To Build a Fire

The Alaska Science and Technology Plan

The Alaska State Committee on Research

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Table of Contents

Contents

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 population 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 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, and the private sector. The state's role is 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.

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 on Research (SCoR) and other bodies.

Alaska's unique characteristics lend themselves to seven specific S&T research arenas, as detailed in this report. 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*. The capacity of communities to adapt to change; arts and culture; and preservation and revitalization of Alaska Native culture and knowledge.
2. *Resource Extraction*. Technology and processes for safe and efficient extraction, transportation and use of oil, gas, coal and minerals, including rare earths.
3. *Energy Solutions*. Alternative energy sources for northern communities, and cold climate housing and technology.
4. *Renewable Resources*. Innovations and strategies to effectively harness the state's renewables, including fisheries, aquaculture, timber, and agriculture.
5. *Environmental Monitoring and Management*. Monitoring and mitigation of environmental change, mapping and remote sensing, unmanned aerial vehicles, and geophysical research.
6. *Human Health*. 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.

An additional section of this report addresses K-12 and university *Education*, with a focus on science, technology, engineering and math (STEM) instruction. It concludes with a discussion of the ways state entities can assist private industry, and a list of *Policy Proposals* for state leaders.

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 $159 million worth of sponsored research in 2011-12, including $128 million at the Fairbanks campus, $16 million in Anchorage, and about $1 million in Juneau. This research activity generates over 2,000 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 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 wilderness and coastline, Arctic location, and its 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.

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.

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: in 2010, only 19% of Alaskan R&D came from industry, versus a national average of 72%. 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 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 that identifies opportunities and improves feasibility. (This topic is discussed in more detail on page 21.)
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. The state can then suggest priorities, encourage partnerships, provide incentives, and improve 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. And the "bellows" represents coordination and long-term planning by the State Committee on 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. While about two-thirds of Alaska's 731,000 residents live in or near the principal cities of Anchorage, Fairbanks and Juneau, 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. **Adaptive Capacity**. A primary focus of Alaskan research is the study of *adaptive capacity*: the ability of communities to effectively respond to environmental and social changes. Alaska NSF EPSCoR (Experimental Program to Stimulate Competitive Research) is implementing a National Science Foundation award to create and refine an adaptive capacity index, which pinpoints the specific elements of communities that enable them to weather change. One goal of the project is to refine principles of community-based participatory research (CBPR) across a range of communities, enabling researchers to better interact with local residents in a mutually beneficial manner. The ultimate goal of the Alaska NSF EPSCoR project is a permanent center to study adaptation in northern social-ecological systems.

Another initiative for adaptation research is the Resilience and Adaptation Program (RAP), an interdisciplinary graduate-level sustainability science program at UAF. RAP students engage in coursework, internships and other training in resilience and vulnerability to prepare them for leadership positions in academia, government, organizations, and education. At UAA, the Resilience and Adaptive Management (RAM) Group studies linked changes in Alaskan environmental and social systems and local sustainability issues. UAF is also home of the Center for Global Change and Arctic System Research, a network for interdisciplinary research and education.

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, and other aspects of social, economic and cultural change. The UA Justice Center also conducts basic and applied research into pressing issues of crime, justice and law that impact community resilience.

Arts 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 and the arts in general are also important facets of resilience and identity, and also contribute to the economy through tourism.

Strategies. The State Committee on Research was actively involved in crafting the Alaska NSF EPSCoR proposal, and provides oversight and coordination to the program's various elements. The state also provides an award match. Alaska NSF EPSCoR is eligible for other NSF funding, and with SCoR oversight regularly submits funding proposals for other activities that address community

sustainability. A significant portion of the NSF EPSCoR award goes toward infrastructure, faculty hires, and education and workforce development, including support for the RAP and RAM programs. Substantial direct state funding was also appropriated in 2012 to support RAP, which had been funded by an expiring NSF IGERT grant. This funding has been picked up by the state as an annual expenditure.

The state increased its role in language preservation and revitalization in 2012 by establishing the Alaska Native Language Preservation and Advisory Council, which will advise the governor and legislators on language projects and policy. The council's first report is due in 2014. Another ongoing contribution to historic preservation is a new $127 million facility to house the state museum, library and archives, which is slated to be completed in 2016. This follows a major expansion of the UA Museum of the North in Fairbanks.

The Alaska State Council on the Arts is the state's primary organization providing 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 is operating under a 2012-16 strategic plan, which 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.

Research Arena 2: Resource Extraction

Introduction. Oil has been the linchpin of Alaska's economy for four decades, but Alaskan production is down by over two-thirds from its 1988 peak. It is estimated that more than 5 billion barrels of accessible oil remain in Alaska's North Slope and billions more are present in Cook Inlet and beneath the Chukchi and Beaufort seas. The North Slope also contains significant heavy oil reserves and shale oil deposits. The state contains an estimated 35 trillion (and potentially upwards of 240 trillion) cubic feet of proven recoverable natural gas, which is largely stranded far from major markets. Alaska is also home to vast coal and mineral deposits, which have as yet seen minimal development.

Research Initiatives. Oil and Gas. One state research goal is to use technology and improved data to refine oil permitting to be more efficient and scientifically sound. This includes improving understanding of the impacts of development on wildlife and of climate change on infrastructure, vegetation and wildlife. Alaska also facilitates oil development by gathering geologic and engineering information for potential oil and gas basins. ISER can offer insights into economies of oil production, including appropriate levels of public versus private investment.

The state also seeks to collaborate with oil and gas multinationals to help 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 heavy oil - which constitutes a huge (an estimated 20 billion barrels), largely untapped reserve - and for oil shale. 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 earths, which have been found in more than 70 different deposits across the state. A major goal of the state is to make informed mineral permitting decisions that minimize harmful effects on the environment. Other goals are to assess public lands for mineral potential, to construct ore deposit models, to develop new techniques to explore for ore through environmental samples, and to conduct research into mine ventilation, remediation, tailings handling, systems engineering and technologies with special emphasis on cold climates. 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 Chuitna 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 which 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, is needed in these areas.

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

Strategies. The Institute of Northern Engineering at UAF hosts a Petroleum Development Lab and a Mineral Industry Research Lab. The state's greatest recent contribution to improving resources research is the partial funding of a pair of $100-million-plus engineering buildings at UAA and UAF, concurrent with a highly successful push to increase UA engineering student numbers.

In 2012 and 2013 the state funded a number of resource initiatives. One project provides ongoing geologic assessments in unexplored oil and gas basins. Another provides new geologic and environmental data on the potential for shale oil, and a third supplies geologic data for deposits of strategic minerals, such as rare earths. In 2012 Alaska adopted a comprehensive five-part plan to develop rare earths, including mineral assessments, industry incentives, permitting changes, coordination with stakeholders, and an information campaign. The state is also funding a new state Geologic Materials Center facility to archive Alaska's legacy collection of geologic samples and data.

The UA is preparing a proposal for a science and technology center to conduct research into Arctic oil spill prevention and preparedness and numerous other oil spill-related topics. This would supplement work being done by the Oil Spill Recovery Institute, a federally-funded research facility in Cordova. The state has also provided support for state-federal-UA surveys of the marine life and habitats in the Bering and Chukchi seas in advance of potential offshore oil drilling.

Research Arena 3: Energy Solutions

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 rural Alaska. 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 energy 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.

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 energy 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 a carrot to attract energy-intensive industries to the state. On a much larger scale, Alaska continues to study the feasibility and cost of a hydroelectric dam on the Susitna River, which could supply almost half of the power needs of the Fairbanks-Anchorage rail belt.

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. The state leader in energy-efficiency research is the Cold Climate Housing Research Center (CCHRC), a university-industry partnership which develops facility designs, materials, and construction techniques for the subarctic and Arctic. One aspect of housing technology being explored in Alaska is the use of nanofluids to enhance convective heat transfer and thus improve home heating.

Strategies. Lawmakers have set goals of reducing Alaskan per capita electricity use by 15%, retrofitting 25% of public buildings for efficiency by 2020, and producing half of the state's energy from renewables by 2025. In 2010 the Alaska Energy Authority - a state organization charged with coordinating state energy priorities - produced Energy Pathway, a master document for use in planning and developing local and regional energy projects. In recent years, various state funds have been used for biomass, geothermal, wind, hydropower, waste heat recovery and energy efficiency projects. Additionally, the state Department of Labor has established the Alaska State Energy Sector Partnership, which funds job skills training aimed at renewables, specifically focused on remote communities where energy projects will be located.

The focal point of Alaskan energy S&T is the UA. CCHRC was founded in 2006 and has completed dozens of research projects to improve energy efficiency and to incorporate alternative energy into home designs. CCHRC has worked closely with other agencies like the Alaska Housing Finance Corporation (AHFC), including jointly producing a 2008 review of state energy efficiency policies and programs which led to a number of new initiatives and which was updated in 2012. The CCHRC has also created a student-occupied "sustainable village" of experimental housing at UAF that is slated for expansion. CCHRC researchers recently partnered with AHFC to study the potential of geopolymer cements, durable building materials made in part from waste coal ash.

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 nonrenewables. ACEP facilities include a power systems integration lab, a wind-diesel generator testbed, and a river generator test site. ACEP recently concluded a $3 million Department of Energy (DOE) EPSCoR grant to develop and test wind-diesel technology in remote villages, and is using remote sensing techniques to assess a large geothermal resource on the Seward Peninsula which could be used to power the town of Nome. In 2013 the state invested $2.5 million to continue ACEP work. ISER regularly analyzes energy issues, including contributing socioeconomic research to ACEP.

Research Arena 4: Renewable Resources

Introduction. Alaska's fisheries are among the most productive in the country, and fishing employs more people in Alaskan than any other industry. Monitoring and managing the state's waters and fisheries is crucial, as climate change and increased human use influence ocean circulation and ecosystem dynamics, impacting biological productivity, marine mammals and fish stocks. Timber and agriculture are other areas where S&T can help increase renewable resource use.

Research Initiatives. **Fisheries and Marine Life.** Alaska contains commercial, subsistence, and sport fisheries. Precise regulation of commercial fisheries is necessary to assure sustainable harvests, and it is imperative that the state collaborate with industry to develop better science-based management of fish and shellfish stocks. There is great potential within the seafood industry for product use and processing to increase the share of seafood processed locally and in-state.

Research priorities include species-specific assessment and modeling for salmon, sablefish, pollock, halibut and other species. Challenges include in situ data collection, data management, spatial data collection 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. 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 marine mammals.

New technology could have major application 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 and kelp, and salmon ranching. The state Legislature has passed several acts designed to help the industry, and research could help pinpoint other ways to encourage growth. This includes ways to reduce shellfish maturation times and up-front investments, improved sources of oyster seed, ways to decrease otter predation of mussels, and methods for commercializing abalone and other underutilized species.

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 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. Alaska's isolation and climate make it extremely "food-insecure:" it is estimated that less than five percent of food eaten in Alaska is produced in the state. Research into bolstering local food production and improving food security is thus critical to the state as a whole.

Strategies. In 2014, the UA School of Fisheries and Ocean Sciences (SFOS) takes delivery of the R/V Sikuliaq, a global-class ice-capable research vessel that will enable up to 26 scientists and students per cruise to conduct multi-disciplinary ocean research. A new Juneau NOAA lab and SFOS facility were recently completed. The UA established an Ocean Acidification Research Center in 2010, and in 2012, the state appropriated $2.7 million to expand oceanic sensor networks in order to track acidification and its effects on fisheries.

A new UA Fisheries Seafood Maritime Initiative (FSMI) collaborates with industry to research sustainable fisheries and to develop a skilled workforce. In 2013 the state committed $7.5 million to an FSMI project to research statewide declines in Chinook salmon, and also supported salmon research in the Susitna River drainage. The statewide project includes adult, juvenile and harvest assessments, as well as genetics, biometrics and local and traditional knowledge. 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 whale-fisheries interactions, effects of climate change and melting glaciers on fisheries, 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.

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. In the town of Tok, a state program is enabling the use of conventional feller-bunchers to harvest small-diameter black spruce trees for the school district's boiler.

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, has crafted a 2012-15 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. In 2013 state legislators recommended establishing a separate working group specifically tasked with increasing local food production.

Research Arena 5: Environmental Monitoring and Management

Introduction. Alaska's 586,412 square miles encompass a wide array of terrestrial and marine ecosystems, which house a rich diversity of wildlife and provide 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. **Monitoring Environmental Change.** High-quality climate observations over extended periods are the only way for researchers to tease out impacts of natural versus human-induced change, a necessary element of understanding and predicting climate patterns. The state's 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. The system will 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, such as those being developed by Alaska NSF EPSCoR (see Arena 1).

Habitat and Wildlife. The state manages wildlife to support diverse populations and to enable hunting, fishing and wildlife viewing. Research into basic biology and ecology, population monitoring, and modeling is important to track wildlife information and to understand the ways climate change affects fauna. Another goal is to identify appropriate means to incorporate local and traditional knowledge into fish and wildlife management. The state must also take a lead role in preventing and, when practicable, eradicating invasive species. Long-term monitoring, process studies, and numerical models of fish 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 UAV's. Alaska is the least mapped state: only a few areas have been charted to the high resolutions of 1-5 meters needed for land use planning and many resource applications. A new Statewide Digital Mapping Initiative brings together the UA, state agencies and numerous stakeholders in an effort to acquire new and better maps for the state. A major focus of UA research is in remote sensing; agencies like the Alaska Satellite Facility are ideally located to process, archive and distribute agency sensing data, and many of the engineering challenges presented by remote sensing open the door for new Alaska industries in sensor development and space-based engineering.

One key innovation under continued development at the UA is unmanned aerial vehicles (UAVs), including helicopters, planes and gliders, which are especially useful for observations in Alaska's harsh conditions. UAF is an international leader in UAV research, and has adopted unmanned aircraft for a number of uses, from fire observations to tracking sea ice to search-and-rescues. UAV's and sensing are areas where Alaska must track and incorporate disruptive innovations, including advanced approaches to in situ environmental monitoring, resource assessment, autonomous underwater vehicles and small satellites.

Earth Science. Studies of the atmosphere, hydrosphere, oceans, biosphere and earth are critical in Alaska, which is exposed to earthquakes, volcanoes, fires, storm surges, tsunamis, floods and solar storms. Increased earth science research can grow knowledge about these phenomena and enable more accurate predictions of changing environmental conditions such as permafrost thaw, flooding, wildfires, and coastal erosion, which will enhance monitoring and response to emergency situations. One area of focus is improving projections of ice cover and its direct effects on evaporation and albedo, which will lead to improved projections of storm events.

Strategies. The state can collaborate on environmental sensing with existing initiatives like the National Ecological Observatory Network, the Arctic Observing Network, and the Alaska Ocean Observing System. The Barrow-based interagency North Slope Science Initiative (NSSI) 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 to tackle invasives.

Alaska NSF EPSCoR has installed or reactivated several integrated sensors and sponsored new LiDAR and aerial photography. EPSCoR data portals implemented by the Geographic Information Network of Alaska (GINA) provide access to sensor and mapping information and facilitate model development. EPSCoR-funded improvements at the Arctic Region Supercomputing Center (ARSC) at UAF have improved its capacity to store and process data. UA organizations engaged in scenario development include the Scenarios Network for Alaska and Arctic Planning (SNAP) and the RAM Group. A substantial 2012 state and federal appropriation enabled the Statewide Digital Mapping Initiative to develop a statewide digital elevation model.

The UAF Geophysical Institute (GI) is Alaska's center for the study of 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 USGS and NOAA in earthquake, tsunami and volcano research and monitoring, and works to maintain, expand and upgrade those networks.

Space research is organized and sponsored by the Alaska Space Grant Program and by Alaska NASA EPSCoR. UAF recently created the Alaska Center for Unmanned Aircraft Systems Integration (ACUASI) to coordinate and oversee UAV efforts. A recent $5 million state grant supports joint development of UAVs by UAF's Poker Flat Research Range and the U.S. Air Force. In 2013 state legislators established a task force to craft a state policy on UAV use.

Research Arena 6: Human 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 maladies like heart disease, cancer, and diabetes, and preventable conditions like obesity and substance abuse. Other health 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. Also important are ecosystem and human health ties including toxicology, zoonotic diseases and other infectious agents, and methods for monitoring food and water safety.

Rural Health Delivery. Places where S&T research can make 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 and social care 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 17% 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 for Natives. 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 on rural-urban health disparities.

Veterans. Alaska has a large veteran population, and must further research veterans' needs, including both physical and psychological therapy for traumas and stresses associated with military service. 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 and capacity-building in Alaska is spearheaded by the statewide NIH INBRE program, focused on the impacts of climate change on contaminant transport and movements of infectious pathogens at high latitudes. UAF's NIH-funded Bioinformatics Core provides computational services to UA life science researchers, including programming, data management support and optimization of applications.

UAA is a focal point for health education and research. Nursing enrollment at the school 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. Beginning in 2013, an additional year of medical instruction takes place in the UAA WWAMI School of Medical Education, allowing half of a physician's training to take place within Alaska. The expanded program will build capacity for further health initiatives in the state, such as a full medical school, a pharmacy school and a graduate program in biomedical research.

Major players in Native and rural health are the Alaska Center for Rural Health at UAA (see below) and the Center for Alaska Native Health Research (CANHR) at UAF. CANHR recently received a $5.3 million, 5-year NIH grant to continue its research into Native nutrition and obesity, genetics, environmental contaminants, behavioral issues, and other topics. The UAA Justice Center engages in research on violence and substance abuse; on the state level, the Alaska Network on Domestic Violence and Sexual Assault evaluates and tests innovative practices, and suicide prevention efforts are stewarded by the Alaska Suicide Prevention Council, a state panel operating under a 2012-17 strategic plan. A state virology lab constructed in 2009 at UAF greatly increased the state's capabilities to track viruses and disease vectors, while UAF is developing a joint program in veterinary medicine with Colorado State University, which includes links between zoonotic disease and human health. A joint UAA-UAF Ph.D. program in Clinical-Community Psychology was recently accredited by the American Psychological Association. A major initiative partners UAF with several North Pacific universities to study childhood obesity.

Research Arena 7: Transport, Communications and Information

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 (IT). 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.

The effective and efficient coordination of this infrastructure is key to the economic and social development throughout the State. While the five research initiatives described below detail specific functional issues, it is also recommended that an overarching program on statewide logistics and systems analysis be developed.

Research Initiatives. **Shipping.** Alaska will be heavily involved in addressing safety, environmental and security concerns engendered by increased Arctic shipping. One research thrust 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. Research is also needed into global supply chain logistics to decrease the amount of perishables spoiled or damaged en route to Alaskan communities.

Land Transport. Areas for development include inter-modal 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 both civilian and military aviation S&T development. Research will support 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 UAV 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. Another need is to improve 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." Another need arises from the establishment of integrated long-term monitoring networks across the state (see Arena 5); 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.

Alaska is also cultivating the potential for IT research. The Arctic Region Supercomputing Center at UAF has recently upgraded its core system, and Alaska NSF EPSCoR support has improved connectivity on both the UAA and UAF campuses, as well as improved the capacity of the Planetarium and Visualization Theatre at UAA to deliver high-resolution interactive visualizations.

Strategies. In 2012, state legislators established the Alaska Arctic Policy Commission, a 20-member panel charged with writing a comprehensive plan by 2015 to address future Arctic developments. Alaska is also funding 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 is studying geopolymer concrete (see Arena 3.) The UA was central to developing the revolutionary NextGen air traffic control system and is one of four founding universities of the FAA Center of Excellence for General Aviation; this center can play a significantly enhanced role in coordinating and conducting aviation S&T. Alaska has reached agreement with NASA to serve as an airship testing ground.

The state recently committed $25 million toward a new launch pad at the Kodiak complex in anticipation of $100 million in support by Lockheed-Martin. The upgrades will make Kodiak the West Coast home of Lockheed-Martin's new Athena III spacecraft starting in 2014. Sounding rocket and UAV testing takes place at UAF's Poker Flat Research Range, while the High Frequency Active Auroral Research Program studies the ionosphere.

Connectivity efforts are led by the Alaska Broadband Task Force, a government-industry panel charged with increasing broadband penetration in both urban and rural Alaska. The Task Force (with ISER support) released its draft report on the future of Alaskan broadband in 2013. In early 2012 a new broadband network was extended to 9,000 homes and 750 businesses in Southwest Alaska, with current plans to expand north into Kotzebue in 2014. The Arctic Slope Regional Corporation has received initial funding for a terrestrial fiber-optic link to Barrow and the Tlingit & Haida Central Council has developed a broadband strategic plan for Southeast Alaska. Alaska may

benefit substantially from a pair of planned London-Tokyo fiber-optic cables, which may be routed through the Northwest Passage and include links to Arctic communities.

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.

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 activities – 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 methodologies, including incorporating STEM research into instruction. One key program is the Alaska Engineering Academies Initiative, a partnership between the UA, state agencies and the Alaska Process Industry Careers Consortium to provide engineering courses and activities to K-12 students. The program has established engineering curricula at schools across Alaska with plans to establish 25 academies across the state in the next five years.

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 almost 35,000 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, which strongly correlate to STEM fields: engineering, health, biomedicine, teaching and workforce development. The university has recently focused resources on engineering and health disciplines, with strong results: enrollment in the UAF College of Engineering and Mines, for example, has increased by 70% since 2006.

One important goal for the state 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, and the federally-supported TRIO programs, and work to optimize their impact on STEM students and others.

Strategies. In 2010, the state formed an Alaska Advisory Task Force on Higher Education and Career Readiness to better prepare K-12 students for college or careers. The Legislature has taken steps to implement their recommendations, which include creating or expanding a number of

training and education programs; enhancing academic advising and teacher mentoring; improving testing; and providing predictable and sustainable education funding. Other recent innovations by the state include a major program of Alaska Performance Scholarships for high-performing students to attend in-state college or training, and rigorous and comprehensive new K-12 academic standards adopted in 2012 after a two-year public process. The Legislature is also providing funding to implement the 2010 Alaska Career and Technical Education Plan, which targets vocational education.

Improving teacher retention is the main goal of the Alaska Statewide Mentor Project, which provides mentors to instructors in 70 percent of Alaska's public schools, as well as to administrators. The UA has recently adopted several programs to improve and streamline 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 program s via distance delivery.

Alaska has introduced several new programs for distance delivery. Founded in 2011, Alaska's Learning Network offers a number of remote core courses in 60 percent of the state's districts; this included a recent high school/college introductory course in mining supported by mining companies. A proposed $5 million "Alaska Digital Teaching Initiative" pilot program would greatly expand distance offerings in STEM fields. UAF's new eLearning and Distance Education Office works to streamline and improve distance offerings at the university level.The 2012 state budget included more than $500,000 for preparing UA students for the state's key industry sectors, all of which relate to critical areas of S&T development: health; oil, gas and mining; engineering; education; and fishing, seafood processing and maritime fields. The state has invested heavily in UA science infrastructure in recent years, including engineering buildings at UAA and UAF, health sciences and integrated sciences buildings at UAA, the Museum of the North and Murie Life Sciences Facility at UAF, and a NOAA-UAF fisheries facility in Juneau.

UA is currently engaged in a public input process called "Shaping Alaska's Future 2017," which is centered on improving student achievement and attainment, fostering research and development for economic growth, providing accountability to the state, and partnering with Alaska's schools, agencies and industries. The UA also pursues infrastructure improvements through collaborating with federal programs: the Alaska NSF EPSCoR award includes several STEM education programs as well as funding for eight new faculty hires, and the current NIH INBRE award includes seven hires. In 2012 the UAA Center for Alaska Education Policy Research was established within ISER to identify and address the most important educational policy issues facing Alaska.

A Note on Direct Business Engagement

Improving Alaska's S&T landscape requires cooperation between leaders in government, academia, research groups, business, and NGOs. 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 Alaska Technology Research and Development Center (TREND) provides workshops, one-on-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 (ORGS) recently 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.

The UAF Office of Intellectual Property and Commercialization (OIPC) 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. Among the office's products are handbooks for inventors and a guide for businesses interested in UAF partnerships.

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. The fund's goal is to provide capital to Anchorage entrepreneurs to spur economic development.

The Alaska Forward Initiative is a project by a consortium of economic development entities, the Alaska Partnership for Economic Development, to identify and bolster industry clusters in the state. The group engaged over 200 industry representatives in facilitated working groups and identified a number of "seed clusters" within the four focus areas of mining, logistics, clean energy, and tourism. Many of the findings of the Initiative are reflected in the body of this report.

The Alaska Marketplace is an annual competition sponsored by the Alaska Federation of Natives to identify innovations with the potential to create jobs and stimulate the 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. The program was expanded in 2011 to encourage corporate giving to a broader range of educational programs.

Policy Proposals

SCoR will work with the below entities to implement these policies over the next half-decade:

A. Government

1. Create a state entity to stimulate S&T by identifying gaps in seed funding, providing capital and/or tax incentives, and supporting next steps such as patenting Alaskan products, streamlining regulations, or changing procurement policies to build markets.
2. Appoint a science advisor in the executive branch to coordinate and represent Alaska leadership on boards and committees, such as the North Pacific Research Board (NPRB) and the U.S. Arctic Research Commission.
3. Create a joint Science and Technology committee in the state Legislature.
4. Establish a "scientific SWAT team," a state brain trust that could quickly formulate scientifically appropriate responses to emergent problems.
5. Encourage the dissemination of traditional knowledge through state support for groups such as the Alaska Native Science Commission.
6. Pioneer methods of supporting K-12 STEM education, including adding STEM elements to Alaska Performance Scholarships.
7. Partner with the UAF and UAA offices of Intellectual Property and Commercialization to identify innovations based on university research, and modify state procurement policies to encourage early adoption of new software and other innovations developed in-state.

B. Academia and Research Groups

8. Use research directors from the three UA campuses as "scouts" to seek out funding opportunities such as those offered by the NSSI and the NPRB.
9. Systematically inventory state needs for research space and cyberinfrastructure (especially improved broadband access) and adjust the long-term development agenda accordingly.
10. Coordinate and sustain established environmental monitoring networks, such as the Arctic Observing Networks and Global Earth Observation System of Systems.
11. Explore ways to provide support and incentives for UA faculty to partner with the private sector on research projects.

C. Business

12. Continue economic development efforts such as the Alaska Forward Initiative.
13. Maintain and encourage use of higher education tax credits.

D. Non-Governmental Organizations

14. Recognize communities, individuals, and centers of excellence in research, innovation and educations, including establishing and publicizing an Alaska Innovators Hall of Fame.

Appendix 1: Drafting Process and SCoR Membership

Drafting Process. "To Build a Fire" is based on "Alaska Research and Development," a statewide R&D plan written in 2003. In 2011 the State Committee on Research authorized a redraft of the plan. An initial outline was prepared in early 2012 by then-SCoR co-chairs Mark Myers and Mead Treadwell. The plan was then written and laid out by Alaska NSF EPSCoR staff. First and second drafts of that plan were presented to the full SCoR, which recommended changes which were implemented and approved by the full committee in November 2012.

The November draft was presented at public meetings held in Fairbanks, Anchorage and Juneau in March and April 2013. Comments from these meetings were incorporated by EPSCoR staff into a new draft presented to SCoR in October 2013. Recommendations from this meeting were incorporated into a further draft and presented at a SCoR meeting in January 2014.

The State Committee on Research would like to acknowledge the many individuals, agency administrators, state and local leaders, university representatives, business owners, and economic development group leaders who attended the public meetings and contributed to this report.

SCoR Membership

1. Mead Treadwell, Committee Co-Chair
Lieutenant Governor, State of Alaska

2. Dana Thomas, Committee Co-Chair
UAF Vice-Provost for Academic Affairs

3. Lilian Alessa
University of Idaho Research Faculty, Landscape Architecture

4. Elisha "Bear" Baker
UAA Provost and Vice-Chancellor for Academic Affairs

5. Sarah Barton
Senior Vice-President, Rise Alaska LLC

6. Susan Bell
Commissioner, Alaska Department of Commerce, Community and Economic Development

7. Rick Caulfield
UAS Provost

8. Jim Hemsath
Deputy Director, Alaska Industrial Development and Export Authority

9. Susan Henrichs
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10. Alex Hills
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11. Jim Johnsen
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12. Karl Kowalski
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13. Mark Myers, Acting Committee Co-Chair
UAF Vice-Chancellor for Research

14. Robert F. Swenson
Deputy Commissioner, Alaska Department of Natural Resources

15. Dan White
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16. Helena Wisniewski
UAA Vice-Provost for Research and Graduate Studies

17. Fran Ulmer (ex officio member)
Chair, U.S. Arctic Research Commission

Appendix 2: Acronyms

ACEP: Alaska Center for Energy and Power
AFN: Alaska Federation of Natives
AHFC: Alaska Housing Finance Corporation
ANSEP: Alaska Native Science and Engineering Program
AOOS: Alaska Ocean Observing System
ARSC: Arctic Region Supercomputing Center
ASET: Applied Science, Engineering, and Technology
CANHR: Center for Alaska Native Health Research
CBPR: Community-Based Participatory Research
CCHRC: Cold Climate Housing Research Center
DOE: Department of Energy
EPSCoR: Experimental Program to Stimulate Competitive Research
FAA: Federal Aviation Administration
GI: Geophysical Institute
IGERT: Integrative Graduate Education and Research Traineeship
IPY GLOBE: International Polar Year Global Learning and Observations to Benefit the Environment
ISER: Institute for Social and Economic Research
NASA: National Aeronautics and Space Administration
NGO: Non-Governmental Organization
NIH INBRE: National Institutes of Health IDeA Network of Biomedical Research Excellence
NOAA: National Oceanic and Atmospheric Administration
NPRB: North Pacific Research Board
NSSI: North Slope Science Initiative
ORGS: Office of Research and Graduate Studies
RAM: Resilience and Adaptive Management
RAP: Resilience and Adaptation Program
S&T: Science and Technology
SCoR: Alaska State Committee on Research
SFOS: School of Fisheries and Ocean Sciences
SNAP: Scenarios Network for Alaska and Arctic Planning
STEM: Science. Technology, Engineering and Math
TREND: Technology Research and Development Center
UAA: University of Alaska Anchorage
UAF: University of Alaska Fairbanks
UAS: University of Alaska Southeast
UAV: Unmanned Aerial Vehicle
USGS: United States Geological Survey
WWAMI: Washington, Wyoming, Alaska, Montana and Idaho