In summer 2019, they employed a backpack-mounted lidar — short for a "light detection and ranging" device — to get a detailed look at changes in FDL-A, the old road and the nearby landscape.

"This helps us to provide estimates to our Department of Transportation for the volume that they should expect will impact that highway," said Margaret Darrow, a UAF geological engineering professor.

Darrow and her colleagues also wonder if there is some way to slow the lobes, which number in the dozens along the pipeline and Dalton Highway route. They want to place instruments in the old highway embankment to see if any clues appear when FDL-A hits it. They're also thinking about ways to change the internal temperature of the lobes and to drain water away from them.

Their research could uncover ways not only to impede the advance of Brooks Range frozen debris lobes but also to deal with other massive earth movements in permafrost areas.



An aerial survey of avalanches in Turnagain Pass, 2019.

MAPPING AVALANCHE RISK FOR A SAFE AND SUSTAINABLE FUTURE

As the deadliest sudden natural-hazard events facing Alaskans, snow avalanches can endanger public safety, halt commerce and isolate remote communities for weeks. Climate change is intensifying this risk, as avalanches become more frequent and difficult to predict.

Gabriel Wolken, a UAF researcher at the Alaska Climate Adaptation Science Center, is leading an effort to map avalanche distribution in Alaska. He also manages the Climate and Cryosphere Hazards Program at the Alaska Division of Geological and Geophysical Surveys.

Despite the risks posed by avalanches, Alaska lacks a comprehensive understanding of where they occur, Wolken said.

"We don't have a baseline to start with. That's our main concern here, is to try to get a baseline over a really large area across the state," said Wolken.

That baseline will help with infrastructure planning, distribution of emergency response resources, and community access to subsistence or outdoor recreation sites.

Wolken works with some of the world's premier snow and avalanche scientists to adapt mapping techniques for Alaska's complex climatic zones and relatively sparse weather and snow data. In areas lacking weather stations or information collected by remote sensing flights, Wolken used regional-scale climate models developed at UAF.

"More than just responding to avalanches, this will also be really critical information for Alaska as it develops responsibly," said Wolken. By mapping avalanche vulnerability across the state, we can look at how climate might affect snow avalanches in the future and ensure responsible and sustainable development, he added.

RESEARCHERS TRACK PERMAFROST'S REACTION TO WARMING TEMPERATURES

Recent warming trends in extreme northern permafrost have surprised Vladimir Romanovsky and his colleagues at UAF. Although permafrost in Arctic Alaska has long been categorized as "cold," recent measurements have shown it is reacting quickly to warm air temperatures of the past few decades.

"Now, I can't say that near-surface permafrost is safe (from thawing) during this century," Romanovsky said. "I used to say it was OK."

Across the far North, ground that was once solid is already sagging beneath some buildings, roads and pipelines. Scientists predict more to come, as permafrost thaws throughout the Arctic and sub-Arctic.

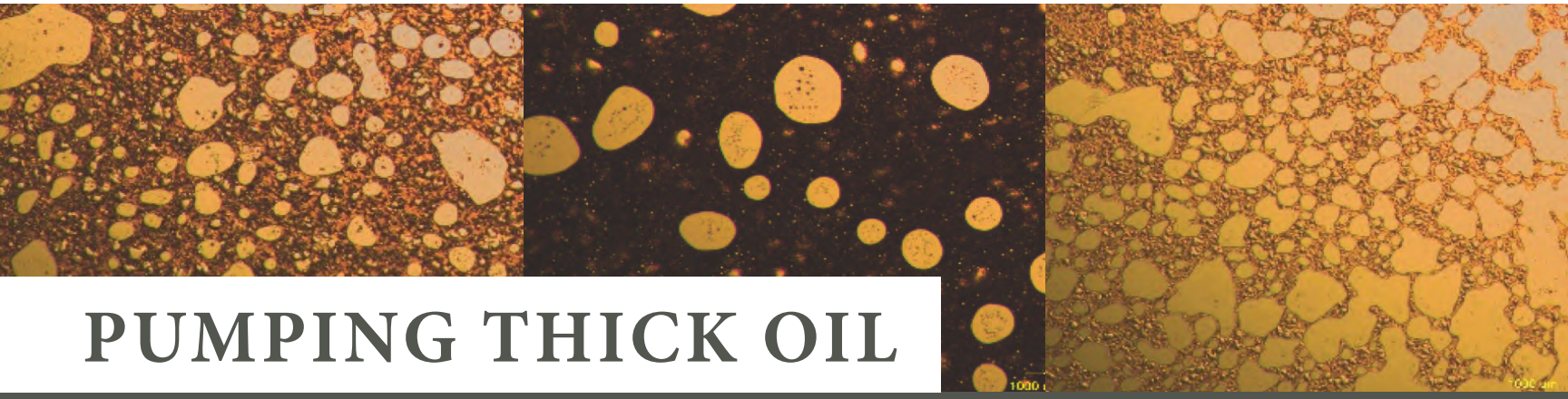
Romanovsky, of UAF's Geophysical Institute, has studied permafrost in Alaska and across the circumpolar North since 1975, the last 27 years in Fairbanks. He was one of eight authors of "Degrading Permafrost Puts Arctic Infrastructure at Risk by Mid-Century," a study published in *Nature Communications* in December 2018.

Permafrost, ground that has remained frozen through the heat of at least two summers, is a relic of colder times. When permafrost thaws, the ground above it sinks, as water that has been ice for perhaps thousands of years drains away. The slumping is most dramatic after the disappearance of ancient ice lenses, which are chunks of clear-ice permafrost that can be larger than a car.

Unless air temperatures cool, oil companies, road-maintainers and homeowners will face expensive repairs or even abandonment of things that were built to last.

In the recent paper, completed with scientists from Finland, Norway, Russia and Michigan, Romanovsky wrote that almost 3.6 million people living on permafrost soils will soon need to react to the uneven, sinking ground left behind during and after its disappearance.

A Fairbanks home sags in the middle due to thawing permafrost.



PUMPING THICK OIL

Billions of barrels of cold, sticky oil lie trapped beneath Alaska's North Slope. For decades, this "heavy" oil has tantalized Alaskans worried about the state's declining revenues from conventional "light" oil. But little of the heavy oil has been produced, given the costs and technical challenges.

UAF Professor Abhijit Dandekar is leading an effort, in partnership with oil producers and others, to see whether more of the sticky stuff can be retrieved. The four-year research project is funded by the U.S. Department of Energy and co-sponsored by Hilcorp Alaska LLC.

The goal is to validate that a technique used elsewhere in the world can work on Alaska's North Slope. The team is making the first-ever attempt to flood a North Slope oil reservoir with a polymer solution to "sweep" the thick oil and make it flow into production wells.

"The application of a polymer in an Arctic environment — I don't think anyone has done that before," Dandekar said.

In August 2018, the team began injecting the polymer solution in two pre-existing wells operated by Hilcorp in the Milne Point field, just west of Prudhoe Bay. They're monitoring the effects upon two nearby production wells.

Water injections have long been used to increase oil production, including at the Milne Point wells. But the method works poorly for heavy oil. The water, being far less viscous, moves through the porous rock underground much faster than the heavy oil. So wells end up producing a lot of water and not much oil. Injecting a thick polymer solution instead of water can counter that problem.

The polymer, a powdered chemical called hydrolyzed polyacrylamide, comes in bags each weighing 1,650 pounds. After it's mixed with water, the resulting viscous solution is pumped down the injection wells at Milne Point.

The team also is studying the benefits of using low-salinity water, which imparts an advantage similar to the cleaning power of soft water compared to that of hard water.

Dandekar said early results are very promising. The water volume from the production wells has dropped dramatically. At the same time, oil production has remained stable.

The full results will take some time to become clear, though. "There are no overnight benefits," Dandekar noted.

"The application of a polymer in an Arctic environment — I don't think anyone has done that before"

Above: These images show different mixtures of oil and water from Milne Point wells.

RURAL VETERINARY CARE HELPS ANIMAL, HUMAN HEALTH

Dogs are abundant in Southwest Alaska, but veterinary care is scarce.

To address that disparity, UAF and Colorado State University have launched the Hub Outpost Project. It provides preventive health care for pets in an underserved region and offers educational opportunities for veterinary students. The project, funded by a grant from PetSmart Charities, provides spay and neuter surgeries, anti-parasite treatments and vaccinations for dogs in the villages of the Yukon-Kuskokwim Delta region.

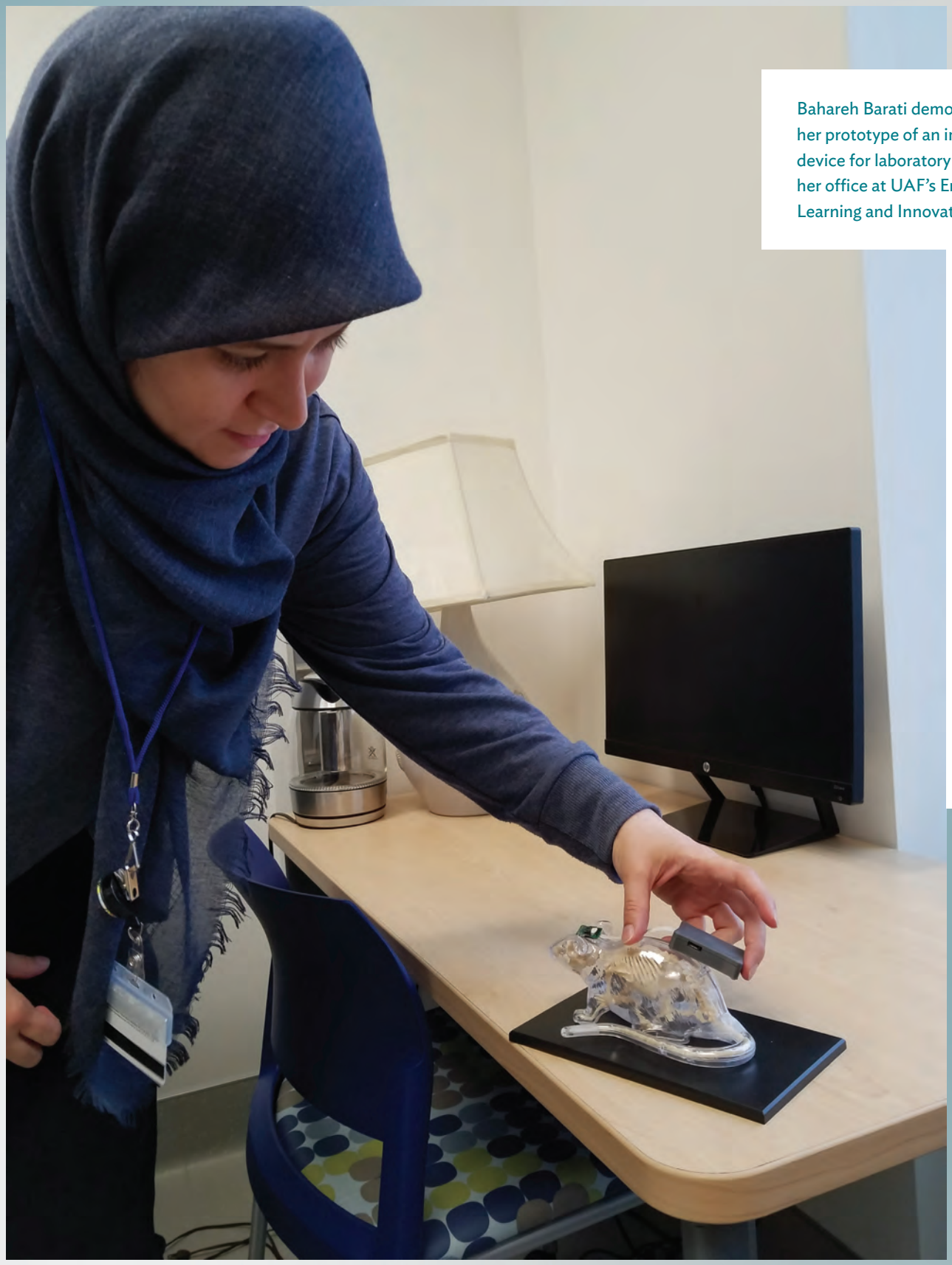
The project exemplifies the schools' commitment to the One Health concept, an approach to public policy and research that focuses on connections between environmental, animal and human health.

An overpopulation of dogs in the Y-K Delta has been difficult to curtail due to the area's remoteness and lack of infrastructure, said Dr. Arleigh Reynolds, a veterinarian, professor and director of the UAF Center for One Health Research. Pet owners also have limited access to vaccinations, which has increased the danger of communicable diseases such as rabies.

UAF veterinary medicine student Roxane Aflalo visits with a dog during a field visit to Tuluksak, Alaska, in January 2020.

UAF and CSU operate a veterinary medicine program that allows students to spend their first two years studying in Alaska before completing their degree in Colorado. The Hub Outpost Project, which is led by a full-time veterinarian, allows many of those students to gain experience and learn about community health in rural Alaska.

"A very important part of this is the public health, not just animal health," Reynolds said. "This is really a tremendous One Health issue and a great way to work on a solution through partnership with those communities."



Bahareh Barati demonstrates her prototype of an imaging device for laboratory animals in her office at UAF's Engineering Learning and Innovation Facility.

NEW TECH AIDS BRAIN RESEARCH

Throughout her career studying the body chemistry of hibernation, UAF researcher Bahareh Barati was often frustrated by the tools available for monitoring brain function in small laboratory animals.

The common techniques for brain scans are either designed for humans or prohibitively expensive for small animals. Barati said those limitations are a particular challenge to researchers who want to evaluate whether treatments for stroke and other neurological disorders are effective in animals before moving on to clinical trials.

To fill that gap, Barati developed her own scaled-down optical imaging device. A tiny probe is placed on the animal's head, which is attached to a thumb-sized processor inside a rat-sized jacket. The technology allows researchers to monitor brain function while animals go about their daily activity, without further surgeries or anesthesia.

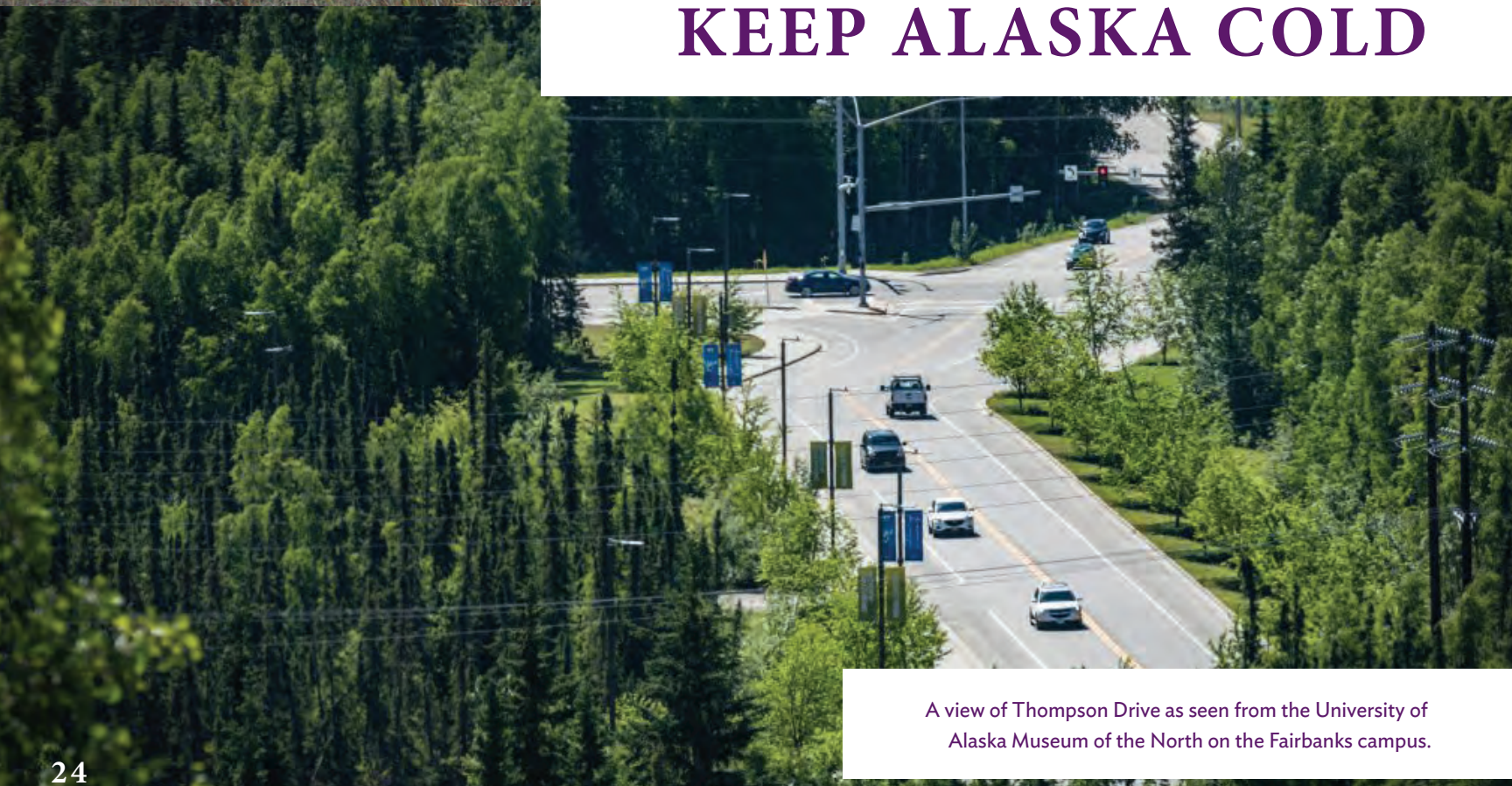
Barati, a researcher at UAF's Institute of Arctic Biology, started her own biotech company to create the imaging device. She is working with UAF's Center for Innovation, Commercialization and Entrepreneurship, known as Center ICE, to develop the product. She also received funding from the National Institutes of Health to refine a prototype and conduct feasibility studies. in animal models of stroke.

"It's very challenging — you have to miniaturize the entire technique," she said. "We hope with this technology we can determine the extent of the brain injury and whether the treatment improves it."

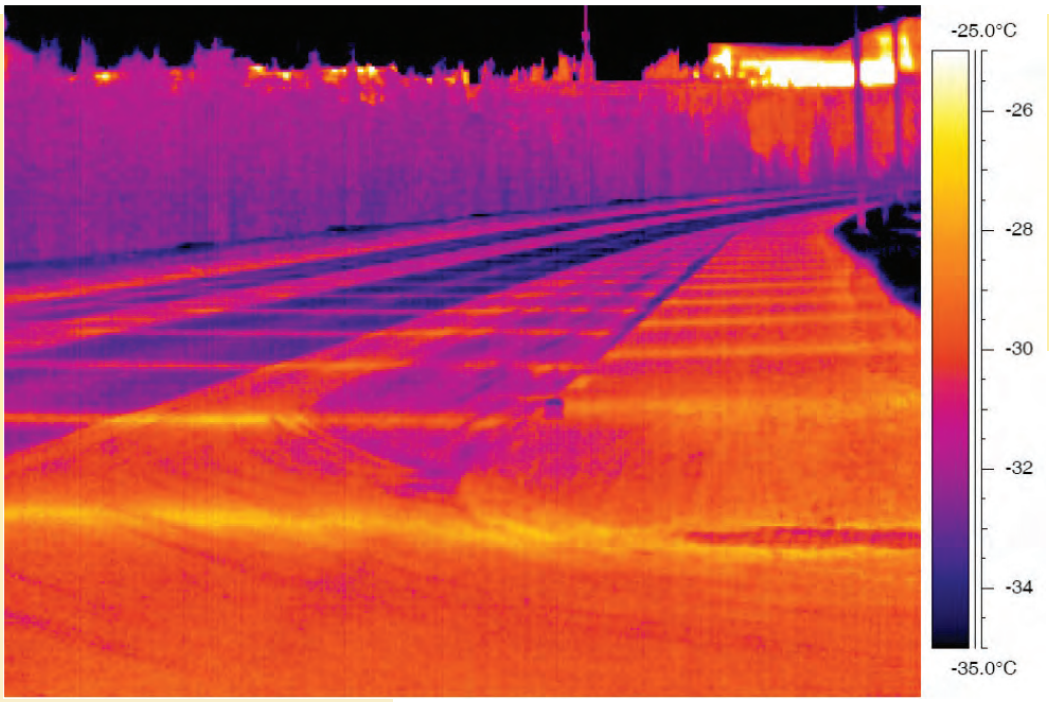
"We hope with this technology we can determine the extent of the brain injury and whether the treatment improves it."

Engineers included thermosyphons in many portions of the trans-Alaska pipeline to keep permafrost below the pipeline frozen. Such design features could become more common as a way to stabilize Alaska infrastructure as temperatures increase.

DESIGNING WAYS TO KEEP ALASKA COLD



A view of Thompson Drive as seen from the University of Alaska Museum of the North on the Fairbanks campus.



A thermal photo of Thompson Drive near the Fairbanks campus shows heat escaping from the roadway where thermosyphons and convection embankments have been included in the design. Such innovations help the ground beneath the roadbed remain stable.

"I think we're in for a challenging time in Alaska in the next century, if not the next few decades"

When Doug Goering looks at his 1969 edition of "The Environmental Atlas of Alaska," it feels very much like a half-century old publication. He flips it open to a statewide mean temperature chart, and notes that the reading in Fairbanks was about 25 degrees Fahrenheit.

"It isn't that cold around here anymore," said Goering, a University of Alaska Fairbanks engineering professor and dean emeritus of the College of Engineering and Mines. In 2019, that figure crept above freezing for the first time.

Alaska's engineers have been trained to keep the state's infrastructure from heating the permafrost beneath it, so the ground remains frozen and stable. In the decades ahead, they'll need to figure out how to keep a changing climate from undoing their work. An ongoing UAF experiment in road design is providing information about building techniques that may help.

Much of Thompson Drive, a UAF connector road, sits atop a layer of permafrost. The road's design includes a surface layer of grapefruit-sized rocks on the shoulders. Gaps between the rocks allow warm air to rise and cool air to sink, chilling the embankment through convection. In addition, gas-filled tubes, called hairpin thermosyphons, were buried horizontally beneath the asphalt surface. The refrigerant inside them evaporates in the lower portion of the tube during the winter, drawing heat energy away from the roadbed. The gas travels upward, condenses inside the upper, colder pipe and drops back down to begin the process again.

Since the road was built in 2005, temperature data shows the design actually cooled the ground below, although the margin has become smaller in recent years as temperatures have increased.

As the region becomes warmer, such additions could become more widespread throughout Alaska, from building foundations to the 800-mile trans-Alaska oil pipeline. Designs will need to be more conservative to account for increasing temperatures.

"I think we're in for a challenging time in Alaska in the next century, if not the next few decades," Goering said. "The opportunities for engineers are only going to be enhanced by all the problems we're going to have, unfortunately."

ALASKA SEA GRANT RESEARCH BOOSTS KELP FARMING

Matt Kern and Lia Heifetz, of Barnacle Foods, hold one of their company's raw products, bull kelp.

A new industry is on the rise in the 49th state: mariculture, which includes shellfish and seaweed farming.

Alaska Sea Grant, part of the UAF College of Fisheries and Ocean Sciences, has spent the past several years assisting mariculture's growth through business development and applied research.

Many see kelp as an important part of Alaska's future role in the mariculture industry, which already is a $10 billion global industry and is projected to double in coming years. Kelp is a sea vegetable used in food processing, cosmetics, medicines, nutritional supplements and animal foods. It is increasingly used in human foods such as pasta, salad, salsa and other condiments.

Alaska is an early adopter of commercial kelp aquaculture. Along with Connecticut and Maine, it is one of the first three states to produce farmed kelp food products. Alaska Sea Grant currently serves as a hub for research, outreach and education for the mariculture industry in the far North.

Alaska Sea Grant-funded applied research grants have helped expand understanding of the kelp life cycle and propagation, with the goal of helping mariculture farmers succeed.

Alaska Sea Grant is also working across coastal Alaska with farmers, tribal organizations, industry associations, state and federal agencies, and the University of Alaska to ensure a thriving mariculture industry. The effort helps people exchange information and attend trainings, creating a network of connected growers across Alaska.

UAF'S PRIMARY RESEARCH CENTERS: AN OVERVIEW

Research is highly collaborative and interdisciplinary at UAF. Many scientists have appointments in two or more major academic or research units, and no part of the university is untouched by the quest for answers.

www.research.uaf.edu

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

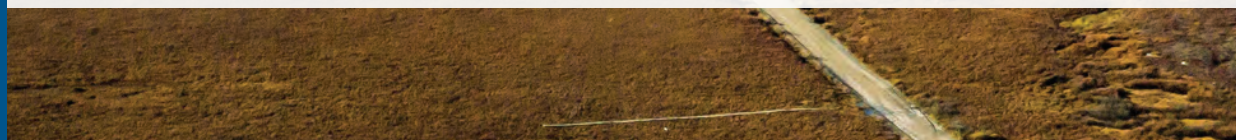
The Alaska Center for Energy and Power is an applied energy research program focused on developing and disseminating practical, cost-effective and innovative energy solutions for Alaska and beyond. ACEP is interdisciplinary, needs-driven and agile, with a wide range of partnerships at the local, state, national and international level to ensure research is relevant, current and world class.

College of Engineering and Mines *http://cem.uaf.edu*
Institute of Northern Engineering *http://ine.uaf.edu*

The College of Engineering and Mines' primary research organization is the Institute of Northern Engineering. The institute, which focuses on Alaska and other high-latitude regions, provides facilities and support to dozens of researchers in several centers. INE's research spans the engineering disciplines, offering expertise and practical solutions in energy production, hydrology, mechanical systems, mining, petroleum development and infrastructure. INE is home to many of the world's leading researchers in cold weather and cold climate science and engineering.

College of Fisheries and Ocean Sciences *ww.uaf.edu/cfos/*
Institute of Marine Science *www.uaf.edu/ims/*

The College of Fisheries and Ocean Sciences' central research arm is the Institute of Marine Science. Research focuses on the Arctic, but faculty and students work worldwide. The institute uses observational, experimental and quantitative modeling approaches to fisheries and ocean sciences, studying marine, estuarine, and freshwater ecosystems and their related human dimensions. IMS administers research by faculty in CFOS' three departments — oceanography, marine biology and fisheries. IMS also is the home unit for CFOS research faculty.



College of Liberal Arts *www.uaf.edu/cla/*

The College of Liberal Arts programs in the arts, humanities, languages and social science represent the human dimension of UAF research and offer limitless collaboration between its 22 disciplines and diverse fields outside the college.

College of Natural Science and Mathematics *http://cnsm.uaf.edu/research/*

College of Natural Science and Mathematics researchers are affiliated with numerous UAF institutes and centers, several of which are listed separately on this page and others in the publication. CNSM faculty, students and staff investigate such diverse topics as climate change, glacier dynamics, ancient ecosystems, theoretical and applied mathematics, environmental contaminants, and the health connections between wildlife, people and the planet. The college has a Division of Research and several modern laboratories that support the work.

College of Rural and Community Development *www.uaf.edu/rural/*

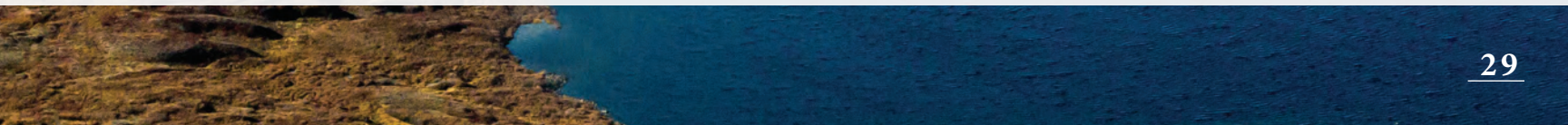
Alaska Native peoples live on the front lines of rapid social, cultural, economic and climatic change, including adaptation to thawing permafrost, thinning sea ice, mixed economies and contemporary health challenges. CRCD empowers indigenous and rural leaders to implement creative solutions to help their communities cope with the effects of a changing Arctic. CRCD campuses span Interior and Western Alaska, serving 160 communities.

Geophysical Institute *www.gi.alaska.edu*

Scientists at the Geophysical Institute study geophysical processes from the Earth to the sun and beyond. Research and education proceed hand in hand, and opportunities abound for student research with GI's renowned scientists. These scientists are experts in atmospheric science; remote sensing; seismology, snow, ice and permafrost; space physics and aeronomy; tectonics and sedimentation; and volcanology.

Institute of Agriculture, Natural Resources and Extension *https://uaf.edu/ianre/*

Researchers with the Institute of Agriculture, Natural Resources and Extension create knowledge and solve problems in agriculture and forest sciences. The institute includes the UAF Cooperative Extension Service and the Agricultural and Forestry Experiment Station, which operates experiment farms in Fairbanks and Palmer. The station develops agricultural cultivars adapted to the North and hosts research in animal management, soils and revegetation, forest ecology and management, and rural and economic development.



Institute of Arctic Biology *www.iab.uaf.edu*

Institute of Arctic Biology scientists, students and staff — along with state, national and international collaborators — conduct research in wildlife, climate change, ecology and ecosystems, physiology, genetics, biomedicine, human health and evolutionary biology. IAB supports research facilities that investigate a range of biological and social issues related to the changing Arctic.

International Arctic Research Center *www.iarc.uaf.edu*

The International Arctic Research Center helps the nation and international community understand, prepare for and adapt to the pan-Arctic impacts of climate change through its integrated science and service program. Key elements of that program include providing, analyzing and synthesizing Arctic climate information; supporting and coordinating Arctic system modeling; and serving as a gateway to research sites in Alaska and elsewhere.

Libraries and special collections

Some of the world's finest collections of materials related to the Arctic, Antarctic and northern regions are housed at UAF, including books, periodicals, photographs, manuscripts, films, oral histories, rare books and maps.

- **Elmer E. Rasmuson Library**, which hosts the Alaska Native Language Archive and the Alaska and Polar Regions Collections & Archives, as well as many other sources of information about the North. *http://library.uaf.edu/*

- **Keith B. Mather Library**, which holds special collections in the geophysical and biological sciences. *www.gi.alaska.edu/services/mather-library*

University of Alaska Museum of the North *www.uaf.edu/museum/*

The University of Alaska Museum of the North is a designated state and federal repository for natural history and cultural collections from Alaska and the circumpolar North. It houses 2.5 million specimens and artifacts that record the region's diverse biological, geological and cultural history. Its facilities include extensive dry and wet collection spaces, one of the largest frozen tissues collections in North America, and molecular, ancient DNA and imaging laboratories. Much of the museum's collections data is digitized and shared publicly through an online database, Artcos.

UAF RESEARCH INSTITUTES, CENTERS AND PROGRAMS

Throughout Alaska and around the globe, UAF research encompasses the human and physical aspects of life in the North.

Advanced Instrumentation Laboratory
Advanced System Security Education, Research and Training Center
AFES West Ridge Greenhouse
Agricultural and Forestry Experiment Station
Alaska Blue Economy Center
Alaska Center for Climate Assessment and Policy
Alaska Center for Energy and Power
Alaska Center for Unmanned Aircraft Systems Integration
Alaska Climate Adaptation Science Center
Alaska Climate Research Center
Alaska Cooperative Fish and Wildlife Research Unit
Alaska Earthquake Center
Alaska Fire Science Consortium
Alaska Geobotany Center
Alaska Native Language Archive
Alaska Native Language Center
Alaska NSF Established Program to Stimulate Competitive Research
Alaska and Polar Regions Collections & Archives
Alaska Quaternary Center
Alaska Satellite Facility
Alaska Sea Grant
Alaska University Transportation Center
Alaska Volcano Observatory
Animal Resources Center
Arctic Coastal Geoscience Lab
Bonanza Creek Long-term Ecological Research program
Center for Alaska Native Health Research
Center for Arctic Policy Studies
Center for Cross-Cultural Studies
Center for One Health Research
Center for Salmon and Society
Center for the Study of Security, Hazards, Response and Preparedness
Coastal Marine Institute
College International Geophysical Observatory
College of Fisheries and Ocean Sciences
College of Liberal Arts
College of Natural Science and Mathematics Division of Research
Controlled Environment Agriculture Laboratories
Delta Junction Field Research Site
Fairbanks Experiment Farm
Forest Soils Laboratory
Genomics Core Lab
Geochronology Facility
Georgeson Botanical Garden
Geophysical Institute
Emergency Management and Homeland Security program
High-frequency Active Auroral Research Program
IAB Research Greenhouse
IDeA Network of Biomedical Research Excellence
Institute of Arctic Biology
Institute of Marine Science
Institute of Northern Engineering
International Arctic Research Center
Kasitsna Bay Laboratory
Kodiak Seafood and Marine Sciences Center
Large Animal Research Station
Lena Point Fisheries Facility
Matanuska Experiment Farm
Mineral Industry Research Laboratory
Molecular Imaging Facility
National Center for Island, Maritime and Extreme Environment Security
Native Art Center
Northern Gulf of Alaska Long-term Ecological Research program
Northern Leadership Center
Ocean Acidification Research Center
Office of Intellectual Property and Commercialization
Petroleum Development Laboratory
Petrology Lab
Poker Flat Research Range
Pollock Conservation Cooperative Research Center
Rasmuson Fisheries Research Center
Reindeer Research Program
Research Vessel Sikuliaq
Scenarios Network for Alaska and Arctic Planning
Scientific Diving Program
Seward Marine Center
Toolik Lake Research Station
University of Alaska Museum of the North
Water and Environmental Research Center
Wildlife Toxicology Lab
Wilson Alaska Technical Center

EDUCATION AND COLLABORATION

Research about the North benefits students, innovators and, ultimately, society.

Center for Innovation, Commercialization, and Entrepreneurship

www.alaska.edu/centerice/

The Center for Innovation, Commercialization, and Entrepreneurship encourages startup enterprises in Alaska through funding, experiences and the Innovators Guild. Funding allows innovators to grow their ideas into realities. Experiences improve innovation skills. The Innovators Guild provides resources, mentorship and networking.

Honors College

www.uaf.edu/honors/

UAF's Honors College is a community of high-achieving students who pursue a rigorous academic experience. Most engage in research and field-based learning, as well as service learning and community initiatives. The college's new Climate Scholars Program, the first of its kind in the nation, offers interdisciplinary studies of climate issues and interaction with UAF's renowned Arctic climate science experts.

UArctic

www.uaf.edu/uarctic/

UAF is a founding member of UArctic, a network of universities, research centers and other organizations focused on higher education and research in the higher latitudes. A constantly flowing exchange of undergraduates, graduates and faculty between UArctic institutes fosters collaboration and creativity, and creates new possibilities in research and education.

Undergraduate Research and Scholarly Activity

www.uaf.edu/ursa/

Students who undertake special research, academic or creative projects at UAF get support through the Office of Undergraduate Research and Scholarly Activity. In addition to mentoring, funding is available for equipment, supplies or travel.

UAF graduate student Kelly Cates, right, checks a petri dish that will be mounted on the drone held by fellow student Jenell Larsen Tempel. The dish will capture breath samples when flown over surfacing whales.

An aerial view of the Toolik Field Station, about 330 miles north of Fairbanks, on Alaska's North Slope. The camp is operated by UAF's Institute of Arctic Biology and hosts scientists from around the world for a variety of Arctic-based research efforts.

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UNIVERSITY OF ALASKA FAIRBANKS