2020 Copper River Basin Symposium Abstracts

Session 1: Climate Research and Modeling

Addressing Climate Change Uncertainty in Planning, Vulnerability Assessment and Natural Resource Management. Jeremy S. Littell, USGS

Climate change affects the natural and built environment in many, often complexly related ways. Yet, incorporating future climate projections into management agency or community planning is legally required, or, at the least, a requirement for obtaining other resources such as grants. One definition of co-production is an iterative partnership between managers who use science as part of their decision making and the researchers who develop that science, such that the science is better tailored to the needs of managers. In climate adaptation work, a key component of the decision-making environment is the uncertainties in climate projections and whether they can be addressed in ways that are simultaneously well communicated and scientifically sound. Here, I describe some common themes encountered in co-production of climate information for various Alaskan stakeholders and why addressing uncertainty directly is important. I address sources of and approaches to climate uncertainty and how they can be accounted for in developing future projections for resource management and planning. I also discuss the implications for using such information in attempting to evaluate what constitutes resilience to future changes and possible exceptions to best-practices. *jlittell@usgs.gov*

*Fifteen Years of Continuous Climate Data Collection in Wrangell-St. Elias National Park and Preserve: Lessons Learned and Emerging Trend*s. Ken Hill and Pam Sousanes, NPS

The National Park Service (NPS) Inventory and Monitoring (I&M) program has maintained five continuous automatic weather stations within Wrangell-St. Elias National Park and Preserve for the past fifteen years. Observations include air temperature, summer rainfall, relative humidity, snow depth, wind speed, wind direction, and soil temperatures. Stations range in elevation from 1,880 feet to 5,240 feet and represent distinct climate regimes including the Chugach Mountains, the Kennicott Glacier complex, the Wrangell Mountain foothills, and the eastern Alaska Range. Real-time data are available online along with quality controlled datasets archived and available through the National Park Service. The challenging mountain environments and continuous, year-round observations make these datasets both unique and valuable for understanding projected environmental changes. In addition to the mountain weather stations, two snow telemetry (SNOTEL) stations provide a decade of year-round precipitation and snow water equivalent observations at May Creek and Chisana. These are the only continuous records of snowpack and winter precipitation in the upper Copper River Basin. Emerging trends and climate extremes from these stations will be presented and put into context by comparing the relatively short weather records with data analyzed from long term sites in Gulkana and Yakutat. *kenneth_hill@nps.gov*

Current and Future Drought in the Forested Copper River Valley. Melissa McShea Valentin, 2100 Consulting

As cold regions warm, boreal forests become more vulnerable to drought and wildfire as summers lengthen and warm. Predominant tools that quantify drought are ill-equipped to assess drought in regions characterized by snow, glaciers, and permafrost. The widely used Palmer Drought Severity Index (PDSI) utilizes a primitive water balance model that does not take snow, glaciers, or permafrost into account, and all precipitation is assumed to be rain regardless of temperature. This study extends the applicability of the Palmer method to cold regions by replacing the primitive water balance with one that represents snow, sublimation, glacier runoff, and the variable permafrost active layer. In addition, the new water balance can be calibrated to external observations of snow cover, streamflow, glacier mass balance, and total water storage.

The Palmer drought index methodology was enhanced in recent years to include self-calibration, alternative methods of potential evapotranspiration calculation, and output from stand-alone hydrologic models. However, none of these enhancements addressed the need to represent snow, glaciers, or permafrost. By incorporating output from a calibrated cold-region water balance model into calculation of the Palmer drought indices, our characterization of current and future drought is greatly improved. The greatest impact derives from representing the storage of winter precipitation as snow and the replenishment of soil moisture by snow melt in the spring. Simulation of the seasonal active layer further refines drought estimates in permafrost regions. The cold-region Palmer drought methodology is demonstrated here in the forested valley of the upper Copper River watershed.
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Session 2: Glaciers

The Meteorology on the Debris-Covered Tongue of Kennicott Glacier, Wrangell Mountains -- from the Micro to the Macro Scale. Pascal Buri, Martin Truffer, Javier Fochesatto, and Andy Aschwanden, UAF

Debris-covered glaciers are characterized by a continuous layer of rock material on their tongue and surface energy balance models are commonly used to estimate melt rates of these glaciers. This requires direct on-glacier measurements of energy fluxes that are rare in many mountain ranges globally and completely absent in Alaska. Using observations from weather stations installed in the middle of the Kennicott Glacier tongue (Wrangell Mts.) during the 2019 melting season, we assess for the first time the meteorological conditions on a debris-covered glacier tongue in Alaska. We measured temperature, humidity and wind speeds at different levels above the debris, as well as turbulent fluxes, solar and long-wave emitted radiation and precipitation. For comparison to off-glacier meteorological conditions we use data from a nearby station installed outside the glacier impacted by the same meteorological fields.

We observed a strong heating rate in the debris-covered surface during the day, while radiative cooling occurred overnight. This nocturnal effect prevents the underlying ice from the accelerated daytime melting enhanced by the debris. Additionally, we found that the heat exchange over debris strongly contrasted the conditions over the debris-free surface on-glacier, as well as the terrain surrounding the valley glacier. The experimental determination of turbulent fluxes (sensible and latent heat) play an important role in precising the energy budget of debris glaciers. However, these observations are difficult because the turbulence regime over the glacier tongue is affected during the melting season due to the appearance and backwasting of crevasses and ice faces. *mtruffer2@alaska.edu*

Modern Changes in Kennicott Glacier: Implications for Residents, Visitors, and the Other 3,120 Glaciers in Wrangell-St. Elias National Park and Preserve. Michael Loso, Wrangell-St. Elias NPP, and Chris Larsen, UAF

Kennicott Glacier is one of the most visible and visited large glaciers in Alaska, largely because of its proximity to the road system and the communities of McCarthy and Kennicott. Volume loss and terminus retreat at Kennicott Glacier, which began with the end of the Little Ice Age around 1860 CE and have accelerated in recent decades, are made especially conspicuous by the well-documented history of mining and tourism-related human development in the valley. Transportation infrastructure, businesses, and even the towns themselves were built at the glacier's edge, serving as conspicuous, and in some cases vulnerable, markers of ongoing glacier change. This shrinkage is not unique, however, and in many ways the Kennicott Glacier's evolution is representative of changes occurring at many of the less visible glaciers in and around Wrangell-St. Elias National Park and Preserve. At the time of the most recent inventory in 2014, the park's 3121 glaciers had lost 5% of their area over the preceding 50 years. That park-wide change converted 1656 square kilometers of glacier cover into newly deglaciated terrain that includes, as it does in the microcosm of the Kennicott Valley, proglacial lakes, freshly exposed bedrock and glacial till, changing river channels, unstable slopes susceptible to landsliding, habitat for colonization by successional vegetation, and new migration corridors for animals and humans alike. This presentation will document those changes at Kennicott Glacier and consider their broader implications for the rest of the park. *michael_loso@nps.gov*

Session 3: Hydrology and Aquatic Ecology

The Past Shapes the Modern Lake Landscape of Wrangell-St. Elias National Park and Preserve. Amy Larsen, NPS

There are just over 10,000 lakes and ponds in Wrangell-St. Elias National Park and Preserve, and because they are small and perched on discontinuous permafrost they are sensitive to slight changes in climate. But, because the geologic landscape in the park is complex the lakes don't all respond to changing climatic conditions in the same way, making it difficult to predict how and when lakes will change. The Central Alaska Network Inventory and Monitoring Program developed a long-term lake monitoring program to help understand the landscape scale factors that drive climate changes in lakes and ponds. Understanding lake ecosystem dynamics is important because so many creatures rely on them for habitat and food. In 2009, the network initiated the monitoring program in the park, sampling physical, chemical and biological attributes of 128 individual lakes. These data were used to develop a lake classification scheme, not surprisingly, most lakes within the park boundary are found in large glacial moraines or along floodplains. In general, lakes in the park are oligotrophic, meaning they are clear with low nutrient concentrations; the most nutrient-rich lakes were near located McCarthy. A variety of climate related impacts were observed among the lakes during a 2017 resampling event. Impacts included mass wasting in lakes located in ice-rich moraines, low water levels associated with low winter snowpack, and warming water temperatures. These changes have profound implications to the animals that rely on these systems including fish, wetland obligate birds, and insect populations. *aslarsen@nps.gov*

Challenges to Operational Hydrology in the Copper River Basin. Jessica Cherry and Crane Johnson, Alaska-Pacific River Forecast Center, NOAA

This talk will give a hydroclimate overview of the Copper River Basin and a review of current data collection and National Weather Service products for the region. Challenges to forecasting in this area will be discussed including the role of Glacial Dammed Lake Outburst Flooding (GLOFs). The history of GLOFS is provided as well as a prognosis for future events and changing glacial stream inputs in general. Impacts of the heavy precipitation events known as Atmospheric Rivers will also be discussed. Solicited from the audience will be needs for additional or different forecast or observational products. *jessica.cherry@noaa.gov*

Flow Regimes and Floods in Alaska: Understanding the Influence of Streamflow Drivers. Janet H. Curran, USGS, and Frances E. Biles, USFS

Streamflow seasonality and flood magnitude are important to a wide range of water resource, engineering, and ecological concerns, making understanding changes in flow regimes in response to climate change a critical water resources management need. Anticipating streamflow response to climate change in Alaska is challenged by the diverse range of seasonality generated by the varying influences of rainfall, snowmelt, and high-elevation snowmelt and ice melt, processes that can be in turn variously influenced by climate change. Seasonal flow regimes were identified from historical data to provide an essential foundation for investigation of streamflow drivers for floods. Classification of historical seasonal patterns for 253 unregulated, non-outburst, and non-redundant USGS-gaged Alaska streams identified 9 flow regimes that fit into 3 major classes dominated by a primary streamflow driver. Rainfall-dominated classes exhibited low overall seasonality and dominantly rain-driven, fall-occurring annual peak flows. Snowmelt-dominated classes were typified by bimodal high flow periods, higher in spring than in fall, and by annual peak flow timing and magnitude ranging from spring-dominated to fall-dominated. In high-elevation stream classes, delayed runoff from high-elevation snowmelt, and from ice melt where glaciers are present, created a unimodal high-flow season that crested in spring to summer and a range of spring, summer, and fall-dominated peak flow timing and magnitude. This classification provides the first systematic synopsis of Alaska flow regimes and identifies subsets for more targeted examination of hydrologic patterns and sensitivity to changes in streamflow drivers. *jcurran@usgs.gov*

Session 4: Research Topics on Glacial Lake Atna – Part 1

Results of Recent Archeological Investigations of Glacial Lake Atna Shorelines in Wrangell-St. Elias National Park and Preserve, Alaska. Lee Reininghaus, Wrangell-St. Elias NPP

Today, with over 25 percent of Wrangell-St. Elias National Park and Preserve being covered in ice, it is hard to imagine that 10,000 years ago anywhere in the park would have been hospitable for human habitation. However, obsidian from Wiki Peak, located in the northeastern corner of the park, is present in some of the earliest archeological deposits in Alaska. Recognizing that the presence of Lake Atna would have influenced land use for people living in the region during the late Pleistocene, identification of Glacial Lake Atna shorelines and associated geomorphological features was undertaken in an attempt to better understand concurrent human land use. As a result of recent investigations, 69 archeological sites have been identified. The majority of these sites are surface lithic scatters located in areas subject to deflation and other natural disturbances; however, one recently identified site revealed a subsurface hearth feature in a buried and stratified context that produced radiocarbon results dating the site to the late Pleistocene. Although obtaining reliable, datable material for most of these sites is challenging, numerous diagnostic artifacts consistent with other early prehistoric assemblages are present throughout the majority of these site locales. While typological comparisons do not always facilitate accurate temporal assumptions, the high quantity of diagnostic artifacts identified as a result of recent investigations is promising. *lee_reininghaus@nps.gov*

Preliminary Results from the Excavation of NAB-533, a Multi-Component Prehistoric Archaeological Site in the Northern Copper River Basin. John T. White, Texas A&M University

NAB-533 is a buried multi-component prehistoric site located in the northern Copper River Basin. National Park Service archaeologists engaged in compliance testing originally recorded the site in 2016. During the 2017 and 2018 field seasons NPS Archaeologist Lee Reininghaus led a project to conduct test excavations at NAB-533. These excavations revealed a feature interpreted as a fire hearth and dated to 11,324-12,188 calendar years ago. In 2019 a team from the Center for the Study of the First Americans at Texas A&M University initiated test excavations to establish the stratigraphic context of the artifacts and cultural features, collect geoarchaeological samples, obtain additional radiocarbon dates, and increase the sample of artifacts. We excavated 4.75 m^2, stratigraphically identifying multiple cultural components. Here we present the first results of our analysis. Data from this site have the potential to shed light on the processes involved in the initial peopling of Alaska, and more broadly of the American dual continent. We present these results in the hope that other such ancient cultural resources may be recognized and protected by individuals involved and interested in heritage conservation in the greater Copper River Basin. *j.w@tamu.edu*

Exploring the Possibility of 12,000 Years of Subsistence Fish Use at Archaeological Site NAB-00533, Copper Basin, Alaska. Allyson Pease, UAA

The purpose of this study is to explore the long-term subsistence use of fish in the Copper River Basin, Alaska. While salmon is currently a dominant subsistence resource in the region, the oldest known archaeological evidence of fish use in the Copper Basin is from approximately 700 cal years BP. Tanada Creek, a tributary of the upper Copper River is a premier sockeye fishery that has been used extensively by Athabascan populations. Archaeological site NAB-00533, situated near the south bank of Tanada Creek, shows evidence of occupations dating to the late Pleistocene and mid Holocene. Significant environmental changes have affected the Copper Basin since the late Pleistocene; most notable is the presence and draining of Lake Atna, which occupied much of the Copper Basin until the early Holocene. Our current knowledge does not demonstrate if prehistoric populations have been harvesting fish in the Copper Basin since the late Pleistocene. Two forms of sedimentological analysis will be performed to determine if the site could have served as a fishing location during both occupations. A geological analysis will aid in understanding the sites proximity to nearby waterbodies. A stable isotope analysis will use $\delta 13C$ and $\delta 15N$ values to determine if primary subsistence resources were terrestrial or aquatic. While still ongoing, this research has the potential to expand the known time-depth of the subsistence use of fish in the Copper River watershed. *allyson.marie.pease@gmail.com*

Session 5: Research Topics on Glacial Lake Atna – Part 2

Spillways, Lake Levels, and the Implications for Human Occupation around Glacial Lake Atna. Richard VanderHoek, State Archaeologist, Alaska Office of History and Archaeology

GLA archaeological work in the Copper River Basin is based on three main questions: 1) when was the lake in existence in relation to the human occupation of southern Alaska, 2) what was the lake elevation during this time, and 3) where above this paleoshoreline should we look for archaeological sites? This presentation will address these questions presenting spillway and paleoshoreline data, the role of isostatic rebound in GLA shoreline identification, probable paleo-resources available, and what all this suggests for modeling GLA-related archaeological surveys in the Copper River Basin. *richard.vanderhoek@alaska.gov*

Geolinguistic Evidence of Dene Presence at High-water Levels of Glacial Lake Atna. James Kari, UAF

Kari (2019) introduces a theory of Na-Dene prehistory, "the Proto-Dene Lex Loci" that derives from *Lexware* dictionary files and cumulative place name for seven adjacent Alaska Dene languages. To investigate Dene prehistory in the Copper River and circum–Glacial Lake Atna (GLA) region, we discuss a selection of 67 Dene place names from seven Dene languages in four Alaska river basins. Dene geolinguistic data are information-rich; highly noticeable are various *watershed tenure devices* (hydronymic districts, patterned duplications, geoduplicates) that reflect ancient Dene vernacular collaborations to facilitate landscape recognition. As few as three Dene place names establish that the Dene occupation of Tanana River preceded the initial Dene names in the Copper River Basin. A group of about 20 Ahtna names termed "the Nen' Yese' Ensemble (NYE)" are overtly descriptive of the geology and hydrology at the Tyone Spillway. One subset of 9 to 10 names plausibly were coined during "a first season on the NYE" (starting at Hogan Hill, *K'ey Tsaaygha*). Another subgroup of 10 or 11 names has four pairs of patterned duplications that indicate spatial-temporal seriation. Plausibly this group of names were coined prior to, during, and after the names of the NYE (11,000 to 9000 years ago) in the time frame of the major GLA drainage shift. As geological, paleo-ecological records for GLA become refined, geo-temporal benchmarks may be attainable. Alaska Dene geolinguistic data sets can broaden interdisciplinary discussions of Alaska and Beringian prehistory. *james.kari@alaska.edu*

The Northern Archaic Tradition and Ahtna Origins. Gerad M. Smith, UAF

This paper synthesizes an updated radiocarbon and archaeological record of the Copper and Susitna River basins. The dataset is used to reconstruct ancient human dispersal into the study region of the Northern Archaic tradition south of the Alaska Range. The paper evaluates the following ecological constraints that these people faced: Glacial Lake Ahtna, the Holocene Thermal Maximum, volcanic events, and salmon populations. Each factor affected ancient settlement systems uniquely, helping determine the development of Ahtna culture. *gmsmith2@alaska.edu*

Poster Session

Federal Subsistence Fisheries Program Overview. Scott D. Ayers, USFWS

This is a brief overview of the Federal Subsistence Management Program's history and structure, and a more thorough discussion of the Program's fisheries related items including the Fisheries Resource Monitoring Program, the Partners for Fisheries Monitoring Program, and how to change Federal Subsistence fishing regulations. *scott_ayers@fws.gov*

The Road and the River: Channel Change on the Copper River Delta. Robin A. Beebee, USGS

The Copper River Delta south of Child's Glacier is a complex and rapidly shifting riverine landscape. Constant deposition and erosion of sediment means that channel patterns change annually. Over the last 30 years, the river has pushed primarily toward the east, inundating the Copper River Highway and threatening or damaging bridges. The bridge at Mile 36 was closed in 2011, but those who could cross the channel were still able to drive the road to Child's Glacier until 2018, when the road at Mile 44 was washed out. The U.S. Geological Survey has partnered with the Alaska Department of Transportation and Public Facilities to study changes in the Copper River Delta and monitor several bridges for scour and deposition. Previous studies identified channel changes through 2007, flow distribution changes through 2010, and described the demise of the Mile 36 bridge in 2011. These studies are updated using recent aerial photography, satellite imagery, flow measurements, and cross-section measurements. *rbeebee@usgs.gov*

Monitoring, Forecasting, and Communicating Changing Snow and Ice Conditions in Alaska's Operational Hydrology Mission. Jessica Cherry and Crane Johnson, NOAA Alaska-Pacific River Forecast Center

This presentation will discuss how changing snow and ice conditions are posing challenges to the National Weather Service's water mission in Alaska, as well as possible responses. Examples include low snow cover and thin ice disrupting winter transportation and food/energy supply networks in roadless areas of the state. Another example is how changing the timing and cause of spring flooding (say between ice jam and snow melt flooding) can affect forecast certainty and community responses. This presentation will describe approaches to estimation of snow and ice conditions, and incorporation of observational data into current and future operational models. These include new approaches to both in situ monitoring and remote sensing in Alaska. The full workflow of co-generated (community and agency) science, product design, and dissemination must be carefully considered when working to mitigate societal impacts of floods and droughts in an operational environment. *jessica.cherry@noaa.gov*

ADF&G Hunter Access Grant Program. Lisa Delaney, ADF&G

This poster describes ADF&G's new Hunter Access Grant Program. The goal of this program is to partner with organizations around the state to fund new and expand existing hunting, trapping, and related access to public lands throughout Alaska. ADF&G will fund up to 75% of project costs using Wildlife Restoration Funds; groups who have a 25% funding match can apply through the ADF&G Hunter Access online portal. This poster outlines additional information and requirements for prospective applicants. *lisa.delaney@alaska.gov*

Climate Trends and Future Projections for the Copper River Watershed: Tools and Considerations for Adaptation and Planning. Jeremy S. Littell, USGS

For communities and agencies planning for - and adapting to - the impacts of climate change, access to appropriate climate information is critical. However, localized summaries of climate information tailored to the needs of communities and agencies have been limited in Alaska to date. Of equal importance, guidance on the uncertainties and their implications for planning are rarely included alongside future projections. In this poster, I describe summary climate information products developed by the Alaska Climate Adaptation Science Center and its partners for adaptation and impacts assessment in Alaska. I provide Copper River watershed examples derived from state-wide analyses of climate and related ecosystem variables (including future seasonal temperature, snowpack, and vegetation change) summarized for other regional adaptation planning needs. I illustrate sub-watershed differences in expected environmental change and Finally, I include information on the uncertainties underlying such projections and best practices for addressing them in planning and adaptation efforts. Specifically, natural climate variability, climate model uncertainty, and emissions scenario uncertainty must all be considered and directly addressed when providing future projections and rates of change. Including climate information in planning documents and proposals is increasingly common, but the best available science requires approaches that consider local environmental setting, practitioner needs for information, and the application of that information to hazard and risk assessment. *jlittell@usgs.gov*

Modern Changes in Kennicott Glacier: Implications for Residents, Visitors, and the Other 3,120 Glaciers in Wrangell-St. Elias National Park and Preserve. Michael Loso, Wrangell-St. Elias NPP, and Chris Larsen, UAF (See Loso and Larsen in Session 2: Glaciers for abstract)

Salmon Blitz: Citizen Science Can Make a Difference! Kate Morse, CRWP

Citizen Science is a research technique that engages non-scientists in the collection of scientific data. It can be especially effective in vast landscapes where limited agency budgets make it challenging to effectively cover and monitor an entire region. Citizen science also provides valuable learning opportunities for participants, instilling a greater excitement for science and a better understanding of and connection to their natural surroundings. Citizen science efforts can even improve citizens' understanding of complex management challenges by actively engaging them in collecting data that can be contributed to natural resource management agencies.

Any citizen science program must be carefully developed in order to ensure citizens are armed with the knowledge and tools necessary to collect quality data. This presentation will share guidelines developed by the Cornell Lab of Ornithology, one of the most extensive citizen science projects in existence today, to help participants potentially develop new citizen science programs for filling data gaps in the region. This presentation will also share local successes of Salmon Blitz, a program that engaged Copper River residents in helping contribute over 70 miles of additional data to the State of Alaska's Anadromous Waters Catalog, the tool used to manage salmon habitat. *kate@copperriver.org*

Environmental Education in Rural Alaska: A Community Approach. Robin Mayo, WISE

The poster focuses on how Wrangell Institute for Science and Environment (WISE) uses partnerships with schools, agencies, indigenous organizations, and other nonprofits to provide place-based education in the Copper River Basin. *robin@wise-edu.org*

Nic'anilen Na': A Partnership in Conservation, Stewardship, and Education. Robin Mayo, WISE

This poster presents photos and information on *Nic'anilen na'*, a property recently acquired by Wrangell Institute for Science and Environment which carries a conservation easement managed by GreatLand Trust. The property will be developed with interpretive signs, trails, and visitor amenities such as outhouses and a pavilion. The intention is for it to be preserved for its value as a wildlife habitat, and used for education and science. *robin@wise-edu.org*

Integrated study of spawning migration, energetics, and pathogens in Copper River sockeye salmon: Preliminary results from 2019. Peter S. Rand, Prince William Sound Science Center (PWSSC), and Kristen B. Gorman, UAF

Following a pilot project in 2016, we embarked on an integrated field and laboratory study in 2019 examining migration behavior, energetics, and physiological and health correlates to determine which factors are related to successful migration of sockeye salmon in the Copper River. We sacrificed adult sockeye salmon at eight locations throughout the watershed to characterize the morphology, energy provisions, reproductive investment, and physiological and health correlates to understand patterns experienced by the average migrant in the run. In addition, we captured, sampled, radio-tagged, and released 198 adult sockeye salmon downstream of Wood Canyon and tracked their fates through the watershed. We tagged fish in the middle part of the run for this initial year of our study. While data from this field season are still being analyzed, our general impression is that the migratory conditions faced by sockeye salmon in the middle return timing group faced significant energetic challenges due to high river flow. Relatively few tagged sockeye salmon were detected at upstream radio towers or during aerial surveys near the spawning grounds. While results are open to a variety of interpretations, we think it is a priority to fully explore the likelihood that fish suffer enroute mortality due to energy exhaustion or related factors, particularly during years of high discharge. These conditions may become more frequent in a warming climate. We will take an opportunity to thank our field partners for making this project possible. *prand@pwssc.org*

Alphabet Hills Prescribed Burn for Moose Habitat Enhancement. Sue Rodman, ADF&G

In cooperation with the Division of Forestry and the Bureau of Land Management (BLM), the Alaska Department of Fish & Game (ADF&G) proposes to burn 53,000 acres near the Alphabet Hills to enhance forage quality and quantity for moose. We expect the burn to occur in 2021 recognizing that it may take several years to attain the appropriate conditions for ignition. Limited fire occurrence in this area has resulted in late successional forests that provide limited food for moose. Fire returns the landscape to an early successional stage and encourages the regrowth of browse species such as willow, aspen, and dwarf birch. Therefore, prescribed fire serves as a management tool for increasing the capacity of this landscape to support more moose and increase harvest opportunity. A portion of this Game Management Unit 13B was burned in 2003 and 2004 cooperatively by BLM and ADF&G to fulfill the same objectives for enhancing moose forage. The new prescribed burn will be enhanced with ADF&G's corresponding studies of moose habitat, movements, nutrition, and densities within the burned area and adjacent control sites. These combined studies will allow greater understanding of the relationship between fire, moose habitat, and moose movement to better inform land and game management decisions.

Earthquake Monitoring and Tectonics within the Copper River Basin and the Wrangell-St. Elias National Park. Natalia A. Ruppert, UAF

Alaska is the most seismically active state in the nation with earthquakes spanning various tectonic regimes, including transform faulting in the Southeast Alaska, collision in the St. Elias Mountains region, subduction in southern Alaska and along the Aleutian Islands Arc, and complex crustal faulting extending north to the Beaufort Sea. In the past 100 years, ten earthquakes of M>=7.9 have occurred in Alaska and the Aleutian Islands, including the 1964 M9.2 Great Alaska earthquake. At the time of the 1964 earthquake only two seismograph stations were operating in Alaska. Over the years the network has expanded and presently comprises of over 500 seismic monitoring stations. The number of detected earthquakes has also grown, concurrent with the network, to over 55,000 events reported in 2018, which was the record breaking year. Tectonics along the Southern Alaska margin are very complex resulting in earthquake activity along the entire margin. The Alaska Earthquake Center is the authoritative source of earthquake information in the state. All events are reported within minutes of occurrence, including thousands of earthquakes within the Copper River basin and the surrounding regions. In addition to tectonic earthquakes, glacial activity and large rock/ice slides are also being detected by the network of dozens of seismic sensors in the area. In our presentation, we will introduce the seismic network in the region, discuss station design and components, and provide an overview of historical and recent seismicity in the region and how it relates to larger tectonic processes. *naruppert@alaska.edu*

Detection of the Invasive Aquatic Plant Elodea by Metabarcoding of Environmental DNA Using Multiple Genetic Markers. Trey Simmons, NPS; Damian Menning and Sandra Talbot, USGS

The use of environmental DNA (eDNA) to detect aquatic species without the need for physical observation has been growing rapidly over the last decade. eDNA persists in the environment and isolation from water samples is becoming routine. The application of sensitive molecular techniques to the analysis of eDNA allows for robust detection of species even when they are present at low abundance. These features of eDNA make it an attractive candidate for early detection of aquatic invasive species (AIS), a growing threat in many parts of Alaska, including the Copper River Basin. We have been developing eDNA-based tools for the simultaneous detection of multiple AIS that are likely to arrive in Alaska in the near future. The first part of this project has focused on the application of eDNA metabarcoding to the detection of *Elodea,* an invasive aquatic plant that has recently begun to spread into water bodies across Alaska, and which is present at several locations in the Copper River Delta. We used multiple genetic markers, including 3 chloroplast markers (atpB-rbc, rps4, trnL-F) and one nuclear marker (5.8S), to increase the specificity of the assay. We tested the assay using voucher specimens as well as replicate eDNA samples from 2 locations where *Elodea* was present, and also applied it to samples collected from 58 lakes as part of traditional rake surveys for *Elodea*. We successfully detected *Elodea* from both locations where it was known to be present, and did not detect it in any of the other samples. However, the signal strength we obtained suggests that the method may not yet be sufficiently sensitive to reliably detect *Elodea* when it is present at low abundance.

A Review of Fisheries Research and Data Collection in the Copper River Drainage, Alaska 1950 – 2019. Mark Somerville, ADF&G

The Copper River has been a focus of scientific interest since the mid-1950's, when the Federal Government contemplated construction of a hydroelectrical project that would have developed a 560 ft dam in Woods Canyon. At that time, little was known about the anadromous salmon and resident fishes of the Copper River basin except that they generated great economic returns and augmented the diet of indigenous people. Since that time, over 75 scientific studies or data reviews have been conducted on the Copper River drainage anadromous and resident fishes. Many of these studies have focused on stock assessments, abundance, and distribution. The greatest amount of focus on salmon has been directed toward Copper River Chinook salmon (*Oncorhynchus tshawytscha*) followed by studies on sockeye salmon (*O. nerka*). Stock assessment of lake trout (*Salvelinus namaycush*) and burbot (*Lota lota*) in area lakes has dominated research for resident species along with directed studies on rainbow and steelhead trout (*O. mykiss*) and Arctic grayling (*Thymallus arcticus*) in the Gulkana River. This presentation will briefly review the scientific work on Copper River drainage fisheries and present the pertinent findings of these works. *mark.somerville@alaska.gov*

Enhancement of Traditional Fish Passage Design on the Trans Alaska Pipeline System. Jeff Streit, Anne Beesley, and Ken Wilson, Alyeska Pipeline Service Company; and Lee McKinley, ADF&G

There are hundreds of fish streams that cross the Trans Alaska Pipeline System; most go through a drainage structure called a Low Water Crossing (LWC) which is a vehicle/equipment ford that allows vehicle access and fish passage. LWCs require on-going maintenance due to vehicle use and can become widened and flattened during normal usage. They also can develop a grade break that can lead to an impedance or blockage to fish passage which can cutoff miles of important fish habitat. Traditionally, fish passage is maintained by narrowing the channel – requiring frequent maintenance and creating higher water velocity. A novel approach has shown to achieve duel goals of extending the life of the LWC between maintenance efforts while enhancing fish passage. The civil maintenance team at Alyeska's Glennallen Base has developed a simple but effective way of backwatering the driveline with placement of large rocks at the downstream end of the crossing. With this method, small and medium sized streams are deepened without increasing the velocity, allowing for greater opportunities for fish to pass through; for larger streams, water velocity is slowed in the crossing, making it easier for juvenile fish to navigate. With placement of additional large rocks in strategic locations downstream, water velocity and turbulence is reduced or eliminated, and additional fish resting pools/eddies are created. The technique of incorporating "S" turns downstream of the LWC extends the channel through the grade break, slowing the velocity while also creating a deep water chute for fish to swim through. *kenneth.wilson@alyeska-pipeline.com*

Enhancement of a Water Balance Model to Simulate Glaciers and Surface Hydrology in the Copper River Watershed from 1949 to 2099. Melissa McShea Valentin, 2100 Consulting

The USGS monthly water balance model MWBMglacier was used to simulate glacier mass balance and surface hydrology over 150 years in the heavily glacierized and ecologically important Copper River watershed. During the historical simulation period 1949 to 2009, glacier ice melt contributed 25% of total runoff, ranging from 12% to 45% in different tributaries, and glacierized area was reduced by 6%. Future simulations through 2099 utilized two scenarios of future climate (RCPs 4.5 and 8.5). By mid-century, mountain temperatures will be above freezing for an additional two month per year which will significantly alter snow/rain partitioning and the generation of meltwater from snow and glaciers. By late-century, Copper River discharge is projected to increase by 49%, driven by 21% more precipitation and 53% more glacial meltwater relative to the historical period. *melissa.valentin@2100consulting.com*

Report on Willow Creek Research Project, a Ten Year Citizen Science Project. Dave Wellman, Willow Creek Water Consortium, and Robin Mayo, WISE

This poster will tell the story of the Willow Creek Research Project, a 10-year citizen science project conducted by Willow Creek Water Consortium, in partnership with Wellwood Conservancy and Wrangell Institute for Science and Environment, Alaska Department of Fish and Game, US Bureau of Land Management Glennallen Field Office, Ahtna Native Corporation, Chitina Native Corporation, Alyeska Pipeline Service Company, and other partners. The purpose of the project is to determine the factors affecting quality and quantity of water in the general area of the Willow Creek watershed, and to ensure the continued benefits of that water for the future. *robin@wise-edu.org*

Invited Evening Presentation: *A Convergence of Knowledge? Scientific and Ahtna Knowledge of Salmon Diversity in the Copper River*. William E. Simeone. Location: Tazlina Community Hall

Ahtna have had a long relationship with salmon. Elder Robert Marshall said without salmon people would have starved. In this presentation I provide a summary of Ahtna knowledge of salmon as told by Ahtna elders.

Session 6: Panel Discussion: Working with Indigenous Communities in the Ahtna Region – Opportunities and Challenges – A Case Study

This panel discussion focuses on the Prince William Sound Science Center energetics study from the standpoint of working with rural and indigenous communities on research projects. The panel will discuss the scope of collaboration, including the field work and sampling part of the project and how the Ahtna Intertribal Resource Commission worked together with the Ahtna, Inc., the Prince William Sound Science Center, and Mentasta Village. They will also cover the challenges and opportunities presented by the case study: what went well, what could be improved, and specific on-the ground stories of successes and challenges. A panel member will talk about notifications, and communications with village councils, communities and families and then go over some best practices and recommendations.

Session 7: Wildlife Research and Management

Bear Density of the Tazlina River Drainage. Trenton Culp, Ahtna, Inc., and Dustin Carl, AITRC

Successful management of sustainable bear populations depends on accurate measurements of population and demographic estimates. Though information on the bears in the Ahtna region is limited, they are an important factor of the ecosystem. As an apex predator the bears significantly impact the populations of moose and caribou in the region. Bears in Game Management Unit (GMU) 13 have been found to kill up to 1.2 ungulate calves a week. Bear populations can be sensitive in recovery if over-harvested though, so finding the right balance between bear harvest and conservation is key to healthy populations for bears, moose, and caribou. Non-invasive genetic sampling techniques have been developed to accurately estimate bear population and density without disturbing or harming animals. We have successfully used these methods to collect genetic samples from bears in the Tazlina River drainage. The genetic analysis from these samples produced 30 individual bears genotypes from the 25 mi2 study area, giving us a density of 1.2 total bears per mi2. This success of sample collection and data analysis allows us to confidently explore more habitats to estimate bear populations throughout the Ahtna region. With the help of local bear baiters we have collected 24 samples from bear habitat sites in Mentasta Lake, and we are currently surveying potential study areas on the Gulkana and Klutina Rivers for the next season. *tculp@ahtna.net*

Direct and Indirect Effects of Temperature and Prey Abundance on Bald Eagle Reproductive Dynamics. Joshua H. Schmidt, Judy Putera, and Tammy L. Wilson, NPS

Understanding the mechanisms by which populations are regulated is critical for predicting the effects of large-scale perturbations. While discrete mortality events provide clear evidence of direct impacts, indirect pathways are more difficult to assess but may play important roles in population and ecosystem dynamics. Here we use multistate occupancy models to analyze a long-term dataset on nesting bald eagles in south-central Alaska with the goal of identifying both direct and indirect mechanisms influencing reproductive output in this apex predator. We found that the probabilities of both nest occupancy and success were higher in the portion of the study area where water turbidity was low, supporting the hypothesis that access to aquatic prey is a critical factor limiting the reproductive output of eagles in this system. As expected, nest success was also positively related to salmon abundance, however the negative effect of spring warmth suggested that access to salmon resources is indirectly diminished in warm springs as a consequence of increased glacial-melt. Together these findings reveal complex interrelationships between a critical prey resource and large scale weather and climate processes which likely alter the accessibility of resources rather than directly affecting resource abundance. While important for understanding bald eagle reproductive dynamics in this system specifically, our results have broader implications that suggest complex interrelationships among system components. *joshua_schmidt@nps.gov*

Session 8: Collaborative Conservation and Human Dimensions of Natural Resource Management

Adventures in the Watershed Classroom. Copper River Stewardship Program participants

Students from the Copper River Stewardship Program, an intensive summer program for high school students, will share their adventures and insights. They will explore the benefits of wilderness adventures in building community, fostering understanding between diverse groups, nurturing personal growth, and growing a stewardship ethic. Copper River Stewardship Program partners are Wrangell Institute for Science and Environment, Copper River Watershed Project, Prince William Sound Science Center, US Bureau of Land Management Glennallen Field Office, Wrangell-St. Elias National Park and Preserve, and US Forest Service Cordova Ranger District.

Managing Forest Carbon for the Next 100 Years. Scott DeBruyne, Ahtna, Inc.

In 2016, Ahtna, Inc. began the process of enrolling approximately 500,000 acres of forested land into the California Air Resource Board's carbon offset program, making it the world's largest forest carbon project. The enrollment of this land was implemented as a means of monetizing forests lands without extensive logging or development. Reporting requirements associated with the project will provide long term forest inventory data that can be used in conjunction with other monitoring programs to improve forest growth models for the region and allow the monitoring of the effects of climate change. Forest management has shifted in support of carbon sequestration by focusing on forest protection through implementation of fire mitigation measures, monitoring of pest species, general forest health monitoring and implementation of forest stand improvement practices. The fragmented nature of the enrolled land has resulted in Ahtna, Inc. working with the National Park Service and other land owners on unified fire management options and other combined efforts to meet shared goals. Efforts to protect forest carbon create management conflicts as mature and senescing forests provide poor moose habitat and increase the risk of catastrophic wildfires. With increased government attempts to mitigate climate change through carbon offset programs, the necessity to manage forests for carbon storage will only continue to grow. *sdebruyne@ahtna.net*

Watershed-Scale Partnerships Resulting in On-the-Ground Action. Kate Morse and Kari Rogers, Copper River Watershed Project

Traditional land boundaries do not encompass complete hydrologic cycles through the landscape, and in the case of the Copper River watershed, there are many public and private landowners connected within its waterways. The Copper River Watershed Project (CRWP) is a nonprofit organization that partners with residents, public and private landowners, resource managers, and recreational users throughout the watershed in an effort to keep the entire ecosystem intact and functioning to support communities reliant on its resources. Maintaining connectivity of aquatic habitat for migratory and resident fish species by systematically replacing culverts with fish-friendly designs, and invasive plant management are two examples of watershed-scale partnerships currently managed by CRWP. We will provide an overview of these partnerships and their recent successes on the ground as well as current challenges and next steps. We will also share what makes these regional partnerships successful and welcome discussion on other programs that might benefit from a watershed-scale approach. *kate@copperriver.org; kari@copperriver.org*

Session 9: Copper River Fisheries – Part 1

Copper River Sockeye Salmon Distribution and Run Timing. Matt Piche, Native Village of Eyak

From 2005-2008 the Native Village of Eyak Department of the Environment and Natural Resources used radiotelemetry techniques on migrating adult Copper River sockeye salmon Copper River to 1) estimate distribution among major spawning drainages and 2) determine stock specific run timing through Baird Canyon (van den Broek et al. 2008). Spawning distribution varied significantly across all study years (x^2 = 127.4, df = 18, P = 0.001). Highest returns were observed in the Klutina River (0.34 – 0.54), followed by the Upper Copper R. (0.09-0.28), Gulkana R. (0.07-0.19), Tazlina R. (0.10-0.19), Lower Copper R. (0.06-0.09), Chitina R. (0.05-0.08), and Tonsina

R. (0.02-0.06). Sockeye run timing showered similar trends to previous studies (Merritt and Roberson 1986) suggesting stocks with earlier mean run timing spawn in the uppermost reaches of the watershed. An exception found across all study years was Gulkana River stocks; which, displayed a later run timing than the Klutina, Tazlina, and Upper Copper River stocks. *matt.piche@eyak-nsn.gov*

Integrating Science-Based Research and Data Analyses into Sustainable Management of the Commercial, Personal Use, Sport, and Subsistence Fisheries of the Copper River Drainage, Alaska. Mark Somerville, ADF&G

Management of fisheries is science based. Whether that management is of long-term resident species in lakes and rivers or short-term during the return life-history phase of anadromous species, it relies on scientifically acquired data. Whether the fishery is commercial, sport, subsistence or personal use its management must be based on the best-known biology of the species being exploited. Managers rely on broad based knowledge and direct data to sustainably manage specific fisheries. Over 75 scientific studies and reviews have been performed on resident and anadromous populations of fish in the Copper River drainage since the 1950's. Data on harvest and use of some species goes back to the early 1900's. Findings from these studies and review of the available data have been, and continue to be, used to develop sustainable management goals for many of our area fisheries. Knowledge gained from scientific work done within the Copper River basin, as well as work done throughout the world, informs management decisions and helps develop regulations that ensure sustainable fisheries. This presentation will provide a look into how management of the Copper River drainage fisheries have used generally accepted biological information and specific research findings from our region to inform adaptive management decisions and sustainable management objectives for the Copper River drainages diverse fishery resources. *mark.somerville@alaska.gov*

Pathogen presence and load in sockeye salmon spawning populations in the Copper River during 2016. K.B. Gorman, UAF and P.S. Rand, PWSSC

Pacific salmon (*Oncorhynchus* spp.) resources in Alaska, including the production of both wild and hatchery-origin salmon, hold important ecological, cultural and economic value to Alaskan communities. A pressing question is whether this important natural resource will remain resilient to the environmental changes of the future? Alaska is already experiencing rather dramatic environmental changes in the form of ocean-climate warming, ocean acidification, and changes in at-sea densities. Stressful environments can magnify the impacts of infectious agents on fish populations. Thus, the lack of disease research on Alaskan salmon is a critical knowledge gap given the value of salmon to Alaskans, and the notable impact disease has had on the productivity of salmon populations elsewhere. Here, we report on a pilot study exploring ecological dynamics between reductions in the body size of adult Sockeye Salmon (*O. nerka*, hereafter Sockeye) returning to spawn in the Copper River, Alaska, and energy density, pathogen loads, and reproductive fitness trade-offs among short- and long-distance migrants. Funding through Alaska INBRE supported our research on the diversity and loads of globally-significant infectious agents known to cause disease in salmonids using novel, genomics-based biomarkers. This presentation describes relationships between returning adult Copper River Sockeye energetic condition, pathogen load, and trade-offs between migration difficulty and reproductive fitness. A related study is using field telemetry to examine energetic and physiological predictors of migratory fate and reproductive success. Our work has revealed that spawning migration by Sockeye Salmon in the Copper River is energetically expensive. Thirteen of 42 pathogens analyzed showed positive detections for Copper River Sockeye and the prevalence and loads of these pathogens varied across populations. Several pathogens detected are known to be associated with premature mortality in other salmon systems. *kbgorman@alaska.edu*

Session 10: Copper River Fisheries – Part 2

Fisheries, Research and Management on the Copper River: Patterns and Trends in Public Engagement. Odin Miller and Nicole Farnham, AITRC

This ongoing research seeks to document contemporary trends in the Copper River drainage's inriver fisheries, with the goal of identifying data needs and facilitating local engagement in the research, management and regulatory processes. Researchers from Ahtna Intertribal Resource Commission (AITRC) have collected data for this project through approximately 20 ethnographic interviews, and will host a series of community presentations in the region that will engage stakeholders in this research and solicit feedback. Drawing on previous ethnographic work, we trace the historical evolution of present-day inriver fisheries, with a particular focus on developments during the past several decades. We provide an overview of contemporary fishing practices and document trends of social and environmental change that are affecting them. Based on the viewpoints of our research participants and a review of available data, we suggest some areas of local priority for future fisheries research and monitoring. Finally, this project offers an analysis of the regulatory and management processes, identifying major areas of consensus and disagreement among stakeholder groups. Through this analysis, we describe ways that Copper River basin residents are engaging in these processes and infer points at which further intervention may be effective.
odin@ahtnatribal.org

The Gulkana Hatchery, Then and Now. Steve Hilton and Tommy Sheridan, Prince William Sound Aquaculture Corporation

The Copper River and its tributaries support extensive fisheries for sockeye salmon (*Oncorhynchus nerka*), including the Gulkana River and its 60 miles of productive spawning and rearing habitat. Between 1962 and 1972, the spawning population in this area declined considerably, with habitat degradation from flooding and highway construction being identified as primary causes for the decline. The Gulkana Hatchery was established in 1973 by the Alaska Department of Fish and Game (ADF&G) to mitigate for lost spawning habitat, and by 1984 the hatchery was incubating the largest number of sockeye salmon eggs of any hatchery in Alaska. In 1993, ADF&G contracted the Prince William Sound Aquaculture Corporation (PWSAC) to operate and manage the hatchery at no cost to the state and by 1999 Gulkana Hatchery sockeye salmon runs reached a peak of over 1 million fish. More recent studies indicate that nearly two-in-five sockeye salmon harvested in Copper River personal use and subsistence fisheries originate at Gulkana Hatchery. Wild sockeye salmon escapements throughout the Copper River watershed have experienced historically high abundance in recent years, although Gulkana Hatchery sockeye salmon runs since 2016 have been far below average and PWSAC has failed to meet its egg take goals at the hatchery for several years. PWSAC and other fishery stakeholders have convened several meetings over the past two winters to determine potential causes for recent declines in returns to Gulkana Hatchery and will present on some of these findings at the Copper River Basin Symposium. *steve.hilton@pwsac.com*

Run Timing and Spawning Distribution of Copper River Chinook Salmon. Corey Schwanke and Tracy Hansen, ADF&G

Past radiotelemetry studies show that Copper River Chinook salmon (*Oncorhynchus tshawytscha*) spawn in 6 major tributary/areas of the drainage and that upriver stocks generally have earlier run-timing than lower river stocks. However, drainage-wide spawning distribution and run-timing was last assessed from 2002–2004 and since then many changes have occurred that may have affected distribution or altered run-timing. In order to reevaluate the current state of Chinook salmon returning to the Copper River, a two-year study is being conducted to estimate annual spawning distribution, abundance to each of the 6 major tributary/areas, and stock-specific run timing. The first year of the study occurred in 2019 and a total of 656 Chinook salmon were captured and radiotagged in the lower Copper River near Baird Canyon. Upstream migration was tracked by 10 ground-based tracking stations and a series of aerial tracking flights. Results of this study will be finalized and presented. *tracy.hansen1@alaska.gov*