To Build a Fire

The Alaska Science and Technology Plan

The Alaska State Committee for Research 2022

Figure 1 - Permissions Pending

Approved and accepted by the Alaska State Committee for Research

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Executive Summary

Alaska’s economy is based on knowledge. Research – the expansion of knowledge – can improve the state’s resilience and competitiveness and contribute to human progress. While Alaska’s vast size, extreme climate, and scattered population present challenges for science and technology development, the state also offers many advantages: a rich resource base, a unique Arctic location, an educated populace and increasingly well-regarded university system, and a landscape ideally suited for the study of human and natural systems undergoing climatic and social change.

This report was prepared by the Alaska State Committee for Research (SCoR) and presents a road map for the future of Alaskan science and technology (S&T) development. Improving Alaskan S&T requires a collaborative effort between the state, the University of Alaska (UA), federal agencies, communities, Alaska’s indigenous peoples and the private sector. The state has a limited ability to broadly fund research, especially in lean financial times. Its role is rather to help provide infrastructure and basic research; education and training; incentives for industrial development; cost matching and focused funding; and research oversight and coordination. By adopting in-state innovations, the state can also leverage and validate Alaskan research. It is also incumbent on the state to refine research efforts to help industry to develop the state economy, and to foster relationships with communities and businesses to better leverage state funds.

To offer an analogy, the state seeks to build a fire under research. The “spark” is education and incentives for innovation. The “tinder” is infrastructure and capacity. The “fuel” is match funding and other support, and the “bellows” represents long-term planning and coordination by the State Committee for Research (SCoR) and other bodies.

Alaska’s unique characteristics lend themselves to seven specific S&T research arenas, as detailed in this report. An overarching theme that ties these arenas together is Alaska’s role in understanding the changing arctic and subarctic onshore and oceanic environments which offer challenges and opportunities for Alaska. These arenas take advantage of Alaska’s natural and human assets and address research questions crucial to the state’s economy, ecology and society:

1. **Community Resilience and Sustainability.** Communities’ capacity to adapt to environmental change; preserve arts and culture; and revitalize Alaska Native languages, culture, and knowledge.

2. **Resource Extraction.** Technology and processes for safe and efficient exploration, extraction, transportation and use of oil, gas, coal and minerals, including rare earths elements and other critical minerals

3. **Energy, Food and Water Nexus.** Create sustainable approaches to ensure food security, access to clean water, and energy independence for Alaska’s communities and all Alaskans.
4. **Renewable Resources.** Innovations and strategies to effectively harness the state’s renewables, including fisheries, mariculture, wildlife, timber, and agriculture.

5. **Environmental Monitoring and Management.** Monitoring and mitigation of environmental change, mapping and remote sensing, fire prevention and response, hazards, marine ecosystem monitoring and geophysical research.

6. **One Health.** Human health, animal health and environmental health are all inextricably linked, necessitating multidisciplinary approaches and delivering effective physical and behavioral health care in the Arctic and subarctic.

7. **Transport, Communications and Information.** Land transport, shipping, aviation, aerospace, telecommunications and information technology in northern environments.

As Alaska addresses these critical S&T research arenas, quality kindergarten through twelfth grade (K-12) and university education, with a focus on science, technology, engineering and math (STEM) instruction is crucial to our success. This report presents a summary of innovative programs and strategies to build the STEM education pipeline. The report concludes with a discussion of how the State and UA can collaborate to partner with the private sector to build a culture of entrepreneurship in Alaska.
Introduction

Developing Alaska’s science and technology capabilities is critical to the state. Research is widely recognized as the most significant engine of economic growth, and also constitutes an economically significant “industry” in its own right: the University of Alaska, for example, conducted $154 million in sponsored research in 2021-22, including $136.5 million at the Fairbanks campus, $17.6 million in Anchorage, and $1.2 million in Juneau. This research activity generates over 1,600 jobs, attracts talent from around the nation and the world, and improves our ability to “grow our own” and to keep our best and brightest in Alaska.

The other reason Science and Technology (S&T) is important in Alaska is the state’s unparalleled richness of human and natural resources. A common saying is, “If we can solve it in Alaska, we can solve it anywhere.” Our goal is S&T that enables us to affordably and sustainably meet socioeconomic needs while preserving the health of our environment and improving our quality of life. These results are exportable as well: better solutions for basic needs such as clean water, green energy and remote health care are needed around the world.

Challenges. Alaska offers unique S&T challenges. The state’s vast size, scattered population, extreme climate and limited transport infrastructure complicate logistics and increase costs. Another hurdle stems from land ownership: Research questions don’t respect the jurisdictional boundaries of the various federal, state, and Native organizations, which own 99% of land in Alaska, complicating the process of obtaining permits and approvals. A further consideration is the significant research conducted on Alaska Native-owned lands, or involving Native communities or populations, which requires special attention to ethics and to intellectual property issues concerning the use of traditional local knowledge.

Opportunities. At the same time, the Great Land has abundant potential for S&T development. The state’s expansive wilderness and coastline, Arctic/subarctic location, abundance of traditional local knowledge, and position at the forefront of climate change all make it a natural laboratory for innovation in environmental monitoring and management. Its isolated rural communities are ideal sites for social and economic research addressing cultural preservation, migration, and community sustainability, and for testing alternative energy technologies and solutions.

Perhaps most of all, Alaska offers motivation: nowhere else in the U.S. presents a more pressing need for innovation in areas like energy production and adaptation. And never before has there been such intense interest in the North, as factors such as climate change, resource potential, and new shipping lanes focus attention on the eight Arctic nations. As America’s only Arctic state, Alaska offers strong opportunities for national and international research, stakeholder collaboration, energy development, and governance initiatives.
Other Segments of the State Economy

Several other Alaskan industries are worth noting due to their contributions to the state, though they are not generally foci of scientific research.

• **Tourism**: Tourism has an economic impact of $3.9 billion a year. 1.93 million people visited the state in 2013-4 (half by cruise ship) and around 46,000 people were employed in tourism jobs during peak season.

• **Military**: Alaska is home to over 20,000 active-duty military personnel, and veterans comprise 10% of the state population, the highest per capita in the nation. The University of Alaska increased cooperation with the military in 2013 by signing an agreement with the multi-services Joint Task Force-Alaska to share information in areas like energy, engineering and communications initiatives. Among other developments, this led to an Arctic Collaborative Workshop in 2014 that drew civilian and military Arctic experts from five countries.

• **Advanced Business Services**: Alaska houses numerous firms that provide customized problem-solving to other businesses, such as consulting and research companies.
The State Committee for Research

This report is a product of the Alaska State Committee for Research (SCoR), an advisory body created to function as the State Committee for Alaska EPSCoR (Established Program to Stimulate Competitive Research) and EPSCoR-like programs. This responsibility includes:

- Oversight and guidance for the EPSCoR and EPSCoR-like programs in Alaska as competitively funded by the National Science Foundation and other federal agencies;
- Promoting research and development as an enterprise and as an engine for economic development in Alaska.

SCoR membership includes representatives from the State of Alaska, the University of Alaska, federal agencies and members of the private sector. It is co-chaired by the UA Vice President for Academics, Students & Research, and the Lieutenant Governor of the State of Alaska.

The Role of the State. Alaska’s unique economic structure and research needs foster a climate dominated by state and federal agencies and the University of Alaska: The function of the state is thus to conduct appropriate research through the UA and state agencies; to bolster research taking place at the federal, tribal, and local levels, and to identify ways to facilitate increased research by private industry. There are five roles the State of Alaska can play in the development of science and technology:

1. **Education and training.** Through the Department of Education and the UA, the state takes a lead role in educating tomorrow’s innovators. In addition to state efforts, tax credits and other support mechanisms can promote private education programs.

2. **Incentives for commercial S&T development.** Alaska seeks to expand private-sector participation in S&T to spur economic growth. Tax incentives, direct financial support, and purchasing and early adoption of innovations contribute to this goal. Industry and government can also share the costs of research and exploration to identify opportunities and to improve feasibility.

3. **Infrastructure and basic research.** Adequate laboratory space at the University of Alaska is critical to science and technology development, as are cyberinfrastructure, faculty retention and recruitment, and independent research by state entities. The state can also support and conduct the basic research that undergirds all applied science efforts, but that is unlikely to attract private funds.

4. **Cost matching.** Many federal programs require a cost match; to the degree that the state seeks to attract such funds, it must provide the needed resources. Similarly, the state bears the burden of building capacity and maintaining excellence in areas where it wishes to attract federal support and private investment.
5. **Oversight and coordination.** It is incumbent upon the state to pull together various elements of S&T by developing a thorough understanding of what is already occurring and the mechanisms by which it occurs, including economic factors. Through participation in the State Committee for Research (SCoR) and other collaborations with the UA and the private sector, the state is actively involved in encouraging partnerships, providing incentives, and improving the S&T climate.

**To Build a Fire**

“Building a fire” under research is critical if the state is to diversify and grow its economy.

- Education and incentives are the spark.
- Infrastructure, basic research and capacity-building provide **tinder**.
- The **fuel** is cost-matching, as well as other financial support and guidance to help new technology to leave the laboratory.
- The **bellow**s represents coordination and long-term planning by the State Committee for Research and other state bodies to foster continued development.

Once the state has lit a fire under S&T, it will take the continued development and application of sound policy to **keep the blaze going**.
Research Arena 1: Community Resilience and Sustainability

Introduction. More than two-thirds of Alaska’s 732,000 residents live in or near the principal cities of Anchorage, Fairbanks and Juneau, while many of the remainder occupy remote “mixed-subsistence” villages, in which residents obtain food from the land but also participate in the cash economy. In recent years there has been a slow migration of village residents toward population centers, driven by jobs, schooling, health facilities, and increasing reliance upon modern technology. The continued viability of these isolated communities is dependent on numerous local and global variables, from wildlife migration patterns to the price of gasoline. Understanding these variables and ways to respond to them is thus critical to preserving the rural Alaskan way of life.

Research Initiatives. Community Resilience. A focus of Alaskan research is the study of adaptive capacity: the ability of communities to effectively respond to environmental and social changes. One key question is how communities and institutions can proactively address major climate-driven landscape changes. Such shifts can profoundly impact food webs and hence resource availability, and can also impact safety by altering characteristics of natural hazards such as forest fires.

Alaska NSF EPSCoR (National Science Foundation Experimental Program to Stimulate Competitive Research) is implementing a “Track-1” award to create and refine adaptive capacity indices, which highlight the specific elements that enable communities to weather change. UAF is also home of the Center for Arctic Policy Studies and Alaska Center for Climate Assessment and Policy, networks for interdisciplinary research and education. UAA hosts the Alaska Center for Conservation Science, which fosters research and education on northern biological conservation and natural resource management.

Social Research. Many of the challenges facing rural Alaska are rooted in economics. The Institute of Social and Economic Research (ISER) at UAA conducts research into subsistence, rural-urban migration, sustainable communities, risk perception, and other aspects of social, economic and cultural change. The UAA Justice Center also conducts basic and applied research into pressing issues of crime, justice and law that impact community resilience.

Arts, Language and Culture. There is a growing global awareness of the importance of traditional local knowledge, especially in regards to a changing climate – but as Alaskan elders age, important knowledge is in danger of being lost to history. Culture, language and the arts in general are important facets of resilience and identity, and also contribute to the economy through tourism.

Strategies
The State Committee for Research was actively involved in crafting the Alaska NSF EPSCoR Track-1 proposal, and provides oversight and coordination to the program’s various elements. The state
also provides an award match. With SCoR oversight, Alaska NSF EPSCoR regularly submits funding proposals for other activities that address community sustainability and contribute to local capacities to respond constructively to change. SCoR has also approved a new Track-1 proposal for 2023-28, which will focus on how climate change is impacting land-ocean connections and how this, in turn, is influencing marine resources critical to Gulf of Alaska communities. High on UAF’s priority list is a planned $40 million Troth Yeddha’ Indigenous Studies Center. Housing Alaska Native research, arts and culture programs. The Alaska State Council on the Arts provides assistance and services to artists, art organizations and arts supporters across the state. Since its inception, the council has provided over 4,000 grants totaling more than $42 million, including direct support for artists and a variety of programs to bring artists and art curricula to schools. The Council’s strategic plan calls for the organization to cultivate awareness of arts and culture; to promote equitable, accessible high-quality arts education; to expand Alaska’s artistic vitality; to build vibrant communities through the arts; and to strengthen the council’s governance and administrative capacity. The nonprofit Rasmuson Foundation also provides major funding and support to Alaskan artists.

Examples of Alaska Native Language and Culture Preservation Efforts

- The UAF Oral History Program preserves more than 11,000 audio and video recordings about Alaska’s history and people, many of which are available online.
- The UAF Alaska Native Language Center researches and documents Alaska’s 20-plus Native languages and raises public awareness of language loss.
- UAF is partnering with Google in the Endangered Languages Project, which enables people worldwide to find and share information about endangered languages.
- UAA’s Kenai Peninsula College operates a major grant-funded research center for language documentation.

- The Alaska Native Science Commission, formed by the Alaska Federation of Natives, works to integrate Native knowledge into research.
- The First Alaskans Institute is a non-profit organization that helps to develop the capacities of Alaska Native people; its efforts include a Native policy think tank and leadership development programs.
- The Sealaska Heritage Institute is a non-profit organization that works to preserve and enhance Southeast Alaska Native cultures.
Research Arena 2: Resource Extraction

**Introduction.** Oil has been the linchpin of Alaska’s economy for four decades, but Alaskan production is down significantly from its 1988 peak. Alaska is home to significant viscous and heavy oil, shale oil, natural gas hydrates and coal deposits, as well as strategic minerals, which are areas of renewed focus from the state. The state strives to provide innovative solutions to extractive industries to improve efficiency, especially during financially difficult times.

**Research Initiatives. Oil and Gas.** The state strives to increase technology and improve data to develop a scientifically sound and efficient refined oil permitting process, and to improve understanding of the impacts of development and climate change on wildlife, infrastructure, and vegetation. Alaska also facilitates oil development by gathering geologic and engineering information for potential oil and gas basins. ISER offers insights into economies of oil production, including appropriate levels of public versus private investment.

The state seeks to collaborate with oil and gas multinationals to develop and implement advanced exploration and production technology, such as directional drilling techniques, 3-D seismic surveys, and reinjection techniques to improve recovery. It is incumbent on the state and industry to identify and “design out” potential environmental problems before development takes place. One key area is production techniques for viscous and heavy oil, which constitute a huge, largely untapped reserve, and for oil shale. The potential for increased Arctic Ocean exploration and drilling means the state must develop and implement better methods for offshore oil spill prevention and response, including research into skimmers and treatment technology.

Alaska can also facilitate natural gas research. High priorities include arctic engineering; cold-climate propane transportation and delivery; resource and reservoir identification studies focused on coal bed methane, natural gas hydrates, and conventional natural gas; gas-to-liquids engineering; and public policy issues. New technologies hold the potential to unlock vast reserves of coalbed methane and hydrates in particular.

**Minerals.** Alaska has deposits of gold, silver, lead and zinc mined at an industrial scale and potentially commercial quantities of more than a dozen strategic minerals. This includes abundant rare earth elements, which have been found in more than 70 different deposits across the state. Making informed mineral permitting decisions that minimize harmful effects on the environment is a priority of the state. Assessing public lands for mineral potential, constructing ore deposit models, developing new techniques for mineral deposit exploration, and conducting research into mine ventilation, remediation, tailings handling, systems engineering and technologies are also goals of the state. In addition, Alaska has the potential to further profit from its mineral resources through in-state
processing and use.

**Coal.** It is estimated Alaska contains half of total U.S. coal reserves, but little is currently economically recoverable; exceptions are the Usibelli Coal Mine and the proposed Chulitna Coal Project. Although most known deposits are not of the scale to merit development for export, many regions could be developed for local use. For example, natural gas generated from coal in Tertiary basins, as well as coal suitable for surface mining, have been identified in regions that rely primarily on imported diesel for heat and electricity. Clean coal, coal gasification, tight reservoir gas production and other emerging technologies could be developed for application in these regions. Further delineation of deposits, in combination with development of technologies for extraction and generation, are needed in these areas.

**Disruptive Innovation.** It is incumbent on the state to position itself to develop, serve as a proving ground for, and take advantage of disruptive technologies, which displace earlier technology and create entirely new markets. Advanced oil and gas exploration and recovery techniques, clean energy storage systems, carbon sequestration, and automated mining are all areas with high potential for disruptive developments in the near future.

**Strategies**
The Institute of Northern Engineering at UAF hosts Petroleum Development and Mineral Industry Research laboratories. Other key analytical labs at the UA are listed below. The state’s greatest recent contribution to improving resources research has been the funding of engineering buildings at UAA and UAF, concurrent with a highly successful push to increase UA engineering student numbers. The state contributed direct funds for UAF hydrocarbon research, focused on heavy and viscous oil, shale oil and gas, and enhanced oil recovery. State oil and gas exploration efforts combine detailed stratigraphic and structural outcrop studies, surface geologic mapping, and subsurface well and geophysical interpretation. Recent and current projects have focused on the North Slope foothills and Colville foreland basin, the Alaska Peninsula back-arc basin, and the Mesozoic to Cenozoic evolution of the Cook Inlet forearc basin and adjoining Susitna basin, with additional studies planned in Alaska’s Interior. Another recent project provides new geologic and environmental data on the potential for shale oil.

UA, in collaboration with the state, has adopted a strategy to develop rare earths, including mineral assessments, industry incentives, permitting changes, coordination with stakeholders, and an information campaign. The Alaska State Geological Survey is collaborating with the U.S. Geological Survey and UA on strategic and critical minerals evaluation, which seeks to identify the regions of highest potential for rare earths and other strategic and critical minerals in Alaska. The state funds the Geologic Materials Center facility to archive Alaska’s legacy collection of geologic samples and data.
Improving oil spill response through better mapping, communications, cooperation and investment is a key recommendation of Alaska’s Arctic policy. The Oil Spill Recovery Institute, a federally-funded research facility in Cordova, develops research into oil spill prevention and mitigation. UA is exploring partnerships with the federal Bureau of Safety and Environmental Enforcement, Alaska Department of Environmental Conservation, and other agencies and oil companies to study arctic oil spill response in laboratory conditions. The state also provides support for joint surveys of the marine life and habitats in the Bering and Chukchi seas in advance of potential offshore oil drilling.

Examples of UA Laboratory Facilities

- The **UAF Advanced Instrumentation Laboratory** specializes in surface and elemental analysis and electron microscopy, and also houses sample preparation facilities.
- The **Alaska Stable Isotope Facility** at UAF and the **Stable Isotope Laboratory** at UAA analyze a wide range of isotope samples.
- The **UAA Applied Science, Engineering and Technology Laboratory** serves researchers studying health, safety, welfare and climate change issues, including toxic substances and chemical environmental changes resulting from glacier and permafrost thaw.
- **Research Computing Systems** at the UAF Geophysical Institute provides advanced computing, storage, data sharing solutions and research information technology support to University of Alaska research communities, collaborators and supporters.
- The **Southeast Alaska Geospatial Environmental Analysis Lab** at UAS provides educational and analytical research capacity in the geospatial sciences, while the **UAS Spatial Ecosystem Analysis Lab** enables the analysis of inorganic and organic samples that are harbingers of socio-ecological and biophysical change.
- The Geophysical Institute’s **HyLab** at UAF is the only hyperspectral imaging facility in the state, which can not only benefit the local, Alaska and national economies, but also national defense by helping delineate Alaska’s deposits of critical minerals.
- The **High-frequency Active Auroral Research Program (HAARP)** at UAF is a research observatory dedicated to exploring Earth’s upper atmosphere and geospace environment.
Research Arena 3: Food, Energy, and Water Nexus

Introduction. Energy prices in parts of Alaska, especially rural Alaska, are astronomical; more cost-effective methods of energy production and distribution are crucial to ensuring the future of the state’s remote communities. In addition to conventional energy resources (see Arena 2), the state’s landscape holds significant potential for alternative energy. The challenge lies in making its use affordable, efficient, and dependable in extreme weather. Alaskan research into cold climate technology also aids in energy conservation.

Research Initiatives. Renewable Energy. Alaska contains abundant fossil fuel alternatives, including more than 50% of the nation’s wave energy resources and over 90% of its river current and tidal energy resources. Renewable energy possibilities for Alaska include the use of shrubs and trees or waste to power small biomass generators (see Arena 4), wind turbines, seasonal solar power; geothermal power generation (including low-temperature geothermal), and hydropower from dams and from river, wave and tidal generators. Alaska is increasingly viewed by the nation as an ideal test bed for remote power microgrids.

Many options for renewable generation in Alaska have been identified and mapped, but further identification of resources and optimal sites for power generation is needed. Even more important will be continued research into power transmission, in order to bridge the long distances between resources and communities. Improvements in energy storage are needed to increase the feasibility of renewables and to lower their cost. One innovation being studied in Alaska is the use of ammonia as an energy storage medium. Hydrogen and nanocellular carbon are other storage media of interest in Alaska.

Another major challenge for renewables lies in Alaska’s climate, which can devastate equipment built for milder weather. Alaskan scientists are continuing research into materials and their performance under arctic conditions, including wind power systems backed up by diesel generators. Research is also needed into the potential for using abundant clean energy resources as an incentive to attract energy-intensive industries to the state.

Economics. A significant dimension of alternative energy is its affordability and its acceptance by the public. State research into developing and implementing alternative energy must take into account the socioeconomic factors involved in developing and delivering renewable energy sources.

Cold Climate Housing and Technology. The other side to the Alaskan energy challenge is conservation. Reducing power and heating costs in rural Alaska is a high priority for the state. The state leader in home energy-efficiency research is the Cold Climate Housing Research Center
(CCHRC), now part of the Department of Energy National Renewable Energy Laboratories, which develops facility designs, materials, and construction techniques for the subarctic and Arctic.

The Water and Environmental Research Center (WERC) is part of the Institute of Northern Engineering and conducts basic and applied research related to water and environmental resources. Research disciplines at WERC include: environmental, civil, and arctic engineering; environmental science; oceanography; limnology; hydrology; microbiology; geochemistry; and hydraulics. WERC research aims to help improve the quality of life for arctic inhabitants while supporting careful and sustainable development of Alaska's bountiful natural resources, protecting fragile ecosystems, and seeking to better understand the role of the arctic and subarctic in the global system.

Alaska Center for Energy and Power (ACEP) based at the University of Alaska Fairbanks is dedicated to applied energy research and testing focused on lowering the cost of energy throughout Alaska and developing economic opportunities for the State, its residents, and its industries. ACEP provides leadership in developing energy systems for islanded, non-integrated electric grids and their associated oil-based heating systems. Integration is a central feature of the program. Because many of the issues related to implementing innovative energy solutions are complex, ACEP must not only address the technical integration of renewables with these small isolated diesel-based energy systems, but must also look at integration from a broader perspective. Key areas are integration of solutions into the social realities of a community, integration of the cultural fabric into sustainable energy solutions, integration of university researchers across disciplines and with community partners; and integration of our facilities and resources with those of our national partners.

The Center for One Health at UAF supports sustainable futures in Alaskan and Arctic communities facing rapid social, environmental, and economic change. Founded on community-based approaches and a holistic One Health framework, the Center for One Health supports mitigation, adaptation, and resilience strategies to maintain cultures, subsistence lifeways, self-determination, biodiversity, and ecosystem health, thus promoting community health and well-being. Social agriculture is an application of a One Health process. One aspect of One Health is social agriculture, which works across disciplines such as human medicine, veterinary medicine, agronomy, botany, soil science, sociology, ecology, nutrition, and economics. It simultaneously supports a holistic approach to community health through its impacts upon physical mental and behavioral health for individuals and societal, environmental, and economic health for communities.

**Strategies**

In 2010 the Alaska Energy Authority (AEA) - an organization charged with coordinating state energy priorities - produced Energy Pathway, a master document for use in planning and developing local and regional energy projects. The AEA is currently working with multiple partners to develop the
Alaska Affordable Energy Strategy, which will outline ways to deliver cost-effective energy to areas of the state without access to a proposed gas pipeline from the North Slope, should one be built. In recent years, various state funds have been used for widespread biomass, geothermal, wind, hydropower, waste heat recovery, and energy efficiency projects. In the private sector, more than 100 small businesses in Alaska are working on microgrid energy solutions. In total there are more than 200 microgrid energy projects in progress across the state, and the state and federal governments have invested nearly a billion dollars in microgrid technology in Alaska over the past decade.

The focal point of Alaskan energy S&T is the UA. The Alaska Center for Energy and Power (ACEP) was founded in 2008 to conduct energy research, and operates under an innovative private sector business model within the UA system. ACEP researches alternative energy sources as well as more efficient use of non-renewables. ACEP facilities include a power systems integration lab, a wind-diesel generator testbed, and a river generator test site. Current projects run the gamut of energy sources, from solar power in Galena and the Northwest Arctic, to geothermal exploration on the Seward Peninsula, to biomass, wave, wind and riverine energy studies.

- **$250 million in bonds** authorized in 2010 to fund energy efficiency improvements in public buildings
- **A Renewable Energy Grant Fund** established in 2008 which has funded more than 250 renewable energy products; in 2012, the fund was re-authorized for 10 years, and has funded approximately $25 million in projects in most years
- **An Emerging Energy Technology Fund** established in 2010, which distributed 20 grants totaling more than $15 million to develop and field-test renewable energy and conservation technologies

![Figure 4: Permits Pending](https://www.photos.ua.edu/Galleries/Alaska/8-BdJkXX/A)
Research Arena 4: Renewable Resources

Introduction. Alaska’s waters, including its fisheries, are among the most productive in the country, with fishing employing more people in Alaska than any other industry. Monitoring and managing the state’s waters and fisheries is crucial, as climate change and increased human use influence land-ocean connections, ocean circulation, and ecosystem dynamics, all of which impact biological productivity, fish stocks, marine mammals, and other subsistence marine species. Mariculture, timber, and agriculture are other areas where S&T can help increase renewable resource use.

Research Initiatives. Fisheries and Marine Life. The state of Alaska manages commercial, subsistence, and sport fisheries; all of which are important to Alaskans. Informed regulation of commercial fisheries is necessary to assure sustainable harvests, and the state collaborates with fishers, processors, and regulatory bodies to develop and improve science-based management of fish and shellfish stocks and other marine resources. There is great potential within the seafood industry for advances in product use and processing to increase the share of seafood processed locally and in-state. Beyond the seafood industry, there is also a great need to manage marine resources so that they can be sustainably harvested into the future.

A focal point of state research is the resilience of coastal and oceanic food webs and the fisheries they support to increasing changes in the environment. Understanding abundance and distribution dynamics of fish, shellfish, aquatic plants, and marine mammals would allow for more responsive resource management and support current subsistence needs and general fishing opportunity important for food security. Current research needs are the declines of western Alaska chum salmon, which have been linked to higher water temperatures, and of Chinook salmon populations, which have been declining statewide. This includes potential large-scale shifts in coastal ecosystem services due to glacial retreat. Ocean acidification is another major cause for concern in Alaska; habitat studies (see Arena 5) are key to charting the effects of acidification and climate change on fisheries and other marine resources. Fisheries priorities include species-specific assessment and modeling for salmon, sablefish, Pollock, halibut, forage fish, and other species. Challenges include in situ and temporal/spatial big data collection, data management and public accessibility, and habitat mapping. One key research area is the decline of Bering Sea Pollock fisheries, which have been linked to higher water temperatures, and of Chinook salmon populations, which have been declining statewide. New technology could have major applications in fisheries. Areas of interest include advances in processing, refrigeration, dehydration, genetics and acoustics, spatial information software, and value-added processes, as well as ways to minimize or mitigate bycatch and to use fish waste.

Another key area for research is the potential for increased mariculture and aquaculture, including the
production of oysters, mussels, clams, invertebrates, aquatic plants, salmon and sea urchin ranching. Governor Walker created the Mariculture Task Force in 2016 and Governor Dunleavy continued the task force with an executive order in 2018 to develop a comprehensive plan to boost the mariculture industry. This final report was presented in 2021 and led to the creation of the Alaska Mariculture Alliance. State legislators have passed several acts designed to foster development of the industry. Research helps pinpoint other methods to encourage growth of the aquatic farm industry, including maximizing growth rates, identifying innovations for efficiency, identifying/mapping natural limiting factors to production, (such as weather and water current exposure), and understanding genetic relationships among areas to ensure permitting of sustainable mariculture. Research will also be necessary with advancement of invertebrate culture and possible enhancement of invertebrate fisheries.

**Timber and Forestry.** Alaska’s timber industry is constrained by changing market conditions and by the small amount of commercial-quality old-growth hardwoods available for harvest. The state can contribute to the industry through innovations: for example, the Ketchikan Wood Technology Center, a government-industry collaboration, developed new strength values for Alaska softwoods, earning them recognition for their aesthetic and structural properties. Market research can also help in the development of value-added products. The state also works to facilitate wood energy, including the use of low-grade timber, wood waste and wood pellets for biomass projects. Field trials of alternative systems, including bailers, forwarders, and in-field chipping systems, could help reduce biomass harvest and transportation costs.

**Agriculture.** Alaska’s isolation and climate make it extremely “food-insecure” and it is estimated that less than five percent of food eaten in Alaska is produced in the state. Alaska’s short but highly productive growing season has strong potential for large-scale agriculture, but less than 1 million acres statewide are used for farming. There are also economic opportunities in certain high-value agricultural products for which Alaska’s high latitude is an advantage, such as reindeer antlers, peonies, and golden root. Research into bolstering local food production and improving food security is thus critical to the state as a whole, as is continued study of the nexus of food, energy and water.

**Strategies**

UA has made strides to becoming a world-class ocean-change research engine. The UAF Juneau CFOS Lena Point facility and National Oceanic and Atmospheric Administration (NOAA) lab were opened in 2008 to greatly improve and enable research in SE Alaska. UAF also established an Ocean Acidification Research Center in 2010, and in 2012, the state appropriated $2.7 million to expand oceanic sensor networks across Alaska to track acidification and its effects on fisheries. In 2015, the UAF College of Fisheries and Ocean Sciences (CFOS) took delivery of R/V *Sikuliaq*, a global-class
ice-capable research vessel that enables up to 26 scientists and students per cruise to conduct multidisciplinary ocean research. In 2018, the Northern Gulf of Alaska LTER was established to perform oceanographic observations to better understand climate change at established station locations in the Gulf of Alaska. With this large focus on Alaska’s oceans and coasts, Alaska NSF EPSCoR has had a history of examining climate change impacts on coastal waters. It is currently working on a new proposal, which will focus on large-scale climate-driven landscape shifts, including research into the impacts of deglaciation on coastal marine resources critical to Alaska communities.

UAS launched applied fisheries programs with an Alaska Aquaculture Semester focused on hands-on education in fish culture and aquatic plant farming and UAF recently established a degree program in Fisheries and Marine Policy.

The UA Fisheries, Seafood, and Maritime Initiative (FSMI) collaborates with industry to research sustainable fisheries and to develop a skilled workforce. Through the program, in 2014-15 eight UA campuses offered 115 maritime classes to 1,121 students across 23 communities. A state-UA-federal study is also mapping the ecosystem of the Bering and Chukchi seas.

The UAF/NOAA Alaska Sea Grant Marine Advisory Program conducts fisheries and aquaculture research, with current projects studying predation on salmon, shoreline erosion around Bristol Bay, whale watching in Juneau, environmental change in Cordova, salmon growth in response to climate change on Kodiak Island, state-federal pollock fisheries management policies, and many other subjects. ISER has been a center for research on the economic impact and future of fisheries and other natural resources, including allocation impacts. Alaska NSF EPSCoR is studying aspects of the effects of glacial melt on coastal and estuarine ecosystems and food webs in Southeast and Southcentral Alaska.

The UAF/NOAA Alaska Sea Grant has held multiple introductory workshops on aquatic farming, navigating the permitting process, and processing aquatic plants.

A multi-agency collaboration resulting in the NOAA Alaska Aquaculture Permitting Portal was launched in 2021 to help prospective and current aquatic farmers navigate the permitting process.

Through initiatives such as an Alaska Wood Energy Development Task Group, the state is supporting new timber and resource roads and working to coordinate timber sales with biomass power projects funded through the Renewable Energy Grant Fund (see Arena 3.)

UAF runs experimental farms in Fairbanks and Palmer, and the UA Cooperative Extension Service has taken the lead at the university level in researching and advocating local food production. A state organization, the Alaska Food Policy Council, is operating under a strategic plan for improving Alaska’s food systems, including expanding school-based programs to provide healthy, local foods; strengthening enforcement of a statute requiring state agencies and school districts to purchase Alaskan food products; advocating for emergency food plans; and supporting local food security
initiatives. The Council works in concert with the Alaska Food Resource Working Group, a panel tasked by state legislators with identifying methods to increase local food production.

Examples of Alaskan Aquatic Research

- **Alaska Sealife Center** (Seward)
- **UAF College of Fisheries and Ocean Sciences** (Fairbanks and Juneau)
- **Kachemak Bay National Estuarine Research Reserve** (Homer)
- **Kodiak Fisheries Research Center**
- **UAF/NOAA Alaska Sea Grant College Program** (Fairbanks)
- **Barrow Arctic Research Center**
- **Gulf of Alaska Ecosystem Monitoring Program** (Anchorage)
- **NOAA Alaska Fisheries Science Center** (Juneau)
- **Prince William Sound Science Center** (Cordova)
- **Alaska Department of Environmental Conservation** (Juneau)
- **Alaska Fisheries Development Foundation** (Anchorage)
- **Alaska Department of Fish and Game** (Juneau, Fairbanks, and Homer)
- **North Pacific Research Board** (Anchorage)
- **Sitka Sound Science Center** (Sitka)
- **Axiom Data Science** (Anchorage)
- **Center for Alaska Coastal Studies** (Homer)

Alaska is home to multiple ocean research efforts undertaken at the state, federal, industry and university levels.

*Figure 7. Chinook (king) salmon is measured at a test fishery on the Yukon River. Photo by Kauai Martin Peralez.*
Research Arena 5: Environmental Monitoring and Management

Introduction. Alaska’s 586,412 square miles encompass a wide array of terrestrial and marine ecosystems, which support diverse wildlife and abundant commercial, recreational, and subsistence resources. The Alaskan environment, to a large extent, defines the people of Alaska, and ensuring the health and sustainability of this environment is crucial to the state as a whole.

Research Initiatives. Fire and Earth Science. Wildfires are growing in importance as a research focus: mammoth fire years in 2004, 2005, 2015 and 2022 burned millions of acres, and evidence is mounting that temperature and precipitation changes are impacting fire frequency and severity and altering forest composition. Research is needed to improve community capacity to model and anticipate forest fires and to take preventative measures. Increasing earth science research in general enables more accurate predictions of changing environmental conditions that contribute to permafrost thaw, flooding, and coastal erosion. This will enhance monitoring and response strategies to emergency situations, as well as realistic analyses of their socioeconomic impacts.

Monitoring Environmental Change. High-quality climate observations over extended periods are the only way for researchers to tease out natural versus human-induced change, a necessary element of understanding and predicting climate patterns. The state seeks to facilitate this effort by coordinating an environmental land and ocean monitoring network consisting of linked in situ and remote sensing nodes with a common data portal, building on and coordinating existing monitoring by state and federal agencies, tribal governments and local communities. The system would track terrestrial conditions, as well as water quality, quantity and availability, glacier and ice extent, and ocean water quality and productivity. This improved information stream would enable enhanced environmental models and forecasts for use in adaptive resource management and refined decision-support tools.

Habitat and Wildlife. The state manages wildlife to support diverse populations and to enable hunting, fishing and viewing. Research into basic biology and ecology, habitat and population mapping, monitoring, and modeling is important to track wildlife information and to understand how climate change affects flora and fauna, with a focus on identifying a means to incorporate local and traditional knowledge into resource management. The state must also take a lead role in preventing and, when practicable, eradicating invasive species. Long-term monitoring, process studies, and models of wildlife, fish, and other harvested species and their habitats are a priority, as are research into marine ecosystem structure and processes, endangered and stressed species, contaminants, effects of water system changes on aquatic communities, and marine mammal management.

Mapping, Sensing and Unmanned Aerial Systems. Only a few areas of Alaska have been charted to the high resolutions of 1-5 meters needed for land use planning and many resource applications. An Alaska Geospatial Council brings together the UA, state agencies and numerous stakeholders to
improve Alaska’s mapping and Geographic Information Systems (GIS) capabilities. A major UA focus is remote sensing. Agencies like the Alaska Satellite Facility, the Geographic Information Network of Alaska (GINA), and the UAF Hyperspectral Imaging Laboratory are ideally located to acquire, process, archive and distribute remote sensing data. Many engineering challenges presented by remote sensing open the door for new Alaska industries in sensors and space-based engineering, including the development and launch of small CubeSAT-type satellites.

The Alaska Center for Unmanned Aircraft Systems Integration (ACUASI) at UAF originated as a program in 2001 at Poker Flat Research Range, and over the years, has expanded its scope, the equipment it operates, and the variety and complexity of research projects that are especially useful for operations in Alaska’s harsh conditions. ACUASI is an international leader in drone research and was designated by the Federal Aviation Administration (FAA) as one of six official drone test centers nationwide. Areas of research at UAF include advanced approaches to in situ environmental monitoring, resource assessment, autonomous underwater vehicles and small satellites.

**Strategies**

Alaska-wide collaborations such as the National Ecological Observatory Network, the Arctic Observing Network, the Alaska Ocean Observing System and the Alaska Corps of Social Observers provide large-scale environmental observation and monitoring. The Alaska Native Tribal Health Consortium’s Local Environmental Observation Program recruits citizen scientists to report unusual plants and wildlife, flooding, wildfires and more. The Utqiagvik-based interagency North Slope Science Initiative collects and disseminates Arctic ecosystem information, and the federal Alaska Climate Science Center and Landscape Conservation Cooperatives collaborate in climate efforts. The UAF Cooperative Extension Service has organized a statewide Invasive Species Working Group.

Alaska NSF EPSCoR maintains *in situ* sensor arrays in areas of Southeast and South Central Alaska, and has sponsored LiDAR surveys, aerial photography, and hyperspectral imagery across numerous areas of the state. EPSCoR data portals provide access to sensor and mapping data and facilitate model development. EPSCoR-funded improvements to UA cyberinfrastructure have improved statewide capacity to store and process data. Alaska’s state mapping and sensing goals are set by a multiagency Geospatial Council, operating under a strategic plan.

Fire research in Alaska is spearheaded by the Alaska Fire Science Consortium, an interagency group headquartered at UAF’s International Arctic Research Center. The mission of the consortium is to coordinate fire science delivery efforts and to facilitate communication between scientists and resource managers. The current NSF EPSCoR project is examining regime change in fire-prone Alaskan boreal forests, with a goal of improving Alaskans’ ability to predict fire behavior and proactively respond to it.
The UAF Geophysical Institute (GI) studies earth science phenomena, including space physics and aeronomy, atmospheric sciences, snow, ice, and permafrost, seismology, volcanology, and tectonics and sedimentation. The State Division of Geological and Geophysical Surveys partners with the GI, the U.S. Geological Survey (USGS) and NOAA in earthquake, tsunami and volcano research and monitoring, and works to maintain, expand and upgrade those networks. Alaska recently benefited from the federal EarthScope program, which operated 260 seismic sensors in a grid across the state. UAF has received funding to continue operation of many of these sites and incorporated enhanced NOAA weather monitoring systems at these sites, providing crucial seismic and environmental monitoring of all of Alaska. Space research is organized by the Alaska Space Grant Program and by Alaska NASA EPSCoR, which awards research grants in the areas of earth system science, technologies for space and extreme environments, and aeronautics.

Examples of UA Biology Research Units

- The UAF Institute of Arctic Biology advances basic and applied knowledge of high-latitude biological systems.
- The Alaska Cooperative Fish and Wildlife Research Unit at UAF is part of a nationwide cooperative university-state-federal program to promote research and training in the ecology and management of fish, wildlife and their habitats.
- The UAA Environment and Natural Resources Institute researches arctic tundra, boreal forest and coastal rainforest regions, including environmental contaminants, geochemical resources, and terrestrial-marine ecosystem linkages.
- The UAF-affiliated Arctic and Bonanza Creek Long-Term Ecological Research stations support research into the consequences of changing climate and disturbance regimes on tundra and boreal forest ecosystems, respectively.
- The UAF Agricultural and Forestry Experiment Station focuses on natural and manipulated ecosystems, sustainable soil productivity, food safety, plant genetics, enhanced livestock production, economic and legal aspects of resource use, silviculture and forest management.
- The Alaska Coastal Rainforest Center at UAS is a university-agency effort to research coastal temperate rainforests.
- The UAF Toolik Field Station provides housing, meals, laboratories and support services for arctic research and education to scientists and students from universities, institutions, and agencies from throughout the US and the world.
- The UAF Large Animal Research Station conducts research, education and outreach in high-latitude biology and provides facilities for and expertise in maintaining colonies of large animals.
- The UAF Institute for Marine Sciences conducts research in fisheries, oceanography and marine biology. The College of Fisheries and Ocean Sciences operates the Natural Science Foundation RV Sikuliaq.
Research Arena 6: One Health

Introduction. Alaska presents health care challenges, as well as opportunities for research and innovation. Environmental contaminants and infectious diseases are health issues, as are chronic ailments like heart disease, cancer, and diabetes, and preventable conditions like obesity and substance abuse. Other issues include behavioral and mental health problems (such as suicide, fetal alcohol syndrome, and violence) and the challenge of providing services to a dispersed population. Further, there are glaring health disparities between Alaska Natives and other Alaskans.

Research Initiatives. Basic, Translational, and Clinical Research. UA has growing expertise in biomedical and population health fields, including cell biology, neuroscience, physiology, immunology, genetics and computational bioinformatics.

Environmental Health. Disease, parasite and virus vectors are major issues in Alaska. Hepatitis and other STDs, tuberculosis, pneumonia, and Helicobacter pylori bacteria are public health concerns. Unusual epizootic diseases erupt in rural villages where people are exposed to feral animals. Severe and catastrophic weather events can render animals and people susceptible to opportunistic infections. Climate change causes new animal migration patterns and human-animal interactions that may increase the incidence of zoonotic diseases, such as West Nile virus. Bioterrorism threats present unique challenges in Alaska because of the distances and isolation. Melting and receding glaciers could unleash new types of pathogens.

Other important environmental, health-related topics in Alaska include the impact of contaminants on food safety and security; improved infrastructure for water supplies, sewage and waste disposal, air quality, maternal and child health, and occupational health and safety. Ecosystem and human health ties, including toxicology, zoonotic diseases and other infectious agents, and methods for monitoring food and water safety are also important.

Rural Health Delivery. Science and technology research provide significant contributions to rural health care include epidemiology in sparse populations and in harsh winter conditions, emergency treatment in the wilderness, seasonal syndromes and cold-induced injuries, health care and social services delivery to remote regions, and advances in telemedicine, including telepsychology.

Behavioral Health. Alaska has staggering rates of suicide, child abuse, alcoholism, substance abuse, sexual assault and violence. Yet, some communities in Alaska are virtually free of these problems. Alaska researchers must parse out what makes these communities resilient compared to their neighbors, and identify effective methods, blending cultural values and traditional Western concepts. Since many significant disparities among segments of Alaska’s population are in the areas of
behavioral health, the intersection of indigenous and Western beliefs and practices are important issues. The Alaska Native health community continues to make essential contributions to these issues, and the people themselves must partner with researchers in their efforts.

**Alaska Native Health.** Alaska Natives, who make up 15% of the state population, have a unique set of health needs. In addition to behavioral health challenges, Natives are subject to heightened levels of chronic disease due to rapid environmental, social, and economic change. Rural-urban migration, in particular, can have profound health ramifications. Alaska’s unique tribal health system, with its university and community partners, serves as a laboratory for testing innovative solutions to these health challenges, and is well-suited for collaborative, translational health research projects. UA also focuses on public health and social services, including studies of rural-urban health disparities.

**Veterans.** Alaska has a large veteran population, and must further research veterans’ needs, including physical and psychological therapies for traumas and stresses. This includes the development and refinement of prosthetic devices for veterans. These research goals may be best met through university partnerships with military agencies.

**Strategies**
Biomedical research in Alaska is spearheaded by the NIH INBRE program, which is administering a 5-year award focused on health and disease as impacted by interactions among the environment, animals and human behavior. Research topics include influenza and other viral infectious diseases, environmental contaminants, and molecular processes associated with cardiac and metabolic health. INBRE also works to reduce health challenges associated with tobacco, environmental changes, and infectious diseases. UAF’s NIH-funded Bioinformatics Core provides computational services to UA life science researchers.

Nursing enrollment at UAA has skyrocketed, and in 2011 UAA expanded the College of Health and dedicated a 66,000-foot health sciences building, the first phase of a new health complex. The expanded program builds capacity for further health initiatives in the state, such as a full medical school, a pharmacy school and a graduate program in biomedical research. The College of Health operates under a 2014-18 Strategic Plan, which includes research partnerships and infrastructure among its priorities. UAA has expanded partnerships to enable students to complete half of their physician’s training in Alaska through the UAA WWAMI School of Medical Education, and an entire Doctor of Pharmacy degree in Alaska through Idaho State University.

Major players in Native and rural health are the Alaska Center for Rural Health at UAA and the Center for Alaska Native Health Research (CANHR) at UAF. CANHR operates under a 5-year, $5.3 million NIH grant to conduct research into Native nutrition and obesity, genetics, environmental contaminants, behavioral issues, and other topics. The state Department of Environmental
Conservation sponsors the Alaska Water and Sewer Challenge, which organizes teams to brainstorm and build innovative rural sewage treatment systems. One promising line of UA research is studying Alaskan bog blueberries as the basis for human central nervous system therapy.

The UAA Justice Center engages in research on violence and substance abuse. The statewide Alaska Network on Domestic Violence and Sexual Assault evaluates and tests innovative practices, and suicide prevention efforts are stewarded by a state panel, the Alaska Suicide Prevention Council. A state virology lab constructed in 2009 at UAF greatly increased the state’s capacity to track viruses and disease vectors, while UAF is conducting a joint program in veterinary medicine with Colorado State University, which includes links between zoonotic disease and human health. A major initiative partners UAF with several North Pacific universities to study childhood obesity. A direct state appropriation in 2015 is funding a pilot community intervention program to reduce levels of fetal alcohol syndrome.

- The **Biomedical Interdisciplinary Group** in the Office of Research and Graduate Studies works to increase interdisciplinary biomedical research.

- The **Institute for Circumpolar Health Studies** researches health problems throughout the world’s northern regions, including current studies of inhalant abuse prevention, HIV interventions, and supportive housing for the homeless.

- The **Center for Behavioral Health Research and Services** is undertaking several studies, including examining aspects of fetal alcohol syndrome, diabetes, and sex offender treatment.

- The **Alaska Center for Rural Health** helps to strengthen systems to deliver comprehensive and culturally relevant health care to rural Alaskans.

- The **Center for Addressing Health Disparities through Research and Education** informs students and faculty about health disparities in Alaska and encourages students from underrepresented groups to pursue health careers.

- The **Center for Human Development** conducts research, education and service in the field of developmental disabilities.
Research Arena 7: Transport and Communications

Introduction. Alaska has less transport and communication infrastructure than any other state. The state has potential for pioneering approaches to land and sea transport, aviation, aerospace, and information technology. In addition, improved telecommunications through the Arctic would place Alaska at the crossroads of global telecommunications, data, and financial networks and position the state for economic growth and new technology industries.

Research Initiatives. Shipping. Alaska will be heavily involved in addressing safety, environmental and security concerns engendered by increased Arctic shipping. One research focus is feasibility studies of expanded shipping and related construction of ports and infrastructure. Other shipping S&T includes engineering studies to improve port design and operations and integration of marine transportation into intermodal systems. Researching global supply chain logistics to decrease the amount of perishables spoiled or damaged en route to communities is an increasing need for Alaskans.

Land Transport. Areas for development include intermodal operations, maintenance methods, construction techniques, engines and fuels for extreme weather, improvement of road traction in snow and ice, and engineering practices to reduce road maintenance and improve longevity.

Aviation. Alaska’s remote areas with minimal surface infrastructure, varied terrain, severe weather, mix of aircraft, low density of air traffic, contained airspace, and areas of minimal flight restrictions make the state ideal for development of both civilian and military aviation S&T. Research supports Alaska’s domestic aviation needs by providing safer and more efficient technology, and can also identify ways to better export goods and services to global customers. An increasing amount of research is also being conducted into the feasibility of using next-generation airships for cargo transport in Alaska. Alaska is also a center for UAS research (see Arena 5).

Aerospace. Aerospace S&T initiatives in Alaska include the launch of sounding rockets for auroral and atmospheric research, a low earth-orbit launch complex at Kodiak, and study of the physical and electrical properties of the ionosphere. Alaska’s sophisticated radars and other ground- and satellite-support instrumentation, the research capabilities of UAF’s Geophysical Institute, and the state’s geographic advantage for accessing polar satellites affords it considerable potential for expanded aerospace S&T research.

Telecommunications and Information Technology. One state telecommunications priority is increasing wide-bandwidth connectivity to support data and computer operations of NASA, the Department of Defense, NOAA, and the university, as well as other state and federal agencies. Improving the state’s ability to serve rural communities through remote delivery of healthcare,
education, and governmental services, as well as to enable universal personal internet use in rural areas to combat the “digital divide”, along with the establishment of integrated long-term monitoring networks across the state (see Arena 5) are increasing priorities. Each group that currently takes remote observations is on its own for communications, resulting in inefficiency, high costs, and considerable interference. Scalable wireless networks taking advantage of satellite connectivity and technologies offer opportunities for coordinated statewide monitoring.

Also key are upgrades to low-earth orbiting satellite services, such as Iridium, to enable realistic data service speeds in unpopulated areas. Incremental improvements to remote satellite communications would benefit multiple user groups, from fire crews to field researchers. The state must also improve techniques for laying fiber-optic cable in hostile Alaskan environments, such as river crossings and permafrost soil. Also important is improving microwave technology, so that the backbone network used in rural Alaska can provide needed high-speed service.

**Strategies**
A major facet of the Alaska Arctic Policy Commission’s 2015 report setting state Arctic priorities was promoting economic and resource development, including facilitating new port systems. The report also recommends improving marine infrastructure to strengthen Alaska’s capacity to respond to marine accidents and emergencies. In 2015, UAA opened the Department of Homeland Security-funded Arctic Domain Awareness Center, which works with 16 partners to conduct research in maritime domain awareness, situational awareness and response support, technology research, and integrated education. Alaska has funded Arctic vessel tracking system upgrades, digital mapping, and an Arctic deep-water port study.

The Alaska University Transportation Center at UAF hosts about $7 million in funded research annually. Anchorage-based Peak Civil Technologies is pioneering a new soil stabilizer that could vastly improve foundations for transport infrastructure, and the CCHRC recently studied geopolymer concrete. The UA was central to developing the revolutionary NextGen air traffic control system and is one of four founding FAA Centers of Excellence for General Aviation. NASA recently held a series of workshops in Alaska on the potential for airship testing and use.

The Alaska Aerospace Corporation operates the Pacific Spaceport Complex, a state-of-the-industry launch site on Kodiak Island, that provides access to planetary orbital space for commercial and government interests. The state-owned corporation is in the process of potentially converting to a public-private partnership. In 2014, the corporation started negotiating a $21 million incentive plan with Lockheed Martin to use the facility for Lockheed’s Athena II S-6 medium-sized rocket. Sounding rocket and UAS testing takes place at UAF’s Poker Flat Research Range. UAF recently took possession of the High-Frequency Active Auroral Research Program (HAARP), a former Air Force operation used to study the ionosphere.
A major recent expansion of broadband has come via Terra, a federally-supported project by General Communications Inc. that has linked up more than 49,000 residents in 72 rural communities in western Alaska and plans to expand farther into the state’s west and north. The Arctic Fibre company is also planning a subsea cable network connecting Asia to Europe that would link to Alaska’s north and west coasts, bringing broadband to more than 26,500 rural Alaskans. The Arctic Slope Regional Corporation is heavily invested in the effort. The Tlingit and Haida Central Council are working to implement a broadband strategic plan for rural Southeast Alaska.
Education

Introduction. The most significant way for the state of Alaska to contribute to S&T innovation is through ensuring quality K-12 and university educations, especially in science, technology, engineering and math (STEM) fields. The contributions that engineers, scientists, and other STEM workers make to the state are multifaceted, as they solve problems and bolster the economy.

Research Initiatives. K-12 Education. Alaska’s biggest educational challenge is K-12 teacher retention, especially in rural areas. At issue is not just retention in general, but the need for teachers with expertise in given areas, such as math, science and special education. A closely related issue is professional certification for teacher aides, and methods to transition these aides, who are often the most stable element in their schools, into teaching.

Distance Delivery. Distance delivery of education is essential in Alaska, both because of its size and dispersed population, and because of the need for students to accommodate other endeavors, such as subsistence activities and jobs, while learning. Challenges for distance delivery include communications systems, teaching methods, faculty proficiency, integration of distance and traditional programs, and cultural relevance and acceptability.

STEM. Guiding students into STEM careers begins at the K-12 level. Many different state, university and private programs work to increase STEM awareness in Alaska through a variety of methods, including incorporating STEM research into instruction and increasing STEM identity among students. (See boxes, below.)

University of Alaska. About 75 percent of STEM workers need a bachelor’s or graduate degree for their positions, compared to only 20 percent of non-STEM workers. The UA, with more than 31,000 students statewide, is crucially important to the state as a STEM teaching institution. The UA in recent years has concentrated on training Alaskans for high-demand jobs in engineering, health, biomedicine, teaching and workforce development, which strongly correlate to STEM fields. The university has recently focused resources on engineering and health disciplines, with strong results: the number of engineering degrees awarded increased 25 percent from 2009-13, and health degrees 20 percent in the same period. UA awards about 50 doctorates per year, of which more than half are in STEM disciplines. Students themselves are also key conductors of research at the UA. One goal for the state is to improve the enrollment and retention of disadvantaged (i.e. minority, low-income or first-generation) students in STEM majors.

Another state goal is to gauge the success of specific programs at the UA, such as the Alaska Native Science and Engineering Program, the Alaska Summer Research Academy, the Rural Alaska Honors Institute, the Della Keats Health Sciences Summer Program, the Alaska Upward Bound Program,
and the federally-supported TRIO programs, and work to optimize their impact on STEM students and others.

Examples of Alaska STEM education efforts

- The **Juneau Economic Development Council** conducts STEM programs in fields like robotics, underwater remotely operated vehicles, and environmental science.

- The **Alaska Native Science and Engineering Program** (ANSEP) at UAA (with UAF and UAS units as well) supports Alaska Native students from sixth grade through grad school, including academies, academic support, professional development, and financial aid for college students.

- **GeoFORCE Alaska** is a UAF program to excite high-school students about Earth science through a series of events which culminate in annual weeklong field trips to sites across the country.

- **Alaska GLOBE**, based at UAF, instructs K-12 teachers on how to run classroom-based research projects into the environment and climate to teach students about science.

- The **Modern Blanket Toss** is an effort by Alaska EPSCoR and the Alaska Upward Bound program to excite rural high school students about STEM fields through experiments with UAS.

**Strategies**

Recent innovations by the state include Alaska Performance Scholarships for high-performing students to attend in-state college or training, and rigorous new K-12 academic standards. The Alaska Commission on Postsecondary Education spearheads an Alaska Postsecondary Access and Completion Network, which aims to increase the percentage of Alaska’s adult population with a postsecondary credential and/or degrees from 47% to 65% by 2025 through synergy among service providers, professional development, public outreach, and research.
Improving teacher retention is the main goal of the Alaska Statewide Mentor Project, which mentors instructors and administrators in 70 percent of Alaska’s public schools. The UA has adopted several programs to improve teacher training, including a new UAF bachelor’s degree in Secondary Education that qualifies students for teaching jobs without post-degree training, a UAF graduate certificate in science teaching and outreach, and a UAS master’s program in science education. UAS also offers two new teacher endorsement programs via distance delivery.

Alaska’s Learning Network offers a number of remote core courses across the state’s school districts. A state-funded Alaska Digital Teaching Initiative pilot program is improving student access to distance education in four school districts. UAF’s eLearning and Distance Education Office offers 129 distance programs.

The state has invested heavily in UA science infrastructure recently, including engineering buildings at UAA and UAF, health and integrated sciences buildings at UAA, the Murie Life Sciences Facility at UAF, and a NOAA-UAF fisheries facility in Juneau. The state has also provided targeted funding for UA students in critical S&T areas; health; oil, gas and mining; engineering; education; and fishing, seafood processing and maritime fields. The Consolidated Alaska Mining Initiative is collaborating with industry to build a state-of-the-art Juneau mine training center.

UA also improves infrastructure through collaborating with federal programs: the current Alaska NSF EPSCoR award includes STEM education programs and funding for five new faculty hires, and EPSCoR’s 2023-2028 proposal includes four more hires. The proposed program also includes research into art-science integration, place-based inquiry, and intentional practices in broadening participation, proven ways to promote interest in STEM among diverse learners as well as the general public. In addition, every year, NSF EPSCoR funds multiple postdocs and graduate and undergraduate students. The NIH Biomedical Learning and Student Training (BLaST) program offers funding opportunities and programs for undergraduate and graduate UA students in biomedical fields, with a focus on rural Alaskans. Both of these programs emphasize research by students, which is an important element of the UA research enterprise.

UA recently concluded a public input process called “Shaping Alaska’s Future 2017,” which centered on improving student achievement and attainment, fostering research and development for economic growth, providing accountability to the state, and partnering with schools, agencies and industries. Recommendations from that process have been used to shape university management policies, budget requests, and other university governance.
• NASA’s **Challenger Learning Center of Alaska** provides space science-oriented camps, custom programs and workshops to K-8 students.

• The UAF-based **Alaska Summer Research Academy** offers 2-week STEM learning academies for middle- and high-school students and a year-round Saturday program.

• Alaska NSF EPSCoR and GINA have built three interactive **augmented-reality sandboxes** which are used to teach students across the state about topography, hydrology, and related topics.

• UAF’s **“Girls on Ice”** program engages diverse groups of high-school-aged girls in field science and STEM activities through extended field trips to glaciers. Alaska NSF EPSCoR has expanded the program to also incorporate trips to Kachemak Bay and Interior Alaskan forests. EPSCoR 2023-2028 also includes excursions in Kenai Fjords National Park.
Building an Entrepreneurial Culture in Alaska

Improving Alaska’s S&T landscape requires cooperation between leaders in government, academia, research groups, business, and organizations. Perhaps the most important way state and local agencies can foster increased S&T development is to provide entrepreneurs with the support they need to cross the “valley of death,” the challenging step between developing a product and actually producing and marketing it. This support can take the form of instruction and business connections, or the more direct form of venture capital. Several programs already exist in Alaska that provide financial support and other services to inventors hoping to establish a market for their innovations.

At UAA, the Business Enterprise Institute links economic development programs across the UA system. These include the Alaska Technology Research and Development Center (TREND), which provides workshops, one-on-one counseling, and grant assistance to small businesses attempting to garner federal Small Business Innovation Research and Small Business Technology Transfer grants, which can be used to bring technology to market. The UAA Office of Research and Graduate Studies has formed a commercialization infrastructure that includes the Seawolf Venture Fund, LP, a for-profit private equity fund which provides early-stage funding for start-up companies based on research from UAA and the community. UAA also established Seawolf Holdings to oversee the fund and to provide a corporate interface between the university and its enterprise companies. This investment infrastructure created its first start-up in 2013, specializing in battery-free long-lifespan remote sensors, and other UAA-patented technologies have ranged from educational software to biomedical devices.

The UAF Office of Intellectual Property and Commercialization works with UAF faculty, staff and student inventors to guide them through the process of intellectual property licensing and protection. It also works with industry partners interested in sponsoring research, licensing technology, or forming startups around UAF innovations. A partner organization, the Nanook Innovation Corporation, is responsible for licensing UAF intellectual property, and owns a majority share of Nanook Tech Ventures, Inc., a for-profit corporation that works with UAF faculty, staff, and students to create startup companies and viable businesses based on their research. The first two spinoff startups built software for UAS, and tools to manage airborne particulate risk from volcanic eruptions and other events. More recently, startup companies have focused on treating contaminated wastewater and molecule drug development.

Drawing from UAF’s best academic and applied research, the Alaska Center for Innovation, Commercialization, and Entrepreneurs (Center ICE) is the University’s Innovation Hub. Center ICE seeks to foster an innovative academic environment and to provide early stage entrepreneurs with funding and training opportunities to be more resilient in moving technologies from lab to market.
Center ICE runs an Innovation Accelerator to support the development of academic research to launch it as a real world solution, and help it scale up. Center ICE offers the Students2Startups experiential learning internship program to place the next generation of leaders at the center of innovation now as well as training programs for customer discovery and early-stage ideation, as well as to support small business growth to engage in research and development funding for technologies that have commercial potential.

The Municipality of Anchorage’s 49th State Angel Fund was started in 2012 with $13.2 million from the U.S. Treasury’s State Small Business Credit Initiative. This was split into four partner funds which began awarding grants to startups in 2014, with a goal of providing capital to Anchorage entrepreneurs to spur economic development.

The Alaska Marketplace is an annual competition sponsored by the Alaska Federation of Natives to identify innovations with the potential to create jobs and to stimulate state and local economies. Winners receive substantial grant funding, as well as entrepreneurial training to refine their concepts. The UAF School of Management hosts an annual Arctic Innovation Competition with similar aims.

Also worth noting is the Alaska Higher Education Income Tax Credit, which encourages private industry to support university research and education by tying donations to tax credits. A similar credit exists for K-12 education as well.
## Appendix: Acronyms

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<th>Acronym</th>
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<td>AAPC</td>
<td>Alaska Arctic Policy Commission</td>
</tr>
<tr>
<td>ACEP</td>
<td>Alaska Center for Energy and Power</td>
</tr>
<tr>
<td>ACUASI</td>
<td>Alaska Center for Unmanned Aircraft Systems Integration</td>
</tr>
<tr>
<td>AEA</td>
<td>Alaska Energy Authority</td>
</tr>
<tr>
<td>ANSEP</td>
<td>Alaska Native Science and Engineering Program</td>
</tr>
<tr>
<td>ASET</td>
<td>Applied Science, Engineering and Technology</td>
</tr>
<tr>
<td>BLaST</td>
<td>Biomedical Learning and Student Training</td>
</tr>
<tr>
<td>CANHR</td>
<td>Center for Alaska Native Health Research</td>
</tr>
<tr>
<td>CCHRC</td>
<td>Cold Climate Housing Research Center</td>
</tr>
<tr>
<td>EPSCoR</td>
<td>Experimental Program to Stimulate Competitive Research</td>
</tr>
<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td>FSMI</td>
<td>Fisheries, Seafood and Maritime Initiative</td>
</tr>
<tr>
<td>GI</td>
<td>Geophysical Institute</td>
</tr>
<tr>
<td>GINA</td>
<td>Geographic Information Network of Alaska</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information Systems</td>
</tr>
<tr>
<td>GLOBE</td>
<td>Global Learning and Observations to Benefit the Environment</td>
</tr>
<tr>
<td>HAARP</td>
<td>High Frequency Active Auroral Research Program</td>
</tr>
<tr>
<td>ISER</td>
<td>Institute for Social and Economic Research</td>
</tr>
<tr>
<td>K-12</td>
<td>Kindergarten through 12th Grade</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NIH INBRE</td>
<td>National Institutes of Health IDEa Network of Biomedical Research Excellence</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NPRB</td>
<td>North Pacific Research Board</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation</td>
</tr>
<tr>
<td>RAP</td>
<td>Resilience and Adaptation Program</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>R/V</td>
<td>Research Vessel</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>Science and Technology</td>
</tr>
<tr>
<td>SCoR</td>
<td>Alaska State Committee for Research</td>
</tr>
<tr>
<td>SFOS</td>
<td>School of Fisheries and Ocean Sciences</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Math</td>
</tr>
<tr>
<td>TREND</td>
<td>Technology Research and Development Center</td>
</tr>
<tr>
<td>UA</td>
<td>University of Alaska</td>
</tr>
<tr>
<td>UAA</td>
<td>University of Alaska Anchorage</td>
</tr>
<tr>
<td>UAF</td>
<td>University of Alaska Fairbanks</td>
</tr>
<tr>
<td>UAS</td>
<td>University of Alaska Southeast</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>WWAMI</td>
<td>Washington, Wyoming, Alaska, Montana and Idaho</td>
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</tbody>
</table>