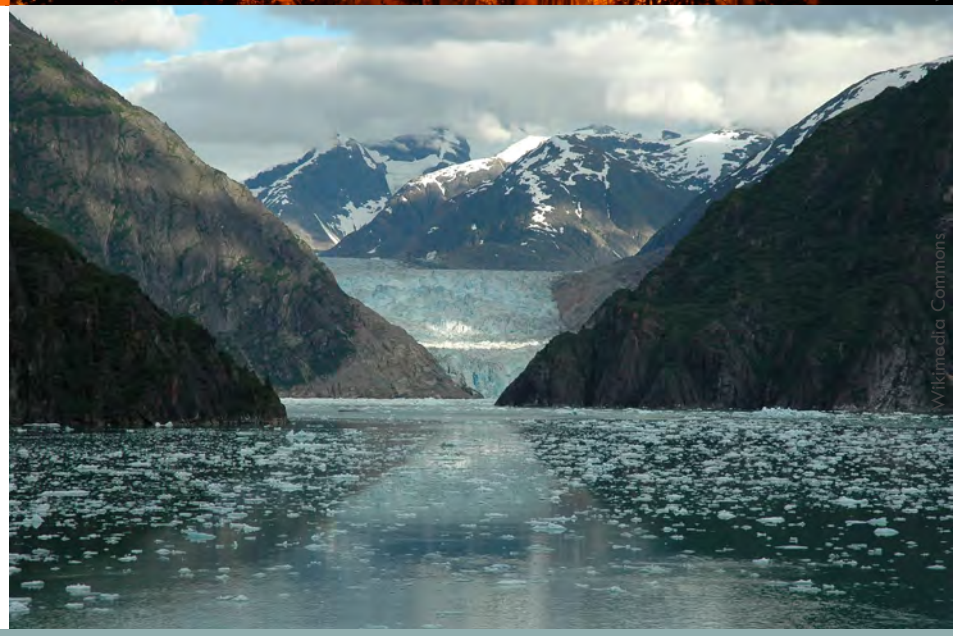
Strategic Plan

Fire and Ice: Navigating Variability in Boreal Wildfire Regimes and Subarctic Coastal Ecosystems



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Executive Summary

Alaska is on the front lines of climate-driven ecological change. Rising temperatures, shifts in precipitation, increasing wildfires, and receding glaciers are among the factors impacting vital resources and straining Alaskans' ability to adapt. There is a pressing need to prepare for and respond to these changes through data-driven management. "Fire and Ice: Navigating Variability in Boreal Wildfire Regimes and Subarctic Coastal Ecosystems (F&I)" will address this need through research in two Alaskan regions undergoing rapid change: the boreal forest and the coastal margins of the Gulf of Alaska (figure 1). In Alaska's boreal, where changes to fire risk and behavior pose threats to communities, a Boreal Fires research team will enhance climate and biophysical data to improve wildfire forecasting and response. In the nearshore Gulf of Alaska, a Coastal Margins team will use biophysical data, experiments, modeling and surveys to anticipate how glacial melt and other changes impact critical ecosystems, marine species and fisheries. A Diversity, Education and Workforce Development (DEW) component will work to ensure that a diverse set of Alaskans participate in and benefit from F&I.

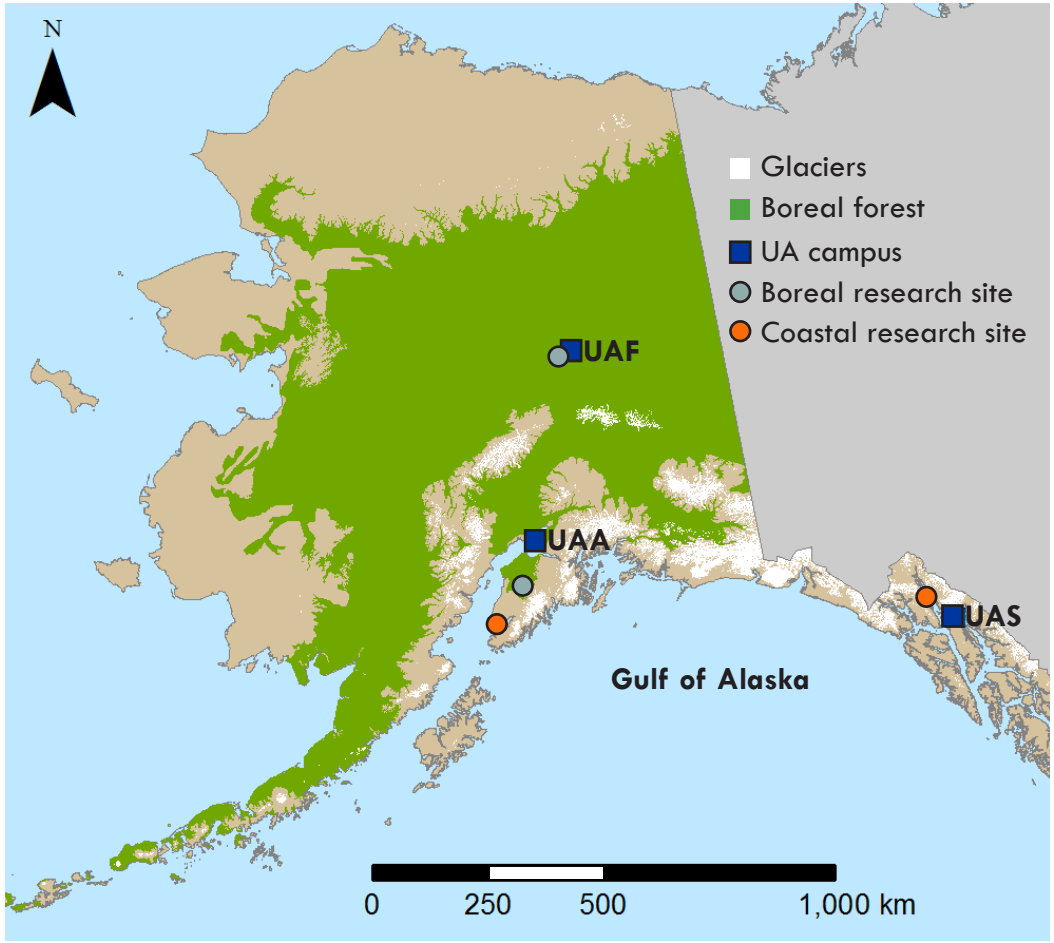

Figure 1. Map of principal research sites and UA campuses.

The **vision** of F&I is to improve global understanding of the drivers, processes and consequences of ecological change in critical northern ecosystems, and to enhance methods for studying such change. The **mission** of the project is to advance scientific knowledge, and to generate data and tools for resource managers and communities to use to prepare for, and respond to, short-term climate-driven ecological change. Research will take place across University of Alaska (UA) campuses in Fairbanks (UAF), Anchorage (UAA) and Juneau (UAS) and aligns strongly with both UA research goals and the State of Alaska's Science and Technology Plan.

Boreal Fires. The Boreal Fires team will increase community resilience to wildfire by improving evaluations of subseasonal-to-seasonal fire risk, modeling fire spread, and increasing understanding of the economics of fire management and of impacts of wildfire to ecosystem services. Their first research goal is to enhance data streams to produce improved seasonal fire outlooks for fire managers. They will work to determine which large-scale climate drivers increase the likelihood of lightning storms; gather airborne hyperspectral data to establish a spectral library of fire fuels, enabling better satellite mapping of fuel types; and identify climate phenomena that create atmospheric conditions conducive to fire weather in Alaska. They will then incorporate these findings into seasonal fire outlooks. The second research goal is to improve predictions of fire spread and assessments of fire severity. Researchers will conduct hyperspectral overflights of recent fires to gather fire impact data, which will be used to refine models of fire spread. They will also assess fire severity by contrasting spectral indices with field surveys of recent fires. The third research goal is to inform wildfire management to foster community resilience. Researchers will work with tribal and agency partners

in rural areas impacted by wildfire to catalog ecosystem services, isolate ways that wildfires and fuels management can impact these services, and identify constructive community responses. Another team of scientists will model wildlife risks and expenditures in Alaska's wildland-urban interface and build scenarios and projections of the benefits and costs of private and public expenditures for wildfire management.

The founding Boreal Fires team consists of 12 core faculty members and staff led by UAF Professor of Atmospheric Science Uma Bhatt and UAF Assistant Professor of Wildlife Biology Todd Brinkman. The component will make two faculty hires: a UAF geospatial scientist and a UAA terrestrial ecologist. The component will hire two postdocs and fund 21 graduate student employment-years and 9 undergraduate employment-years. Key external partners include Bonanza Creek Long-Term Ecological Research (LTER), the Alaska Fire Science Consortium, the NASA Arctic-Boreal Vulnerability Experiment (ABoVE) program, and the Scenarios Network for Alaska and Arctic Planning (SNAP).

Coastal Margins. The Coastal Margins team will quantify biological responses to climate-induced changes in physical and chemical conditions along a gradient of glacial to non-glacial waters, and study potential responses of fishing communities to these changes. Research will take place in Kachemak Bay scross from Homer and Lynn Canal near Juneau. The first research goal is to gather physico-chemical data about the Gulf nearshore and the rivers that feed it. Researchers will acquire nearshore data from drifters, hyperspectral overflights, oceanographic sensors and surveys. To study freshwater conditions, researchers will deploy sensors in 10 watersheds and combine these data with in situ samples and measurements. This will enable them to craft mechanistic models of freshwater and nutrient flux and nearshore circulation, which will be combined with a 30-year hindcast simulation to illuminate physical and chemical impacts of climate-induced changes.

The second Coastal Margins goal is to quantify how nearshore organisms and biological communities respond to changing conditions. Researchers will use fish sampling, intertidal transects, and plankton tows to gather data on estuarine fish, macroalgal, invertebrate and plankton communities. These data will be used to evaluate community shifts along environmental gradients using a suite of statistical models. They will also use stable isotope and diet data to trace sources of organic matter to nearshore consumers. The team will construct an Ocean Change Experimental System (OCES) to test the physiological responses of marine species to changing conditions. Experimental and field data will be used to model metabolism and growth responses of marine species to temperature, pH, and salinity. The third research goal is to gain a better understanding of how resource users may respond to these changes, which will be accomplished through interviews with fishers and institutional representatives in two coastal communities.

The founding Coastal Margins team includes 16 core faculty led by UAF (Juneau) Associate Professor of Fisheries Anne Beaudreau and UAF Professor of Marine Biology Brenda Konar. The team will make three faculty hires: a UAF oceanographer, a UAF (Juneau) fish genomicist/physiologist, and a UAS microbiologist. The component will hire three postdocs and fund 23 graduate student employment-years and 35 undergraduate employment-years. Key external partners include the Northern Gulf of Alaska LTER, the National Oceonographic and Atmospheric Administration (NOAA), and the Kachemak Bay National Estuarine Research Reserve (KBNERR).

Diversity, Education and Workforce Development (DEW). The DEW component aims to: 1) increase five "key competencies" essential for addressing sustainability challenges, and 2) broaden participation in science, technology, engineering and math (STEM) fields. To build key competencies among Alaskans, DEW will implement out-of-school programs in which K-12 students work through current and future landscape scenarios related to F&I research. DEW will also hold workshops to help K-12 teachers integrate case studies and other scenario-based activities into existing curricula, and will enhance UA course offerings related to F&I. DEW will also work to increase diversity in Alaska STEM, with a focus on female, first-generation and Alaska Native students. DEW will support peer tutoring for underrepresented UA students; hold "difference-education interventions" to encourage the success of underrepresented UA students in STEM; create and share "STEM success stories" highlighting diverse UA alumni succeeding in STEM careers; work to ensure diversity in Fire and Ice faculty and student hires; and conduct a qualitative, multi-year educational research study of a cohort of first-generation students designed to isolate factors leading to the students' identification, or lack of identification, with STEM. The DEW component will also implement "Girls on Water" and "Girls in the Forest" programs to engage high-school-aged girls in field science through field trips to Kachemak Bay and the Alaskan boreal.

DEW's third goal is to increase the UA's capacity for F&I science and teaching. F&I will provide mentoring for F&I faculty and postdoc hires, offer a mentorship training workshop(s) to F&I faculty, and competitively award faculty travel grants for professional development. F&I will offer workshops on science communication and indigenous knowledge, as well as workshops teaching the "values-affirmation" intervention, another method for fostering success at STEM, especially among underrepresented students.

The founding DEW team is led by UAF Research Associate Professor of Science Education Laura Conner and incorporates two other UA faculty and a postdoc hire. Primary external partners of the DEW component include the Fairbanks and Juneau school districts and KBNERR.

Seed Funding and Emerging Areas. F&I will competitively award at least 14 grants of up to $20,000 each to UA faculty and at least 15 grants of up to $5,000 each to UA students to seed high-risk, potentially transformative research at the UA related to F&I themes. F&I will also competitively award up to 10 education and outreach seed grants of up to $10,000 each to UA researchers with innovative ideas 1) to increase STEM interest, practices and identity among Alaska Natives, women, or other underrepresented groups at the K-12 or university level; and/or 2) to generate F&I research visualizations for use in STEM efforts.

Partnerships and Collaborations. F&I will partner with economic development groups to sponsor and organize activities that encourage STEM entrepreneurship, including workshops on federal small business awards; training sessions to encourage UA applications for private funding; community technology events teaching hands-on skills; and large-scale entrepreneurship events like Startup Weeks. The second half of F&I's partnership strategy is for project components to collaborate with external and UA organizations to extend the depth and breadth of their research and outreach efforts, including partnering with larger agencies and programs throughout the project and with emergent local partners over the course of the research.

Communication and Dissemination Plan. F&I will implement a comprehensive information flow within F&I and with five target audiences: K-12 students; communities in research areas; academics; policymakers; and the public. Internal communications include a project listserv, an online newsletter, and annual All-Hands Meetings for all project participants. Traditional external communication methods include glossy midcourse and final reports; annual keynote speakers; "Science Pubs" in which F&I scientists share research in a relaxed setting; and annual science training workshops for tour guides. Online communications methods include the aforementioned newsletter, a regularly updated website, a social media presence on at least five platforms, and short F&I videos shown on YouTube and on public television.

Sustainability Plan. F&I will contribute to sustainable capacity at UA through hires of five tenure-track faculty and six postdocs, all of whom will enjoy strong F&I support. F&I researchers will also seek to continue and expand their work by applying for more than 100 external awards, including collaborating on NSF Research Traineeship and Research Coordination Network awards, leading up to a preliminary application(s) for a Science and Technology Center at UA in year 5.

Management, Evaluation and Assessment. F&I adopts a shared leadership model, with four Management Team members running day-to-day operations and an eight-person Leadership Team leading science and outreach. Alice Veazey serves as Project Director and Tara Borland as Project Administrator. Oversight will be provided by a roughly 20-member Statewide Committee for Research composed of leaders from government, academia, and industry, and F&I will also be advised by a 4-person External Advisory Council (EAC) of outside experts in F&I fields. External evaluators Julia Melkers and Eric Welch will collect quantitative data using consistent metrics for longitudinal tracking of activities and outputs, and qualitative data to explore nuances of project work. An additional DEW evaluation will be undertaken by Angela Larson of the Goldstream Group LLC, who will provide feedback on DEW's capacity to build the five key competencies among stakeholders, as well as stakeholders' interest in science and development of a science identity. Both Melkers/Welch and Larson will provide annual reports, including recommendations which will be used to institute formative changes as appropriate.

Risk Mitigation. The F&I Risk Mitigation Plan breaks down the most likely risks that F&I faces and logical steps to prevent and alleviate them. The largest risks stem from personnel issues, including potential attrition of key faculty or delays in hiring processes.

Introduction

Alaska is on the front lines of climate-driven ecological change. Rising temperatures, shifts in precipitation, increasing wildfires, and receding glaciers are among the factors impacting vital resources and straining Alaskans' ability to adapt. There is a pressing need to prepare for and respond to these changes through data-driven management, which is crucial to Alaska and applicable to changing ecosystems everywhere.

This NSF EPSCoR RII Track-1 project – "Fire and Ice: Navigating Variability in Boreal Wildfire Regimes and Subarctic Coastal Ecosystems (F&I)" – will address this need through research initiatives in two Alaskan ecosystems undergoing rapid change: the boreal forest and the coastal margins of the Gulf of Alaska. In Alaska's boreal forest, where changes to fire risk and behavior pose threats to communities, a Boreal Fires research team will use remote sensing and enhanced climate and biophysical data to facilitate improved wildfire preparation and response. In the nearshore Gulf of Alaska, a Coastal Margins team will use biophysical data, experiments, and modeling to anticipate how climate-driven changes to glacial and non-glacial material flux affect critical ecosystems, marine species and fisheries. A Diversity, Education and Workforce Development (DEW) component will work across teams to ensure that a diverse set of Alaskans participate in and benefit from F&I research efforts, and will also conduct its own research into retention of first-generation college students.

The **vision** of F&I is to improve global understanding of the drivers, processes and consequences of ecological change in critical northern ecosystems, and to enhance methods for studying such change. The **mission** of the project is to advance scientific knowledge, and to generate data and tools for resource managers and communities to use to prepare for, and respond to, short-term climate-driven ecological change.

UNIVERSITY of ALASKA ANCHORAGE

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UNIVERSITY of ALASKA SOUTHEAST

Primary Organizational Partners. Research and outreach will be conducted by faculty, staff and students at the University of Alaska, including its three main campuses in Fairbanks, Anchorage, and Juneau. Primary Boreal Fires external partners include Bonanza Creek LTER, the Alaska Fire Science Consortium, and the NASA ABoVE program. Primary external partners of the Coastal Margins component include the Northern Gulf of Alaska LTER, NOAA, and the Kachemak Bay National Estuarine Research Reserve (KBNERR). Primary external partners of the DEW component include the Fairbanks and Juneau school districts and KBNERR.

Alignment with Alaska Science and Technology (S&T) Plan. The Alaska S&T Plan was developed by the State Committee for Research, a panel of government, academic, and industry leaders which also provided input for F&I. The plan divides Alaskan S&T priorities into seven "research arenas" and also describes state education priorities; F&I activities directly align with four of these eight foci. An "Environmental Monitoring and Management" arena calls for research into wildfires and into coastal ecosystems, and emphasizes the development of integrated modeling techniques to enhance environmental forecasts, mitigation strategies, and decision tools. Coastal Margins research into impacts of climate change to marine food webs addresses needs described in the "Renewable Resources" arena. The "Community Resilience and Sustainability" research arena aligns with F&I research into human dimensions of fire and coastal resource management. And the education section stresses science, technology, engineering and math (STEM) education for underserved groups, an F&I DEW priority.

Benefits to Alaska and to Alaska's academic research and education infrastructure. The boreal forest covers almost half of Alaska, an area which contains its two largest cities and hundreds of population centers. The Boreal Fires team will examine the complex and poorly-understood relationship between interannual climate variability, weather, fuel conditions and fire behavior, resulting in new findings that will enhance fire managers' capacity to anticipate and respond to wildfires. This will be coupled with research into fire's impact on ecosystems and into fire management strategies, which will provide useful data for fire mitigation, suppression and recovery efforts across the boreal forest.

Many of Alaska's large population centers are located along the Gulf of Alaska. Alaskans in these communities rely on healthy coastal

ecosystems for economic activities, food, cultural traditions, and recreation, and they house one of the world's most productive fisheries. However, glaciers along the Gulf of Alaska are losing volume at one of the highest rates on the planet, and precipitation is increasingly falling as rain rather than snow, both of which impact freshwater discharge to the coast and in turn affect nearshore marine life. Despite the imminence and scale of these changes, we have limited understanding of the ways they may alter downstream coastal ecosystems, which would in turn impact commercially and culturally important species and the fishing communities that rely on them. The F&I Coastal Margins team will quantify biological responses to changes in physical and chemical conditions of watersheds and coastal waters, and work to understand the potential responses of fishing communities. This will generate key data for management of changing Alaskan marine habitats and resources.

F&I will build capacity across the three campuses of the University of Alaska and concentrate support in areas of strong potential growth at the UA. It will also impact Alaskan education at all levels through its multiple DEW initiatives. The project will:

Table 1: F&I Faculty Hires

Campus	Position
UAA	Terrestrial Ecologist
UAF (Juneau)	Fish Genomicist
UAF	Oceanographer
UAF	Geospatial Scientist
UAS	Microbiologist

- Hire five tenure-track faculty (Table 1) and six postdocs and provide 44 graduate and 45 undergraduate employment-years;
- Enhance UA resources to collect, synthesize, model, and visualize data related to biophysical change and resource availability and use;
- Capitalize on UA expertise in climate dynamics to inform UA research and outreach products;
- Adopt and refine new technologies to enhance UA research, including unmanned and manned aerial systems with advanced optical, thermal infrared, multispectral and hyperspectral sensors;
- Increase the quality and quantity of Alaska's STEM students and workforce, focusing on Alaska Natives and first-generation students; and
- Enable UA to incorporate improved data on wildfire behavior and nearshore ecology into change projections, solidifying its position as a leader in forecasting, preparing for, and responding to change.

Project Implementation. *Strategic Planning Process*. Elements of this Strategic Plan were prepared by members of the F&I Leadership Team (see *Management, Evaluation and Assessment Plan,* below) beginning in July 2018. On August 2, 2018 the Leadership Team met to coordinate strategic planning. Research and DEW leads and Leadership and Management team members prepared tables and text sections describing their activities. These were discussed and refined at a Strategic Planning meeting, held in Fairbanks on August 27-8, 2018 and facilitated by John Riordan of Cindy Zook Associates. Leadership and Management Team members then collaborated to complete this final document.

Elements of the Strategic Plan. The F&I project consists of a number of interlocking components and plans that together constitute a diverse, statewide research and education enterprise. Each component is described in its own text section, accompanied by a table listing goals, objectives and milestones to be reached over the five years of the project. Each separate project objective is also accompanied by a list of *outputs*, defined as tangible products of F&I activities, and *outcomes*, defined as changes or benefits resulting from F&I activities.

Boreal Fires and *Coastal Margins* sections detail the research at the crux of F&I efforts, as well as associated outreach and training. *Diversity, Education and Workforce Development* combines three key aspects of F&I extending from K-12 activities through to the professional level. *Seed Funding and Emerging Areas* describes plans to allocate funds to emergent strains of research and education stemming from our activities.

Partnerships and Collaborations describes interactions with partner organizations, with a focus on economic development. The *Communications and Dissemination Plan* lists strategies to share information both within the project and with the general public. The *Sustainability Plan* explains how F&I will use faculty hires and applications for external funding to extend impacts beyond the lifetime of the project. A *Management, Evaluation and Assessment* section details the multilayered levels of leadership and advising that will keep the project on course to accomplish its goals. And a *Risk Mitigation Plan* describes the likelihood and magnitude of risks to the project and methods to manage them.

Boreal Fires

The goal of the Boreal Fires team (Table 2, below) is to increase community resilience to wildfire by developing outlooks for subseasonal-to-seasonal fire risk, by modeling fire spread and severity, and by improving understanding of the economics of fire management and of impacts of wildfire to ecosystem services. Research will cover the entire Alaskan boreal (Figure 2); some specific research will focus on the Bonanza Creek LTER near Fairbanks and the Kenai National Wildlife Refuge outside of Anchorage, while other research locations will depend on the timing and location of wildfires during the project. Boreal Fires researchers will use data collection, process studies, predictive modeling, and integrated analysis at a variety of spatial and temporal scales to address four goals (Table 3, below):

Goal BF1: *Produce seasonal fire outlooks by merging data on lightning probability and available fuels with seasonal climate forecasts.* Improved seasonal fire outlooks will take the form of map layers and time series graphs indicating fire risk across Alaska's relevant fire management zones over the course of the fire season, which will be a valuable tool for fire and resource managers. These outlooks will result from three related lines of inquiry. First, researchers will improve the accuracy of Alaska's historic lightning database by incorporating changes to lightning detection over time, then work to determine which large-scale climate drivers (in particular patterns of convective precipitation) increase the likelihood of lightning storms, and test these findings through ground observations.

Second, researchers will gather multiple sets of airborne hyperspectral data over sites including the Bonanza Creek LTER, the North Campus of UAF, and the Caribou-Poker Creeks Research Watershed over a period of several years and ground-truth it with field data, building a spectral library for use in better mapping the distribution, variability and available biomass of fuel types via satellite. These overflights will bridge critical gaps in spatial scale between measurements of field plots, instrumental observations of atmospheric conditions, and satellite data. The researchers will also examine the hyperspectral data in concert with satellite imaging to evaluate the influence of seasonality and snow cover duration on fuel conditions.

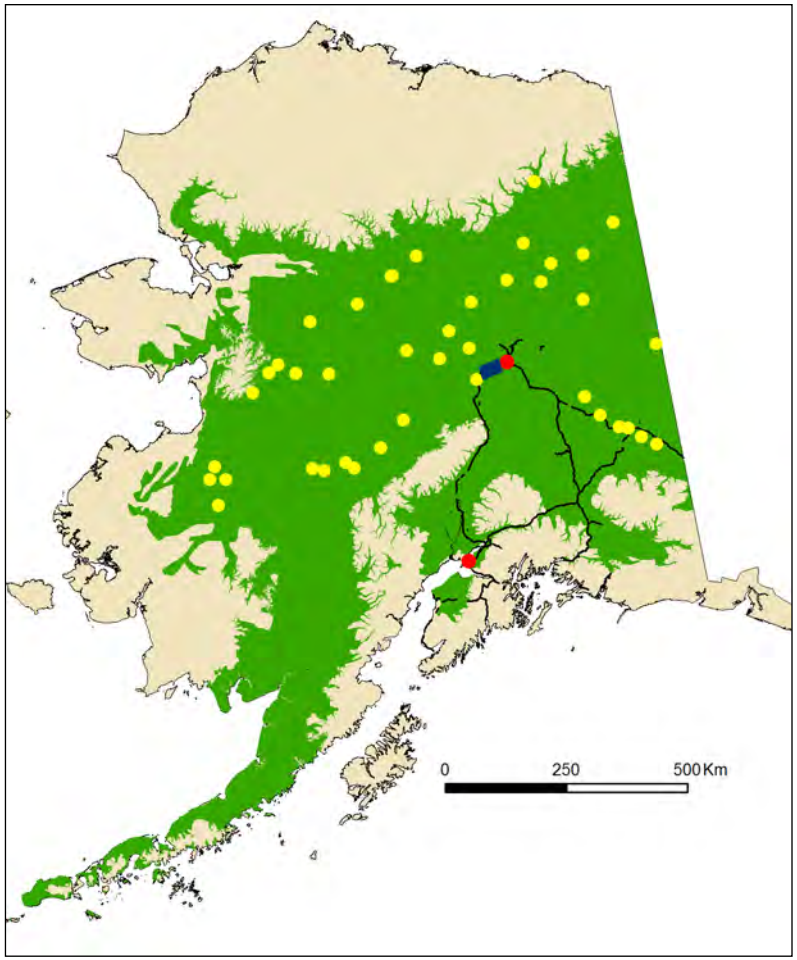

Figure 2. Boreal forest (green), rural communities for potential opportunistic partnerships (yellow dots), Bonanza Creek LTER (blue box), UAF and UAA campuses (upper and lower red dots), and road system (black lines).

Third, Boreal Fires researchers will study climate data to identify phenomena (such as sea surface temperature or sea ice area anomalies) that create atmospheric conditions conducive to fire weather in Alaska, and apply these findings to improve interpretation of subseasonal-to-seasonal weather forecasts. The research team will then combine these lightning, fuel and weather data streams into fire outlooks.

Goal BF2: *Enhance active fire characterization, spread prediction, and severity assessment in the boreal through improved remote sensing, short-term weather data, and field measurements.* By meeting this goal, the component will improve the ability of managers to predict fire behavior,

contributing to improved suppression strategies. Researchers will opportunistically conduct hyperspectral overflights (either manned or via unmanned aerial vehicle) of active fires over multiple years to obtain a robust set of fire behavior data, which will be used to refine and calibrate satellite data. They will then use the data, including digital elevation models generated from hyperspectral imagery, to generate fire case studies, which they will evaluate to refine models of fire spread. At the same time, Boreal Fires scientists will work to improve assessment of fire severity by contrasting spectral indices (gathered as part of Goal BF1) and field surveys of recent fires, including the key criteria of how much vegetation was consumed, how much duff remains, and how much mineral soil was exposed.

Table 2: Boreal Fires founding core faculty and staff

Name	Affiliation	Expertise	Goal
Matt Berman	UAA ISER	Risk mitigation	3
Uma Bhatt (co-lead)	UAF GI	Climate variability	1,2
Peter Bieniek	UAF SNAP	Climate variability	1,2
Todd Brinkman (co-lead)	UAF IAB	Ecology	3
Krista Heeringa	UAF SNAP	Community liaison	3
Teresa Hollingsworth	UAF IAB	Fire ecology	1
Randi Jandt	UAF IARC	Fire agency liaison	1,2
Joseph Little	UAF SOM	Risk mitigation	3
Santosh Panda	UAF GI	Remote sensing	1,2
Anupma Prakash	UAF Provost	Remote sensing	1,2
Jennifer Schmidt	UAA ISER	Ecosystem Services	3
Martin Stuefer	UAF GI	Fire spread modeling	1,2
Geospatial Scientist hire	UAF GI	Hyperspectral sensing	1,2
Terrestrial Ecologist hire	UAA CAS	Ecosystem services	1

Goal BF3: *Develop science-based options for improving wildfire management policy to maintain ecosystem service flows and foster community resilience.* Using a two-part approach, the Boreal Fires team will provide information beneficial to multiple groups, including tribal leaders and residents of Interior Alaska subsistence communities, land and resource managers, and property owners in the expanding communities on the wildland-urban interface (WUI) in Southcentral Alaska. An Interior Alaska team will conduct a regional assessment around approximately 40 rural communities to catalog ecosystem services that may be vulnerable to wildfire. They will then develop intensive research partnerships with tribal and agency partners to assess the consequences of and response to recent wildfires. Focus group discussions and interviews with stakeholders will guide these assessments. Existing data on land cover (e.g., fire history, habitat) and resources (wildlife distribution and abundance) will be used to facilitate a region-wide, spatially-explicit catalog of ecosystem services. This will in turn enable the team to identify ways that wildfires and fuels management can impact these services, and to recommend methods by which communities can enhance positive wildfire effects and minimize negative ones.

A second team will focus on fire prevention and suppression at the wildland-urban interface in Anchorage and on the Kenai Peninsula. Researchers will model location, value, and vulnerability to wildfire of structures in the WUI, building on previous studies and an ongoing study of cost-effectiveness of fuels mitigation. They will conduct choice experiments asking respondents to select mitigation alternatives based on different costs, incentives, and risks, and will recruit volunteers to participate in local group field experiments. Researchers will then develop an economic model of mitigation and suppression costs and use it to run fire scenarios, which will generate data for use in evaluating how different policy options may generate varying levels of property damage and suppression costs.

Goal BF4: *Hire and train researchers and share results with academic audiences and stakeholders.* The Boreal Fires component will make two faculty hires: a UAF geospatial scientist and a UAA terrestrial ecologist. Two postdoctoral researchers will be hired and up to 6 graduate and 6 undergraduate students will participate each year. Boreal Fires researchers will submit at least 21 articles for peer review based on F&I research and will meet regularly with agencies, communities, tribes and other stakeholders to enable knowledge co-production and to disseminate outlooks, scenarios, visualizations, and other useful products. All team members will participate in activities related to Goal BF4.

Table 3: Boreal Fires Goals and Milestones							
Goal BF1: Produce seasonal fire outlooks by merging data on lightning probability and available fuels with seasonal climate forecasts.							
Objective BF1.1: Develop maps of lightning probability.							
Objective BF1.2: Develop maps of available fuels.							
Objective BF1.3: Produce seasonal fire outlooks from dynamic models.							
Objective BF1.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF1.1a Improve homogenization of lightning data	Bieniek	New metadata integrated into historic lightning database; regional changes to lightning data evaluated in context of new metadata					Improved historic lightning database. Monthly to seasonal spatial assessment of summer lightning predictability across Alaska.
Task BF1.1b Quantify lightning predictability	Bieniek	Precipitation data from weather stations evaluated for relationship to lightning strikes	Teleconnections identified between Alaska lightning strike database and observed and reanalyzed climate variables	Predictability of lightning quantified in seasonal forecasts	Lightning forecasts tested in real time		
Task BF1.1c Apply lightning predictability to seasonal forecasts	Bieniek		Methodology identified to forecast lightning	Historic lightning forecasts evaluated	Lightning forecasts integrated with seasonal weather forecasts (obj. BF1.3)		
Outcomes	Improved climate analysis and ability to quantify fire ignition risk on a monthly to seasonal basis.						
Objective BF1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF1.2a Acquire and process hyperspectral data on fuels	Stuefer, Panda, geospatial scientist hire, Prakash	Instruments adapted and calibrated; 400-2500nm imagery acquired of research sites; initial data processed	Imagery of research sites acquired; data calibrated; radiometric and geometric corrections made	Imagery of research sites acquired if needed; data calibrated; radiometric and geometric corrections made	Imagery of research sites acquired if needed; data calibrated; radiometric and geometric corrections made	Techniques papers submitted in the area of high-latitude hyperspectral remote sensing	Improved fuel maps and fire risk data sets for the entire boreal study domain at landscape scale (1km) and for selected communities at finer scale (5m). Spectral library of fuel types. New algorithm enabling fuel characterization from satellite imagery.
Task BF1.2b Improve characterization of fuel map	Panda, Stuefer, Jandt, geospatial scientist hire, terrestrial ecologist hire, Prakash	Field data collected at Bonanza Creek and other sites concurrent with hyperspectral acquisition	Field data collected concurrent with hyperspectral acquisition; hyperspectral data processed for biomass, moisture content, fuel condition	LTER fuel maps finalized; relationship examined between snowmelt timing and fire season fuel moisture	Fire weather, fuel maps, and snow seasonality analyzed to study links between boreal fire weather, fuel condition, fire risk	Improved fuel maps generated for stakeholders; stakeholder engagement	
Task BF1.2c Scale up fuel map to the entire boreal study domain	Panda, geospatial scientist hire, terrestrial ecologist hire, Prakash		Coarse-resolution satellite data processed for input into scaled-up fuel maps of 2019 fire season	Algorithms developed to link hyperspectral fuel characterization to satellite imagery; link investigated between fuel properties and seasonal snow attributes	Results prepared for publishing and stakeholder engagement		
Outcomes	Significant improvement in boreal fuel mapping capabilities. Improved ability to upscale local fuel characterizations using algorithms.						

Table 3: Boreal Fires Goals and Milestones, continued							
Objective BF1.3	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF1.3a Identify regional short-term weather processes	Bhatt, Bieniek	S2S forecasts evaluated for accuracy in predicting elements of fire weather	Biases in S2S forecasts corrected	Forecasts tested in real time			Improved seasonal forecasts, integrated into GIS-based fire outlooks and associated tools for fire managers.
Task BF1.3b Identify large-scale climate drivers of boreal fire	Bhatt, Bieniek		Teleconnections identified between large-scale climate patterns and Alaska fire weather	S2S forecasts evaluated to identify conditions conducive to fire weather			
Task BF1.3c Synthesize data to build seasonal fire outlooks	Bhatt, Bieniek, Jandt, Hollingsworth				Methods identified to integrate S2S forecasts, climate dynamics, lightning probability and fuels	Forecast components integrated into tools and maps for fire managers	
Outcomes	Improved seasonal climate forecasts, which will contribute to seasonal fire outlooks for use by fire managers. Enhanced capacity to predict zones of more likely fires.						

Goal BF2: Enhance active fire characterization, spread prediction, and severity assessment in the boreal through improved remote sensing, short-term weather data, and field measurements.							
Objective BF2.1: Improve active fire characterization and enhance prediction of fire spread.							
Objective BF2.2: Improve fire severity assessments.							
Objective BF2.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF2.1a Undertake infrared remote sensing of active fires for fire characterization	Stuefer, Panda, Cahill, geospatial scientist hire, Prakash	Instrument integrated and calibrated; opportunistic airborne fire surveys undertaken	Opportunistic airborne fire surveys undertaken; active fire characteristics retrieved	Opportunistic airborne fire surveys undertaken; active fire characteristics retrieved	Opportunistic airborne fire surveys undertaken; active fire characteristics retrieved	Case studies generated of active fire behavior in boreal forests; articles submitted on low and high-temperature fires	Near-real-time snapshots of active fire characteristics. Interactive simulation of boreal fire activity that enables user to input variables and see how they influence fire spread.
Task BF2.1b Use hyperspectral data to improve fire spread models	Stuefer, Panda, Bhatt, Bieniek, Jandt, Prakash	Fire spread models identified; utility of sub-seasonal forecasts to inform models evaluated; hyperspectral and field fuel data processed	Hyperspectral data processed and evaluated; fire case studies conducted	Hyperspectral data processed; hyperspectral and fuel change data evaluated; fire case studies conducted; DEM generated of active fire areas	Fire spread models completed; capabilities of scientific and operational weather models evaluated	Fire spread assessments demonstrated; findings disseminated	
Outcomes	Validation of satellite data, enabling improved monitoring of fire temperatures and intensities and characterization of low-intensity fires. Enhanced ability to forecast fire behavior.						

Table 3: Boreal Fires Goals and Milestones, continued							
Objective BF2.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF2.2a Opportunistically assess fire severity	Hollingsworth, Panda, Stuefer, Prakash		Fire severity after suppressed fire(s) assessed via spectral indices and field survey of vegetation consumed, duff remaining, and mineral soil exposure	Fire severity after suppressed fire(s) assessed via spectral indices and field survey of vegetation consumed, duff remaining, and mineral soil exposure	Optimal imaging combinations explored for improved assessment of fire severity	Results prepared for publishing and stakeholder engagement	A case study characterizing fire severity. A field protocol on severity assessment.
Outcomes	Improved information on fire severity at opportunistic fire sites.						

Goal BF3: Develop science-based options for improving wildfire management policy to maintain ecosystem service flows and foster community resilience.

Objective BF3.1: Identify relationships between ecosystem services and wildfire spread and severity and estimate consequences to communities.

Objective BF3.2: Develop options for changing wildfire management policy and finance in the WUI to reduce costs and increase social benefits.

Objective BF3.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF3.1a Catalog ecosystem service changes near localities impacted by wildfire and fuels management	Brinkman, Heeringa, Schmidt	Participation resolutions passed with communities/tribes, existing data assembled on wildfire locations, fuels management and environmental changes	Focus groups and interviews conducted; local research needs and ecosystem services identified	Regional ecosystem services catalog generated	Results presented to partners, feedback collected	Results prepared for publishing and stakeholder engagement	Database and maps of ecosystem services around approximately 40 communities. Quantitative estimates of vulnerability of ecosystem services for Interior communities. Likert-scale estimations of relative effects of wildfire on ecosystem services. Rankings of adaptation options.
Task BF3.1b Identify relationships between ecosystem services, wildfire spread/severity, and fuels management	Brinkman, Schmidt, Berman			Statistical associations modeled and estimated among ecosystem service availability, wildfire activity, fuels, spread, and severity	Likelihood of exposure and sensitivity of ecosystem services to wildfire assessed	Partner feedback and interpretation solicited; results prepared for publishing	
Task BF3.1c Estimate regional societal consequences of wildfires and management	Brinkman, Heeringa, Schmidt, Berman				Societal consequences of fire-related changes in ecosystem services quantified	Options identified to enhance positive wildfire effects and minimize negatives; findings disseminated	
Outcomes	Increased knowledge of the impacts of fire on ecosystem services, and valuable data for contingency planning by Interior communities.						

Table 3: Boreal Fires Goals and Milestones, continued							
Objective BF3.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF3.2a Develop database, model, and scenarios of wildfire management expenditures	Little, Berman	Historic fire and fire management information assembled	Suppression expenditures across agencies calculated; relevant fire behavior information identified	Statistical model to predict seasonal expenditures by region designed and populated	Model applied to estimate expenditure sensitivities; scenarios co-produced	Results prepared for publishing and stakeholder engagement	Database of wildfire management expenditures. Models and projections of wildfire expenditures, models of community wildfire risks. Scenarios of management expenditures. Wildfire spread scenarios with associated visualizations, and scenarios projecting expansion of WUI and property values at risk for wildfire.
Task BF3.2b Incorporate fire spread modeling to model wildfire risk around communities	Berman, Schmidt, Little	Vegetation and fire risk data assembled; regional fuel model types evaluated	Anchorage fire exposure model refined; homeowners surveyed to inventory wildfire risk mitigation strategies	Fire risk and spread data incorporated into second homeowner survey; data collected on contingent mitigation	Data analyzed; wildfire spread visualizations generated; results presented	Results prepared for publishing; further presentations held	
Task BF3.2c Determine distribution of suppression resources and expenditures; identify co-management options; analyze scenarios	Berman, Little	Data collected on distribution in Alaska of various firefighting resources	Distribution of suppression expenditures identified by firefighting resource; management options ranked to reduce costs and risks to WUI communities	Scenarios developed to analyze effect of policy options on resource distribution and suppression costs		Wildfire spread visualizations presented to stakeholders	
Outcomes	Presentations to policymakers, which will improve the potential to reduce costs of fire prevention and suppression and increase social benefits.						

Goal BF4: Hire and train researchers and share results with academic audiences and stakeholders.							
Objective BF4.1: Hire faculty and postdocs, employ and train student researchers.							
Objective BF4.2: Share findings with academic and public audiences.							
Objective BF4.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF4.1a Hire faculty and postdocs	BF faculty	Search begun for UAF geospatial scientist; 1 postdoc hired	Geospatial scientist hired; search begun for UAA terrestrial ecologist; second postdoc hired	UAA terrestrial ecologist hired			1 UAA and one UAF faculty hire. 2 postdoc hires. 9 undergraduate employment-years, 21 graduate student assistantships.
Task BF4.1b Employ and train undergraduate and graduate researchers	BF faculty	6 undergraduates, 3 graduate students employed and trained	1 undergraduate, 4 graduate students employed and trained	1 undergraduate, 6 graduate students employed and trained	1 undergraduate, 5 graduate students employed and trained	3 graduate students employed and trained	
Outcomes	Faculty, postdocs and students employed and supported to meet research and outreach goals.						
Objective BF4.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task BF4.2a Share results with academic audiences	BF faculty		3 academic articles submitted	5 academic articles submitted	8 academic articles submitted	14 academic articles submitted; final report produced	30 articles submitted for peer-reviewed publication. Final printed report of findings. Presentations at 14 or more public forums.
Task BF4.2b Liaise with community stakeholders and partners	BF faculty	Initial meetings held with agency representatives and communities/tribes for knowledge co-production	Presentation of preliminary products to agency representatives; focus groups and interviews in Interior	Presentations to agency representatives; input used for mid-course adjustments to data processing and products	Final products presented to agency representatives, Interior & Southcentral stakeholders	Further dissemination of final products	
Outcomes	F&I findings disseminated to benefit scientific community. Community stakeholders invited to shape research project and kept apprised of important findings.						

Coastal Margins

The goal of the F&I Coastal Margins team (Table 4, below) is to quantify biological responses to climate-induced changes in physical and chemical conditions along a gradient of glacial to non-glacial coastal waters, and to understand the potential responses of fishing communities to resulting shifts in ecosystem services. Research will take place in two regions of the Gulf of Alaska, Kachemak Bay near Homer and Lynn Canal near Juneau (Figure 3). Coastal Margins researchers will use field and remote sensing data, field and lab experiments, modeling, and user surveys to address four goals (Table 5, below):

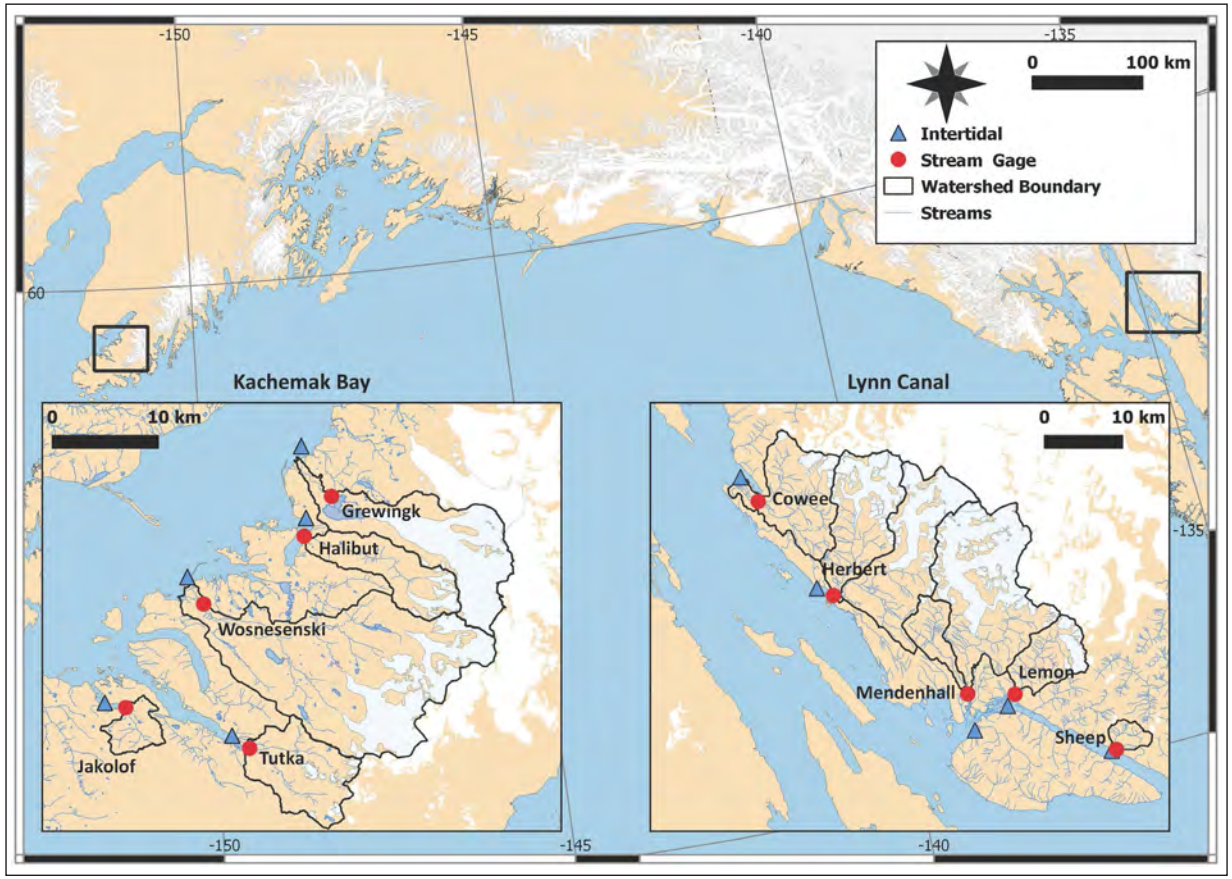

Figure 3. Coastal Margins study regions and sites. Boxes are (l to r) Kachemak Bay and Lynn Canal regions. Blue triangles are sampling sites at estuary mouths, and red dots are stream sampling sites.

Goal CM1: *Characterize the hydrological and biogeochemical dynamics of rivers along a glacial to non-glacial watershed gradient and their linkages to coastal oceanography.* Through intensive measurement of physical and chemical data at the study sites, researchers will better understand how local hydrological and oceanographic drivers affect larger-scale coastal processes, and how these linkages may shift with a changing climate.

Researchers will deploy up to 15 drifters a year across the two regions to gather oceanographic data; Lynn Canal deployments in project year 1 will also test drifter lifespan and recovery options. Researchers will then build circulation models based on both drifter and hyperspectral data from both regions. Oceanographic sensors in Kachemak Bay and Lynn Canal will be used to collect data at 3-hour intervals year-round, and monthly conductivity, temperature, and depth (CTD) transects will be conducted from April to September. Together, these datasets will yield four years of nearshore physico-chemical conditions including pH, salinity, photosynthetically active radiation and temperature. To quantify freshwater inputs to the coast, researchers will deploy sensors in 5 watersheds in each region and combine their data streams with *in situ* coastal measurements, creating a rich multi-year dataset of variables including discharge, stage height, temperature, conductivity, turbidity, and dissolved oxygen. These efforts will enable researchers to craft mechanistic models of freshwater and nutrient flux and nearshore circulation, which they will combine with a 30-year hindcast simulation to identify correlations between freshwater forcing, biogeochemistry and ecosystem structure and function for Gulf of Alaska coastal watersheds.

Goal CM2: *Quantify biological responses of nearshore marine organisms to varying physical and chemical conditions along the glacial to non-glacial gradient.* Impacts to coastal waters from glacial retreat and other climate-driven processes will likely affect both biological community structure, as measured by species composition; and primary and secondary production, as measured by organism abundance and biomass.

Monthly beach seine, quadrat, and plankton sampling from April to September of each year will enable Coastal Margins researchers to quantify spatial, seasonal, and interannual variation in nearshore communities. To understand how the trophic ecology of commercially and ecologically important consumers varies along the glacial to non-glacial gradient, stomach contents will be sampled from at least 200 coho salmon to determine diets, and stable isotopes of carbon and nitrogen will be measured in three invertebrate species and primary producers. Researchers will also construct an Ocean Change Experimental System (OCES), a flow-through laboratory setup designed to test the physiological responses of marine species – in this case mussels, chitons, kelp, and salmon – to changes in temperature, pH, salinity and combinations thereof.

Table 4: Coastal Margins founding core faculty

Name	Affiliation	Expertise	Goal
Anne Beaudreau (co-lead)	UAF-Juneau CFOS	Fisheries ecology and human dimensions	1,2,3
Matt Berman	UAA ISER	Human dimensions	3
Allison Bidlack	UAS ACRC	Coastal rainforest ecosystems	1,2
Jason Fellman	UAS SAS	Hydrology and food webs	1
Claudine Hauri	UAF IARC	Ocean acidification and modeling	1
Eran Hood	UAS SAS	Watershed biogeochemistry	1
Katrin Iken	UAF CFOS	Marine food webs	2
Mark Johnson	UAF CFOS	Nearshore currents and climate variability	1
Amanda Kelley	UAF IMS	Marine biology	1,2
Eric Klein	UAA SAS	Hydrology	1
Brenda Konar (co-lead)	UAF IMS	Benthic community ecology	1,2
Franz Mueter	UAF-Juneau CFOS	Biostatistics and fisheries oceanography	1,2
LeeAnn Munk	UAA CAS	Hydrogeochemistry of watersheds	1
Alexei Pinchuk	UAF-Juneau CFOS	Plankton	1,2
Jennifer Schmidt	UAA ISER	Human dimensions and spatial analysis	3
Martin Stuefer	UAF GI	Hyperspectral remote sensing	1
Oceanographer hire	UAF CFOS	Plankton	2
Fish Genomicist hire	UAF-Juneau CFOS	Fish genetics and physiology	2
Microbiologist hire	UAS SAS	Aquatic microbiology	2

Biological community data, fish diets, and stable isotope data will be modeled as a function of physical-chemical data collected in Goal CM1 to quantify species-environment relationships along the glacial to non-glacial gradient using multivariate statistics and regression models. A mechanistic consumption model for coho salmon will be used to explore how current and future temperature and prey quality scenarios could affect the growth potential of coho salmon. Experimental results will be used to generate functional relationships between metabolism and temperature, pH, and salinity for several organisms.

Goal CM3: *Understand potential responses of coastal resource users to current changes and anticipated future shifts in nearshore marine resources.* Changes to nearshore habitat and organisms could have major impacts to distribution and productivity of harvested species crucial to fishing communities. Researchers will interview up to 50 fishers and 30 institutional representatives in the communities of Homer and Juneau about their observations of changes in the environment, ways they have responded to past ecological, economic, and regulatory pressures, and anticipated future changes. Interviews will provide information on past responses to environmental change to identify avenues for building adaptive capacity to future change.

Goal CM4: *Hire and train researchers and share results with academic audiences and stakeholders.* The Coastal Margins team will make three faculty hires: a UAF biological oceanographer; UAF fish genomicist/physiologist; and a UAS microbiologist. The Boreal Fires team's UAA terrestrial ecologist hire will also assist the Coastal Margins component to collect and analyze physico-chemical data from freshwater and the nearshore. Three postdoctoral researchers will be hired for data integration, model building, and remotely sensed data processing and analysis. Up to 10 graduate and seven undergraduate students will participate each year. Researchers will submit at least 28 articles for peer review and will hold at least six meetings/outreach events with stakeholders. All team members will participate in activities related to Goal CM4.

Table 5: Coastal Margins Goals and Milestones

Goal CM1: Characterize the hydrological and biogeochemical dynamics of rivers along a glacial to non-glacial watershed gradient and their linkages to coastal oceanography.

Objective CM1.1: Characterize how watershed characteristics across a glacial to non-glacial gradient are reflected in nearshore ocean physical and chemical properties.

Objective CM1.2: Characterize how these terrestrial-marine linkages are influenced by large-scale climate drivers in the Gulf of Alaska.

Objective CM1.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM1.1a Collect and analyze oceanographic data	Johnson, Stuefer, oceanographer hire	5 drifters deployed in KB and 10 in LC; hyperspectral imagery acquired along transects in LC and KB	Up to 15 drifters deployed in LC and KB; hyperspectral imagery acquired along transects in LC and KB	Up to 15 drifters deployed in LC and KB; hyperspectral data analyzed	Up to 15 drifters deployed in LC and KB	Drifter data analyzed; remote sensing and drifter data used for spatial mapping and circulation models	Up to 60 drifter deployments, 2 regional drifter data sets, and 2 regional hyperspectral datasets. High-frequency and monthly data from 2 nearshore regions. Physico-chemical data from 10 streams in 2 regions for 4 years. Up to 32 grab samples for geochemical analysis and *in situ* measurement sets. Freshwater and nutrient flux models, nearshore ocean circulation models, and freshwater plume spatial maps.
Task CM1.1b Collect and analyze nearshore marine physico-chemical data	Kelley, Konar, Pinchuk, Munk, BF terrestrial ecologist hire	3 oceanographic sensors deployed in LC and 3 in KB region; data collected at 3-hour intervals; monthly CTD transects conducted Apr-Sept	Data collected at 3-hour intervals; monthly CTD transects conducted Apr-Sept	Data collected at 3-hour intervals; monthly CTD transects conducted Apr-Sept	Data collected at 3-hour intervals; monthly CTD transects conducted Apr-Sept	Data analyzed, used to inform experiments and biological community analyses (see Goal CM2)	
Task CM1.1c Collect and analyze freshwater physico-chemical data	Bidlack, Munk, Klein, Hood, Fellman, BF terrestrial ecologist hire	Sensors installed in 5 streams per study region; sensor data extracted hourly to daily; grab samples and measurements collected up to 8 times	Sensors relocated or re-installed if needed; sensor data extracted hourly to daily; grab samples and measurements collected up to 8 times	Sensor data extracted hourly to daily; grab samples and measurements collected up to 8 times	Sensor data extracted hourly to daily; grab samples and measurements collected up to 8 times	Data analyzed, used to inform experiments and biological community analyses (see Goal CM2); flux models refined and scaled up to region	
Outcomes	Physico-chemical data across a glacial to non-glacial watershed gradient and maps of surface circulation, which will lead to better understanding of how freshwater runoff influences coastal oceanographic processes.						

Objective CM1.2	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM1.2a Model oceanographic and physico-chemical data	Hauri		30-year hindcast simulation analyzed for biogeochemical cycle variability and ecosystem sensitivity	Influence modeled of large-scale climate drivers on biogeochemical cycle and ecosystem			Publishable quasi-4D hydrodynamic and biogeochemical model displaying freshwater signal in marine system.
Outcomes	Models of nearshore ocean circulation and the influence of large-scale climate drivers, which will improve predictions of future conditions in glacially influenced estuaries.						

Table 5: Coastal Margins Goals and Milestones, continued

Goal CM2: Quantify biological responses of nearshore marine organisms to varying physical and chemical conditions along the glacial to non-glacial gradient.

Objective CM2.1: Assess how nearshore biological community composition and production vary across a spectrum of glacial to non-glacial ecosystems.

Objective CM2.2: Assess how nutritional condition and physiological responses of estuarine organisms to freshwater and material flux vary across a gradient of glacial influence.

Objective CM2.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM2.1a Collect and analyze biological field data for fish communities	Beaudreau, Konar, fish genomicist hire	Fish sampling conducted monthly (Apr-Sept); data analyzed and modeled	Fish sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Fish sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Fish sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Data analyzed and modeled	Data sets for abundance and size of fish communities, data on intertidal macroalgae and invertebrates, and plankton community data sets collected 6 months/ year for 4 years in 2 regions. Statistical models of species-environment relationships.
Task CM2.1b Collect and analyze biological field data for macroalgae and invertebrates	Konar, Beaudreau	Macroalgal and invertebrate intertidal sampling conducted monthly (Apr-Sept); Data analyzed and modeled	Macroalgal and invertebrate intertidal sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Macroalgal and invertebrate intertidal sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Macroalgal and invertebrate intertidal sampling conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Data analyzed and modeled	
Task CM2.1c Collect and analyze biological field data for plankton	Pinchuk, Mueter, oceanographer hire	Plankton tows conducted monthly (Apr-Sept); Data analyzed and modeled	Plankton tows conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Plankton tows conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Plankton tows conducted monthly (Apr-Sept); Previous year data analyzed and modeled	Data analyzed and modeled	
Outcomes	Information on how biological communities vary along a glacial to non-glacial watershed gradient, providing insight into the relative importance of key environmental drivers (including freshwater) on nearshore ecosystems.						

Objective CM2.2	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM2.2a Collect and analyze fish stomach contents	Beaudreau, Konar, fish genomicist hire	Monthly (Apr-Sept) field sampling and processing conducted of stomach contents of 100-150 fish in 2 regions	Monthly (Apr-Sept) field sampling and processing conducted of stomach contents of 100-150 fish in 2 regions	Data analyzed; statistical modeling conducted	Mechanistic model constructed of fish consumption and growth rates		Stomach content data for 200-300 coho salmon. Isotope values for 3 invertebrates and primary sources. OCES data for mussels, chiton, kelp and salmon. Mechanistic model of coho consumption and growth, statistical models of organic matter sources of nearshore consumers and of organismal functional responses to temperature, pH, salinity.
Task CM2.2b Collect and analyze isotope data to study diets	Iken, Beaudreau, Konar, microbiologist hire	3 sampling events/site undertaken for freshwater drift samples and plankton	3 sampling events/site undertaken for freshwater drift samples and plankton; samples analyzed in lab	3 sampling events/site undertaken for freshwater drift samples and plankton; samples analyzed in lab; data analyzed			
Task CM2.2c Conduct OCES experiments	Kelley, Konar, Sutton, fish genomicist hire	OCES constructed, calibrated and tested	Physiological responses tested of two species to temperature, pH, salinity, and combinations	Physiological responses tested of two species to temperature, pH, salinity, and combinations	Data analyzed and modeled		
Outcomes	Experimental data on physiological responses to environmental drivers, enabling better understanding of how organisms will respond to changing ocean conditions. Field data to illustrate how sources of nutrition to organisms change along the glacial to non-glacial gradient, elucidating marine-terrestrial linkages in a changing environment.						

Table 5: Coastal Margins Goals and Milestones, continued

Goal CM3: Understand potential responses of coastal resource users to current changes and anticipated future shifts in nearshore marine resources.

Objective CM3.1: Characterize how resource users perceive and respond to changes in local abundance and distribution of harvested species.

Objective CM3.2: Assess the ability of fishing communities to adapt to climate change and other co-occurring pressures.

Objective CM3.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM3.1a Interview fishers, analyze data, build scenarios	Beaudreau		Outreach conducted to participants in Homer and Juneau	Outreach conducted to participants; 15-25 interviews held; data analyzed	15-25 interviews held; data analyzed; outreach conducted to participants	Analysis completed	Interviews with 30-50 fishers in 2 communities. Data on perceptions of environment change and future vulnerabilities.
Outcomes	Local ecological knowledge and resource user responses to ecological change, which will highlight adaptive capacity and reveal potential vulnerabilities to environmental change.						
Objective CM3.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task CM3.2a Interview institutional representatives, analyze data, build scenarios	Berman, Schmidt		Institutional partners engaged in Homer and Juneau; outreach conducted to participants	Outreach conducted to participants; 10-15 interviews held; data analyzed	10-15 interviews held; data analyzed; outreach conducted to participants	Analysis completed	Interviews with 20-30 institutional representatives in 2 communities. Data on institutional or regulatory responses to ecological changes.
Outcomes	Improved understanding of institutional capacity to respond to change, which will provide information to mitigate community vulnerability.						

Goal CM4: Hire and train researchers and share results with academic audiences and stakeholders.

Objective CM4.1: Hire faculty and postdocs; employ and train student researchers.

Objective CM4.2: Share findings with academic and public audiences.

Objective CM4.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CM4.1a Hire faculty and postdocs	CM faculty	Search begun for UAF oceanographer, UAF fish genomicist	UAF oceanographer and fish genomicist hired; search begun for UAS microbiologist; 2 postdocs hired	UAS microbiologist hired; 1 postdoc hired			3 faculty hires, 3 postdoc hires. 35 undergraduate employment-years, 23 graduate student assistantships.
Task CM4.1b Employ and train student researchers	CM faculty	7 undergraduates, 4 graduate students employed and trained	7 undergraduates, 6 graduate students employed and trained	7 undergraduates, 6 graduate students employed and trained	7 undergraduates, 5 graduate students employed and trained	7 undergraduates, 2 graduate students employed and trained	
Outcomes	Faculty, postdocs and students employed and supported to meet research and outreach goals.						
Objective CM4.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task CM4.2a Share results with academic audiences	CM faculty		4 academic articles submitted	6 academic articles submitted	12 academic articles submitted	18 academic articles submitted; final report produced	40 articles submitted for peer-reviewed publication. Final printed report of findings. At least 6 partner meetings/outreach events.
Task CM4.2b Liaise with community stakeholders and partners	CM faculty	Initial meeting(s) held with agency partners to discuss knowledge co-production	Workshop held with agency partners to collaborate on processes, share data and results	Workshop held with agency partners; outreach event held for fishery stakeholders	Outreach event held for fishery stakeholders	Public presentations and school visits held	
Outcomes	F&I findings disseminated to scientific community. New collaborative work with agency partners. Fishery stakeholders invited to shape research project and kept apprised of important findings.						

Diversity, Education and Workforce Development

The Diversity, Education and Workforce Development (DEW) component has two overarching aims: 1) to increase five "key competencies" (Table 6) that are identified in educational literature as essential for building capacity to address sustainability challenges, and 2) to broaden participation in science, technology, engineering and math (STEM) fields. To accomplish this, DEW will undertake a suite of interventions to build key competencies among K-12 students and teachers, to increase STEM interest and identification among a broad swath of K-12 and UA students, and to build capacity among UA faculty to better teach and support UA's diverse student body. The DEW faculty team (Table 7, below), assisted by F&I Southcentral/Southeast Outreach Coordinator Courtney Breest, will work to achieve three goals (Table 8, below):

Table 6: The Five Key Competencies
Systems thinking: comprehending how systems are connected, and internal system dynamics
Futures thinking: envisioning how the past and present inform and influence the future
Values thinking: understanding the effects our values have on our decisions
Strategic thinking: developing strategies to achieve a vision
Interpersonal competence: communicating, deliberating, negotiating, collaborating, leading, and fostering empathy

Goal DEW1: *Build key competencies among stakeholders to address ecological change.* F&I focuses on complex ecosystems undergoing large-scale physical and biological changes. Alaskans who rely on these systems need to be aware of these changes, but education must go beyond simple awareness: addressing large-scale problems requires new ways of thinking, so that stakeholders can effect change and promote sustainable outcomes. DEW adopts the key competencies framework to build capacity to better address the complex challenges that are at the center of F&I research.

To enhance key competencies, DEW will implement two major programs for K-12 teachers and learners: after-school programs and teacher workshops. In partnership with Fairbanks and Juneau school districts and KBNERR, the team will develop games and activities for use in out-of-school contexts, including afterschool activities and summer camps, which have been identified as particularly valuable for building identification with STEM. These activities, which will reach at least 350 students, will enable students to work through current and future landscape scenarios related to F&I research. DEW will conduct three 3-day key competencies workshops to help K-12 teachers develop and integrate new case studies and other scenario-based activities into existing mandated curricula. These will be presented in a real-world narrative format, which has been shown to be key to achieving impacts on students. F&I will also enhance five UA course offerings related to F&I themes, including adding F&I-specific modules to courses in remote sensing, wildlife management, glacial geology, and ocean acidification.

Goal DEW2: *Build a diverse pool of STEM learners and workers in Alaska.* DEW will focus on female, first-generation and Alaska Native K-12 and UA students, helping members of these underrepresented groups to develop and maintain an interest in, and identification with, science. All of these groups face challenges in STEM: first-generation students take longer to complete their education, drop out at higher rates, and have lower academic performance than students of parents with degrees, and these problems may be especially pronounced among STEM majors. Forty-one percent (41%) of UA undergraduates are first-generation, and many are also Alaska Natives, who make up 15% of the total student population; Alaska Natives are also underrepresented in STEM fields. Women are underrepresented in most STEM majors as well: in 2012 women received 36% of undergraduate geosciences degrees, 21% of undergrad computer science degrees, and just 12% of undergrad engineering degrees.

DEW will partner with the federal TRiO program to support peer tutoring for at least 180 students and to hold difference-education interventions for at least 215 students. In these interventions, senior students from underrepresented groups (first-generation, low-income, and/or Alaska Native) lead a one-hour panel discussion for new underrepresented students about their backgrounds and the challenges and opportunities they have created in college. These have been shown to increase STEM self-efficacy and success and to instill a sense of belonging, as measured by grades, retention, and/or graduation rates. In addition, the DEW team to create 5-10 "STEM success stories" highlighting UA alumni from diverse backgrounds who are succeeding in STEM careers. The team will collaborate with marketing directors

and public information officers to share these stories broadly through websites and other venues across the UA system (including rural and community campuses) to increase a sense of belonging among underrepresented students.

Also, DEW will conduct an educational research project in a situated identity context to learn more about how diverse students negotiate STEM pathways. It is increasingly understood that to pursue STEM, students must incorporate the identity of a scientist into their personal identity; however, individuals hold multiple social identities, such as gender, ethnicity or a particular vocational bent, and these sometimes conflict, causing identity interference. The conflict between gender and science identities has been studied in detail, but no research has been done on students' reconciling first-generation and science identities. DEW researchers will undertake a qualitative, multi-year study of a cohort of 10-15 students that will isolate factors leading to first-generation students' identification, or lack of identification, with STEM.

Table 7: DEW core faculty

Name	Affiliation	F&I Focus
Laura Conner (lead)	UAF GI	Education, diversity and research
Beth Leonard	UAA CAS	Diversity, education
Joanna Young	UAF	Girls on Water/Girls in the Forest

The DEW team will take the lead on implementing a strategy to increase diversity among Fire and ice faculty and student hires. Faculty openings will be advertised in more than 20 outlets, including many aimed at underrepresented groups, and F&I representatives will publicize openings at Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conferences and the Western Alaska Interdisciplinary Science Conference (WAISC). Fire and Ice personnel will also work with students to explore establishing a SACNAS chapter at UAF in year 3. Members of hiring committees will be required to undergo implicit bias training, and F&I will offer a larger implicit bias workshop in year 4.

Finally, DEW will initiate two programs modeled on the successful NSF-funded "Girls on Ice" (PLR-1063649) program, which engages diverse groups of high-school-aged girls in STEM and field science through extended trips to glaciers. In keeping with F&I research themes, DEW will implement both a "Girls on Water" program in Kachemak Bay, and a "Girls in the Forest" program in the Alaskan boreal forest, reaching a total of 54 girls. These activities will also build several key competencies among participants.

Goal DEW3: *Increase capacity for F&I science and teaching among UA faculty and students.* To support faculty and to increase their capacity to conduct research, DEW will work with UA provosts and the UAF Office of Faculty Development to assess mentoring needs for faculty and to offer workshops and other support as needed. F&I will provide mentoring for all F&I faculty hires aimed at introducing them to F&I research, aligning their work with project goals, and helping them to build a broad research network. F&I will also provide mentorship to postdocs in accordance with an established plan, and help to implement a postdoctoral mentoring and networking group across the UA system. In addition, F&I will offer a mentorship training workshop to all F&I faculty in Year 1, and as needed for new faculty hires and affiliates in later years. The event will focus on effective methods for mentoring both undergraduate and graduate students and making them feel more connected to F&I. DEW will also competitively award up to 40 faculty travel grants of up to $2,000 each to support professional development through attendance at conferences and workshops. DEW will also support 4 or more individuals per year in years 2-5 to attend WAISC, a valuable event for networking with a diverse set of researchers and community members.

Finally, DEW will offer a suite of workshops focused on diversity and on teaching and learning. Diversity events include a Year 1 workshop on indigenous knowledge, and follow-up workshops that engage with diversity issues related to Alaska Natives, first-generation college students, and women. A year 1 teaching and learning workshop will teach the values-affirmation intervention, in which students write about their values for 10-15 minutes at the beginning of a course; the technique reduces stereotype threat, or the worry that one might confirm a stereotype about one's own sociocultural group (such as race or gender). Stereotype threat has been shown to lower exam performance among underrepresented groups, especially in math and science. Potential workshops later in the award period include a follow-up event on stereotype threat; a workshop on active learning; and other events focused on current topics in K-12 and collegiate education.

Table 8: Diversity, Education, and Workforce Development Goals and Milestones							
Goal DEW1: Build key competencies among stakeholders to address ecological change.							
Objective DEW1.1: Increase K-12 student competencies in systems, values and futures thinking and student knowledge about ecological change related to F&I themes.							
Objective DEW1.2: Prepare UA students with knowledge and skills related to systems and futures thinking.							
Objective DEW1.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW1.1a Implement out-of-school programs	Conner	postdoc hired; needs assessment held with program leaders	Pilot programs for 50 students designed and implemented	Revisions incorporated; programs offered to at least 100 students	Programs offered to at least 100 students	Programs offered to at least 100 students	At least 350 K-12 students served; transferable educational modules developed. At least 60 teachers trained in key sustainability competencies; teacher case studies for classroom use.
Task DEW1.1b Hold teacher workshops	Conner	Staff hired; Content developed	Fairbanks workshop held	Anchorage workshop held	Juneau workshop held		
Outcomes	Increase in student STEM knowledge and competency in futures, systems, and values thinking. Increased teacher skill in meeting Next Generation Science Standards and in guiding students through scenarios to help them develop key competencies.						
Objective DEW1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW1.2a Implement UA F&I course modules	Munk, Panda, Brinkman, Kelley	GEOS 422, WLF 322 modules taught	GEOS 422, GEOS 654, WLF 322, MSL 494 modules taught	GEOS 422, GEOL 463/663, WLF 322 modules taught	GEOS 422, WLF 322 modules taught	GEOS 422, WLF 322 modules taught	Hundreds of students instructed in ecological change, system connections, future scenarios, and human impacts.
Outcomes	Increased knowledge and skills related to systems and futures thinking in the context of ecological change in F&I regions.						

GEOS 422: Geoscience Applications of Remote Sensing; GEOS 463/663: Glacial and Periglacial Geology; GEOS 654: Visible and Infrared Remote Sensing; MSL 494: Field Techniques in Ocean Acidification Research; WLF 322 :Principles and Techniques of Wildlife Management

Goal DEW2: Build a diverse pool of STEM learners and workers in Alaska.							
Objective DEW2.1: Increase the success of diverse UA undergraduates as they pursue STEM degrees, and support diversity in Fire and Ice research hires.							
Objective DEW2.2: Increase interest in, and identification with, science among pre-college girls.							
Objective DEW2.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW2.1a Support peer tutoring	Conner	Semester STEM tutor supported for at least 20 students	2 STEM tutors supported for at least 40 students	2 STEM tutors supported for at least 40 students	2 STEM tutors supported for at least 40 students	2 STEM tutors supported for at least 40 students	180 diverse students tutored. 215 diverse students received difference-education interventions. Qualitative, multi-year study of 10-15 first-generation undergraduate students in STEM. 5-10 stories of underrepresented students shared on institutional websites across UA campuses. Job openings shared through at least 20 venues. At least 20 attendees at implicit bias workshop.
Task DEW2.1b Hold difference-education interventions	Conner	One intervention held for at least 15 students	One intervention held for at least 50 students	One intervention held for at least 50 students	One intervention held for at least 50 students	One intervention held for at least 50 students	
Task DEW2.1c Conduct research on undergraduate science identity	Conner	Postdoc hired (same as in 1.1a); baseline data collected	Data collected	Preliminary data collected and analyzed; results presented at conference	Data collected	Data analyzed; Results presented at conferences and submitted for publication	
Task DEW2.1d Share STEM success stories	Leonard, Conner	Individuals identified to highlight; initial stories collected and edited	Editing concluded; Publicized with UA marketing directors/PIO's	Publicized across all campuses	Publicized across all campuses	Publicized across all campuses	
Task DEW2.1e Support diversity in research hires	Hiring teams, Borland, Bhatt, Conner	Broadly shared job openings	Broadly shared openings; implicit bias training; attended SACNAS and WAISC	Broadly shared openings; implicit bias training; attended SACNAS and WAISC; explored SACNAS chapter	Implicit bias workshop; attended WAISC and SACNAS	Attended WAISC and SACNAS	
Outcomes	Increased sense of STEM self-efficacy, belonging, retention, and/or graduation rates among participants. Increased knowledge about factors leading to success and retention in STEM fields. Increased awareness of potential for STEM success among students from underrepresented groups. Increased diversity in researcher hires.						

Table 8: Diversity, Education, and Workforce Development Goals and Milestones, continued							
Objective DEW2.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW2.2a Implement Girls on Water and Girls in the Forest	Young	Girls on Water held for 9 girls	Girls on Water held for 9 girls	Girls on Water held for 9 girls, Girls in the Forest held for 9 girls	Girls in the Forest held for 9 girls	Girls in the Forest held for 9 girls	54 girls participate in outdoor experiential learning.
Outcomes	Increased participant interest in and identification with science. Anticipated gains in participants' systems, values, and futures thinking.						
Goal DEW3: Increase capacity for F&I science and teaching among UA faculty and students.							
Objective DEW3.1: Provide mentorship, training and travel opportunities to F&I faculty and postdocs.							
Objective DEW3.2: Increase UA faculty capacity to teach diverse students.							
Objective DEW3.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW3.1a Mentor F&I faculty and postdocs	Borland, Veazey, Conner	Postdocs mentored; Mentorship workshop held for all F&I faculty	Faculty hires and postdocs mentored; mentorship workshop held if needed	Faculty hires and postdocs mentored; mentorship workshop held if needed	Faculty hires and postdocs mentored; mentorship workshop held if needed	Faculty hires and postdocs mentored; mentorship workshop held if needed	Mentorship for 5 faculty hires and 6 postdoc hires. At least one mentoring workshop for at least 12 F&I faculty, focused on helping students connect to F&I. 40 awards for faculty attendance at workshops and conferences, 16 awards for WAISC attendance.
Task DEW3.1b Provide faculty travel funding	Borland, Veazey	8 travel grants awarded	8 travel grants, 4 WAISC grants awarded	8 travel grants, 4 WAISC grants awarded	8 travel grants, 4 WAISC grants awarded	8 travel grants, 4 WAISC grants awarded	
Outcomes	Increased faculty and postdoc productivity and retention. Increased sense of affiliation to F&I for students mentored by workshop attendees. Networking and exposure opportunities for faculty.						
Objective DEW3.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task DEW3.2a Hold diversity workshops	Leonard, Conner	One science communication and indigenous knowledge workshop held per campus		follow-up workshop held and videoconferenced across UA		follow-up workshop held and videoconferenced across UA	At least 150 UA faculty and postdocs served by diversity events. At least 80 faculty served by teaching and learning events.
Task DEW3.2b Hold teaching and learning workshops	Conner	Anchorage workshop held	follow-up workshop held and videoconferenced across UA		follow-up workshop held and videoconferenced across UA		
Outcomes	Increased ability to teach diverse students effectively; increased modal grades among students where interventions are used.						

Seed Funding and Emerging Areas

The goal of the F&I seed funding component (Goal SF1, Table 9) is to seed high-risk, potentially transformative research and outreach at the UA related to F&I themes. F&I will accomplish this through two types of competitive seed awards. First, over years 2-5 F&I will award at least 14 grants of up to $20,000 each to UA faculty, and at least 15 grants of up to $4,000 each to UA students, to seed high-risk, potentially transformative research in F&I fields. Proposals will be solicited via an open competition advertised through Alaska NSF EPSCoR and UA outlets. Recipients will be selected through competitive ranking by at least four members of the F&I Leadership Team, based on their intellectual merit, feasibility, novelty, and potential contribution to F&I. Teams with higher proportions of junior faculty will be weighted favorably in decisions. Applicants will be required to generate proposals for continuation support from federal or local agencies.

F&I will also award up to 10 education and outreach seed grants through a parallel solicitation and selection process. Grants will be awarded to UA researchers with innovative ideas 1) to increase STEM interest, practices and identity among Alaska Natives, women, or other underrepresented groups, at the K-12 or university level; and/or 2) to generate F&I research visualizations for use by the STEM community. Grants of up to $10,000 each will be awarded through open competitions in years 2 and 4. F&I will also hold a Methods and Approaches workshop on the UAF campus in Year 2 to update participants on research and help them to nurture seed grant and other research ideas.

Table 9: Seed Funding and Emerging Areas Goals and Milestones

Goal SF1: Seed high-risk, potentially transformative research and outreach related to F&I.

Objective SF1.1: Support UA faculty to pursue potentially transformative research related to F&I.

Objective SF1.2: Support UA faculty to enhance F&I STEM outreach.

Objective SF1.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task SF1.1a Award Research seed grants	Veazey, Borland		4 faculty, 5 student awards	4 faculty, 5 student awards	4 faculty, 5 student awards	2 faculty awards	14 seed grants of up to $20,000 each awarded to UA faculty. 15 seed grants of up to $4,000 each awarded to UA students. Workshop for at least 20 UA faculty.
Task SF1.1b Methods and Approaches workshop	Veazey, Borland		Workshop held				
Outcomes	Faculty and students able to pursue important research questions related to the F&I project. Applications for further funding based on seed grant research.						

Objective SF1.2	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task SF1.2a Award Education and Outreach seed grants	Conner, Veazey, Borland		up to 5 awards		up to 5 awards		Up to 10 seed grants of up to $10,000 each awarded to UA faculty.
Outcomes	Development of innovative methods for reaching underrepresented groups, and of visualizations to further F&I research and outreach, which will enhance and extend F&I DEW efforts.						

Partnerships and Collaborations

F&I adopts a two-part strategy for partnerships, as detailed in Table 10. First, the project will contribute to STEM-based economic development (Goal PC1) by leveraging its financial resources with the expertise of organizations such as the Alaska Technology Research and Development (TREND) Center; the Launch Alaska business accelerator, and the UAF Office of Intellectual Property and Commercialization (OIPC). With their support, F&I will sponsor and organize activities that encourage a community and culture supportive of STEM activities and entrepreneurship. These include 10 workshops in applying and administering federal SBIR/STTR small business awards; support for at least 25 "Phase 0" SBIR/STTR awards for Alaskan startups; at least 5 training sessions designed to encourage UA applications for external private funding; and at least 10 community technology events like Interior Alaska Hackathons, in which programmers create applications for community use, and Raspberry Pi Jams, which include hands-on programming education. These activities are part of a pipeline that feeds into entrepreneurship events like Alaska Startup Week, Mentor Alaska and Launch Alaska events, and programs of the Alaska Small Business Development Center; F&I will collaborate on 15 or more of these events over 5 years. These activities will be overseen by Tara Borland, with assistance in technology events from data visualization specialists Cassidy Phillips and Naomi Hutchens.

The second half of F&I's partnership strategy is for project components to collaborate with external and UA organizations to extend the depth and breadth of their research and outreach efforts (Goal PC2). Boreal Fires partners such as Bonanza Creek LTER and the Alaska Fire Science Consortium offer access to key expertise, facilities and data sets. Coastal Margins researchers will benefit from data sharing with partners including NOAA and KBNERR. KBNERR will also partner with DEW on outreach programs through its headquarters in Homer, while school districts in Fairbanks and Juneau will also be key to implementing DEW out-of-school activities.

Table 10: Partnerships and Collaborations Goals and Milestones

Goal PC1: Strengthen and expand Alaska's STEM economy and entrepreneurial ecosystem.

Objective PC1.1: Collaborate to foster and support the Alaskan entrepreneurial environment and technology community.

Objective PC1.2: Develop and sustain collaborations between UA and industry.

Objective PC1.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task PC1.1a Promote Alaskan SBIR/STTR submissions	Borland	2 SBIR/STTR workshops held; "Phase 0" grants supported through Alaska TREND	2 SBIR/STTR workshops held; "Phase 0" grants supported through Alaska TREND	2 SBIR/STTR workshops held; "Phase 0" grants supported through Alaska TREND	2 SBIR/STTR workshops held; "Phase 0" grants supported through Alaska TREND	2 SBIR/STTR workshops held; "Phase 0" grants supported through Alaska TREND	10 SBIR/STTR workshops. 25+ "Phase 0" awards. 10 community technology and/or "maker" events. 5 Startup Week events, 10 entrepreneurship events. All events held in collaboration with economic development organizations. Goal of 20 participants per event.
Task PC1.1b Sponsor community technology/ maker events	Borland, Phillips, Hutchens	2 events hosted with partners	2 events hosted with partners	2 events hosted with partners	2 events hosted with partners	2 events hosted with partners	
Task PC1.1c Collaborate on Alaska Startup Week and community entrepreneurship events	Borland	Startup Week, two other events supported	Startup Week, two other events supported	Startup Week, two other events supported	Startup Week, two other events supported	Startup Week, two other events supported	
Outcomes	Promotion for participants to pursue and commercialize new STEM-related products, and professional assistance in transforming ideas to products and getting products to market. Material contributions to STEM entrepreneurism in Alaska.						

Table 10: Partnerships and Collaborations Goals and Milestones, continued							
Objective PC1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task PC1.2a Train UA affiliates to apply for external private funding	Borland	Industries identified, one application training session held on UA campus, tele/ videoconferenced across UA, and archived online	one application training session held on UA campus, tele/ videoconferenced across UA, and archived online	one application training session held on UA campus, tele/ videoconferenced across UA, and archived online	one application training session held on UA campus, tele/ videoconferenced across UA, and archived online	one application training session held on UA campus, tele/ videoconferenced across UA, and archived online	5 training sessions on applying for private support. Goal of 20 participants per event.
Outcomes	Development of collaborations between UA and industry; development of new partnerships; fostering of information exchange and of increase in UA applications to private sector for funding.						

Goal PC2: Build partnerships to increase depth and breadth of F&I research and outreach.							
Objective PC2.1: Build and sustain productive research partnerships.							
Objective PC2.2: Build and sustain productive outreach partnerships.							
Objective PC2.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task PC2.1a Partner with external organizations to further Boreal Fires research	Bhatt, Brinkman	Partnered with Tanana Chiefs Conference, Bonanza Creek LTER, NASA ABoVE, SNAP, and AFSC	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	At least 4 Boreal Fires and 3 Coastal Margins external partners.
Task PC2.1b Partner with external organizations to further Coastal Margins research	Beaudreau, Konar	Partnered with Northern Gulf of Alaska LTER, NOAA, KBNERR	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	
Outcomes	Contribution of data and assistance to extend breadth and depth of research, as described under Boreal Fires and Coastal Margins research components.						

Objective PC2.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task PC2.2a Partner with external organizations to increase reach of DEW activities	Conner, Leonard	Partnered with school districts, KBNERR, community organizations	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	Partnered with organizations and communities	At least 3 external DEW partners.
Outcomes	Wider dissemination of program materials; improvements to depth and breadth of DEW education and diversity efforts.						

Communication and Dissemination Plan

F&I will disseminate information through multiple diverse and complementary measures, including DEW efforts, economic development partnerships, regular leadership and science meetings, academic publications and presentations, and stakeholder outreach. Through these venues, F&I will implement a comprehensive information flow both within F&I and between the project and five target audiences: K-12 students; communities in research areas; academics and science professionals; policymakers; and the public (Goal CD1). Most of these efforts are described elsewhere in this report; the specific elements of the Communication Plan detailed here (Table 11) are designed to complement and augment communications activities of the research and DEW components.

On an internal level, the plan includes a project listserv used to share announcements and opportunities, as well as regular email updates from the F&I Principal Investigator, which are also available via a project website. F&I participants will also communicate via annual All-Hands Meetings that will bring together leaders, researchers and students from across the project in years 2-5. External communications efforts will reach a broad and diverse audience through a mix of traditional and new media. Traditional methods include a brochure and glossy midcourse and final reports. F&I will also sponsor at least one keynote speaker each year for a UA workshop; hold two "Science Pubs" a year in Fairbanks, Anchorage or Juneau, in which F&I scientists share their research in a relaxed setting; and partner to conduct annual science training workshops for tour guides, with the goal of increasing their ability to discuss scientific topics with some of Alaska's two million annual visitors.

These efforts are complemented by a robust online presence, including a website hosted by the University of Alaska as well as social media updated at least four times a week, incorporating Facebook, Twitter, YouTube, Instagram, Issuu, and other platforms. Social media will expand to new platforms as they emerge. In addition to YouTube, F&I videos will be shown on AlaskaOne/KUAC-TV public television in Fairbanks, and F&I will develop content for virtual reality and other interactive applications. F&I will also partner with UA public information offices to broaden dissemination of F&I news and findings. F&I Communications Manager Tom Moran will oversee the Communication and Dissemination Plan, F&I Southcentral/Southeast Outreach Coordinator Courtney Breest will assist in generating social media content and staging events, and data visualization specialists Cassidy Phillips and Naomi Hutchquist will create videos and data visualizations.

Table 11: Communication and Dissemination Plan

Goal CD1: Implement smooth and comprehensive information flow within F&I project and between project and target audiences.

Objective CD1.1: Deliver regular project updates and announcements to F&I participants.

Objective CD1.2: Engage diverse external audiences in F&I project.

Objective CD1.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task CD1.1a Share pressing updates with F&I participants	Moran	EPSCoR listserv updated for F&I, listserv updates shared as needed	Updates shared as needed	Updates shared as needed	Updates shared as needed	Updates shared as needed	Updated listserv, regular announcements, up to 9 Letters from the PI and at least 16 online newsletters. 4 All-Hands Meetings bringing together all project participants.
Task CD1.1b Share periodic updates with F&I participants	Veazey, Moran	Letters from the PI shared every 6-8 weeks to share progress	Online newsletter issued every 1-3 months to share progress	Online newsletter issued every 1-3 months to share progress	Online newsletter issued every 1-3 months to share progress	Online newsletter issued every 1-3 months to share progress	
Task CD1.1c Hold All-Hands meetings	Borland, Veazey		Fall meeting held in Fairbanks	Fall meeting held in Anchorage	Fall meeting held, location TBD	Fall meeting held in Fairbanks	
Outcomes	Participants kept informed about progress of project, leading to motivated researchers, increased understanding by F&I participants of project scope, and increased collaborative opportunities across components.						

Table 11: Communication and Dissemination Plan, continued							
Objective CD1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task CD1.2a Provide consistent web presence	Moran	EPSCoR website revamped for F&I; material contributed to UA website(s) for greater exposure	Website updated to reflect project progress, material contributed to UA website(s)	Website updated to reflect project progress, material contributed to UA website(s)	Website updated to reflect project progress, material contributed to UA website(s)	Website updated to reflect project progress, material contributed to UA website(s)	Continually updated website. 2 printed reports sent to at least 600 people each. Project brochure. Up-to-date social media presence delivered to audience of at least 600 Facebook friends. At least 15 videos, VR programs, or other interactive media items. 5 speakers, 10 science pubs, and 5 tour guide workshops, with audiences of at least 25 for each event.
Task CD1.2b Share progress via publications	Moran	Mailing list updated	Program brochure published	Midcourse Report published		Final Report published	
Task CD1.2c Share progress via social media	Moran, Breest	Social media updated 4x/week; F&I students and faculty recruited to contribute	Social media updated 4x/week; F&I students and faculty recruited to contribute	Social media updated 4x/week; F&I students and faculty recruited to contribute	Social media updated 4x/week; F&I students and faculty recruited to contribute	Social media updated 4x/week; F&I students and faculty recruited to contribute	
Task CD1.2d Share progress via videos and interactive media	Moran, Phillips, Hutchquist	At least 3 videos, VR programs, or other items shared online	At least 3 videos, VR programs, or other items shared online	At least 3 videos, VR programs, or other items shared online	At least 3 videos, VR programs, or other items shared online	At least 3 videos, VR programs, or other items shared online	
Task CD1.2e Engage public in F&I events	Borland, Moran, Breest	1 speaker supported, 2 science pubs and 1 tour guide workshop held	1 speaker supported, 2 science pubs and 1 tour guide workshop held	1 speaker supported, 2 science pubs and 1 tour guide workshop held	1 speaker supported, 2 science pubs and 1 tour guide workshop held	1 speaker supported, 2 science pubs and 1 tour guide workshop held	
Outcomes	Key audiences informed about F&I progress and findings; raised profile of F&I and of research in general; contributions to science literacy; improved relations with the public; pathways to mobilize results.						

Sustainability Plan

A principal goal of F&I is to build sustainable capacity at the UA and in Alaska to increase knowledge about climate-driven ecological change and to mobilize it for use by researchers and stakeholders. F&I will accomplish this through a Sustainability Plan (Table 12) consisting of faculty and postdoc hires and of applications for outside funding (Goal SU1). F&I's education and workforce development initiatives will build sustainability by providing STEM inspiration, instruction and capacity at levels ranging from K-12 through to graduate students. But F&I's central contribution to long-term UA human resources development will be its five tenure-track faculty hires, who will continue to add to UA expertise after F&I concludes. These hires will enjoy a high level of research freedom as well as professional support and mentoring and will have 60% research workloads, enabling them to focus on F&I work. F&I will also hire six postdoctoral fellows, who will operate under a mentoring plan and also benefit from a new cross-UA postdoctoral mentoring and networking group F&I will help to implement.

Long-term sustainability of F&I science will be realized through support from diverse funding streams. F&I will mentor faculty and students applying for numerous federal, state and UA awards. F&I researchers will apply for at least 100 external awards based on an annual plan, which will enhance F&I research competitiveness and strengthen UA researchers' capacity to provide input to the NSF's "Navigating the New Arctic" program. This plan includes collaborating on applications for NSF Research Traineeship (NRT) awards in year 2 and submitting Research Coordination Network (RCN) applications in year 3. Both the Boreal Fires and Coastal Margins components will craft white papers for a potential UA Science and Technology Center (STC) in year 4 and, pending UA approval, then submit 1 or 2 preliminary STC applications in year 5.

Table 12: Sustainability Plan

Goal SU1: Increase sustainability of F&I research through new hires and applications for external funding.

Objective SU1.1: Hire UA faculty and postdocs.

Objective SU1.2: Apply for multiple levels of external funding.

Objective SU1.1	Responsible Parties	Milestones					Outputs
		Year 1	Year 2	Year 3	Year 4	Year 5	
Task SU1.1a Boreal Fires hires (see also BF4.1a)	Bhatt, Brinkman, Veazey, Borland	Search begun for UAF geospatial scientist; 1 postdoc hired	Geospatial scientist hired; search begun for UAA terrestrial ecologist; second postdoc hired	UAA terrestrial ecologist hired			3 new UAF faculty, 1 new UAA faculty, 1 new UAS faculty, new postdocs.
Task SU1.1b Coastal Margins hires (see also CM4.1a)	Beaudreau, Konar, Veazey, Borland	Search begun for UAF oceanographer, UAF fish genomicist	UAF oceanographer and fish genomicist hired; search begun for UAS microbiologist; 2 postdocs hired	UAS microbiologist hired; 1 postdoc hired			
Task SU1.1c DEW postdoc hire	Conner	UAF postdoc hired					
Outcomes	Contribution of faculty hires to F&I fields both during and after project period. Contribution of postdocs to F&I goals and to strengthening UA's reputation in F&I areas.						
Objective SU1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task SU1.2a Applications for external funding	F&I faculty	At least 10 F&I-related proposals submitted	At least 15 proposals submitted; Collaborated on NRT propoals	At least 25 proposals, 2 RCN proposals submitted	At least 25 proposals submitted; 2 STC white papers drafted	At least 25 proposals, preliminary STC proposal(s) submitted	At least 100 proposal submissions; 1 or 2 preliminary Science and Technology Center proposals.
Outcomes	External funding procured to expand upon and continue F&I research and outreach.						

Management, Evaluation and Assessment Plan

F&I will implement a thorough and responsive management structure (Goal ME1, Table 15, below) overseen by highly qualified Leadership and Management teams (Table 13), assisted by three panels of authorities and experts. Project leaders will benefit from annual feedback from two groups of evaluators, one focused on general project activities (Table 14, below) and the other on DEW.

Management. F&I adopts a shared leadership model proven effective in large team science projects, with five Management Team members providing day-to-day management and another eight providing science and outreach leadership. The Project Director will provide strategic guidance and lead synthesis discussions. The Project Administrator will oversee project coordination. A Financial Manager will provide financial oversight, a Communications Manager will coordinate external engagement, a Data Visualization Specialist will lead Vis Space activities, and a Data Manager will oversee data acquisition, storage and dissemination. Science leadership comes from the Coastal Margins and Boreal Fires co-leads, the DEW lead, and UAA and UAS campus liaisons.

Table 13: Leadership and Management Teams

	Name	Role
Leadership Team	Alice Veazey	Principal Investigator and Project Director
	Tara Borland	Project Administrator
	Uma Bhatt	Co-Lead, Boreal Fires Team
	Todd Brinkman	Co-Lead, Boreal Fires Team
	Brenda Konar	Co-Lead, Coastal Margins Team
	Anne Beaudreau	Co-Lead, Coastal Margins Team
	Allison Bidlack	Co-PI, University of Alaska Southeast
	LeeAnn Munk	Co-PI, University of Alaska Anchorage
	Laura Conner	DEW lead
Mgmt. Team	Alice Veazey	Principal Investigator and Project Director
	Tara Borland	Project Administrator
	Shannon Watson	Financial Manager
	Tom Moran	Communications Manager
	Cassidy Phillips	Data Visualization Specialist
	Vanessa Raymond	Data Manager

The Leadership and Management teams ensure F&I meets goals and objectives set forth in this Strategic Plan; respond to external evaluations and NSF Site Visit and Reverse Site Visit recommendations and implement appropriate changes; award seed grants; and compile NSF reports, including creating an online database to facilitate annual reporting by participants. The Management Team will also oversee the management and dissemination of data and data products generated by the project, which will be stored in an F&I data catalog and made available via an online portal, both maintained by a dedicated data manager. The Leadership and Management teams will meet four times a year to coordinate progress, and will also meet with leadership teams of individual components at least monthly. Additionally, the Coastal Margins, Boreal Fires, and DEW leads will maintain internal communication with team members. Component teams will meet in person or by teleconference at least once every two months.

Three different groups will offer input and oversight to the Leadership Team. Alaska NSF EPSCoR is governed by a roughly 20-member State Committee for Research (SCoR), consisting of leaders from government, agencies, academia, and the private sector. Alaska Lieutenant Governor Kevin Meyer and UA Vice-President for Academics, Students and Research Paul Layer serve as co-chairs. F&I PI Veazey is a non-voting member. SCoR will semi-annually review F&I progress and provide guidance to assure the program achieves state S&T goals.

The Leadership Team will also draw on recommendations from an External Advisory Council (EAC) consisting of outside experts in F&I fields, who will measure progress toward milestones and recommend course corrections. Members are Michelle Mack, Professor at the Center for Ecosystems and Society at Northern Arizona University, who will advise on ecosystem ecology and disturbance regimes; Dar Roberts, Professor of Geography at the University of California Santa Barbara, who will advise on hyperspectral analysis and wildfires; Phil Levin, Lead Scientist of the Nature Conservancy, who will advise on marine ecology, fisheries, and ocean modeling; and Phil Higuera, Associate Professor of Fire Ecology at the University of Montana, who will advise on fire ecology and modeling. In addition, Leadership Team members will meet with

leaders of the three main UA campuses and of the UA system once a year to update them on F&I progress, issues, and accomplishments, to solicit feedback on keeping F&I objectives and goals relevant to UA, and to ensure that UA institute and departmental commitments to F&I are fulfilled.

Succession Plan. F&I operates under a Succession Plan to ensure swift and orderly transitions should any Leadership Team members exit the project. Should PI/PD Veazey leave the project, a successor will be identified and approved by leaders at the three main UA campuses and the statewide UA system. That individual will then be confirmed by the UA President, pending approval by the NSF. In the event any Co-PI's or the PA leaves their position over the course of the project, the Project Director will choose a replacement.

Evaluation and Assessment. External evaluators of the project as a whole are Julia Melkers, Associate Professor of Public Policy at the Georgia Institute of Technology, and Eric Welch, Director of Arizona State University's Center for Science, Technology and Environmental Policy Studies, serving as independent consultants. An additional DEW evaluation will be undertaken by Angela Larson of the Goldstream Group LLC, a Fairbanks-based planning, development and evaluation company. Both Melkers/Welch and Larson will provide annual reports, including summaries of data, findings, and recommendations, which will be shared with the F&I Leadership Team and with the NSF. F&I leaders will institute annual midcourse changes based on these evaluations as appropriate.

Melkers and Welch will collect quantitative data using consistent metrics (Table 14, below) for longitudinal tracking of activities and outputs, and qualitative data collection to explore and understand nuances of project work. Primary data collection will include annual interviews with F&I leadership and key faculty, as well as annual surveys (including social network analysis) of faculty and/or students. Team productivity will be assessed with bibliometric and/or grant proposal data in years 2-5. Data collection and analysis will address project development, interdisciplinary collaboration, knowledge production, and related outcomes in the Boreal Fires and Coastal Margins teams. The analysis will also take into consideration differences across program participants by career stage, institution, discipline, and other factors. Metrics will be selected to reflect development of research capacity and competitiveness.

The Larson DEW evaluation will provide feedback to improve the capacity of the DEW component to build the five key competencies among stakeholders, as well as stakeholders' interest in science and development of a science identity. In particular, the evaluation will focus on measuring outcomes of three K-12 programs - out-of-school programs, teacher workshops, and Girls on Water/Girls in the Forest - as well as diversity, teaching and learning workshops. Larson will provide annual formative and summative assessments of fidelity to F&I objectives and identified competencies; stakeholder engagement in the learning process; self-reported stakeholder learning of competencies or dispositions that contribute to science identity; and stakeholder use of knowledge gained through participation in F&I activities.

Larson's team will collect data via: 1) fidelity rubrics for each major program activity type; 2) observations, PI interviews, and analysis of project documents; 3) post-surveys to assess participant engagement in learning; 4) pre/post written surveys to measure participants' changes in competencies and their plans to use competencies or knowledge gained; and 5) annual surveys of adult participants to measure use of competencies gained. Surveys will be analyzed using descriptive statistics, content analysis, and parametric statistics where appropriate. Annual reports will summarize results and provide recommendations for each major program activity, as well as a summary of progress toward goals, objectives, and milestones.

Table 14: F&I External Evaluation Criteria		
Data Source	**Topic**	**External Evaluation Metrics**
Project Implementation and Management		
Project documents and institutional records	Implementation, management, timeliness, and structure	Milestones attained: faculty hired; equipment purchased; students hired (including underrepresented students); proposed activities initiated; students supported and engaged in research
Integration and Productivity		
Faculty and stakeholder data collection, including faculty surveys, faculty interviews, stakeholder interviews, bibliometrics, online metrics	Research production and impact	•Academic production (papers, presentations, publications) •Co-authorship, collaborative patterns, statewide collaborations •Journal impact factors, citation rates •Grant submissions and awards •National and international visibility and reputation
	Interdisciplinary integration	•Interdisciplinary academic production (presentations, publications) •New collaborative teams and partnerships •Evidence of interdisciplinary knowledge development •Barriers and opportunities for interdisciplinary integration
	Research capacity development	•Statewide research activities and outcomes •Institutional support and cultural enhancements •Enhanced statewide monitoring and assessment capacity
	Equipment and data sharing	•Access and use of data sources •Impacts of data access and use on research production
Workforce Capacity Development		
Project documents and other institutional records, including faculty and student surveys	Early-career impacts	•New faculty hires, junior faculty funding, career progress and advancement •Early-career participation in collaborative activities, early-career outputs •Articles, conferences, grants
	Diversity	•Underrepresented participants (diversity by race/ethnicity, gender, first-generation status), changes over time, by rank, participation and role •Barriers and opportunities for diversity development •Collaborative engagement, co-authorship, and academic production by underrepresented faculty and students •Targeting and involvement of underrepresented participants in outreach •STEM interest of underrepresented outreach participants and change over time
Student surveys, focus groups, online metrics	Student capacity development and F&I impacts	•Number of students involved in academic products •Student skill development outcomes •F&I-related dissertation activity •Student postgraduate placement and advanced degree status
Broader Impacts and Outreach		
Stakeholder interviews, project documents	Outreach development and impacts	•Development of stakeholder-appropriate research dissemination products •Participation in visualization events and assessment of usefulness

Table 15: Management, Evaluation and Assessment Plan							
Goal ME1: Develop and implement a comprehensive management structure to ensure project success.							
Objective ME1.1: Implement project and solicit advice through meetings of Leadership Team, advisory boards, and components.							
Objective ME1.2: Evaluate F&I activities to track progress and enable course corrections.							
Objective ME1.1	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task ME1.1a Provide statewide oversight	Alaska SCoR	2 or more SCoR meetings held	2 or more SCoR meetings held	2 or more SCoR meetings held	2 or more SCoR meetings held	2 or more SCoR meetings held	At least 10 SCoR meetings, 2 EAC site visits, 5 meetings with UA leaders, 20 leadership meetings, 180 project leaders/ component lead meetings, 90 component meetings. Database for reporting and portal for research data dissemination implemented and kept up-to-date.
Task ME1.1b Provide external intellectual oversight	External Advisory Council		F&I site visit held; recommedations implemented		F&I site visit held; conclusions delivered		
Task ME1.1c Provide university oversight	UA campus leaders	met with F&I PD and/ or PA	met with F&I PD and/ or PA	met with F&I PD and/or PA	met with F&I PD and/ or PA	met with F&I PD and/ or PA	
Task ME1.1d Gather Leadership Team	Borland, Veazey	2 in-person meetings, 2 videoconferences held	1 in-person meeting, 3 videoconferences held	2 in-person meetings (incl. Midcourse Retreat), 2 videoconferences held	1 in-person meeting, 3 videoconferences held	1 in-person meeting, 3 videoconferences held	
Task ME1.1e PD and PA meet with individual component leads	Borland, Veazey	Met at least once a month with each component	Met at least once a month with each component	Met at least once a month with each component	Met at least once a month with each component	Met at least once a month with each component	
Task ME1.1f Component meetings	CM, BF, DEW leads	Met at least once a month	Met at least every other month	Met at least every other month	Met at least every other month	Met at least every other month	
Task ME1.1g Implement participant database, data portal	Raymond, Veazey, Borland, Moran	Database implemented, used on pilot basis; Data manager hired; Data portal implemented	Database fully impemented and updated; Data portal populated	Database updated; Data portal populated	Database updated; Data portal populated	Database updated; Data portal populated	
Outcomes	Feedback to F&I leadership to help reach goals. Avenues to coordinate activities within and across components. Project data collected and made available.						
Objective ME1.2	**Responsible Parties**	**Milestones**					**Outputs**
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
Task ME1.2a External evaluation	Julia Melkers, Eric Welch	Leadership interviews held, faculty surveyed	Lead and student interviews held, faculty and students surveyed, grants analyzed	Lead, faculty, partner interviews held, students surveyed; bibliometric and grant analyses undertaken	Lead, faculty, partner, UA interviews held; faculty and students surveyed; grants analyzed	Lead, partner, UA interviews held; students surveyed; bibliometric and grant analyses undertaken	5 external evaluators' reports, 4 DEW reports on 4 DEW activities each. Data and recommendations provided to Leadership Team.
Task ME1.2b DEW evaluation	Angela Larson	Evaluation planned out	4 types of DEW activities evaluated	4 types of DEW activities evaluated	4 types of DEW activities evaluated	4 types of DEW activities evaluated	
Outcomes	Implementation of changes to project as appropriate based on evaluations, improving ability to meet research and outreach goals.						

Risk Mitigation Plan

A research project of this scale and complexity carries with it an inherent degree of risk. The next five years present any number of possible developments that may complicate our efforts to reach project goals. The F&I Risk Mitigation Plan (Table 16) breaks down the most likely risks that F&I faces and logical steps to mitigate these problems, broken out into categories. Risks are color-coded based on both the likelihood they will arise and the magnitude of their impact.

Table 16: Risk Mitigation Plan

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Research Components	Damage to instrumentation	Loss of funds and time	Medium	Medium	Use secondary data; redeploy if necessary
	Poor weather conditions	Delays in field data collection	Medium	High	Mine secondary sources for datasets
	Attrition of key faculty	Loss of expertise, skills	High	Medium	Enable diversity of personnel through component sub-teams
	Failure or delays in faculty or postdoc searches	Delay in placing significant team member	High	Medium	Recruit early and use faculty networks to identify strong pool of applicants
	Lack of diversity in faculty hire pool	Loss of richness in perspectives and participation	Medium	High	Widely advertise openings in manners that reach diverse audiences
	Research activities hindered by timeline and budget	Activities and measurements unproductive for capacity building	Medium	Medium	Make years 1-2 incubation period, with flexibility to "red flag" vulnerable activities and devise alternatives
	Insufficient personnel for fieldwork, processing, community work	Delays in field data collection	Medium	Medium	Redouble volunteer recruitment; liaise with community organizations for additional help
	Failure to liaise with communities in fieldwork areas	Lost opportunities for knowledge co-production and sharing	Medium	Low	Revise approach to align with community interests. Pursue alternative communities or alternative organizations within communities
	Lack of timely, accessible wildfires	Delays in Boreal Fires field data collection	High	Low	Broaden geographic range and scope of acceptable wildfires; delay some research a season if necessary
DEW	Lack of research component and DEW cross-pollination	Poorly integrated research and education	Medium	Low	Maintain strong communication channels, including periodic DEW attendance at research component meetings
	Stagnant or low diversity numbers in STEM programs	Loss of richness in perspectives and participation	Medium	Low	Reevaluate and revise recruitment methods and programs
	Implementation failures by out-of-school program partners	Failure to achieve goals for participants	Medium	Low	Pursue alternative out-of-school partner districts and organizations
Communications	Low attendance at F&I events	Missed opportunities to inform public	Medium	Medium	Increase marketing; engage better-known speakers; change locations and times; make content available online
	Public misconceptions about F&I work	Lack of support/ understanding	Medium	Medium	Pursue information campaign through mainstream media (i.e. newspaper guest columns) and stakeholder communication channels (i.e. tribal newsletters)
Management	Loss of senior personnel	Lack of continuous guidance for project implementation	High	Medium	Follow through with succession plan; identify supporting personnel to fill potential voids
	Coordination and management overwhelm research	Lack of intellectual merit; science and inspiration suffer	Medium	Medium	Disperse leadership roles and involvement; obtain dedicated institutional support and recognition
	Lack of understanding of responsibilities by project teams	Lack of progress toward project goals	Medium	Low	Clearly delineate resposibilities early in project and maintain open communication between leaders and project teams. Focus on co-development of transparent contracts.
Evaluation and Assessment	Poor contact lists	Less thorough survey and bibliometric analysis	Medium	Low	Cooperate with F&I staff to maintain high-quality personnel lists; pioneer and refine online database
	Poor response to surveys	Unreliable evaluation findings	Medium	Low	Work with F&I leadership to communicate importance and relevance of the evaluation

Appendix A: Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

In July 2018, members of the individual F&I components as well as F&I leaders met independently to develop SWOT analyses for their components. These analyses were discussed and refined by component leads as a group in an August 2018 meeting and again at the August 2018 Strategic Planning Meeting.

When asked to identify strengths, many F&I faculty pointed to the experience of the researchers and management team, the interdisciplinary nature of the science and of the research teams, and the innovative approaches being applied. Major weaknesses cited included the lack of specific expert personnel in some areas; funding limitations; and concerns about the challenges of doing research in the Alaskan environment.

Faculty and staff noted that F&I presents opportunities to extend the depth and breadth of the research through collaboration with external organizations. They also cited opportunities to increase integration within F&I, and to enhance knowledge co-production and outreach by working with communities. Threats to F&I research came in areas including weather impacts to equipment and fieldwork plans; personnel turnover and recruitment difficulties; and unexpected changes to funding support.

Strengths

Program Management

- A seasoned management team
- Established relationships across Alaska
- Long history of experience with NSF EPSCoR
- Responsiveness to opportunities
- Vis Space visualization facility and other valuable infrastructure
- Strong and established communication network and venues
- Strong award management processes
- Strong network with Alaska's economic and workforce development communities

Boreal Fires component

- Research rooted in basic science with societal relevance and applications
- Knowledge co-production with stakeholder communities and fire managers
- Interdisciplinary research team to address complex problem
- Innovative elements including use of hyperspectral remote sensing to characterize fuels, fire spread, and fire severity; inclusion of lightning potential in seasonal forecasts; and exploring new institutional mechanisms for wildfire management
- Well-established research collaborations with Alaska fire managers
- Co-location of researchers with stakeholders and with wildland fires
- Long-term field data access through established partnerships, e.g. with Bonanza Creek LTER

Coastal Margins component

- Strong, experienced research team
- Diverse collaborative team that brings together the fields of remote sensing, hydrology, biogeochemistry, oceanography, physiology, fisheries, ecology, anthropology, and economics to address complex questions in a linked social-ecological system
- Experience of team members working at many of the proposed study sites
- Existing data from the study regions collected by team members and/or available from agencies, and established protocols for data collection
- Unique study regions providing a gradient of relatively undisturbed watershed types within a small geographic area
- Existing infrastructure for field support in both study regions
- Innovative elements, including potential use of hyperspectral and satellite imagery to resolve the extent, duration, and variability of river plumes in the nearshore marine environment, and use of Ocean Change Experimental System to examine impacts of multiple stressors simultaneously on economical and ecologically important species
- Potential to develop new transdisciplinary tools for understanding social-ecological systems and engaging communities through applied social science

Diversity, Education, and Workforce Development component

- Well thought-out design built on unified key competencies framework
- Team with diverse prior NSF EPSCoR experience
- Team members with deep understanding of educational programs and diversity
- Project elements built from successful models or from previous activities with proven success
- Innovative inclusion of educational research in NSF EPSCoR context

Weaknesses

Program Management

- Extra management needed to coordinate across separate science components
- Lack of leadership with expertise across both project disciplines
- Research expensive and separated by vast geographic distances
- Limited overlap of faculty and staff skill sets due to small institutional system
- Substantial, repeated cuts to University of Alaska budget
- Challenges of attracting diverse candidates for faculty hires and other recruitment

Boreal Fires component

- Weak link between scientific findings and potential policy implementation
- Time-consuming nature of research tasks
- Need for additional spatial dynamic ecosystem services expertise
- No in-house training available in open-source data processing, agency tools, and Google Earth engine

Coastal Margins component

- Need for more involvement of oceanographic, statistical and ecological modelers
- Need for additional expertise in applied social sciences in order to realize the full value of data generated through synthesis
- Lack of expertise in phytoplankton in initial stages of project
- Limited mechanistic modeler expertise
- Reliance on volunteers for fieldwork, which could present recruitment and training challenges
- Reliance on external sampling efforts (i.e., by NOAA)
- Distributed, relatively remote research sites, which require extensive travel resources
- Significant reliance on postdoctoral researchers for advanced data analysis, modeling, and synthesis
- Potential for emergency repair and replacement of major equipment

Diversity, Education, and Workforce Development component

- Diverse group of staff and faculty undertaking multiple levels of tasks, which creates challenges in task management
- Lack of system-wide, embedded incentives for faculty participation in training
- Limited control over STEM enrollment/retention rates, as they are contingent on many factors outside EPSCoR's purview
- Challenges to minority hires and participation due to competitive nature of recruiting

Opportunities

Program Management

- Increased integration across research components and with DEW
- Increased visibility across jurisdiction through enhanced communications efforts
- Partnership opportunities in burgeoning field of Arctic research
- Enhanced outreach through facilities such as the Vis Space
- Chance to further develop science management capacity across the UA system
- Evolving media platforms provide new opportunities to reach stakeholders and the public

Boreal Fires component

- Broader application of research beyond boreal forest
- Collaboration with regional wildfire consortia to transfer research to additional North American ecosystems, communities at the wildland-urban interface, and terrain/vegetation types
- Preparatory science to develop baseline products for hyperspectral satellite sensors
- Incorporation of findings into Google Earth
- Potential to collaborate with Coastal Margins team on topics such as ecosystem services, hyperspectral imagery, research data management, and resource management
- Collaboration on coursework with UA distance learning and instructional designers
- Creation of useful products for practitioners, such as fuel maps, risk maps, models, interactive visualizations, and animations

Coastal Margins component

- Development of new interdisciplinary and transdisciplinary tools for marine management and conservation through human dimensions component of research
- Co-production of research with communities and stakeholders
- Potential use of OCES to examine more stressors and species
- Use of hyperspectral imagery and advanced remote sensing techniques to map nearshore turbidity and vegetation
- Collaboration between Coastal Margins and Boreal Fires teams on human dimensions research
- Targeted science-sharing meetings with groups like the Coastal Rainforest Margins Research Coordination Network, Gulf Watch Alaska, and Gulf of Alaska LTER
- Collaboration with NOAA and other agencies to collect data in Kachemak Bay
- Concrete partnerships with NOAA, ADFG, tribal organizations, and other entities within the university system
- Engagement of community members in scientific data collection

Diversity, Education, and Workforce Development component

- Leveraging of incoming postdoc's skills and interests to expand focus on undergraduate STEM identity development into other areas that could impact diversity at UA
- Emergent outreach opportunities based around specific communities targeted for Boreal Fires and Coastal Margins research
- Expansion of out-of-school programs to other school districts
- Expansion of interventions (difference-education, etc.) to other campuses

Threats

Program Management

- Failed faculty searches
- Research stymied by excessive bureaucracy
- Lack of understanding of responsibilities by component teams
- Turnover and attrition in both management and science
- Team conflict (personal conflict, unaligned goals, poor internal communication)
- Decrease to state matching funds

Boreal Fires component

- Locations and occurrences of fires not conducive to affordable research
- Delays in onboarding personnel
- Instrument malfunctions
- Delays to project engendered by co-production of research with communities
- Personnel turnover, and challenges with retention and recruitment

Coastal Margins component

- Potential damage to *in situ* equipment from floods and storms as well as local boaters
- Bad weather limiting days in the field
- No duplication of expertise

Diversity, Education, and Workforce Development component

- Limited control over implementation of out-of-school programs by external entities
- Lack of buy-in from faculty with respect to DEW participation
- Lack of diversity of faculty hires due to characteristics of applicant pool

Appendix B: Acronyms

ABoVE: Arctic-Boreal Vulnerability Experiment
ACRC: Alaska Coastal Rainforest Center
ACUASI: Alaska Center for Unmanned Aircraft Systems Integration
ADFG: Alaska Department of Fish and Game
AFS: Alaska Fire Service
AFSC: Alaska Fire Science Consortium
BF: Boreal Fires
CAS: College of Arts and Sciences
CFOS: College of Fisheries and Ocean Sciences
CM: Coastal Margins
CNSM: College of Natural Science and Mathematics
CTD: Conductivity, Temperature, and Depth
DEM: Digital Elevation Model
DEW: Diversity, Education, and Workforce Development
EAC: External Advisory Council
EPSCoR: Established Program to Stimulate Competitive Research
F&I: Fire and Ice
GI: Geophysical Institute
GIF: Girls in the Forest
GIS: Geographic Information Systems
GOA: Gulf of Alaska
GOW: Girls on Water
IAB: Institute of Arctic Biology
IACUC: Institutional Animal Care and Use Committee
IMS: Institute of Marine Science
ISER: Institute for Social and Economic Research
K-12: Kindergarten through 12th Grade
KB: Kachemak Bay
KBNERR: Kachemak Bay National Estuarine Research Reserve
LC: Lynn Canal
LTER: Long-Term Ecological Research
NASA: National Aeronautics and Space Administration
NOAA: National Oceanic and Atmospheric Administration
NSF: National Science Foundation
OCES: Ocean Change Experimental System
OIPC: Office of Intellectual Property and Commercialization
PD: Project Director
PI: Principal Investigator
PIO: Public Information Officer
S2S: Subseasonal-to-seasonal
SAS: School of Arts and Sciences
SBIR: Small Business Innovation Research
SCoR: State Committee for Research
SES: Social-Ecological Systems
S&T: Science and Technology
SNAP: Scenarios Network for Alaska and Arctic Planning
SOM: School of Management
STC: Science and Technology Center
STEM: Science, Technology, Engineering and Mathematics
STTR: Small Business Technology Transfer
TREND: Alaska Technology Research and Development
UA: University of Alaska
UAA: University of Alaska Anchorage
UAF: University of Alaska Fairbanks
UAS: University of Alaska Southeast
WUI: Wildland-Urban Interface