Alaska Section

AMERICAN WATER RESOURCES ASSOCIATION

This conference would not have been possible without you - the conference participant, our sponsors, session chairs, and least but not last, the energetic efforts by the conference committee members:

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American Water Resources Association – Alaska Section
Annual Conference
Juneau, Alaska
5-7th March 2012

Edited by Anna Liljedahl, Conference Chair

Page

Program

Abstracts

Monday, March 5th, Centennial Hall

10:00 AM	**Registration opens**
12:00 - 1:15 PM	**LUNCH – Provided**
1:15 - 1:30 PM	**Welcome** ***– Anna Liljedahl***
1:30 - 2:15 PM	**Keynote Presentation** ***Christopher Estes, Chalk Board Enterprises LLC*** *The status, use, and importance of hydrologic data required for natural resource management , conservation, development and research to present and future Alaskans: What data are needed and examples of actions underway to address data gaps, needs and data management*
2:15 - 2:30 PM	**BREAK**
2:30 - 4:00 PM	**Panel Discussion** **How do we effectively inventory, report, and manage water availability in our data sparse state?**

Moderator: Christopher Estes, Chalk Board Enterprises LLC

Tom Barrett*, BP Exploration Alaska*

Dana Infante*, Fisheries and Wildlife, Michigan State University*

Eric Johnson*, U.S. Forest Service*

Douglas Kane*, Water and Environmental Research Center, U. of Alaska Fairbanks*

Rick McClure*, U.S Department of Agriculture, National Resources Conservation Service*

David Meyer*, U.S. Geological Survey*

Bill Rice*, U.S. Fish and Wildlife Service and Interagency Hydrology Committee of AK*

Gary Prokosh*, AK Department of Natural Resources*

4:00 - 7:00 PM	**RECEPTION – Light food & cash bar**
4:00 - 7:00 PM	**Poster Session**

North Slope hydrology and water use

Joel Bailey	*Using snow fences to augment fresh water supplies*
Erica Betts	*Understanding the mechanisms by which a perennial Arctic stream appears intermittent*
Angelica Floyd	*Using synthetic aperture radar to study river ice break-up on the Kuparuk River, Northern Alaska*
Joel Homan	*Arctic snow distribution patterns at the watershed scale*
Erica Lamb	*Characterization of suspended sediment load and bedload on three North Slope rivers*
John Lenters	*Toward a circum-Arctic lakes observation network (CALON)*
Emily Youcha	*The use of meteorological data to perform hydrologic analyses in North Slope basins*

Glacier hydrology, hazards and hydropower	
Jeff Apple Benowitz	*Modern glacial outwash sand thermochronology along the Denali Fault: Constraints on glacier erosion dynamics*
Amy Dethlefs	*Nutrient limitation of snow algae and its role in surface melt on the Harding Icefield, Alaska: An experimental and observational approach*
Anna Liljedahl	*Glacier melt: A source for groundwater recharge and streamflow in semi-arid Interior Alaska*
Michael Lilly	*A hydrologic study of three small streams and the Kogoluktuk River in Northwestern Alaska for hydroelectric resource evaluations*
Molly Tedesche	*Assembling snow hydrology data from high altitude watersheds for use in climate change models applied to hydropower forecasting in Southeast Alaska: A proposed PhD project*

Water and waste treatment for rural Alaska	
Laona DeWilde	*Urban surface water contaminants and protection issues in Fairbanks, Alaska*
Chris Kasanke	*Microbial community analysis of petroleum contaminated soil at a long-term, cold climate phytoremediation test site*

Working at the interface of multiple systems: Examining process and managing for interactions occurring across terrestrial, freshwater, and atmospheric boundaries	
Greta Burkhart	*Building a network of watershed observations sites in support of conservation*
Chas Jones	*Using local knowledge, hydrology, and climate scenarios to develop a driftwood harvest model in interior Alaska*
Ann Olsson	*Wildfire and permafrost: Post-fire dissolved organic matter and nitrogen in a boreal forest stream*
Matthew Rogers	*AKWIN: The Alaska Water Isotopes Network*
William Rice	*Restoration and characterization in the Wasilla Creek watershed near Palmer, Alaska*
Andrew Vermilyea	*Mercury fluxes out of glacial and non-glacial streams, as determined by continuous measurements*

7:00 – 8:30 PM DINNER, Centennial Hall – Provided

Tuesday, March 6th, Centennial Hall

8.30 - 10.00 AM	North Slope hydrology and water use I

Session Chair: Michael Lilly, GW Scientific

8:30 - 8:45	Alessio Gusmeroli	*Exploring the Alaskan cryosphere with ground penetrating radar*
8:45 - 9:00	Nathan Stephan	*Dye tracers for characterizing breakup in Arctic rivers: An old school solution for a modern conundrum*
9:00 - 9:15	Chris Arp	*Landscape limnology within and across Alaska's lake districts*
9:15 - 9:30	Erin Trochim	*Quantifying evapotranspiration: Upscaling from plots to Landsat in the Alaskan Arctic Foothills*
9:30 - 9:45	Joshua Koch	*Water, heat, and nutrient fluxes on the Arctic Coastal Plain, Alaska*
9:45 - 10:00	Brittany Potter	*Climatic controls on the summertime energy balance of a thermokarst lake in northern Alaska: Short-term, seasonal, and interannual variability*

10:00 - 10:30 AM BREAK

10:30 - 12:00 PM	North Slope hydrology and water use II

Session Chair: Michael Lilly, GW Scientific

10:30 - 10:45	Tereza Bendlova	*Investigation of hydrologic and thermal regimes of lakes used for water supply in Kotzebue, Alaska*
10:45 - 11:00	Sveta Stuefer	*Using snow fences to augment fresh water supplies in the arctic lakes*
11:00 - 11:15	Michael Lilly	*Characteristics of lake and reservoir ice thickness and growth on the North Slope, Alaska*
11:15 - 11:30	Gerald Sehlke	*Adaptive management of Alaskan North Slope water supplies: A novel approach to lake water permitting*
11:30 - 12:00	*Clifford Voss, invited*	*Geophysical permafrost mapping and permafrost-hydrology interaction - US Geological Survey studies in Yukon Flats, Alaska*

12:00 - 1:30 PM LUNCH - On your own, AWRA-AK Board Meeting

1:30 - 3:15 PM	Glacier hydrology, hazards and hydropower

Session Chair: Gabriel Wolken, DGGS

1:30 - 1:45	Gabriel Wolken	*The influence of glacier change on hazards and hydrology in Alaska*
1:45 - 2:00	Regine Hock	*How will glaciers affect runoff in Alaska?*
2:00 - 2:15	Anthony Arendt	*Ongoing Alaska glacier hydrology research at the Geophysical Institute, UAF*
2:15 - 2:30	Janet Curran	*Analysis and extension of streamflow records in the Susitna River Basin, Alaska*
2:30 - 2:45	Sam Herreid	*Rocks, and their role in glacier longevity*
2:45 - 3:00	Eran Hood	*The 2011 Mendenhall Glacier outburst flood event*
3:00 - 3:15	Scott Willis	*Negotiating fuel supply contracts with mother nature: Challenges and opportunities managing hydroelectric projects in Southeast Alaska*

3:15 - 3:45 PM **BREAK**

3:45 - 5:25 PM **Water and waste treatment for rural Alaska**

Session Chair: William Schnabel, WERC/UAF

3:45 - 4:05	Sam Li	*Microbial fuel cells for wastewater treatment and energy generation*
4:05 - 4:25	Fatima Ochante	*Social and institutional barriers to a sustained access to safe drinking water and sanitation in Alaska Native villages*
4:25 - 4:45	Amanda Byrd	*Short rotation woody biomass as a reliable fuel source for rural Alaska*
4:45 - 5:05	Abhijit Chatterjee	*Simultaneous removal of Cd (II) and Zn (II) ions by protonated citrus peels in batch and fixed-bed reactors*
5:05 - 5:25	Edda Mutter	*Assessment of rural Alaskan solid waste leachate*

5:45 PM **Departing to EVENING SOCIAL, Juneau Fish Hatchery - Cash bar & light food**

Wednesday, March 7th, Centennial Hall

8.30 - 10.00 AM	**Aquatic resources management in SE Alaska - Filling the information gaps through research, analysis and lessons learned**

Session Chair: Jessica Kayser, SE Alaska Watershed Coalition

8.30 - 8.35	Christopher Estes	*Review of the day*
8:35 - 8:50	John Hudson	*Aquatic and riparian habitat improvement in Juneau – An inventory and assessment*
8:50 - 9:05	Jared Ross	*Evaluating aquatic habitat in anadromous streams draining second growth watersheds of southeast Alaska*
9:05 - 9:20	Jason Fellman	*Stream temperature response to changing glacier coverage in coastal watersheds of southeast Alaska*
9:20 - 10:00	*Douglas Kane, invited* *Sveta Stuefer*	*Updated precipitation-frequency atlas for Alaska*

10:00 - 10:30 AM BREAK

10:30 - 12:00 PM	**Working at the interface of multiple systems: Examining process and managing for interactions occurring across terrestrial, freshwater, and atmospheric boundaries**

Session Chairs: Christopher Estes & Dana Infante

10:30 - 10:45	Jessica Kayser	*Developing a third party aquatic resources and wetland mitigation program in Southeast Alaska - Challenges, opportunities and lessons learned*
10:45 - 11:00	Michael Gracz	*An efficient binomial HGM classification for freshwater peatlands in the Cook Inlet basin, Alaska*
11:00 - 11:15	David D'Amore	*Soil water flow and accumulation model for southeast Alaskan watersheds*
11:15 - 11:30	Sonia Nagorski	*Mercury occurrence in water and biota across a spectrum of southeastern Alaskan streams*
11:30 - 11:45	William Battaglin	*Does proximity to a road facilitate amphibian disease or malformations through changes in water quality or thermal disturbance? A multidisciplinary investigation*

12:00 - 1:30 PM LUNCH - On your own

1:30 - 3:15 PM	**Improving knowledge, techniques, and data for better management of current conditions: A focus on rivers**

Session Chairs: Christopher Estes & Dana Infante

1:30 - 1:45	Jeff Conaway	*Hydrology and hydraulics of the Copper River Highway closure*
1:45 - 2:00	Charles Podolak	*Multi-method assessment of the braided planform stability - Toklat River, Alaska*
2:00 - 2:15	Erik Johnson	*The Southeast Alaska hydrography database (SEAK Hydro)*

2:15 - 2:30	Christopher Estes	*Introduction to the National Fish Habitat Partnership and implementing the National Fish Habitat Action Plan: the origins of the report, "Through a fishes eye: The status of fish habitats in the United States 2010"*
2:30 - 3:00	*Dana Infante, invited*	*Assessment of Alaska's fluvial resources for the National Fish Habitat Partnership: Improving management and conservation through Information development and interagency cooperation*
3:00 - 3:15	Katherine Miller	*Summary of the coastal (estuarine and marine habitats) assessment process used for the national fish habitat partnership: developing the initial Alaska Coastal Assessment and suggestions for the future*

3:15 - 3:45 PM **BREAK**

3:45- 5:00 PM

Planning for the future: Anticipating changes and identifying opportunities for better conservation and management of Alaska's aquatic resources

Session Chairs: Christopher Estes & Dana Infante

3:45 - 4:00	Jason Leppi	*Climate vulnerability of a salmon-bearing stream in Southcentral Alaska*
4:00 - 4:15	Sue Mauger	*Using thermal infrared imagery for salmon habitat protection on the Anchor River in Southcentral Alaska*
4:15 - 4:45	*Jedediah Smith, invited*	*Institutionalizing watershed partnerships in Alaska freshwater management*
4:45 - 5:00	DISCUSSION	

Thursday, March 8th

8.30 AM - 12.00 PM	**FIELD TRIP, Juneau hydro- & thermal power facilities**

Contact: Paul Burger

The field trip requires pre-registration. Participants will depart from the Centennial Hall at 9:00 am. Drop-off at the airport and the Centennial Hall.

Sponsored by Alaska Electric Light and Power

12:00 - 1:00 PM **LUNCH – On your own**

1:00 - 5:00 PM	**Spring 2012 IHCA Meeting**

Contact: Crane Johnson

AK DOT Conference Room, 3132 Channel Dr., Juneau

The meeting will focus primarily on agency project updates and summer data collection efforts in order to maximize collaboration and data sharing.

Thursday & Friday March 8-9th

8:30 AM - 5:00 PM	**FORUM: Community based watershed management**

Contact: Jessica Kayser

Baranof Hotel, Juneau

The forum aims to bring together a diverse group of community leaders, tribal leaders, land resources agency staffers, municipalities, scientists, and user groups to share knowledge and resources about community-based watershed management.

Abstracts – Invited

The status, use, and importance of hydrologic data required for natural resource management, conservation, development and research to present and future Alaskans: What data are needed and examples of actions underway to address data gaps, needs and data management.

***Christopher Estes*[1],** christopher@chalkboardllc.com
David Meyer[2], Michael Lilly[3], Gary Prokosch[4], Douglas Kane[5], Tom Barrett[6], Rick McClure[7], Bill Rice[8], Dana Infante[9],
[1]Chalkboard Enterprises LLC (retired, Alaska Department of Fish and Game); [2]U.S. Geological Survey; [3]Geo-Watershed Scientific; [4]Alaska Department of Natural Resources; [5]University of Alaska Fairbanks; [6]BP Exploration Alaska; [7]U.S. Department of Agriculture; [8]Michigan State University

Alaska's vast surface and subsurface water resources provide a variety of essential purposes and benefits by supporting water demands for human consumption, environmental, industrial and other uses.

Natural resource management, conservation, and development decisions and research are dependent on the acquisition and analyses of sufficient amounts of geographic based, site specific and regional hydrologic data such as precipitation, river flows in lotic (flowing water environments), groundwater availability from subsurface locations, and water level and volumes in lake/reservoir type (lentic) water sources on a year-round basis. Adequate amounts of hydrologic data contribute to the overall socioeconomic well-being of Alaskans.

Alaska has 20% of the nation's land area, approximately 50% of the nation's coastline and 40% of the nation's flowing surface waters. The quality and availability of Alaska water sources and usages differ significantly from the majority of other locations in the United States and other countries. Less than 1% of Alaska's water bodies have been modified or have site specific data collected for those water bodies.

Most of the existing Alaskan water bodies that have been altered and used for supply water have been capable of supporting the majority of present water demands for various human needs and at the same time to sustain fish and wildlife production and other ecological functions. The current balance between water supply and demand can be partially attributed to Alaska's youth as a state, its relatively small human population, the early stage of industrial and natural resources developments, and the socioeconomic value associated with retaining portions of water within water bodies to support fish, wildlife, water quality, navigation, and other public interest purposes.

Alaska became a state in 1959 and remains in its infancy in terms of human population growth and in development of its abundant and diverse natural resources. The population of Alaskans has increased from 224,000 in 1959 to over 700,000 in 2011. Alaskans celebrated its 50th anniversary of statehood in 2009.

Some equate Alaska's current stage of water availability knowledge and uses with that experienced by the western United States approximately 160 years ago which was extremely limited and resulted in expensive and long-term efforts to meet human and other water demands in part because water use decisions were based on inadequate data and comprehension of water needs. Unfortunately past water management actions and policies implemented in the lower 48 states over the past 100 years ultimately resulted in over-appropriation (overallocation) of water from most surface-water bodies. That means more water was allocated for diversions, withdrawals, and impoundments versus amounts of water needed and retained within rivers and lakes to sustain all types of water uses including human consumption, industrialization, and fish and wildlife habitat and other ecological processes and services.

These are all situations that Alaskans have an opportunity to avoid.

Present and projected water management uses and issues in Alaska are typically associated with the impact of increased demand and competition for water use associated with human population, energy, recreation, industrial growth, and maintenance of fish and wildlife and other natural resources. Another growing use of water is based on demands by other parts of the country and planet to import water of good quality from Alaska.

The steady increase in the growth of competing water uses should encourage Alaskans to closely evaluate the adequacy and availability of hydrologic and other water related information needed for effectively balancing and meeting competing water demands in the best public interest.

By doing so, one will observe there are a variety of insufficient site specific and regional hydrologic data, especially data required to document baseline historical water availability of surface and subsurface water supplies in most locations throughout Alaska. Not knowing how much water naturally exists within a water supply source at any given time of the year (and being able to project how water availability changes over multiple years during wet and dry periods) can result in inadvertent errors in determining and predicting how much water can or should be removed and left within rivers, lakes, and wells in the overall best public interest.

The framers of the Alaska Constitution recognized the socioeconomic importance for sustainable and wise natural resources management. Fortunately, Alaska's youth as a state provides unique opportunities unlike most other locations on the planet to learn from and apply the lessons learned by the lower 48 states and our limited experiences as a state. Applying these lessons and working together will enable current and future Alaskans to take actions to obtain the required hydrologic and other information to beneficially manage Alaska's water needs for human and other natural resource management, conservation, development and research purposes.

This presentation and the subsequent panel will summarize the types and status of hydrologic information required for natural resource management and research, including gaps and initiatives used to compensate for insufficient data. Hydrologic data management and reporting considerations will also be addressed.

The Alaska Chapter of the American Water Resources Association, Interagency Hydrology Committee for Alaska, academic, federal, state, nongovernmental organizations, tribal, and private interests have all contributed to identifying hydrologic data gaps and options for identifying hydrologic data gaps and needs. Individually and collectively they have collaborated to meet the various hydrologic data needs of Alaskans and tackled challenges associated with data management and reporting of this information. The subsequent panel will summarize these efforts and provide an introduction to the overall theme of many of the presentations that will be discussed in greater detail over these next couple of days. Regarding the status of hydrologic information required for effectively managing Alaska's wealth of water resources, it is envisioned attendees will be able to contribute to identification of these and other hydrologic data needs and define future courses of actions that all might contribute.

Abstracts – Invited

Geophysical permafrost mapping and permafrost-hydrology interaction – U.S. Geological Survey studies in Yukon Flats, Alaska

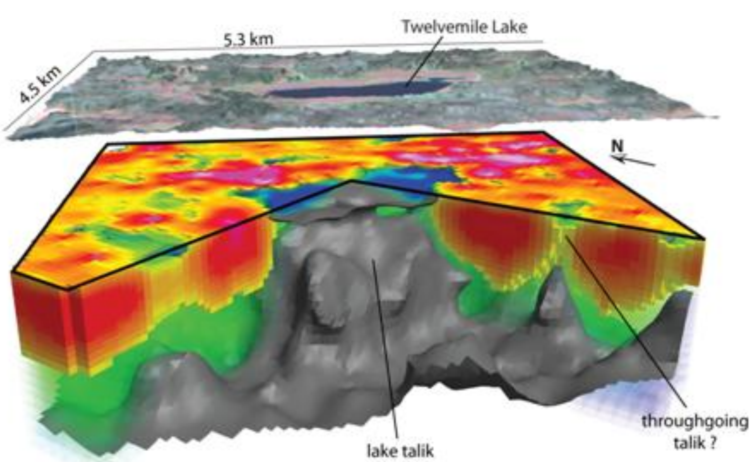
Clifford I. Voss[1], cvoss@usgs.gov

Jared D. Abraham[1], Frederick D. Day-Lewis[1], Steven M. Jepsen[1], Jeffrey M. McKenzie[2], Burke J. Minsley[1], Jay Nolan[3], Jennifer Rover[1], Bruce D. Smith[1], Michelle A. Walvoord[1], Tristan P. Wellman[1], and Bruce K. Wylie[1]

[1] US Geological Survey, [2] McGill University, [3] Rutgers University

The U.S. Geological Survey (USGS) and collaborators have, in recent years, undertaken a program in Yukon Flats, Alaska, to characterize the current permafrost distribution and to improve understanding of permafrost interactions with hydrology. This effort was motivated by the fact that changes in climate can cause permafrost to thaw in the region, resulting in major hydrologic and ecological changes. Several studies in this program are highlighted in this presentation.

(1) Both ground-based and aerial geophysical mapping provide a first-ever shallow to deep three-dimensional picture of discontinuous permafrost over large areas. The complex patterns observed together with their interpretation may serve as a touchstone for cold-regions studies in the near future.
(2) Electrical resistivities of the shallow subsurface in areas in the Yukon Flats not directly mapped by aerial geophysics were estimated by a regression-tree analysis that correlated measured resistivity with Landsat indices, reflectance, and ancillary data. This allows proxy maps of shallow conditions (e.g. permafrost table depth) to be created where only remotely-sensed data are available.
(3) A time-lapse remote-sensing study resulting in a map of lake surface water extent trends indicates the widespread hydrologic changes that have occurred over the past 30 years.
(4) Hydrologic analysis of one shrinking lake's water budget shows how changes in permafrost depth and several other factors, such as a sub-lake talik (zone of permafrost absence), might have caused the observed changes in lake volume.
(5) Classical groundwater-flow modeling analysis, for the entire Yukon Flats basin, indicates how groundwater flow and groundwater discharge to surface-water bodies would change, should permafrost coverage decrease.
(6) Recently-developed software for heat-transport-coupled groundwater-flow modeling that includes the dynamic process of groundwater flow and ground ice interaction demonstrates the importance of groundwater flow in creating and changing the large-scale permafrost distribution and illustrates how groundwater flow affects formation of taliks below lakes.
(7) Geophysical modeling of the simulated permafrost-talik evolution provided by the groundwater-ice models, shows how electrical resistivity would appear given different lithologies and permafrost configurations. This allows more confident inversion and interpretation of geophysical data.



Work at USGS is underway to combine the results of these field characterization and hydrologic analyses in order to understand the changing landscape of permafrost and hydrology. Hopes are that improved understanding can lead to more-effective management of water resources and ecosystems in permafrost areas, especially with regard to adaptation to possible climate-change impacts.

Figure. *Permafrost distribution interpreted from airborne resistivity measurements.*

Abstracts – Invited

Updated precipitation-frequency atlas for Alaska

Douglas L. Kane[1], dlkane@alaska.edu
Sanja Perica[2,3,4], Sveta Stuefer[1];
[1]Water and Environmental Research Center, University of Alaska Fairbanks; [2] National Oceanic and Atmospheric Administration, [3] National Weather Service, [4] HSDC

NOAA's National Weather Service's Office of Hydrologic Development and University of Alaska Fairbanks, Water and Environmental Research Center are updating precipitation frequency estimates for the state of Alaska. Precipitation frequency estimates are used by hydrologists, engineers and others when designing infrastructure built to cope with runoff. The new estimates in an electronic format, which will replace estimates published in early 1960s, will be published in NOAA Atlas 14 Volume 7 and will be available through the NOAA's Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds), starting in February 2012. In our presentation we will go through the steps taken in the data collection, analysis, QA/QC, discuss some of the problems and finally present results.

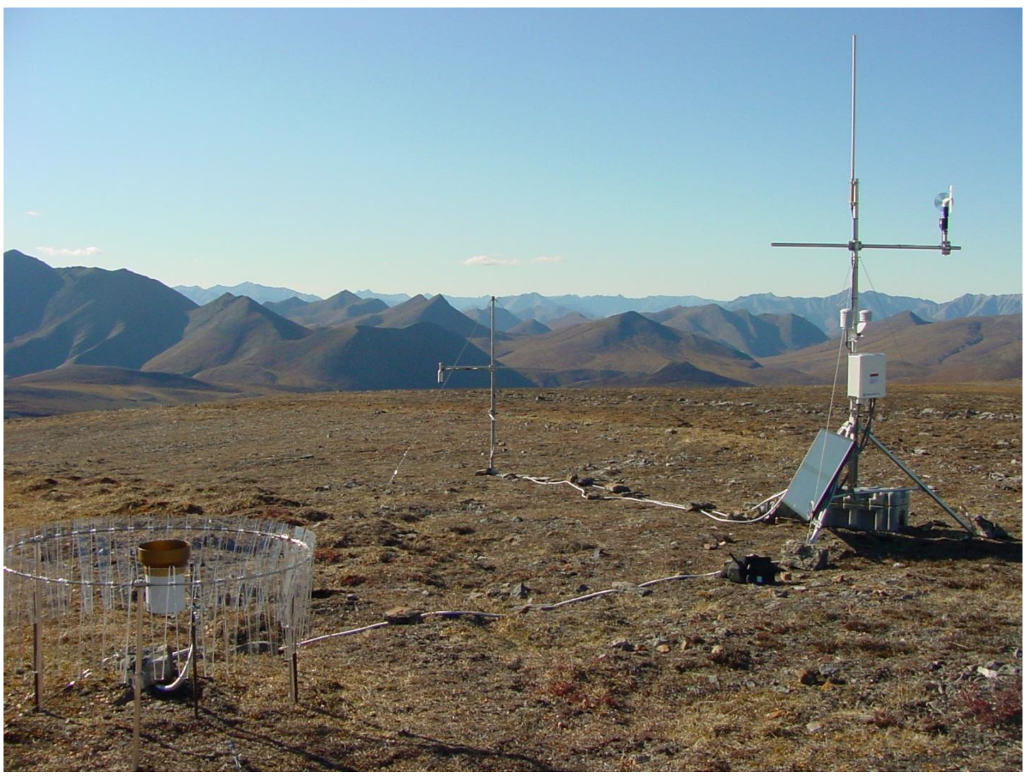


Figure. *Shielded rainfall gauge in the remote Brooks Range, Alaska.*

Abstracts – Invited

An assessment of Alaska's fluvial resources for the national fish habitat partnership: Improving management and conservation through information development and interagency cooperation

***Dana Infante[1]**,* infanted@msu.edu
Peter Esselman[1], Christopher Estes[2], Li Wang[3], Gary Whelan[4], Arthur Cooper[1], Dan Wieferich[1], and Jared Ross[1]
[1]Fisheries and Wildlife, Michigan State University, [2]Chalkboard Enterprises LLC (retired, Alaska Department of Fish and Game), [3]International Joint Commission, [4]Michigan Department of Natural Resources

Working to implement the 2006 National Fish Habitat Action Plan (www.fishhabitat.org), the National Fish Habitat Partnership (NFHP) represents a coalition of governmental and non-governmental groups voluntarily applying non-regulatory habitat conservation actions to protect, restore, and enhance fish habitats throughout the United States and its territories. In 2010, science and data teams and members of Fish Habitat Partnerships supporting the NFHP completed the Nation's first initial assessments of inland and coastal systems in the lower 48 United States, Hawaii, and Alaska -- an unprecedented effort based on the spatial scale and diversity of aquatic systems evaluated. An independent analysis and summary of the assessments was performed and reported by NFHP staff and other NFHP partners for the National Fish Habitat Board, "*Through a Fish's Eye: The Status of Fish Habitats in the United States 2010" (summary report).* This presentation is limited to the data and does not address the summary report.

Currently, the summary report and data on which assessments were based are slated to be updated every 5 years. This presentation for AWRA focuses on the Alaska portion of the data and methodology used for the initial Alaska inland freshwater assessment. It provides an initial effort to produce a state-wide look at relative condition of the Alaska's vast fluvial resources through development of a single disturbance index combining effects of landscape-scale anthropogenic activities that negatively impact fluvial fish habitat. The basic spatial unit used for this Alaskan inland assessment was the 12-digit hydrologic unit (HUC), the finest spatial unit currently available state-wide, and data linked to individual HUCs included 14 measures of disturbance characterizing factors like anthropogenic land use, inputs of toxic materials, and barriers to fish movement. While initial assessment results are useful for various purposes, for example identifying waters that can be protected or restored based on presence of manageable stresses, conducting the assessment allowed for a careful accounting of data needs to better support conservation and management state-wide. These needs included not only additional disturbance layers describing factors known to impact fish habitat and other aquatic resources but improved representation of the state's waterbodies and a supporting spatial framework to isolate landscape factors most directly affecting them. While addressing these limitations will be broadly supported by NFHP and individual Fish Habitat Partnerships working in Alaska, access to such information would benefit other partners as well. In the face of large, landscape-scale changes such as land use and climate change, meeting information needs identified by the NFHP Alaskan assessment can serve as a stepping-stone for greater collaboration state-wide and ultimately, improved management and conservation of the state's aquatic resources. Discussion as part of this presentation will include plans for improving the assessment and opportunities for addressing data limitations. Obtaining feedback and suggestions for improving future assessments will be welcome!

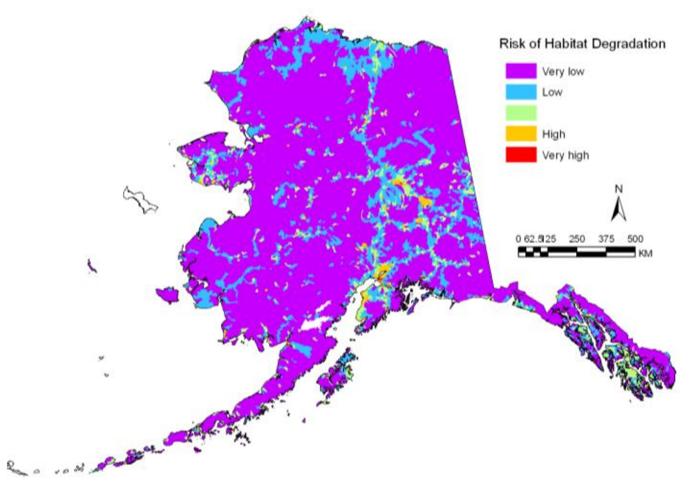


***Figure.** Cumulative scores indicating relative risk of habitat degradation to Alaska's fluvial waterbodies.*

Abstracts – Invited

Institutionalizing watershed partnerships in Alaska freshwater management

Jedediah Smith*[1]*, akjedediah@gmail.com
[1]Alaska Center for the Environment

Alaska is still in the process of building the institutional capacity to address water-related challenges such as appropriation, availability and the maintenance of high water quality among competing uses, at a time when the physical and social environment is changing rapidly. The manifestations of climate change in Alaska are intertwined with these water challenges on many levels and will invariably affect the course of society's interaction with the environment. The major social pressure on Alaska's freshwater systems are increased resource development pressures and population changes that, in concert with a changing climate, poses a threat to regular provision of freshwater for multiple users in society from small-scale households to large-scale mining and oil and gas operations. Alaska's distribution of organized local government does not equally cover the state's sparse and scattered population. Regional administrative boundaries such as boroughs in many cases cut across ecosystems. Further, some communities exist within formalized governments, while others exist outside or beyond local boundaries. While formalized local governments may increase governance complexity, they also provide organization through which to implement decisions and persuade resource management agencies, a basic level of decentralization. On the other hand, the potential for transboundary conflict exists among communities that may benefit from service flows while not directly contributing to them. Some communities outside of local government jurisdiction may experience the negative impacts of decisions and have little recourse in the decision-making process. Alaska will need to seek out and implement new ways to govern water resources. Facilitating activities and discussions at the watershed scale is one way to engage local rules and norms into the development of new freshwater institutions. The watershed partnership model has been proven an effective institutional framework for managing some common pool resource problems in the Lower 48 states, notably in addressing complicated non-point source pollution. Alaska's partnerships in some cases have been effective in addressing discrete local problems through consensus building and collective action. Developing new institutional rule sets to anticipate, identify and adapt or address these problems will be crucial managing freshwater resources during the next 50 years.

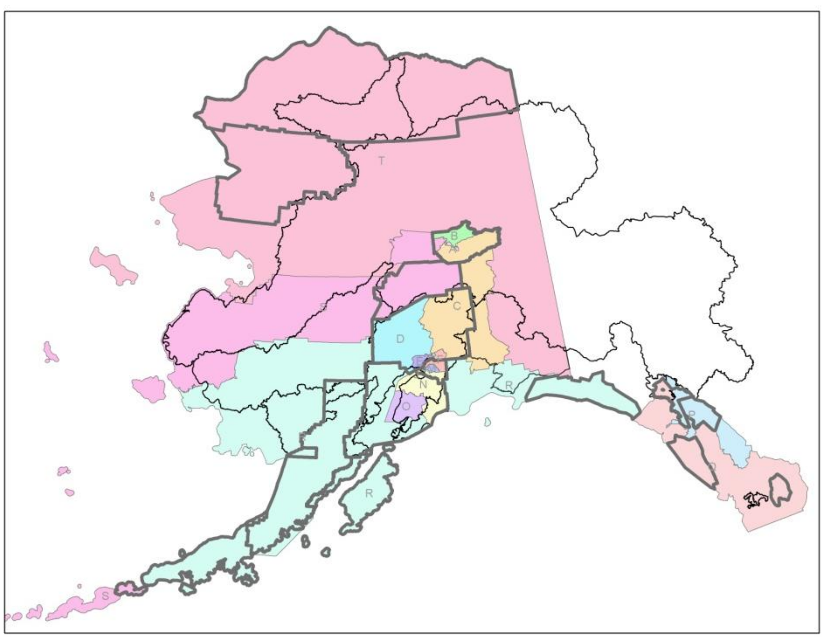


***Figure**. Ecologic, administrative and political boundaries, intersections and conflicts, in development of freshwater policy.*

Abstracts

Ongoing Alaska glacier hydrology research at the Geophysical Institute, UAF

Anthony Arendt[1], arendta@gi.alaska.edu
R. Hock[1], C. Beedlow[1], J. Davis[1], S. Herreid[1], C. Kienholz[1], J. Rich[1], and J. Young[1]
[1]Geophysical Institute, University of Alaska, Fairbanks

Glaciers occupy the headwaters of many Alaska watersheds and play a key role in modulating the characteristics of watershed discharge. Glaciers provide a base level of streamflow in dry summer months and can dramatically alter the discharge of rivers in the absence of precipitation inputs. Glaciers are also extremely sensitive to climate variations. In a warming climate, glacier runoff will likely increase and lead to increased occurrences of hazards associated with flooding, but may over time decrease as glaciers lose volume. Understanding and predicting the spatial and temporal patterns in Alaska glacier discharge is therefore vitally important to a wide range of local community, industry and state and federal agency stakeholders.

The Geophysical Institute at the University of Alaska Fairbanks is currently partnering with federal and state agencies to improve our ability to assess present glacier changes and model their future evolution. We are filling a major knowledge gap by providing the first comprehensive and accurate inventory of glacier locations, both at the time of 1950s USGS mapping as well as the most recent extent from modern satellite imagery. Changes in glacier area during this time period are providing new information on landscape evolution that is vital for ecosystem assessment and watershed modeling. We have a number of ongoing glacier mass balance projects that include field studies on the Kahiltna, Valdez, Yakutat, and numerous eastern Alaska range glaciers; repeat airborne laser altimetry measurements of glacier volume change; and satellite measurements of gravity variations providing regional assessments of both seasonal and secular mass losses. Glacier dynamics play a major role in controlling glacier variations of coastal tidewater glaciers, and to address this we are using satellite radar observations to track glacier velocities and determine the partitioning between dynamic and climatic mass changes. In order to accurately simulate future glacier changes we are developing computer simulation models of varying complexity. Some models use simple, temperature and precipitation based parametrizations of glacier melt to simulate glacier changes from individual catchment to broad regional scales, while others incorporate more detailed physics to predict the flooding potential of individual watersheds. Our goal is to assemble these multiple research projects into a comprehensive set of tools that can be used to inform decision making for mapping potential flood hazards, predict changes in groundwater recharge, and assess discharge magnitudes for hydroelectric projects.

Landscape limnology within and across Alaska's lake districts

Chris Arp[1], cdarp@alaska.edu
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The state of Alaska has more than 400,000 lakes greater than 1 hectare in surface area and many more small lakes, ponds, and wetlands. Collectively these surface water bodies provide valuable ecosystem services, such as water supply for villages and habitat for abundant fish and wildlife, and regulate watershed runoff and water quality, surface energy balance and permafrost distribution, and greenhouse gas emissions. Thus, research efforts to better understand lake processes at landscape-scales are essential for appropriate management Alaska's environmental resources, particularly with respect to how lakes and landscapes are responding to climate change. A notable characteristic of lakes in Alaska and elsewhere is their uneven distribution across the landscape; such as in regions associated with river floodplains and deltas, glacial recession, and ice-rich permafrost that often have lake area extents exceeding 10 to 20%. These lake-rich regions are referred to as lake districts and 20 major lake

districts have been identified across the state, covering 16% of the land area but holding 75% of lakes. Examples of these lake districts include the oil- and wildlife-rich Arctic Coastal Plain of northern Alaska, the hinterlands and mountains surrounding Bristol Bay, the Matanuska-Susitna Valley with rapid population growth, the Yukon-Kuskokwim Valley dotted by native villages and particularly vulnerable to sea-level rise, and the NW portion of Denali National Park and Preserve. Not only are there multiple resource management needs associated with these and other lake districts in Alaska, but research focused around lake districts provides a useful organizational framework for limnological research in this state. In this paper, we will report on the status of three new projects focused on landscape limnology within and among Alaska's lake districts. First, we will describe a new program called the Circumarctic Lake Observation Network (CALON, NSF-AON) focused on collecting baseline data to describe lake physical processes using in situ monitoring and remote sensing across the North Slope. Next, research funded by U.S. Fish and Wildlife Service's Western Alaska Landscape Conservation Cooperative is being initiated to understand past, present, and future temperature regimes across large lakes and lagoons in western Alaska (from Kodiak to Kotzebue). Finally, a remote sensing study of 11 lake districts in Alaska funded by NASA – Alaska EPSCoR will seek to identify patterns and processes of ice-out timing from 2001 – 2012. Together, these and other limnological research represent important progress towards improved understanding of lakes at relevant scales in the vast and very lake-rich state of Alaska.

Does proximity to a road facilitate amphibian disease or malformations through changes in water quality or thermal disturbance? A multidisciplinary investigation

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Physical abnormalities, intersex gonads, anomalies in population demographics, and disease (chytridiomycosis) have been documented in Kenai National Wildlife Refuge (NWR) wood frogs. The mechanisms for these abnormalities likely involve interactions among multiple stressors. Preliminary studies indicate an association between the occurrence of abnormal frogs and the distance to the nearest road, high metals concentrations, and the abundance of invertebrate predators. Roads are known to have deleterious effects on water quality and the biota found in receiving waters due to contaminants such as salts and metals in road runoff. There is increasing need for new roads on the Kenai Peninsula to support oil and gas development, tourism, and a growing population. Objectives of this investigation include: determining the presence, type and quantity of contaminants; and thermal signature associated with various classes of roads in the Kenai NWR; and conducting spatially explicit statistical analyses to assess the relationships between roads, contaminants, temperature, habitat, macroinvertebrate predators, and amphibian abnormalities.

Approximately 30 sites are included in this investigation. All sites are visited multiple times each summer, and a subset of sites are instrumented with data loggers. Data collected include: water-levels and climate data; water, sediment, soil, dust, snow, tissue, and periphyton samples for contaminants analysis; habitat assessments and macroinvertebrate surveys; and disease screenings. Sampling began in 2010 and will continue through 2012. Preliminary assessment of the 2010 and 2011 data suggest weak inverse relationships between distance to the nearest road and the occurrence of Batrachochytrium dendrobatidis in water samples and specific conductance. This multidisciplinary investigation is utilizing the skills of wildlife biologists, hydrologists, ecologists, and chemists.

Investigation of hydrologic and thermal regimes of lakes used for water supply in Kotzebue, Alaska

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Lakes are an important component of Arctic ecosystems and many Alaskan communities rely on lakes as a municipal freshwater source. Therefore, understanding the baseline condition of lakes is essential to evaluate present and future vulnerabilities, such as water quality deterioration. Lake thermal regimes represent an important attribute of lake condition as temperature impacts both the chemical and biological characteristics of a waterbody. Our study focuses on the thermal regime of lakes near Kotzebue, Alaska that are being used as a source of community water supply; Devil's and Vortac Lakes. In summer 2011, we installed in water temperature and pressure sensors in these water supply lakes and two adjacent control lakes not being subjected to water extraction. We also installed a weather station along the shore of Devil's Lake that measures air temperature, solar radiation, and precipitation. Our goal is to establish a baseline using these summer water temperature data and to develop an empirical model driven by air temperature and solar radiation. We are able to use information not only from our weather station but also from a long-term weather station at the local airport to implement this model. To validate this modeling approach we will use measurements of surface water temperature from the satellite MODIS during the last decade of a lagoon just south of Kotzebue and one of the water bodies monitored in 2011. With data from recent *insitu* measurements, a long-term climate station, and thermal remotely sensed imagery, we plan to develop a baseline of summer temperature regimes for both water supply and reference lakes and also identify potential trends in thermal regimes of these lakes using long-term hindcasts from the 1950s to present.

Modern glacial outwash sand thermochronology along the Denali Fault: Constraints on glacier erosion dynamics and sub-glacial hydrological regimes

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It is now generally accepted that increased climate instability and extent of glaciation associated with late Cenozoic global cooling has led to increased erosion rates in most of the world's orogenic belts. However, the connection between surface processes and mountain building continues to be contentious because while some argue that tectonically driven rock uplift in continental collision zones is the most significant influence on erosion rates others suggest that the deep exhumation found in mountain ranges can mostly be explained by focused erosion driven by climatic processes. The relationship between the introduction of glaciers and erosion rates is also complicated by glacier process behavior in itself. It has been demonstrated that glacial advance-retreat cycles and high basal sliding rates are critical factors affecting if the introduction of glaciers will increase or decrease long-term exhumation rates. Natural experiments using detailed glacial outwash sand thermochronology, by providing an integrated time-space record of material flux, have been shown to be useful on constraining a regions sub-glacial erosion and exhumation history. The Denali Fault system, a continental-scale strike-slip fault and the associated Alaska Range with a known orogenesis development history, a documented increase in exhumation rates correlated to the start of Northern-Hemisphere glaciation, and a known surge-type glacier/fault relationship make the region a prime location to investigate the interaction of active faulting and glacial processes on erosion patterns. We can distinguish between three different scenarios from the full detrital and bedrock age data set: a) Outwash data slightly younger than bedrock data set-This would imply the same trend as bedrock samples, where as bedrock thermochronometric ages get younger as you approach the Denali Fault in agreement with dip-slip on a sub-glacial Denali Fault master strand as a significant contributor to topographic development in the region. b) Outwash data same or older then bedrock data set-This would imply structures that are not located

in the modern "glacier trench valley" are predominately responsible for exhumation in the region. c) Outwash data significantly younger than bedrock data set which would imply some other process is occurring, potentially a glacier/strike-slip fault exhumation feedback loop or unmapped sub-glacial active structures. Preliminary glacial outwash sand results (110 biotite 40Ar/39Ar single grain ages) from the Black Rapids Glacier and Susitna Glacier overlap respective biotite 40Ar/39Ar age histograms from the up-drainage bedrock age data sets. Preliminary results also favor a dominant point source for both glacier systems on the south side of the Denali Fault. This is a surprising result considering stronger tectonic forcing and associated higher erosion rates known to be on the north side of the Denali Fault. Also, the lack of sub-glacial sediment mixing implies efficient sub-glacial channelization. Further work is planned to investigate glacial outwash sand thermochronology as a tool to track seasonal changes in sub-glacial hydrological regimes.

Understanding the mechanisms by which a perennial Arctic stream appears intermittent

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Fish and wildlife species in the Arctic have developed life history strategies to deal with the extreme climate of the North. In the case of Arctic grayling, these strategies include long life, yearly spawning, and migration. In order to understand how such a species will be affected by a changing climate, we must determine how these adaptive strategies may be at odds with the changing Arctic landscape. Arctic grayling migrate to spawning grounds just after break up in the spring, then migrate to feeding sites in early summer, and finally in the fall migrate back to their overwintering sites. Low precipitation and high evapotranspiration rates early in the summer can lead to low water levels and a fragmentation of the hydrologic landscape. This fragmentation creates a barrier to fish migration. The Kuparuk River is a perennial stream originating in the foothills of the Brooks Range on the North Slope of Alaska. The basin is entirely underlain by permafrost which essentially cuts the system off from deep groundwater. Subsurface flow occurs in the active layer, that area above permafrost which undergoes seasonal thawing in the summer. Sections of the Kuparuk are intermittent in that during low flows in the system these reaches appear dry. Water reappears downstream of these dry reaches and it is believed that water continues to flow below the surface through the unfrozen thaw bulb beneath these reaches. These dry reaches act as summer barriers to fish migration within the Kuparuk River system. Previous research of this phenomenon sought to understand the location and timing of these "dry" events. This work found that these reaches appear dry anywhere from 2 days to 4 weeks at a time and average about 22 dry days a year. The timing of these dry events is fairly uniform throughout the summer. The three dry reaches in this study range from 1.5 miles in length to over 5 miles. The research presented here represents year two of the current project which has focused on understanding the mechanisms which drive these dry events in an effort to determine whether climate change will act to increase the instances of such events.

Building a network of watershed observations sites in support of conservation

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The Arctic climate is warming at a rate twice as high as the global average. Hydrologic changes expected to occur are difficult to predict, and due to the lack of data, will be difficult to document. Understanding these changes and their impact on fish and wildlife habitat will be critical for conservation planning. The Arctic Landscape Conservation Cooperative (LCC) is a self-directed partnership supporting conservation by providing land managers and policy makers with the science and tools necessary to make better-informed decisions. The Arctic LCC steering committee, composed of field-level managers responsible for conservation of land and natural resources in the Arctic, has emphasized the need for strategic monitoring focused on improving our understanding of the rates and magnitude of forecasted hydrologic change. In turn, the Arctic LCC hydrology working group proposed a network of existing and forthcoming watershed observation sites supported by a diverse group of academic and agency scientists. Interdisciplinary monitoring efforts conducted at these focal watersheds will link climate, hydrology, and biological processes, providing information necessary to evaluate the effects of climate change on natural resources. To date, the Arctic LCC and partners have designed and populated a hydroclimatological database, conducted analyses to optimize network configuration, and invested in an improved and well-coordinated network of partners leveraging existing science infrastructure and historic data. Establishment of this network has included support of river gaging stations, collection of chemical and biological data, and a multidisciplinary effort assessing the impacts of glacier loss on fluvial and coastal ecosystems.

Short rotation woody biomass as a reliable fuel source for rural Alaska

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Biomass may be a key component of renewable energy source in Alaska's future, and may have the advantage of being cheaper than fossil fuels, especially in rural areas. It may also have the added result of net sequestration of carbon. However, there has been little study on management of biomass as an energy source in Alaska, but it has been shown in our study that woody biomass accumulation is limited by water availability. We recently began several studies to determine the yield potential and overall carbon balance of willows and poplars under management intensities and practices, ranging from very limited management to intensive farming of biomass, including growth in dryland and wetland areas. We harvested willows and poplars from the UAF Agricultural and Forestry Experimental Station, willows planted at the Trans-Alaska Pipeline spill site near Livengood, and poplars and willows on an experimental landfill cap at Elmendorf Air Force Base. Wood yields ranged from approximately 1/3 to 3 ton per acre per year (dry weight basis). Yields may be much higher under intensive management, and higher water availability. We have an established study site on Elmendorf Air Force Base in Anchorage, Alaska to determine the feasibility of farming poplars and willows for energy. Rotation periods for farmed, woody biomass usually range from three to ten years; our oldest plots are currently six years old. We harvested the first poplar crop on Elmendorf in the spring of 2011. Preliminary data is available on the first harvest at Elmendorf, but we do not yet have firm data on yields for carbon balance for farmed woody biomass in Alaska.

Simultaneous removal of Cd (II) and Zn (II) ions by protonated citrus peels in batch and fixed-bed reactors

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Conventional methods for treating metal-bearing wastewater, such as chemical precipitation, ion exchange and membrane filtration often fail to meet stringent regulatory criteria or are too costly to operate for dilute wastewaters. Alternatively, biosorption is a low cost technique for removing metals from the wastewater based on the metal-sequestering capacity of certain natural organic materials. Those may be microbial biomass or agricultural residues which are particularly suitable for concentrating metals from a large volume of dilute discharge such as mining effluent. This study focused primarily on the simultaneous biosorption of Cd (II) and Zn (II) ions by protonated citrus peels in batch and fixed-bed reactors. For experimental purposes, it is easier to utilize a batch reactor than a fixed bed reactor while the latter is more suitable from a commercial point of view as it can be operated at continuously with a higher driving force. A fixed-bed column made of clear extruded polyacrylic with a length of 30 cm and a diameter of ž inch was used for the dynamic study whereas equilibrium isotherms were derived from batch experiments. The equilibrium uptake of Cd (II) and Zn (II) ions was found to be 0.68 and 1.02 meq/g respectively according to single metal isotherms at pH 5.0. When both metals were biosorbed simultaneously, equilibrium uptake capacities were decreased due to competitive behavior. It was observed that biosorption of Zn (II) ions was more influenced by the presence of Cd (II) ions than vice-versa. In the fixed bed reactor, 19 L of feed solution containing 0.1 meq/L of Cd (II) ions were treated in the column at a flow rate of 9 ml/min until breakthrough occured. Compared to that, the breakthrough volume was only 16 L for a feed solution containing 0.1 meq/L Zn (II) ions. When both metals were present simultaneously, individual breakthrough volumes were decreased compared to the mono-component systems. Citrus peels were found to remove Cd (II) and Zn (II) ions from a sample of mining effluent which was collected from Greens Creek Mine, Juneau. Breakthrough curves were modeled considering a finite mass transfer rate.

Hydrology and hydraulics of the Copper River highway closure

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On August 19, 2011, the Alaska Department of Transportation and Public Facilities (ADOT&PF) closed the Copper River Highway at mile 36 indefinitely due to safety concerns at bridge number (BN) 339. In 2011, flow in excess of four times the design discharge scoured the streambed at the bridge to a level that the minimum thresholds for lateral load stability at the piers were exceeded. These conditions did not result from high flows on the Copper River, but from a redistribution of flow across the braid plain. The distribution of flow through the 11 bridges that cross the braid plain was relatively stable until the mid-1990s. In 1991, up to 68 percent of the Copper River flowed through 3 bridges on the western side of the braid plain. In 2004 during average flow conditions, these same bridges conveyed only 8 percent of the total flow while 90 percent of the flow passed through 3 bridges on the eastern side of the braid plain. Up until mid-2009, the main channel of the braid plain led to BN 342, located approximately a half mile to the east of BN 339. BN 342 is 880 ft long and can accommodate more discharge than BN 339, which is 400 ft long. Deposits from flooding in 2006 initiated a shift in the main channel from BN 342 towards BN 339. Discharge measurements, scour monitoring equipment, channel soundings, and aerial photography document decreased flow and deposition at BN 342 and increased flow and streambed scour at BN 339. The channel area at BN 339 increased from 4,880 ft2 in July of 2009 to 13,600 ft2 in September of 2011. Maximum channel depths exceeded 65 ft at the time of closure, leaving some piers with as little as 8 ft of embedment and 55.5 ft of the pier exposed to velocities approaching 11 ft/s. ADOT&PF received funding in the

fall of 2011 to begin the design phase for a replacement bridge. Pending the availability of construction funds, construction of a replacement bridge could begin in 2015. Until that time, access by road to the Million Dollar Bridge and nearby campground is not possible.

Analysis and extension of streamflow records in the Susitna River Basin, Alaska

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The Susitna River Basin covers 20,000 square miles of Southcentral Alaska in terrain ranging from glaciated mountains to extensive lowlands. Streamflow patterns in the basin reflect the capacity of these various landscapes to store and release water, which provided the opportunity to match short-record streamgages with similar index stations to extend their streamflow records. Daily mean streamflow over the period of record in most streams increased dramatically at the onset of breakup in the spring. In glacially influenced streams, daily means continued to rise until a mid-summer glacial-melt peak, then declined throughout the fall and winter. In less glacially dominated streams, daily mean streamflow fell off after breakup and maintained more modest summer levels punctuated by short-term response to rainfall.

In response to streamflow data needs associated with a proposed major dam on the Susitna River, the USGS sought to extend streamflow records for 14 streamgages with daily records in the Susitna River Basin. Unlike many areas in Alaska, the Susitna River Basin has adequate long-term index station records that correlate well with short-term records at other sites and permit estimation of missing years of record. Two USGS streamgages, the Susitna River at Gold Creek and the Talkeetna River near Talkeetna, collectively served as index stations for each other and for eight glacially influenced streams to fill out the period of water year 1950-2010. The Little Susitna River near Palmer streamgage, although outside the Susitna River Basin, had an unbroken record during that period and served as an appropriate index station for one non-glaciated mountainous stream, Willow Creek near Willow. However, no index stations adequately matched the three lowland streams such as the Deshka River.

Record extension with these long-term index stations provided not only a reliable estimate of missing daily values but also helped adjust long-term streamflow statistics for climate patterns such as the Pacific Decadal Oscillation. Four short-term streamgage records fell almost entirely in a warm phase of the PDO (1977-2006), a period when streamflows are higher in winter months and lower in summer months. Extended records included most of a cool phase of the PDO (1947-1976), providing a more balanced estimate of long-term monthly averages.

Soil water flow and accumulation model for southeast Alaskan watersheds

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Water is a ubiquitous feature across the landscape of the coastal temperate rainforest of Southeast Alaska. There is abundant information for surface water flow in stream channels, but water flow through soils has not been well documented. To model groundwater presence and flow through soils in Southeast Alaska, we quantified monthly water table elevations from several long-term datasets to establish a spatially explicit foundation for soil saturation. We then used the monthly water table elevations to derive a landscape model using a compound topographic index for water flow and accumulation. The flow model provides a much more detailed integration of terrain and flow accumulation than the drainage classes assigned to soil map units. The flow model is calibrated for hillslopes and the complex terrain of the humid maritime region of the coastal temperate rainforest. The model provides the first predictive, spatially distributed soil water table model for the northern coastal temperate rainforest. The water table model can be used to establish correlations and predictions for plant communities and their susceptibility to shifts in soil saturation patterns. The water table map also provides the basis for establishing a predictive model for changes in soil saturation calibrated to climate predictions in order to create vulnerability assessments for ground water dependent ecosystems such as ponds, lakes, and streams.

Nutrient limitation of snow algae and its role in surface melt on the Harding Icefield, Alaska: An experimental and observational approach

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Glaciers are high altitude oligotrophic ecosystems dependent on mostly allochthonous input of nutrients. Near the equilibrium line altitude (ELA) snow algae, such as the common and widespread Chlamydomonas nivalis, can be abundant enough to be detected from satellite imagery. This study considered the influence of snow algae on glacial snow melt on the Harding Icefield, Alaska through (1) observation of snow melt and algal abundance, (2) manipulation of algal abundances and (3) the relationship between albedo and algal abundance. Twenty-four observational plots located along a 78 m elevational gradient spanned the ELA and were sampled four times for surface melt and three times for algal abundance from 11 June to 23 July 2011. In addition, three blocks of four experimental plots (+N, + P, +N and +P, and a +water control) were sampled similarly from 11 June to 23 July 2011. Nutrient concentrations of phosphorous and nitrogen were sampled for some observational plots on 2 and 23 July 2011 and all experimental plots on 23 July 2011 with background samples taken 25 May 2011. Algal abundance showed a moderately strong, positive correlation to P and a weak positive correlation to N. However, experimental increase of algae abundance with nutrient addition was small, as often observed in nutrient poor environments. Algal abundance showed a complex relationship with surface melt that was dependent on date. As expected, snow melt rate was negatively correlated to elevation, but the strength of the correlation depended on algal abundance. Experimental manipulation of algal abundance suggests that melt rates become more dependent on algal abundance later in the melt season. The results of this study suggest that both phosphorous and nitrogen limit for algal growth, with P more limiting than N, as expected for oligotrophic, aquatic ecosystems. Furthermore, by reducing albedo, snow algae increase melt rate, but follows the patchy dispersion of algal blooms.

Urban surface water contaminants and protection issues in Fairbanks, Alaska

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Does road run-off, de-vegetation, open pit mining and development pollute the surface waters in interior Alaska? Fairbanks Alaska is the largest community in the 832,700 km² Yukon River watershed in northwestern Canada and Interior Alaska. This study monitors Escherichia coli and fecal coliform bacteria populations as well as trace metals, nutrients, conductivity and temperature over a 1.5 year period in local Fairbanks rivers, streams, lakes, gravel ponds, sloughs, storm drains and directly off the roads. A total of 222 samples were taken.

Results show bacteria populations, sedimentation, arsenic levels, chlorides, sodium, nitrates, phosphorus and lead were highest in storm drains, areas that are paved or de-vegetated and during flushing events such as spring melt and flooding in late July. Rivers with high sediment loads, streams that are de-vegetated due to mining and active gravel ponds all had higher concentrations of arsenic than other sites, especially when not filtering the samples before analyzing compared to filtering with a .2 um pore size filter. This suggests arsenic comes from geological sources on the sediment that flushes into the water off of paved surfaces and de-vegetated regions. Soil moisture and temperature is highly related to release of anions and cations into surface waters. Often filtered samples compared to unfiltered samples have opposite patters of correlation to

other parameters. The results suggest that this community is a source of contamination of an otherwise relatively unpolluted watershed.

Introduction to the National Fish Habitat Partnership and implementing the National Fish Habitat Action Plan: the origins of the report, "*Through a Fishes Eye: The Status of Fish Habitats in the United States 2010*"

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The National Fish Habitat Action Plan (NFHAP) was adopted in April 2006 by the fifty state fish and wildlife agencies under the Association of Fish and Wildlife Agencies and the U.S. Departments of Interior and Commerce to use non regulatory habitat conservation actions to protect, restore and enhance freshwater, estuarine and marine fish habitats in the United States and its territories. NFHAP serves as a national blueprint for establishing a National Fish Habitat Board and Fish Habitat Partnerships (FHP) to voluntarily and collectively implement the plan as a national fish habitat partnership (www.fishhabitat.org).

The mission of NFHAP is to (use non regulatory habitat conservation actions) to protect, restore and enhance the nation's fish and aquatic communities through private-public partnerships formed voluntarily and referred to FHPs that foster fish habitat conservation and improve the quality of life for the American people

Goals of the plan are to:

- Protect and maintain intact and healthy aquatic systems.
- Prevent further degradation of fish habitats that have been adversely affected.
- Reverse declines in the quality and quantity of aquatic habitats to improve the overall health of fish and other aquatic organisms.
- Increase the quality and quantity of fish habitats that support a broad natural diversity of fish and other aquatic species.

One of several objectives established by the plan is to: Prepare a "*Status of Fish Habitats in the United States*" report in 2010 and every five years thereafter.

The initial status report was completed to meet this objective in 2010: "*Through a Fishes Eye: The Status of Fish Habitats in the United States 2010*". Data and analyses used to prepare the 2010 report are summarized in the next two presentations following this brief overview of NFHAPand fish habitat partnerships that are based in and related to implementation of the plan in Alaska.

Stream temperature response to changing glacier coverage in coastal watersheds of southeast Alaska

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Glacial environments are sensitive to changes in climate because of linkages between atmospheric conditions, glacier mass-balance and runoff, and water quality. Changes in glacier mass-balance that result in declining summer flows could therefore have substantial hydroecological effects, especially for stream temperature. We measured stream temperature continuously during the 2011 summer runoff season (May through October) in nine watersheds of coastal southeast Alaska that provide spawning habitat for Pacific salmon. Five of the watersheds have glacier coverage ranging from 9 to 55%. Our goal was to determine how air temperature and watershed land cover, especially glacier coverage, influence stream temperature across the seasonal hydrograph. Our results provide insight into how changing glacier coverage may influence stream thermal suitability for Pacific salmon.

Mean stream temperature for the runoff season ranged from a low of 3.4°C in the highly glacial Mendenhall River to a high of 14.7°C in the non-glacial Auke Creek, which has a large lake upstream of the sampling site. Stream temperature strongly reflected contributions of glacial meltwater during the summer months of July through September with the highest temperatures observed in the non glacial-fed streams and lowest temperatures observed in the highly glaciated watersheds. Watershed glacier coverage was negatively correlated with mean monthly stream temperature ($r2$ values ranged from 0.52 to 0.89, all $p<0.04$) for all months except May ($r2=0.13$, $p=0.33$). Mean monthly stream temperature was also unrelated to mean monthly air temperature for all sites except two non-glacial streams. Furthermore, the maximum weekly average stream temperature (MWAT, an index of thermal suitability for fish species) was less than 8.0°C for the five glacial-fed streams, which is well below the optimum of 12.8–14.8°C for coho salmon growth. A linear regression between MWAT and watershed glacier coverage ($r2=0.97$, $p<0.01$) predicted an increase in MWAT of 0.8°C for every 10% reduction in glacier coverage. Under this scenario, some future reduction in glacial meltwater input may enhance salmon survival in heavily glaciated streams in northern southeast Alaska through greater food availability and improved thermal suitability for salmon physiology.

Using synthetic aperture radar to study river ice break-up on the Kuparuk River, Northern Alaska

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A combined use of remote sensing techniques, modeling and in-situ measurements is a pragmatic approach to study arctic hydrology, given the vastness, complexity, and logistical challenges posed by most arctic watersheds. Remote sensing techniques can provide tools to assess the geospatial variations that form the integrated response of a river system and therefore provide important details to study climate change effects on the remote arctic environment. The proposed study tests the applicability of remote sensing and modeling techniques to map, monitor and compare river temperatures and river break-up in the coastal and foothill sections of the Kuparak River, which is an intensely studied watershed.

We co-registered about hundred synthetic aperture radar (SAR) images from RADARSAT-1 and ERS-2 satellites, acquired during the months of May through July for a period between 1999 and 2010. Co-registration involved a Fast Fourier Transform (FFT) match of amplitude images. The offsets were then applied to the radiometrically corrected SAR images, and converted to dB values to generate an image stack. We applied a mask to extract pixels representing only the river, and used a statistical analysis to correct for perplexing variations in wind velocities. A threshold based on image segment standard deviations was used to delineate open water from frozen areas. The river break-up period can be bracketed by defining open vs. frozen river conditions.

Additionally, summer river surface water temperatures will be simulated through the well-established HEC-RAS hydrologic software package and validated with field measurements. The three-pronged approach of using remote sensing, modeling and field measurements demonstrated in this study can be adapted to work for other watersheds across the Arctic.

An efficient binomial HGM classification for freshwater peatlands in the Cook Inlet basin, Alaska

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A classification scheme that groups wetlands that function similarly will benefit wetland research, assessment, and management. The National Wetland Inventory classification used in the US (Cowardin et al. 1979) may be too general, and some hydrogeomorphic (HGM) classifications that have been tested have failed to group similar wetlands (Cole & Brooks 2000, Azzolina et al. 2007), did so inefficiently (Morrice et al. 2011), or were not transferrable to broader regions (Cole et al. 2002), or greater distances (Cole et al 2008). Here I present the Cook Inlet Classification (CIC) which classifies wetlands using hydrology and geomorphology, and test it against NWI and LLWW, an HGM classification developed for the glaciated northeastern US (Tiner 2003). Tests using both physical and biological variables on the Cook Inlet Lowlands show that the CIC produces greater within-group similarity than LLWW, NWI, or a combination of the two (cf. Brooks et al 2011). These findings suggest that the generic approach of using geomorphology and hydrology in a classification intended to predict wetland function (Brinson 1993) is sound, but that using different proxies for hydrology and geomorphology in the classification produces varying results. Further, although yet another classification may be found that will produce even more efficient groupings, any wetland classification will need to be combined with spatially explicit information to maximize its utility in wetland assessment.

Exploring the Alaskan cryosphere with ground penetrating radar

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The hydrological system in Alaska is heavily affected by the presence of seasonal and perennial ice. Snow and ice melt contributes significantly to river run-off whereas permafrost may act as a barrier for water infiltration. Ground penetrating radar (GPR) transmits electromagnetic waves from the surface into the subsurface. Such waves are partially reflected when they meet inhomogeneities in electrical properties and the travel time and amplitude of the recorded energy can be used to characterize the subsurface. In this presentation, we will illustrate recent applications of GPR to study the Alaskan cryosphere. Examples will include snow depth profiling; snow water content estimation; soil thaw depth measurements; river and lake ice profiling; glacier-bed imaging and determination of the glacier thermal regime. Two detailed case studies will be analyzed. In one we used multi-frequency GPR to reconstruct the spatial variation of the active layer thickness at the time of maximum thaw in the Arctic tundra near Barrow. In the second case the GPR was used to complement Synthetic Aperture Radar (IFSAR) measurements to infer the thermal properties of the Kahiltna Glacier in the Alaska Range. Both studies suggest that GPR is a powerful tool to characterize the cryospheric components of the hydrological cycle.

Rocks and their role in glacier longevity

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Glaciers in Alaska are melting at an accelerated rate. Glacier surface lowering causes debuttressing of valley walls, promoting rock fall and an increase in rock volume on the glacier surface. Additionally, an increase in melt rate causes an increase in the rate of exhumation of rocks entrained within a glacier. A thick layer of supraglacial rock debris has the effect of reducing the local melt rate and allows heavily debris-covered glaciers to extend further down-valley than meteorological variables alone would suggest. Debris cover can alter glacier topography facilitating the growth and collapse of supra- and englacial lakes by trapping water that would otherwise exit the glacier more efficiently. We present observations and measurements of glacier response to supraglacial debris in the Eastern Alaska Range on a time scale of days to decades. Using the Landsat archive and USGS topo maps, a 55-year comparison was made between two Alaska Range glaciers, one debris-covered and one debris-free. We tracked increases in glacier debris cover over time and the formation of a moraine-dammed lake that grew in surface area from 0 to 1.2 km^2. Field measurements of daily average glacier melt rate under varying thicknesses of debris cover were collected in 2011, as well as 107 point measurements of debris thickness on 8 Alaska Range glaciers. Using these data as control points, we explored the possibilities of using thermal remote sensing as a tool for approximating debris thickness on a regional scale. Here we identify a series of variables affecting glacier longevity that help facilitate discussion of glaciers as a landform and water resource in the future.

How will glaciers affect runoff in Alaska?

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Glaciers significantly modify streamflow both in quantity and timing, even with low percentages of catchment ice cover. Glaciers cover roughly 90,000 km^2 in Alaska and have been thinning and retreating during the last decades dramatically, recently at an accelerating rate. These changes will have profound effects on river runoff quantity, seasonality and peak flows in Alaskan drainage basins. Characteristics of glacier discharge include pronounced melt-induced diurnal cyclicity and a concentration of annual runoff during the melt season. Annual runoff from a glacierized basin is a function of glacier mass balance, with years of negative balance producing more runoff than years of positive balance. As climate changes and causes glacier mass balances to become progressively more negative, total glacier runoff will initially increase followed by a reduction in runoff totals as the glaciers retreat. With high percentage of ice cover the initial increase in runoff can be substantial, considerably exceeding the runoff changes to be expected from any other component of the water budget. However in the long term the loss of ice will lead to lower watershed yields of water. Despite their significant glaciers are often only crudely represented in hydrological models. It is essential that models are developed that consider the effects of glaciers and their wastage in order to make accurate projections for water resources management and hydropower schemes.

We investigate the effect of future climate change on glacier melt and runoff of four basins in the Juneau Icefield. Glacierized areas within these basins range from 6 to 122 km^2, and together comprise 5 % of the total Juneau Icefield surface area (4261 km^2). Meteorological and discharge data for all four outlet streams are available since 1965, with some records extending back to 1951. A temperature-index model including potential direct solar radiation is calibrated for each glacier based on recent mass balance and discharge data. Discharge is modeled using a linear-reservoir approach. Future scenario RCP6.0 CCSM4 simulations are downscaled to 5-10 km resolution over the study area with the Weather Research and Forecasting (WRF) model. Results indicate a substantial loss in glacier area and an increase in glacier discharge until 2100.

Arctic snow distribution patterns at the watershed scale

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Watershed scale hydrologic models require good estimates of the spatially distributed snowpack at winter's end. Snow on the ground in treeless Arctic environments is susceptible to significant wind redistribution, which results in heterogeneous snowpacks, with greater quantities of snow collection in depressions, valley bottoms and leeward sides of ridges. In the Arctic, precipitation and snow gauges are very poor indicators of the actual snowpack distribution. Snow distribution patterns are similar from year to year because they are largely controlled by the interaction of topography, vegetation, and consistent weather patterns. From one year to the next, none of these controls radically change. Consequently, shallow and deep areas of snow tend to be spatially predetermined, resulting in depth (or SWE) differences that may vary as a whole, but not relative to each other, from year to year. We intend to identify snowpack distribution patterns and establish their stability in time and space at a watershed scale in the Arctic. Snow patterns are intended to be established by (1) numerous field survey points from end of winter field campaigns and (2) through the relationship between the snow and more easily established replacement patterns like topography. The integration of these pattern identification methods will produce a hybrid approach to identifying snowpack distribution patterns. Improvement in our estimates of the snowpack distribution will aid in the forecasting of snowmelt runoff events, which are the most significant hydrologic event of the year for larger Arctic watersheds.

The 2011 Mendenhall Glacier outburst flood event

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Glacier lake outburst floods are a common hydrologic hazard in Alaska. In July, 2011 a glacier lake outburst flood from the Mendenhall Glacier caused a sizeable flood on the Mendenhall River in Juneau, Alaska. The flood originated from an ice marginal lake in Suicide Basin two miles up from the terminus on the East side of the Mendenhall. Water began draining from Suicide Basin on July 19 and by July 22 discharge on the Mendenhall River had increased by nearly 400% from 2500 cfs to greater than 12,000 cfs. The flooding led to the closure of several roads and a US Forest Service campground near Mendenhall Lake, however damage to property was minimal. This presentation will discuss the mechanisms responsible for the flood event and highlight ongoing efforts to monitor future outburst flood events in the Mendenhall Valley.

Aquatic and riparian habitat improvement in Juneau – An inventory and assessment

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Over the past 30 years, considerable effort and funding have been directed toward improving aquatic and riparian habitats in Juneau for the purpose of restoration, enhancement, and/or mitigation. However, few projects have been monitored to evaluate whether project goals were met. In 2009, the U.S. Fish and Wildlife Service partnered with the Juneau Watershed Partnership to inventory and assess habitat improvement projects on the Juneau Road System. Based on project records and interviews, we determined the goals and objectives for more than 80 projects. Project goals and objectives, if identified, were then used to qualitatively evaluate the success of a subset of projects in the field. The purpose of the assessments was to inform future restoration practices as well as identify projects where additional habitat improvement will be necessary to achieve the intended goals. Most (30%) of the projects identified in this study were related to fish passage improvement. Five fish passage projects evaluated in the field, including a roughened channel and fish ladder, appeared to be successfully passing fish. All bank stabilization projects were successfully preventing bank erosion. However, most projects constructed of rip-rap did not support riparian plant communities. Wetland creation success was linked to groundwater availability at the site. Wetlands created in borrow pits connected to groundwater sources developed diverse and productive wetland communities; wetlands created in upland areas reverted to upland plant communities. Several swales and infiltration basins that were designed to improve the quality of stormwater entering streams appeared to function as intended, although effectiveness has not been monitored. Two out of three channel relocation/reconstruction projects failed to meet one or more project goals due to poor water quality and lack of sufficient surface flows. Successful implementation and evaluation of future habitat improvement projects in Juneau will benefit from clearly defined goals, quantitative objectives, and post-project implementation and effectiveness monitoring.

The Southeast Alaska hydrography database (SEAK Hydro)

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A partnership for the collaborative stewardship of the National Hydrography Dataset (NHD) has been established at the University of Alaska Southeast (UAS). NHD is the surface water component of the National Map; which is a cooperative effort among the United States Geological Survey (USGS) and other Federal, State, and local partners to improve and deliver topographic information for the Nation. Direction requiring all federal agencies to adopt NHD as their primary source of hydrographic data is provided by the National Spatial Data Infrastructure established by Executive Order 12906 Apr 11, 1994.

As hydrography is a key data component of Alaska's GIS fabric and often is the foundation for other spatial layers, a data partnership, dubbed the Southeast Alaska Hydrography Database (SEAK Hydro) project, was stood up in 2011 in order to increase efficiencies and reduce costs associated with updating and maintaining the NHD; and to provide local entities with hydrography attributes meeting a full range of business requirements. Current SEAK Hydro stakeholders include USGS, the Alaska Department of Fish and Game (ADF&G), the Tongass National Forest (TNF), and UAS. It is expected that SEAK Hydro will soon provide services to entities beyond southeast Alaska such as the Chugach National Forest, as well as additional federal, state, and local agencies.
SEAK Hydro includes all of the features needed to update the NHD and delivers the following bio-geographical information to its partners, the scientific community, and the general public:

- Aquatic organism and habitat data including fish observations collected during field samples, locations of potential barriers to fish passage (i.e., bedrock waterfalls), locations of engineered fish passes, and locations of suitable anadromous fish habitat;
- Physical features such as rivers, streams, glaciers, lakes, dams, intertidal areas, estuaries, salt chucks, and minimum low- and maximum high-tide shorelines;
- Stream geomorphology information including fluvial process groups, stream channel gradient, stream pattern, stream bank incision, and stream containment;
- Regulatory fishing information integrated from the state's Anadromous Waters Catalog;
- Stream networks; which allow upstream or downstream tracing from dams, gauges, fish barriers, and contaminants.

SEAK Hydro data is comes in a straightforward, user-friendly format. As NHD update processes are concentrated at UAS and provided as services to partnering agencies, SEAK Hydro is less costly and easier to manage than directly maintaining NHD through USGS editing tools. The SeakHydro process also includes the spatial tracking of edits which minimizes editing conflicts between editors from different agencies or offices.

SEAK Hydro data is publically available through the UAS GIS Library (http://seakgis.alaska.edu/). The project is currently seeking new partners who are interested in providing additional data and/ or assisting with the editing process as well as entities that are in need of services for uplifting their hydrography information into NHD. Funding assistance to support the SEAK project is also desired. SEAK Hydro will contribute to building a better GIS in southeast Alaska and beyond by providing the best available information to partners and stakeholders while ensuring the NHD is accurate, reliable, and up to date.

Using local knowledge, hydrology, and climate scenarios to develop a driftwood harvest model in interior Alaska

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Many rural Alaskan residents rely on harvested driftwood from the Yukon River for fuel and construction materials, however they have stated that the character of the summer discharge in the Yukon River is changing and affecting their ability to harvest this resource. We examined whether the perceived changes in driftwood availability are related to changes in river hydrology and how changes in hydrology may affect future driftwood flows and the livelihoods of rural Alaskans. The Yukon River flows northwesterly through British Columbia and the Yukon Territory before flowing southwest through Alaska. In most summers, major driftwood flows occur in the Yukon River during two different periods. Typically, driftwood accompanies high flows on the Yukon River associated with spring break-up. A few weeks later, a second series of driftwood appears, associated with the "2nd rise," which is reported to occur during early June, which is when the rural residents of Tanana, Alaska plan to harvest their annual supply of driftwood. This study examined the nature of the differential timing of high flow events in the Yukon River. Increasingly, villages in rural Alaska are trying to lessen their dependence upon expensive fossil fuels. To achieve this goal, a number of Alaskan villages have recently installed wood-fired boilers to generate heat and/or electricity and additional boilers are slated to be installed in rural Alaska in the near future. These boilers are largely fed by driftwood, a cheap and easily processed wood source. Some Tanana residents have expressed concern that in recent years, driftwood was not readily available because the "2nd rise" flood event was absent. Rural Alaskans find this disconcerting because they have offset a dependence on fossil fuel use for heat and electricity with an increased reliance on wood. In our study, the local knowledge of rural Alaskans was used in conjunction with the historic hydrology to model the historic driftwood harvest from the Yukon River near Tanana. The model allowed us to explore how various hydrologic scenarios might influence the lives of rural Alaskans.

Microbial community analysis of petroleum contaminated soil at a long-term, cold climate phytoremediation test site

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Effective cleanup of surface contaminants is important in preventing groundwater contamination. Remediation techniques which are low cost and low maintenance are desired for any cleanup of pollutants, but are especially important for sites in cold regions such as Alaska, which tend to be more remote and inaccessible. One method that shows promise for petroleum bioremediation is phytoremediation. Many studies have investigated the effects of nutrient addition or rhizosphere enhancement bioremediation on hydrocarbon degradation rates in petroleum contaminated sites, however the long-term effects of various bioremediation treatments on soil microbial community composition are not well understood. In 1995 the Army Corp of Engineers Cold Regions Research and Engineering Laboratory conducted a 362 day comparative study on the effects of different treatment methods for soils contaminated with crude oil and diesel fuel. The contaminated plots were treated with different combinations of nutrient addition and/or phytoremediation by seeding with annual ryegrass (Lolium multiflorum), annual ryegrass-arctared fescue (Festuca rubra) mix, or no treatment. The initial 362 day study found all treated soils to have increased degradation rates and significantly lower total petroleum hydrocarbon content when compared to untreated soils, which studies of similar sites have correlated with increased microbial biomass. This site has remained undisturbed for 15 years and is undergoing plant succession with native vegetation. Previous studies have shown that some native Alaskan vegetation possesses

phytoremediation potential. Phospholipid Fatty Acid (PLFA) analyses are being applied to quantitatively examine the soil microbial community structure, composition, and biomass to determine if a correlation exists with vegetation type, accelerated biodegradation and original phytoremediation treatment. Information gathered will help identify plants and treatments most effective at promoting long-term decontamination and restoration of petroleum contaminated sites in cold and remote regions.

Developing a third party aquatic resources and wetland mitigation program in Southeast Alaska- Challenges, opportunities and lessons learned

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The Clean Water Act prohibits the discharge of materials, such as soil or sand, into waters of the United States, unless authorized by a permit issued under Section 404 of that act. The Corps of Engineers, or a state program approved by the Environmental Protection Agency, has authority to issue such permits and to decide whether to attach conditions to them in order to achieve no net loss of wetlands within the Section 404 program. Compensatory mitigation requirements for impacts to wetlands and streams in Alaska can be met through permittee-responsible compensatory mitigation, mitigation banks, or in-lieu fee (ILF) programs. Despite a nationwide policy goal of no-net-loss of wetlands, Southeast Alaska and the State continue to experience losses to the functions and values of wetlands, streams, riparian areas and other aquatic resources.

Studies of compensatory wetland mitigation in Alaska and across the country generally demonstrate that less than 50 percent of mitigation sites are successful ecologically in achieving their performance standards and intended goals. Furthermore, they fail to effectively replace lost or damaged resources, habitats, and functions. On April 10, 2008 the COE and EPA issued The 2008 Final Rule. The Final Rule outlines the performance standards and criteria for the use of compensatory mitigation to improve the quality and success of compensatory mitigation projects for activities authorized by Corps permits. The Final Rule provides a process for natural resources managers to follow in order to support the national policy goal of a “no-net-loss” to wetlands.

On February 25, 2009 the Alaska District of the COE issued a Regulatory Guidance Letter to define the Alaska District's review procedure for compensatory mitigation with respect to the 2008 Final Rule. An end result of these missives is the COE will usually require compensatory mitigation that is appropriate and practical to replace functional unavoidable losses to aquatic resources caused by permitted actions. Federal regulations have identified In-Lieu Fee (ILF) programs as one potential option to correct some of the shortcomings in existing mitigation techniques. Review of the 2008 Final Rule and numerous sources relating to ILF programs clearly show that ILF programs add value to the overall effectiveness of aquatic resource mitigation nationwide. ILF programs consolidate compensatory mitigation projects and resources in order to target more ecologically significant functions, provide financial planning, provide scientific expertise, reduce temporal loss of function, and reduce uncertainty about project success. In Southeast Alaska there is no operating wetland mitigation service program that prioritizes aquatic resource restoration, enhancement and creation opportunities over preservation as a mitigation option.

Currently SAWC is developing an In Lieu Fee Wetland Mitigation Program. The program will be the first of its kind in the state in that it will meet the requirements of the 2008 Federal Rule Compensatory Mitigation for Losses of Aquatic Resources (Final Rule) and will support the nationwide policy goal of “no-net-loss” to wetlands and aquatic resources. It will do this by utilizing a watershed approach to indentify wetland and stream restoration and enhancement projects and facilitate the development of said projects.

Water, heat, and nutrient fluxes on the Arctic Coastal Plain, Alaska

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Arctic ecosystems are evolving rapidly in response to a changing climate. While many high latitude areas are expected to dry as a result of warming, the Arctic Coastal Plain (ACP) of Alaska will remain relatively wet, due to increased winter precipitation and limited potential for drainage through thick, continuous permafrost. This landscape is characterized by large lakes and many smaller ponds and wetlands that form in the low centers and troughs/edges of the polygonal/patterned ground. This region provides important breeding habitat for many migratory birds, and the lakes and streams are inhabited by several species of fish. Greater winter precipitation will likely lead to larger summer hydrologic fluxes, and may provide a bottom-up control on nutrient availability, ecosystems, and fish and waterfowl populations. This research incorporates physical and biogeochemical measurements in two 30 km^2 plots within the ACP to 1) quantify water budgets and nutrient availability in various surface water bodies, and 2) predict how increased temperatures and altered hydrologic fluxes will affect the lake, pond, and stream water budgets, nutrient availability, and ultimately the ecosystems. Lake stage records and δ^2H and $\delta^{18}O$ indicate that lakes, trough ponds, and low-centered polygon ponds may lose up to 5, 20, and 100% of their water volume over the flow season, respectively. The potential for accelerated loses in future summers has implications for the movement of fish between lakes, and the magnitude and timing of food availability for breeding birds. Generally the upland areas (ponds and troughs) display much higher organic matter and nutrient concentrations relative to the large lakes. Lake water budgets suggest that substantial amounts of water drain from the upland landscape during the summer, and implicate subsurface thaw and transport as a potentially important component of future water, heat, and nutrient flow. Hydrologic modeling and nutrient enrichment experiments will be used to quantify the potential for change in major fluxes, with the ultimate goal of predicting how continued warming and the changing physical environment will affect fish and waterfowl populations.

Characterization of suspended sediment load and bedload on three North Slope rivers

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Little research has been done to describe the basic characteristics of the majority of rivers on the North Slope of Alaska. The fundamental hydrologic and sedimentologic properties of these rivers is unknown; this coupled with only short-term measurements of precipitation and runoff makes further analysis of the region difficult. Increased human presence on the North Slope makes it imperative to collect basic measurements on these rivers, and to improve the temporal and spatial resolution of data collection.

The Anaktuvuk, Itkillik and Chandler Rivers originate in the Brooks Range of Alaska and flow north, joining with the Colville River in the foothills and coastal plain. Frozen for over seven months of the year, most sediment transport must occur during the summer months; the largest hydrologic event is most frequently snowmelt, which begins in late-May in the foothills. The purpose of this study is to gather baseline data on the suspended sediment and bedload transport on the Anaktuvuk (N 69°27.807’, W 151°09.928’), Itkillik (N 68°55.041’, W 150°06.776) and Chandler (N 69°16.972’, W 151°24.277’) Rivers. During a field campaign from May to June 2011, suspended sediment samples were collected at regular intervals on all three rivers, using both integrated and grab sampling techniques. On the Chandler River bedload samples were also taken during the spring melt. The results of these measurements will be presented in an effort to characterize the sediment transport on these three rivers.

Toward a circum-Arctic lakes observation network (CALON)

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Roughly one-quarter of the lakes on Earth are located in the Arctic. However, to date there has been no systematic collection of key lake parameters or baseline data with which to make spatial and temporal comparisons to assess the impact of warmer temperatures, changing cloud cover and precipitation patterns, permafrost degradation, and human water use on lake water quality and quantity. With funding from the National Science Foundation's Arctic Observing Network (AON) program we are working toward the establishment of a Circum-Arctic Lakes Observation Network (CALON) by focusing our initial efforts on a set of lakes located in northern Alaska. As separate groups, we have been working on lakes in Arctic Alaska for the past decade and are currently monitoring lake characteristics at a number of locations. The primary objective of CALON is to expand and integrate our existing lake monitoring network across Arctic Alaska as well as to further develop lake monitoring strategies for Arctic conditions to provide data for key indices using in situ measurements, field surveys, and remote sensing/GIS technologies. In 2012, we will enhance the existing in situ network by instrumenting lake monitoring sites to collect year-round baseline data and assess physical, chemical, and biological lake characteristics across environmental gradients. This will be accomplished by implementing a multiscale (hierarchical) lake instrumentation scheme with 16 intensive and 35 basic monitored lakes. Regional scaling and extrapolation of key metrics will be accomplished through calibration and validation of satellite imagery with ground measurements. Thus, multi-sensor remote sensing will be a key component in the development of CALON. Initially, we will focus on bathymetric mapping using high-resolution multispectral satellite imagery, detection of water quality parameters using spaceborne and airborne platforms, historic lake stage and ice surface elevation measurements using ICESat and comparable future laser altimetry missions, the detection of surface water temperatures from spaceborne and airborne thermal imagers, as well as changes in lake ice timing and thickness using SAR image time series. Through the combination of in situ field sensors and continuous data logging, field surveys, and airborne and spaceborne remote sensing, we plan to standardize protocols that will enable inter-site comparison and to prepare for expansion toward a pan-Arctic network. All data acquired within CALON will be made publicly available in a timely manner in accordance with NSF AON goals of rapid data sharing. Furthermore, measurements collected by the CALON project can be used as validation sites for future airborne and spaceborne missions in the Arctic.

Climate vulnerability of a salmon-bearing stream in Southcentral Alaska

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The main objective of this study was to assess the long-term impacts of climate change on the Chuitna watershed hydrologic system. To do so, available geology, soils, climate, surface and groundwater and vegetation data were used to develop a 3-dimensional integrated conceptual flow model of the surface and subsurface flow system within the Chuitna Watershed. Based on this conceptualization, a fully integrated hydrologic numerical flow model was then developed for the entire Chuitna Watershed using the MikeSHE/Mike11 hydrologic code. We used this model to simulate surface and subsurface hydrologic conditions using spatially distributed air temperature, precipitation and reference evapotranspiration at 3-hour intervals for a historical basecase period

(1980 to 2000). The model was calibrated to capture key characteristics of spatially distributed snowpack, streamflow and groundwater depth data over multiple years.

To assess future climate change impacts, we used modeled maximum, minimum and median air temperature and precipitation projections from the International Panel on Climate Change (IPCC) for the A1B emission scenario to develop five seasonally-variable climate scenarios for the Chuitna watershed. Results suggest that for even the minimum projected increases in air temperature and precipitation, significant changes in hydrology are projected to occur in the Chuitna Watershed for the 2080 to 2100 time period. Much of the projected changes to the system can be attributed to temperature-driven increases in AET and changes in the snowpack. Average annual actual evapotranspiration (AET) is projected to increase by 10% to 46% in lower watersheds and by 14% to 58% in upper watersheds. Across all climate scenarios, average annual snowpack is projected to decrease by 4% to 92% with an average decrease of 62% across all sub-watersheds in the system. By the end of the century, snowpack is projected to accumulate 1-2 weeks later and to melt out 1 to 3 months earlier. Such changes in the quantity, timing and duration of water inputs to the system result in seasonal impacts to soil moisture, groundwater recharge, and both surface and baseflow to streams. As a result, winter streamflow is projected to increase by 43% to 640% and summer streamflow is projected to decrease by 7% to 73% across the Chuitna watershed for all climate scenarios.

Microbial fuel cells for wastewater treatment and energy generation

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Microbial fuel cell (MFC) has drawn much attention over the past decades for its potential applications in electricity generation, wastewater treatment, and chemicals production. Apart from bioelectricity generation, some other applications could be explored in the MFC, including ioremediation and bioproduction. In this study, manganese dioxide materials were tested as alternative cathode catalysts for oxygen reduction reaction (ORR) in air-cathode microbial fuel cells (MFCs). Prepared by solution-based methods, the MnO_2 nanoparticles were comprehensively characterized and incorporated into electrodes together with carbon nanotubes (CNTs). The electro-catalytic activities in neutral electrolyte were investigated by cyclic voltammetry (CV). Beta-MnO2 appeared to have the highest catalytic activity due to its structure and better interaction with carbon nanotubes. Although for bioelectricity generation, the power output was too low for industrial use, it was possible to incorporate MFCs with power storage device, e.g. lithium battery, to make it portable and capable to provide higher power output during discharge. In addition, it was possible to fabricate homemade MFC to provide continuous but low power for devices not requiring high voltage using waste water as the power source, while achieving wastewater treatment

Glacier melt: A source for groundwater recharge and streamflow in semi-arid Interior Alaska

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In Alaska, local and regional management affected by glacier wastage includes flood forecasting, drinking water supply, and energy availability, which are all important in order to develop economic opportunities for the State, its residents, and its industries. Effective state and borough leadership in water resource issues depends upon a good understanding of the hydrologic fluxes and stores, including how glacier mass balance affects low-land hydrology. The overall goal of the research is to integrate hydrologic and glacier mass balance measurements to obtain a deeper understanding of the effect of glacier wastage on watershed-scale hydrologic processes. Our specific objectives are to a) quantify low-land streamflow and groundwater recharge at a glaciated watershed, Jarvis Creek (634 km^2), in semi-arid Interior Alaska and b) assess the contribution of glacier melt to runoff.

Jarvis Cr. is a typical headwater draining the north leeward, rain shadow side of the Alaska Range as it begins at rugged snow- and glacier capped ridges (1,800 m to 2,800 m) and its confluence with the Delta River is in a low-gradient floodplain (300 m asl). Preliminary data collected in 2011 suggest that two glaciers feeding Jarvis Cr., Jarvis and Riley, exert a major control on the lowland hydrology throughout summer despite representing about 5 % of the total watershed area. Near the mouth of Jarvis Cr., which is about 60 km downstream of the glacier terminus, the glacial contribution is evident through diurnal runoff variations related to changes in glacier melt and by the chemical composition of the water as represented by major ion and stable isotope analyses. Sub-weekly specific conductance measurements show a marked variation (i.e. more than a twofold range) through the season that is likely attributable to changing source contribution and flow paths. Variations in the δD and $\delta^{18}O$ values indicate a seasonally evolving contribution of snow versus glacial inputs. In addition, simultaneous measurements of the flow in Jarvis Cr. along its final 25 km show significant losses to the groundwater system with the creek losing nearly half its water as it exits the relatively impermeable till and flows over the more permeable outwash gravels. However, the influent nature of Jarvis Cr. was not evident during the very early season flow. Until our preliminary data collection, there was no continuous gauging station in the watershed and few glacier mass balance studies have been located on the north facing Alaska Range. The relationship between glacier mass balance, climate and low-land hydrology is complex and still poorly understood in Alaska due to a lack of measurements. Integrated monitoring efforts are necessary in order to develop improved decision making tools, such as models and hazard maps, which can allow local and state managers to make informed decisions for the benefit of Alaska.

Characteristics of lake and reservoir ice thickness and growth on the North Slope, Alaska

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Natural lakes and man-made reservoirs are the primary sources for freshwater supplies on the North Slope, Alaska. Water uses include building and maintaining ice roads, working pads, and runways; drilling support for exploration and productions wells; camp supplies and emergency fire suppression. The adjudication of water rights for seasonal or longer-term use involves a water-rights application through the Alaska Department of Natural Resources, and additional permits are required through the Alaska Department of Fish and Game in cases where fish populations may be present. The general permit approach is focused on protecting the over-winter fish habitat functions in the lakes and reservoirs.

The end of season ice thickness is one of the key permitting criteria used for estimating how much water is available at the end of the winter season in a lake or reservoir; hence, the amount of water available for use during the winter season. The general assumption used for years is that ice thickness at the end of the winter season would be seven feet for lakes deeper than seven feet. This assumption is not based on any direct analysis of lake ice thickness at end of winter. It has been generally accepted as a conservative value to use, when lacking more detailed studies or seasonal and/or regionally based parameters. A better understanding of the variation in ice thickness, environmental factors that influence ice growth and approaches to estimate ice thickness are important to developing better estimates of the quantity of water actually available in lakes and reservoirs on the North Slope.

Ice formation on lakes and reservoirs will generally start over a several week period on the North Slope coastal plain and may range over a month when considering the foothills region south of the coastal plain. Water body size, volume, surface recharge, wind and early-winter snow and temperature conditions all effect initial ice formation. Wind can break up thin ice cover and early snowfall can delay complete ice cover by days to weeks. On the coastal plain where lakes are in fairly flat terrain and they are generally exposed to fairly constant winds. Lakes will be mechanically well mixed going into early winter ice-cover. This reduces the thermal budget of the water bodies which can further delay ice growth in the early part of the winter season.

Once ice covers the entire water body and is thick enough to be stable in the wind conditions, the ice will start to thicken at a rapid rate. Snow cover during this period plays an important role limiting the initial rates of ice growth and the resulting end-of-season ice thickness. Coastal plain lakes and reservoirs will commonly have 2-3 feet of ice development by mid-December. Ice-road construction activities generally begin around this time. The timing of initial ice growth is hard to predict, but by December, when a third to half of the total season ice growth is achieved, and snow conditions on the ice surfaces are known, our ability to predict end of season ice conditions improves significantly. With each passing month thereafter, the rate of total ice growth decreases and our ability to predict the end-of-season ice growth continues to increase. Our presentation will address the various environmental factors impacting ice growth, measured field data, and other information that is useful for permitting and managing freshwater supplies on the North Slope.

A hydrologic study of three small streams and the Kogoluktuk River in Northwestern Alaska for hydroelectric resource evaluations

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The Cosmos Hills are located in the central portion of the Kobuk Watershed, northwestern Alaska. The hills are just north of the Kobuk River and village of Kobuk and south of the Ambler Lowlands. There are three primary creek watersheds draining the south flank of the Cosmos Hills toward the Kobuk River. Cosmos Creek is located on the westerly side of the Cosmos Hills, east of the Shungnak River. Wesley Creek is located in the central portion and Dahl Creek is located on the eastern end of the Cosmos Hills, west of the Kogoluktuk River. The Kogoluktuk River Watershed starts further north at the Brooks Range divide and drains to the south, across the Ambler Lowland, and then through the Cosmos Hills and into the Kobuk River. A hydrologic study was started in August 2010 to evaluate the hydrology of the three creeks and the Kogoluktuk River for hydroelectric resource potential. A series of gauging stations were installed at potential intake structure locations with the objective of verifying, with field data, the actual flows, starting the development of stage-discharge rating curves, and improving the understanding of the general hydrology for each of the creeks and the Kogoluktuk River systems.

Through a comprehensive field program, the information collected through the first hydrologic year allowed the four surface-water sources to be evaluated and it was determined that hydrologic data collection should continue for Wesley Creek and the Kogoluktuk River. Evaluation of the first-year's information, resulted in the establishment of a winter supplemental station at the upper Kogoluktuk River Falls area, where the river channel is in a stable bedrock-controlled reach. Through a combination of remote monitoring of water levels, water temperature, and automated photo images of the measured channel reach, the winter flow conditions have been studied throughout the current winter season. The data collection systems and field programs are helping improve methods for understanding the winter flow regime for streams and rivers in this area of Alaska. The understanding of river ice development, snowfall, and winter baseflow conditions are important for understanding the annual flow system and how it may be used for successful hydroelectric power generation.

Summary of the coastal (estuarine and marine habitats) assessment process used for the national fish habitat partnership: developing the initial Alaska Coastal Assessment and suggestions for the future.

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One part of the 2006 National Fish Habitat Action Plan (NFHAP, www.fishhabitat.org) was a requirement to assess the condition of freshwater, estuarine and marine fish habitats in the United States. For the marine and estuarine portion of this assessment (referred to as the *coastal assessment), the* goal was to rank coastal watersheds based on their current habitat status with respect to fish habitat health condition and identify anthropogenic impact and associated risk to fish habitat quality. The original plan for performing the coastal assessment for the nation did not include Alaska, Hawaii, and the Pacific Islands due to time constraints, lack of data, and limited financial resources. Importantly, Alaska had not been included in the national Coastal Assessment Framework developed in the 1990s by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Coastal and Ocean Science (NCCOS). The NOAA NCCOS framework was chosen as the spatial framework for performing the coterminous US (lower 48 states) portion of the NFHAP coastal assessment. Alaska also was not included in several of other "national" environmental quality datasets that were proposed for use in the NFHAP coastal assessment. To be included in the NFHAP coastal assessment, an independent GIS-based framework for Alaska needed to be developed and regional data needed to be found to supplement missing national data sources. However, the combination of strong participation and interest from Alaska's Fish Habitat Partnerships and Alaska's large proportion of the nation's coastal fish habitats ultimately convinced the National Fish Habitat Board to direct the national data and science teams to attempt an initial effort to analyze coastal data for Alaska.

One goal of the national coastal assessment was to have a coastal ranking system that could be compared between regions and states. To accomplish this, the lower 48 assessment restricted analysis to using "national" datasets of water quality variables to develop an index of coastal health. Many of those data sets do not extend into and provide coverage for large portions of Alaska. Since Alaska had a develop a separate spatial framework and much of the data to construct the Alaska coastal assessment had to come from local and regional data sources, the Alaska Coastal Assessment was performed as a parallel, but separate, evaluation reported within the national coastal assessment report "*Through a Fish's Eye: The Status of Fish Habitats in the United States 2010."*

Alaska began the process of developing the coastal assessment a full year after work had started on the lower 48 coastal assessment. In combination with the other issues regarding the spatial framework and regional data collection, the result was that there was not enough time or resources to complete the coastal assessment for the entire state, so only Southeast Alaska was completed. The resulting initial Alaska assessment highlighted the need to take a more regional approach to future assessments both within Alaska and in the rest of the United States to allow flexibility to include data outside the somewhat limited "national" datasets.

In the next five years, the national science and data teams for the coastal assessment will be tasked with upgrading the initial assessments by connecting data on habitat quality from the first coastal assessment to the effects of habitat degradation on fish and invertebrates. In addition, work is currently ongoing to complete the spatial framework and initial coastal assessment for the rest of Alaska. This presentation summarizes the differences between the national, Hawaii and Alaska coastal assessments and presents some thoughts on data gaps, data needs, and how to move ahead with the next phase of assessing coastal fish habitat health and opportunities for all of Alaska.

Using thermal infrared imagery for salmon habitat protection on the Anchor River in Southcentral Alaska

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As stream temperatures rise in many non-glacial salmon streams in the years ahead, cold water refugia – areas within a stream which are persistently colder than adjacent areas – will be critical to the survival and persistence of salmonids and other fish species. Researchers in the Pacific Northwest have identified deep pools, overhanging vegetation and undercut banks as potentially important for providing refuge from the warmest temperatures. Stream reaches with groundwater interactions (i.e. springs and seeps) may also result in measurably cooler water. Mapping these cold water habitats is valuable to plan future fisheries research, direct monitoring efforts and protect critical fish habitat as thermal change continues. In 2010, Cook Inletkeeper worked with Watershed Sciences, Inc. to map cold water habitat using airborne thermal infrared (TIR) imagery along 34 miles of the south fork of the Anchor River. This exciting technology is an effective method for mapping small-scale temperature patterns in streams. The TIR imagery provides a snapshot of stream temperatures at the time of the survey. And although temperature values change year-to-year, groundwater-fed cool water refugia remain persistent over time. Even in the cool summer of 2010, the location and thermal influence of 18 tributaries, 23 seeps and springs, 11 sloughs, and 9 small side channels and drains is apparent in the imagery. Now, Cook Inletkeeper will use these spatially-explicit thermal data, as well as other current research in the watershed, to help Kachemak Heritage Land Trust determine which parcels with key Chinook and coho habitat are the highest priorities for permanent conservation. By linking state-of-the-art technology with conservation planning, we will improve landscape-scale resilience for salmon in Southcentral Alaska during a time of rapid climate and land-use change.

Assessment of rural Alaska solid waste leachate

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In Alaska, rural communities are highly sensitive to changes in the surrounding ecosystem and its effects upon subsistence activities. In turn, ecosystems themselves can be highly sensitive to perturbations brought about by ineffective solid waste management practices. Many rural communities have insufficient waste disposal practices to guarantee human and ecosystem health. For instance, untreated waste material including household waste, chemical compounds, pharmaceuticals, personal hygiene products, potentially hazardous material (i.e. lead batteries, electrical waste, etc.), and frequently human waste are disposed in unpermitted landfills overlying permafrost or on the wet ground surface. A two-year study was performed to evaluate the prevalence and diversity of landfill leachate pollutants and their potential impacts on freshwater resources, which are often used as drinking water sources. To accomplish a microbial and chemical contaminant assessment, shallow ground and surface waters along with soil samples were collected and analyzed for pathogen indicator organisms and heavy metals in the vicinity of five rural Alaska solid waste sites. Microbial indicator analysis was performed using most probable number methods (i.e., Colilert® for E.coli, and Enterolert® for ENT). Metals analysis was based on EPA method 200.8. The study results indicated a significant elevation of E. coli and Enterococcus populations in waste site soils and surface waters compared to non-impacted controls. Moreover, the microbial indicator organisms' density obtained from the waste impacted surface waters were all above the recommended Alaska Water Standards for recreational waters with a range of 1.1-2.7 Log MPN/100mL. The study did not reveal evidence of microbial indicator organisms migrating into subsurface waters. The metals analysis indicated a general trend of enriched metals in subsurface and surface waters compared to control waters for aluminum, zinc, iron, nickel, and copper.

Mercury occurrence in water and biota across a spectrum of southeastern Alaskan streams

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Southeastern Alaska is likely experiencing increased rates of deposition of atmospheric mercury (Hg), primarily due to growing emissions from upwind Asian sources. Very little information is available on the extent and magnitude of Hg occurrence in Alaskan watersheds. Here we present the first survey of Hg concentrations in a variety of regional streams. We show that streams draining wetland-rich landscapes tend to have higher Hg concentrations in water and stream biota (mayfly larvae in the families Baetidae and Heptageniidae; and juvenile coho salmon (Oncorhynchus kisutch)) than streams draining younger, glacially-influenced watersheds. Wetland-rich streams also carry the majority of the mercury load in their filtered phases, whereas Hg in glacially influenced streams is largely associated with particulates. Both methylmercury-- the more toxic and bioavailable form of the metal-- and dissolved organic carbon were significantly higher in the wetland-rich watersheds as well. The distribution of Hg in the sprectrum of streams show that watersheds are variably sensitive to mercury inputs and that landscape characteristics may be controlling whether Hg is stored, released, and/or converted to toxic methylmercury.

Social and institutional barriers to a sustained access to safe drinking water and sanitation in Alaska Native villages

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The task of ensuring that all Alaska Native villages have access to potable water and proper sanitation is still not complete despite many decades of federal and state efforts. Barriers to the continued operation and maintenance of water and sewer systems are various and increasing, placing public health and capital investment at risk. There is an emphasis on looking for financial and technological solutions disregarding the fact that both are mainly provided by actors outside these remote villages. Research initiatives that focus on fostering local capacity to enhance the sustainability of these systems at the village level are minimal. This study aims to explore how the current system for providing water utilities relates to native notions of healthy water and well-being considering that place-based policy design could render more successful results. This study will also open up the discussion on how the current system for provisioning water and sanitation impacts rural villages and self-reliance. To achieve these aims, qualitative interviews will be conducted with representatives of villages in the Interior region of Alaska, public officials and water experts. Responses to questions will be analyzed through coding and using a grounded theory approach. Findings will potentially elucidate limitations and opportunities for policymakers, resource managers, scientists, community and tribal leaders; as well as the strengths and limitation of the current public program for delivering water and sanitation services in rural Alaska.

Wildfire and permafrost: Post-fire dissolved organic matter and nitrogen in a boreal forest stream

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Projections predict wildfire frequency and severity in the boreal forest will likely increase as a result of climatic warming. Increased fire frequency will have large impacts on carbon and nutrient fluxes in streams through the loss of vegetation, combustion of soils, thawing of permafrost, alteration of watershed flowpaths, and changes in stream hydrology (such as surface water-groundwater interactions and flow regime). Because soil and stream water are closely connected through subsurface flow paths, changes in soil structure and soil chemistry will affect stream water chemistry. The goal of our research was to examine how wildfire in the boreal forest influences the concentrations and exports of dissolved organic matter and nutrients from headwater streams. The research was conducted in the Caribou-Poker Creeks Research Watershed (CPCRW), located in interior Alaska. Following a wildfire in 2004, stream water dissolved organic carbon concentration declined, whereas inorganic nitrogen concentration increased, potentially caused by the combustion of soil organic carbon stocks, or alteration of hydrologic flows from shallow to deeper flowpaths, or decreased plant productivity and uptake. Water samples from springs and the headwater stream were collected in the burned headwater watershed P6, within the CPCRW. Nitrate concentration decreased longitudinally (0.91 mgN L^{-1}- 0.22 mgN L^{-1}) over 3.6 km, with highest concentration in the region of most intensive burning. Dissolved organic carbon concentration increased (2.2 mgC L^{-1} – 3.6 mgC L^{-1}) over the same distance. We also observed a negative correlation between nitrate and electrical conductance. These results suggest that nitrate is derived from a shallow flowpath, and that fire might be responsible for changing the ydrologic flowpaths. Using an end-member mixing model, we are examining how wildfire has altered watershed hydrology and the resulting effects on solute export.

Multi-method assessment of the braided planform stability - Toklat River, Alaska

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Maintaining infrastructure in the vicinity of a dynamic braided river is a challenging, yet necessary activity in Alaska, and it requires some understanding of likely future river planform configurations. The intersection of the 150-kilometer-long gravel road which carries all of the traffic in the Denali National Park, AK, with the Toklat River, draining the north side of the glaciated Alaska Range, highlights several of these challenges. Immediately downstream from the point where the road crosses the 800-meter-wide braid plain via two bridges and a causeway, park infrastructure (a rest stop and a maintenance facility) has been threatened by bank erosion. In order to better protect this section of the park the National Park Service sought a geomorphic assessment of the Toklat River from the US Geological Survey. The assessment of likely planform configurations was conducted with a four-method approach - analyzing 1) channel patterns in the downstream direction, 2) changes in the lateral slope of the braid plain over time, 3) influences on the geometry of a significant tributary junction, and 4) probable post-avulsion channel configurations. This suite of analyses were based on a series of cross-section surveys and a large airborne LiDAR dataset and they were carried out using MATLAB, Quick Terrain Modeler, and ArcGIS. Patterns in the down-and cross-valley slopes, the braid plain width, and the cross-sectional forms demonstrate that valley- and braid plain-scale features influence the channel planform in such a way as to create a persistent set of challenges for park management. Temporal trends in the cross-section surveys, photographic evidence, and vegetation patterns show a braidplain that is regularly reworked. Relative discharge was estimated from two basins using a USGS-developed empirical method and used along with confluence geometry to constrain likely planform patterns downstream of a significant tributary junction. The simple momentum-based model showed a likely persistence of the current planform. The LiDAR-derived topography was used in a probabilistic analysis of likely avulsion scenarios and their likely resultant channel configurations. The multiple avenues of investigation demonstrate one approach of incorporating uncertainty inherent in any single method of analysis and show a river which can quickly change its planform configuration while retaining large-scale forcings toward certain configurations.

Climatic controls on the summertime energy balance of a thermokarst lake in northern Alaska: Short-term, seasonal, and interannual variability

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Shallow, thermokarst lakes that develop atop permafrost are a prominent landscape feature on the Arctic Coastal Plain (ACP) of northern Alaska. The ACP is vulnerable to ongoing climate change and landscape modification, as thousands of thaw lakes and ponds are impacted by changes in temperature, precipitation, thawing permafrost, and human activity. Although summer in the Arctic is short, incoming solar radiation and lake evaporation are relatively high, and both factors play a significant role in the landscape water balance. Lake evaporation studies across arctic Alaska are needed to accurately estimate future water availability and water cycling in the region. Furthermore, lake evaporation is anticipated to increase as the ice-free season lengthens and water temperatures become warmer. To improve our understanding of hydrology in arctic Alaska, we performed a multi-year energy balance analysis of a shallow, thermokarst lake near Barrow, Alaska. Timeseries of net radiation, Bowen ratio, and rates of heat storage in the water and sediments were used to calculate sensible and latent heat fluxes during the 2008-2010 ice-free periods. Results of the energy balance analysis show rapid lake warming immediately following ice-off (due to high insolation), followed by similar increases in sensible and latent heat flux. Lake evaporation averaged 1.2 mm/day during the ice-free period, which is nearly twice the mean summertime precipitation rate of 0.7 mm/day for Barrow, Alaska. Daily evaporation rates ranged from zero to greater than 4 mm/day, while short-term and seasonal patterns varied significantly from one year to the next. Much of this variability was associated with changes in cloud cover, air temperature, relative humidity, and wind speed.

Restoration and characterization in the Wasilla Creek watershed near Palmer, Alaska

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Wasilla Creek watershed is located in the developing core area of the Matanuska-Susitna Borough. Past restoration work over the past 12 years has mainly involved replacing culverts along the mainstem and tributaries for fish passage, part of a comprehensive effort to remove all barriers on the creek mainstem and significant tributaries. Out of a total 37 culverts in the watershed, over 11 culverts have been replaced, including a culvert-to-bridge project involving channel relocation. These efforts have increased road crossings with juvenile salmon passage to over 40% within the watershed, as opposed to 13% in 1999. To expand restoration efforts, in 2011 a project was initiated by US Fish and Wildlife Service to walk 17 miles of the mainstem of Wasilla Creek, documenting channel location, channel qualities, modifications and riparian types. In addition, available watershed information in terms of landcover, imperviousness, land use, and biology were compiled and mapped. As a result of these efforts, potential future restoration projects were identified and information gained to help planners and various agencies evaluate the present condition of the watershed.

AKWIN: The Alaska water isotopes network

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The hydrological cycle is central to the structure and function of northern landscapes and is also the basis for interactions between terrestrial, aquatic, marine and atmospheric systems. Understanding the processes and the spatial patterns that govern the stable isotopic ($\delta^{18}O$ & $\delta^{2}H$) characteristics of the hydrological cycle is highly valuable to many fields of fundamental and applied research.

Our principle aim is to develop a GIS-based data layer package that will allow us to quantify, analyze, compare and contrast the patterns of stable isotopes in the hydrological cycle across Alaska. We anticipate using this information to understand modern and historical processes including reanalysis of past AK climates using proxies such as tree rings, ice cores, and lake sediments. Understanding modern, historical and ancient processes will provide the basis for forecasting future hydrological and ecological conditions.

Evaluating aquatic habitat in anadromous streams draining second growth watersheds of southeast Alaska

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Terrestrial landscape factors including surficial geology, land cover, and topography are known to affect characteristics of fluvial systems, and anthropogenic land uses, including urbanization, agriculture, and deforestation have myriad negative effects on stream habitats and the biota they support. Landscape factors are known to affect streams differentially across multiple spatial scales, and land uses in the riparian zone, for example, have been shown to directly affect amounts and types of woody debris, sediment regimes, and substrate in a given stream reach. In the Pacific Northwest, timber harvest in stream riparian zone is acknowledged as having negative effects on aquatic habitat and anadromous fishes. In response, regulations have been put in place including Alaska's Forest Resource and Practices Act (FRPA) of 1971, with important amendments regarding riparian harvest being applied in 1990. These amendments are intended to protect fish habitat, water quality, and productive forests by restricting harvest in riparian zones. As southeast Alaska's largest private landowner and a prominent timber management company in the region, Sealaska has recently engaged in an effort to evaluate the effectiveness of this legislation in protecting aquatic and riparian resources. During the summer of 2011 in-stream and riparian habitat data were collected and summarized from 28 streams of different sizes and types from throughout Sealaska-managed lands in an effort to first characterize the current condition of habitat that exists in streams harvested before the regulation changes that occurred in 1990. By first quantifying how habitats in these streams are affected by natural landscape factors, we can more effectively identify the influence of o differing management practices. Streams of similar types draining un-logged watersheds within the Tongass National Forest will be compared to our set of Sealaska streams, with the end goal of addressing the effectiveness of the buffer protection regulations put in place in 1990. With this information, we will better understand specifically which habitat factors may be affected by timber harverst in the riparian zone and can provide Sealaska as well as other managers of the regions' streams with better information for protecting southeast Alaska's anadromous fisheries.

Adaptive management of Alaskan North Slope water supplies: A novel approach to lake water-use permitting

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Water rights adjudication (permitting) is a legal mechanism for providing certainty to water users and for providing an orderly process for states to manage their water resources. Generally, water rights systems are prescriptive and rigid; setting forth a relatively transparent and systematic process (e.g., defining whether water can or cannot be withdrawn; the instantaneous and total rates of withdrawal; the place of diversion and use; the type of beneficial use; the period of use; and the amount that can be consumptively and/or non-consumptively used). Such prescriptive requirements are generally simpler and are relatively less expensive and easier to implement. These simple approaches provide stability and predictability for water users and regulating agencies.

On the North Slope, Alaska, the primary source of fresh-water supplies is natural lakes. A majority of these water sources are thaw lakes in the permafrost dominated landscape. In addition, many old gravel mine sites (gravel pits) serve as water reservoirs. For water adjudication purposes these pits are treated as natural lakes. Natural lake-water supplies and industry demands are rarely static and future water supplies and demands can rarely be accurately predicted in advance. Because of this high level of uncertainty, Alaska has developed conservative assumptions in the existing permitting system to provide a high level of water supply and environmental protection. However, in cases where these simple approaches to water permitting do not address water-user needs, then developing more flexible and accurate water-supply assessment and management methods and tools may be both warranted and valuable.

The overall goal of an adaptive water-rights management process should be to increase water-user flexibility while fully meeting the state's regulatory needs and goals. An adaptive management approach should be able to provide a water-rights framework that; is scientifically rigorous, meets applicable state and federal regulatory and policy requirements, is protective of the environment, is clear, flexible and relatively easy to implement by water users, and helps both the regulators and water users achieve their desired goals. However, an adaptive-management approach is not a panacea. It generally increases the cost of permitting and managing water rights, and while increasing flexibility it may also increase water user-risks. That is, while it may allow a water use to utilize more water during times of plenty or during periods of uncertainty, it may also decrease the amount of water available for use during periods of drought. Therefore, both water agencies and water users need to understand and weigh both the potential risks and rewards and decide whether the benefits outweigh the risks relative to utilizing an adaptive management approach for water management in Alaska.

This presentation provides an overview of the concept of adaptive water management and gives a hypothetical example of how an adaptive management based water rights system may be implemented in Alaska. This example focuses on adaptively managing potential water withdrawals relative to the uncertainty of ice thickness on a given lake; however, the principles and methods can be extrapolated to other water use situations (e.g., managing withdrawals from rivers).

Lake-ice thickness and how we estimate it affects the amount of water that can be withdrawn from a given lake during the winter. Most ice roads, working pads and runways built for the winter operations season are dependent on the current approach of estimating the available end of winter season, under-ice water volume. The practice developed over the last couple of decades is to assume that the ice thickness at end of winter would be 7 feet, based on antidotal evidence. Currently, ice thickness is not measured for estimating lake-specific water availability; however, extensive measurements taken over recent years indicate that the maximum ice cover is generally between 5 and 6 feet. The hypothetical example provided will show an approach for permitting water withdrawals from lakes with variable ice thickness, and management approaches that water users can apply to safely utilize the flexibility provided by an adaptive management approach.

Dye tracers for characterizing breakup in Arctic rivers: An old school solution for a modern conundrum

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Discharge in arctic rivers is often near its annual maximum during spring breakup. However, the presence of swiftly moving ice at this time of year leads to unsafe boating conditions, thus complicating the collection of discharge information through modern methods such as acoustic Doppler current profiling (ADCP). In this paper, we report the results of a study designed to evaluate the breakup discharge of Alaska's Itkillik River using Rhodamine WT, a fluorescent dye. Notable advantages of the method included the ability to inject and collect the dye without entering the water. A disadvantage of the method was the confounding effects of turbidity and/or suspended solids.

Using snow fences to augment fresh water supplies in the arctic lakes

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Arctic lakes are often the main fresh water source for humans and industries on the North Slope of Alaska. Based on extensive research on snow drifting, this project evaluates the use of snow management and snow fences to augment fresh water supplies in shallow arctic lakes. We have implemented snow control practices to enhance snowdrift accumulation, which leads to the increased meltwater production, and lake recharge despite possible surface storage deficit and/or low precipitation. Two lakes with similar hydrological regimes have been selected and monitored for three years: one is an experimental lake, where a snow fence has been installed; the other is a control lake, where the natural regime has been preserved. The snow fence technique was effective in augmenting the lake water supply in summer 2010 and 2011. The effects of snow drift on lake water regime will be discussed in terms of (i) “new” water available due to reduced sublimation losses from blowing snow; (ii) extended duration of snowmelt runoff from the snow fence’s drift, (iii) lake-volume net increase, and (iv) assessment of costs. Support for this work comes from the Department of Energy, National Energy Technology Laboratory.

Assembling snow hydrology data from high altitude watersheds for use in climate change models applied to hydropower forecasting in Southeast Alaska: A proposed PhD project

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When deciding where to develop new hydropower, or during maintenance and expansion of existing facilities, it is beneficial to know how long term climate changes may affect flow volumes, as well as timing of flow, from contributing watersheds. The accumulation of snow and the timing of spring melt/breakup in mountainous watersheds above hydropower facilities in Southeast Alaska (SEAK) could be key contributing factors to the accuracy of climate change models that are currently available for use in the forecasting of flows into these infrastructures. Modeling seasonal changes in snow depths and snow water equivalent (SWE) over multiple winters within contributing watersheds may (1) help operators of existing hydropower plants predict how much energy they can expect to produce and (2) decide what size, type, or if, new infrastructure should be built. I am proposing a PhD project to enhance snow hydrology information available for Southeast Alaska’s hydropower

industry through a robust dataset including both in-situ measurements and airborne and satellite remote sensing. The observation portion of our study will likely involve collaborators from the Natural Resources Conservation Service's (NRCS's) SNOTEL (Snow Telemetry) program, the National Weather Service's River Forecast Center, the NOAA-NESDIS Proving Ground for next generation satellites, the National Operational Hydrological Remote Sensing Center, University of Alaska at Fairbanks and Southeast and utility operators.

Quantifying evapotranspiration: Upscaling from plots to Landsat in the Alaskan Arctic Foothills

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In the Arctic hydrological cycle, evapotranspiration is the least studied and hardest to predict component. It is defined as the processes which remove water by atmospheric and biological pathways. Moreover, derivation of evapotranspiration rates depends on both spatial and temporal resolutions of the input data. Satellite land surface temperature (LST) and leaf area index (LAI) plays a key role for calculating evapotranspiration in large areas, especially in the two-source energy balance model being used here for ET computation. In the study area, centered on the Imnavait Basin, precipitation patterns, soil moisture regimes, and ecological communities can vary greatly over short distances. This study examines the effect of upscaling data by comparing plot level data with satellite based products collected at high (2.5 m) and medium (30-60 m) spatial resolutions. During the first ten days of July 2010 a field campaign was undertaken where 2 m2 plots were quantified using visible, near and thermal IR imagery in addition to vegetation percent cover, soil morphology and depth to the active layer. Plots were aligned over transects which bisected surficial drainage networks known as of water tracks. LAI was calculated using cover photography (an alternative indirect method) at the plot level. During this period Landsat-7 ETM+ data was acquired on June 30, and July 9 and 25. Fortuitously, WorldView-2 images, with a spatial resolution of 2.5 m and 8 bands placed in the spectral range from 400 to 1040 nm were acquired on July 10. Additionally, an ASD spectrometer was used to measure the reflectance of different vegetation types found in the study area and repeated daily while measuring the changes in moisture content. This allowed indices such as the normalized difference vegetation index (NDVI) and enhanced vegetation index (EVI) to be compared using ground and satellite based imagery. These indices have been correlated to estimates of LAI in previous studies. A comparison of NDVI, EVI and tasseled cap transformation was calculated between the different available data. LST was retrieved using the thermal band and then compared to plot level measurements. The concurrent collection of data also permitted the examination of change in plant physiology due to water stress to be examined. It is worth remarking that spectral response of mosses (*Aulacomnium palustre, Hylocomium spendens & Sphagnum angustifolium*) varied as it does not have stomatal control during the transpiration process. This effect was examined over the variety of imagery available.

Mercury fluxes out of glacial and non-glacial streams as determined by continuous measurements of turbidity and CDOM

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Discharge from glaciated watersheds contributes nearly half of the freshwater discharge to the Gulf of Alaska and can play an important role in the near-shore marine ecosystem. Mercury (Hg) in streams originating from glaciers has not been well studied in terms of total Hg flux, speciation, or its relationship with other stream parameters. It is important to understand how watersheds with different landscapes facilitate the transfer of Hg to the marine

environment. This study compares and contrasts the Hg concentrations, fluxes, partitioning, and speciation in two proximate coastal watersheds, one heavily glaciated (Lemon Creek) and one dominated wetlands (Peterson Creek). This is the first study to use in-situ sensors for chromophoric dissolved organic matter (CDOM) fluorescence and turbidity to calculate fluxes of total mercury (UTHg).

Negotiating fuel supply contracts with mother nature: Challenges and opportunities managing hydroelectric projects in Southeast Alaska

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Generating power from a hydroelectric plant takes water and head (elevation), both of which are found in abundance in Southeast Alaska. Developing hydroelectric projects brings communities the benefits of renewable energy, long-term rate stability, and relatively low power costs (at least compared to the diesel alternative). It also brings challenges for utility managers in forecasting seasonal availability of energy as well as long-term planning for future power supply. This presentation will briefly review the more than 100 year history of hydroelectric power in the Juneau area and discuss challenges faced by the local electric utility as it manages multiple hydro projects in an isolated electrical system.

The influence of glacier change on hazards and hydrology in Alaska

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Glaciers occupy many of the catchments in mountainous regions of Alaska and form the headwaters of many of the state's watersheds. Within these watersheds, glaciers serve as frozen freshwater reservoirs, effectively regulating precipitation and meltwater, and thus, profoundly influencing the quantity and seasonality of runoff. Glaciers are also sensitive indicators of climate change and have generally retreated in Alaska since the end of the Little Ice Age with a substantial increase in the rate of mass loss in recent years. Projections, based on climate scenarios, indicate that glaciers in Alaska may lose a large fraction of their current volume over the next century. Our knowledge of the extent and magnitude of these changes is critically important to our understanding of the potential impacts on communities and infrastructure and on the feasibility and operational longevity of proposed and existing hydroelectric projects

The use of meteorological data to perform hydrologic analyses in North Slope basins

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Early (1970s) hydrologic data collection on the North Slope of Alaska consisted of a few stream gauging stations and fewer climatic stations, all located along the coast. Spatially distributed at the watershed scale complementary data was totally absent. Starting in 1985 through a series of research projects, the University of Alaska Fairbanks, Water and Environmental Research Center personnel built a meteorological network consisting of a maximum of 40 stations distributed from the coast to the drainage divide in the Brooks Range. Available data include hourly air temperature, relative humidity, wind speed and direction, summer net radiation, summer precipitation, and winter snow depth. Other data included discharge of several streams and rivers, some soil temperature and moisture data and some suspended and bedload sediment measurements. Once per year near the end of April a survey of snow on the ground is made at over 100 preselected sites from west of the Canning River to the western boundary of the Chandler River and from the coast to the Brooks Range. The timing and location of observations depended upon research funding. The availability of this spatially distributed data set allows us to gain a much better understanding of the hydrologic response of these Arctic watersheds through water balance studies, flow frequency analysis, as input into hydrologic models, and insight into ungauged watersheds.

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