Alaska Section

AMERICAN WATER RESOURCES ASSOCIATION

AWRA

Community, Conversation, Connections

2011 ANNUAL CONFERENCE

APRIL 4TH-6TH

CHENA HOT SPRINGS RESORT, ALASKA

Monday, April 4th

12:00-1:00 pm	Conference Registration
1:00-1:15 pm	**President's Welcome** - Chris Arp, AWRA-AK President, *Water & Environmental Research Center, University of Alaska - Fairbanks*

1:15-2:45 pm	**Session 1: North Slope Hydrology & Water Use - I**	
Moderator: Michael Lilly		
1:20-1:40 pm	Horacio Toniolo	*Hydrologic field observations on three major rivers in the North Slope Foothills region*
1:40-2:00 pm	Erica Betts	*Linking North Slope Climate, Hydrology, and Fish Migration*
2:00-2:20 pm	Chris Arp	*The Hydrology and Ice-cover of Teshekpuk Lake in a Changing Arctic Climate*
2:20-2:40 pm	Anna Lijedahl	*The role of low- and high centered polygons on arctic wetland water balance*

2:45-3:30 pm	Break / Late Registration

3:30 - 5:00 pm	**Session 2: North Slope Hydrology & Water Use - II**	
Moderator: Michael Lilly		
3:35 - 3:55pm	Greta Burkart	*A New Hydroclimatological Database and Network Analysis for Arctic Alaska: AQUABASE II*
3:55 - 4:15 pm	Kristina Plett	*Current Water Management Practices and Guidelines for Water Users on the North Slope of Alaska*
4:15 - 4:35 pm	Horacio Toniolo	*Practical Applications of Ice Growth Simulation Tools to Help with Adaptive Water Management of Arctic Lakes*
4:35 - 4:55 pm	Michael Lilly	*Designing Adaptive Management Approaches for Summer Water Use of Arctic Lakes*

5:15 - 6:30 pm	Dinner (included in registration)
6:30 - 8:00 pm	**Chena Geothermal Presentation and Field Tour** Bernie Karl, *President, Chena Power*

8:00-9:00 pm	AWRA Business Meeting

Above: *Western Cook Inlet, Alaska*
Cover: *Susitna River, Alaska*

Tuesday, April 5th

7:00-8:00 am	Breakfast (included in registration)	
8:00-9:30 am	**Session 3: Mining & Water - From Permitting to Monitoring**	
	Sponsored by HDR	
	Moderator: Jim Munter	
8:05-8:25 am	William McGee	*Water Quality and Water Management at Hard Rock Mines*
8:25-8:45 am	Charlotte MacCay	*Successful Coexistence of Mining and Fish*
8:45-9:05 am	Dudley Reiser	*Evaluating effects of potential flow modifications on fish habitats in the vicinity of the Pebble Project*
9:05-9:25 am	Clyde Gillespie	*"Producing and Protecting" at Kensington*
9:30-10:15 am	Break	
10:15-11:15 am	**Session 4: Mining & Water - Monitoring and Looking Back**	
	Moderator: Jim Munter	
10:15-10:35 am	Bill Morris	*Aquatic Bio-Monitoring at the Red Dog and Fort Knox Mines, Alaska*
10:35-10:55 am	Bob Ourso	*Water quality and biology of streams draining abandoned and reclaimed mined lands in the Kantishna Hills area, Denali National Park and Preserve, Alaska*
10:55-11:15 am	Jim Munter	*A retrospective view of the water connections of the Kennecott Mines and Copper River Salmon 100 years after the first ore shipments*
11:15-12:30 pm	Lunch (included in registration)	
12:30-1:30 pm	**Keynote Address:** *"Large Mines: Overview of six and the challenges and successes with a focus on water quality issues"* Ed Fogels, Deputy Commissioner, Alaska Department of Natural Resources	
1:30-3:00 pm	**Session 5: Fish in Our Rivers - Management and Education**	
	Sponsored by The National Park Service	
	Moderator: Robin Beebee	
1:35-1:55 pm	Mike Cox	*Using Hydrodynamic Modeling and Fish Passage Windows to Evaluate Barriers in River Systems Under Changing Climate Regimes*
1:55-2:05 pm	Sean Reiss	*The Trans-Alaskan Strontium Isotope Survey (TASIS) – geochemically characterizing Alaskan watersheds to track salmon migrations*
2:05-2:25 pm	Joe Klein	*Summary of Instream Protection in Alaska*
2:25-2:55 pm	Amber Bethe	*Fish Habitat Restoration and Education in Alaska*
3:00-3:30 pm	Break	
3:30-5:00 pm	**Session 6: Water Sources for Alaska**	
	Moderator: Chris Arp	
3:35-3:55 pm	Tereza Bendlova	*Sources of Drinking Water in Alaskan Villages*
3:55-4:15 pm	Colin Kikuchi	*Spatially telescoping measurements for efficient characterization of groundwater contribution along a small stream in south-central Alaska*
4:15-4:35 pm	Ann Marie Larquier	*Glacial Influences on Water Resources of the Eklutna Basin, Alaska*
4:35-4:55 pm	Regine Hock	*The effect of glacier wastage on streamflow*
6:00-8:30 pm	Poster Session / Evening Social (heavy appetizers provided)	

6:00-8:30 pm	**Session 7: Posters**
Sponsored by MWH Global	
Abhijit Chatterjee	*Biosorption of Cd (II) from single and binary metal solutions using protonated citrus peels in a fixed bed column reactor*
Christy Everett	*Tanana Valley Adopt A Stream Program: Managing our Watershed One Volunteer at a Time*
Ben Gaglioti	*Changes in water isotopes from Lake Selby in the southwestern Brooks Range during the last 14,000 years of climate change.*
Joel Homan	*Arctic Snow Distribution Patterns at the Watershed Scale*
Chas Jones	*Integrating remote sensing, field studies, and traditional knowledge to assess hazardous river conditions*
Joshua Koch	*Seasonality in water, carbon, and nitrogen fluxes from an upland boreal catchment underlain by continuous permafrost*
Heather McBride	*Balancing Preservation & Development of Aquatic Resources*
Mark McBroom	*Hydrologic & Hydraulic Modeling and Flood Hazard Mapping Tools in Support of FEMA's National Flood Insurance Program (NFIP)*
John Mumm	*Profusions of Evaporation Pan Observations on the Alaskan North Slope*
Chuck Podolak	*Influences on the current planform of the braided Toklat River, Alaska*
Eric Rothwell	*Using Hydrology Equations to Estimate a Water Budget and Examine Data Gaps, Eyak Lake, AK*
Catlin Stevens	*Monitoring Turbidity in Goldstream Creek, Alaska for TMDL Development*
Sveta Stuefer	*Using Snow Fences to Augment Fresh Water Supplies in the Arctic Lakes*
Emily Youcha	*Simulations of discharges at Arctic Alaskan runoff basins using minimal input data sets*

Knik River, Alaska

Wednesday, April 6th

7:00-8:00 am	Breakfast (included in registration)

8:00-9:30 am	**Session 8: Alaskan Hydropower - Opportunities Large & Small**	
Sponsored by Geo-Watersheds Scientific		
Moderator: Michael Lilly		
8:05-8:25 am	Robin Beebee	*Susitna Hydroelectric: Past, Present, and Future*
8:25-8:45 am	Horacio Toniolo	*A comprehensive approach to estimate hydrokinetic resources on the Tanana river at Nenana, Alaska*
8:45-9:05 am	Dave Brailey	*Establishing Hydroelectric Networks for Assessing Small Stream and River Hydropower Potential, Cosmos Hills, Alaska*
9:05-9:25 am	TBA	*TBA*

9:30-10:00 am	Break (sponsored by R2 Resource Consultants Inc)

10:00-11:30 am	**Session 9: Alaskan Hydropower - Optimizing under Uncertainty**	
Sponsored by HDR		
Moderator: Michael Lilly		
10:05-10:25 am	Katrina Bennett	*Understanding the impacts of changing hydro-climate extremes to hydropower resources in SE Alaska*
10:25-10:45 am	Jessica Cherry	*Impacts of Climate Change and Variability on Hydropower Systems: results from Southeast Alaska and Scandinavia providing lessons for Susitna*
10:45-11:05 am	Edmund Parvin	*Optimization of Bradley Lake Hydropower using Lake Elevation Rule Curve Modeling*
11:05-11:25 am	Dudley Reiser	*Selecting appropriate techniques for evaluating effects of hydroelectric project development and operation on aquatic resources*

11:30-12:15 pm	Lunch (included in registration)

12:15-1:45 pm	**Session 10: Flooding, Foreign Invaders, and Future Research**	
Moderator: Chuck Podolak		
12:20-12:40 pm	Jason Mouw	*Hydrologic controls on the recruitment of riparian plants and the maintenance of flood plain wildlife habitat*
12:40-1:00 pm	Robin Beebee	*Floodplain Mapping on a Braided Northern River, Alaska Considering Debris, Ice and Groundwater*
1:00-1:20 pm	Amy Larsen	*Potential impacts of Elodea canadensis on freshwater ecosystems of Alaska*
1:20-1:40 pm	Bill Schnabel	*Overview of Current Research Efforts and Interests at the UAF Water and Environmental Research Center*

2:00 pm	Bus leaves for Fairbanks Airport (sponsored by Hatch Associates)

Abstracts

Session 1: North Slope Hydrology & Water Use - I

Hydrologic field observations on three major rivers in the North Slope Foothills region

Toniolo, Horacio
Professor, Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Doug Kane, Emily Youcha, Bill Schnabel -Water & Environmental Research Center, University of Alaska, Fairbanks

Researchers from the Water and Environmental Research Center, University of Alaska Fairbanks are conducting a hydrologic research project in the Foothills area. Studies are performed on the Anaktuvuk, Chandler, and Itkillik rivers. Field work encompasses river monitoring and stream gauging during breakup and summer. As part of the project, several meteorological stations were installed in the watersheds. We will present the hydraulic conditions and the rating curve on the Anaktuvuk gauging site, as well as surface water levels on the Itkillik and Chandler rivers.

Linking North Slope Climate, Hydrology, and Fish Migration

Betts, Erica
Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Doug Kane -Water & Environmental Research Center, University of Alaska, Fairbanks

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 in the spring and early summer to spawning and feeding sites and then in the fall migrate back to overwintering sites. Migration to spawning sites occurs just after break up when rivers are quite swollen from the melting of an entire winter's worth of snow. 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. As the summer progresses, precipitation tends to increase and evapotranspiration decreases. Hydrologic connectivity is generally restored by the end of summer and soils are wet prior to freeze-up. Increased temperatures associated with climate change lead to greater evapotranspiration. This may lead to increased drying in the summer in the Arctic. Although annual precipitation rates are expected to increase, the direction and magnitude of the change in summer precipitation is less clear. Another possible change in precipitation may be in the form of increased variability or in the probability of extreme events. The research to be presented here details an attempt to recreate the occurrence of hydrologic barriers to fish migration in the Upper Kuparuk River on the North Slope of Alaska. Locations along the Upper Kuparuk which become barriers to migration during low flows were identified and monitored during the summer of 2010. These locations were chosen because during previous low flow events, these stretches run dry even though water is seen flowing both up and downstream of these stream segments. Although not fully understood yet, the geomorphological conditions along these stream segments are such that the flow becomes 100% hyporheic during periods of low flow. The data collected at these locations over the summer is then compared to 15 years worth of discharge data collected in the Upper Kuparuk to determine when, how often, and under what conditions these barriers have occurred. This is the first step in an ongoing research effort to predict how future changes in the hydrologic regime of the Arctic may affect Arctic grayling. Migration of Arctic grayling provides a useful mechanism of study as most arctic fish species migrate between or within streams, rivers, lakes, wetlands and coastal waters during some period in their life cycle. Although this research aims to help answer whether barriers to fish migration are occurring frequently enough to create an impact on Arctic grayling, an increase in the formation of these barriers has the potential to affect all fish utilizing these same migration routes.

The Hydrology and Ice-cover of Teshekpuk Lake in a Changing Arctic Climate

Arp, Chris

Water & Environmental Research Center, University of Alaska, Fairbanks

At 430 km^2, Teshekpuk Lake is the third largest freshwater inland lake and the largest Arctic lake in Alaska, and possibly the largest thermokarst lake in the world. Although set on the Arctic Coastal Plain (ACP) only a meter above sea level with maximum depth reaching < 7 m, Teshekpuk Lake has very fresh water, partly owing to runoff from Keolok Creek that drains a ~1200 km^2 area of sand sea to the south. Teshekpuk Lake provides habitat for at least 14 species of fish, hosts an abundant population of a marine invertebrate Saduria entomon, and likely has important influences on the regional land and climate that make this area important habitat for caribou, geese, and other wildlife. Because of its immense size and position near the Beaufort Sea coastline, ice cover typically persists well into July and occasionally mid-August or later making this the last lake in the state to completely lose its ice cover. Thus, open-water duration at Teshekpuk Lake persists at most for 3 months, more commonly for 2 months, and potentially may maintain perennial ice-cover during some years. Thus, the ice-cover regime likely plays a key role in its long-term hydrological and limnological behavior. Thus to better understand the relationship between ice-cover and hydrology on Teshekpuk Lake, we estimated ice-cover regimes from 1947 to present using air temperature records from Barrow calibrated to local weather and lake stations and verified with remotely sensed imagery from 1973 to 2010, and field observations from 2007 to present. For this 62 year period, average ice-out timing was 29-July (±14 d SD) with the earliest date of 7-July in 1998 and a trend towards earlier ice-out of 0.4 d/yr (r^2=0.27) was found. Average ice-on timing was 22-September (±11 d SD) with the latest date of 10-October in 1954 and no trend in ice-on timing. Ice-cover duration averaged 55 days (±21 d SD) with the longest duration estimated to occur in 199

8, 91 days. These results also suggest that Teshekpuk Lake had at least partial, perennial ice cover during the summers of 1956 and 1969. Using downscaled composite output from five global climate models for the A1B emissions scenario, we predicted future ice-cover timing and duration for Teshekpuk Lake based on empirical relationships to mean monthly air temperature, which as expected show a continued trend toward longer open-water duration. Both the timing of ice-cover and its duration may have important affects on the water balance of Arctic lakes because of how it regulates water temperature and evaporative losses during short summers. In the case of Teshekpuk Lake, its large surface area relative to volume and watershed area may make it particularly vulnerable to longer periods of evaporation in years with below normal rainfall. Making improved predictions about this important water resource and ecosystem of the Alaskan ACP will benefit from the long-term monitoring program we have established for Teshekpuk Lake, its watershed, and climate system.

The role of low- and high centered polygons on arctic wetland water balance

Liljedahl, Anna

University of Alaska, Fairbanks

Coauthors:Larry D. Hinzman - IARC, University of Alaska; Jörg Schulla,

Hydrologic Software Consultant, Zurich

Polygon patterned ground and related microtopographic features are ubiquitous to landscapes underlain by permafrost. Polygon patterned ground can be divided into two main sub-classes dominated by either high- or low-centered polygons. Surprisingly, their different role on hydrological fluxes and stocks is not well quantified. We performed hydrological modeling analyses using the physically-based model WaSiM-ETH forced and validated by measurements from the Biocomplexity Experiment, Barrow, Alaska, (1999 to 2009) to investigate the effect of these microtopographical features on the overall basin water balance. During the 2-3 weeks directly following snowmelt, the measured water levels in the vegetated drained thaw lake basin measured up to 15 cm above the ground surface. Measured water levels in four neighboring low-centered polygons and site photographs showed a period of brief surface connectivity during snowmelt followed by a nearly two month long lateral disconnection. A larger rain event (6 mm) in combination with thicker active layer depths established a sub-surface connection in early August. The timing of observed rain events in relation to the thaw depth of the active layer was shown to determine sub-surface connectivity. The presence of elevated rims in model simulations, aimed to represent low-centered polygon tundra, reduced runoff while increasing evapotranspiration and surface water storage. The absence of rims resulted in an increased runoff, and reduced storage, with an evapotranspiration similar to low-centered polygon tundra. The high-centered polygon landscape produced more than twice the runoff than the low-centered polygon scenario, while storage and runoff drastically decreased. The observed extensive inundation period at the Barrow study site was only replicated by WaSiM-ETH when low-centered polygon rims were represented. It is evident that microtopography plays an important role on the hydrologic fluxes and stocks of arctic wetlands. Moderate climate warming can transform low-centered polygons into high-centered polygons when permafrost degrades and rims subside, allowing the formation of small drainage channels. Differential ground subsidence could potentially dominate the direct effects of climate change on arctic wetland hydrology.

Session 2: North Slope Hydrology & Water Use - II

A New Hydroclimatological Database and Network Analysis for Arctic Alaska: AQUABASE II

Burkart, Greta
University of Alaska, Fairbanks
Coauthors: Jessica Cherry -Water & Environmental Research Center & International Arctic Research Center, University of Alaska, Fairbanks; Amy Jacobs, International Arctic Research Center, University of Alaska, Fairbanks

In 2008 the US Fish and Wildlife Service held a workshop (WildREACH) to identify priority research, modeling, and synthesis activities necessary to advance our understanding of the effects of climate change on fish and wildlife in Arctic Alaska. Common themes that emerged during the workshop were the need to improve synthesis and dissemination of existing climate and hydrology data, to improve hydrologic modeling efforts and to optimize the design of the current climate and hydrologic monitoring network in Arctic Alaska. We have partnered with the Arctic Landscape Conservation Cooperative to address these issues. To improve data synthesis and dissemination we created a relational geodatabase, AQUABASE II, to store and retrieve meteorological, hydrological, water quality, and aquatic ecology data and metadata for Arctic Alaska. We inventoried hydrologic and related datasets held by universities, state and federal agencies, and the private sector and populated the database with metadata for over 5000 sites and more than 100 sources at numerous institutions. During the second phase of this project we will prioritize data rescue efforts, populate the database, and perform network analyses to assess historic trends and to develop an optimized design for an improved climate and hydrologic monitoring network in Arctic Alaska.

Current Water Management Practices and Guidelines for Water Users on the North Slope of Alaska

Plett, Krissy
Natural Resources Manager, Alaska Department of Natural Resources
Coauthors: Roy Ireland, Alaska DNR; Michael Lilly, GW Scientific; Gerald Sehlke, Idaho National Laboratories

Surface-water resources on the North Slope are the primary freshwater resources used by industry and communities for freshwater supplies. Uses include drinking water, drilling support, road watering, ice roads and pads. Future uses may include low-salinity water flooding and other resource development activities. Rivers and lakes are considered state resources and are regulated by the Alaska Department of Natural Resources, Division of Mining, Lands and Water. Managing the Alaskan water resources requires the user to determine the type of water use and length of use. For long-term uses (more than 5 years), such as a drinking water supply, the user may apply for a Water Right. For short-term water uses (less than five years), such as exploration, the user may apply for a Temporary Water Use Authorization. The process of managing the Water Resources is an administrative adjudication process, which requires the State to take into account other uses of the water resources in question. These may include ecosystem (fisheries, wildlife, birds) resources, other current users, and potential future users.

Water adjudication practices and requirements on the North Slope developed primarily with oil and gas development in the central coastal plain, where there is a high density of lakes and old gravel sites that now serve as water reservoirs. There was little data available for lakes and reservoirs and simple and conservative practices were developed to help manage use of state water resources. Current management goals are focused on protection of over-wintering fish habitat, and adequate recharge of water sources. As new information becomes available and resource development needs increase, water management requirements may change, but the protective goals and objectives of managing water for the best uses for the State will remain the same. Our talk will present the basic requirements of Alaska water management; the current standards and challenges that are facing water users.

Practical Applications of Ice Growth Simulation Tools to Help with Adaptive Water Management of Arctic Lakes

Toniolo, Horacio
Professor, Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Michael Lilly, Jeffrey Derry, GW Scientific; Gerald Sehlke, Idaho National Laboratories

The primary water supplies for arctic transportation networks come from lakes and reservoirs. One of the primary objectives for managing water sources is the protection of over-wintering fish habitat. A historical assumption for estimating how much water may be available at the end of winter is to assume 7 feet of ice is formed each winter. This ice thickness is rarely measured and in many years many lakes have ice thicknesses between 5 and 6 feet. Developing a permit process to use actual ice thickness would allow water users to adapt water use limits to actual field conditions. This would require simple but accurate tools and methods to estimate end-of-winter ice thickness at varying decision points during winter months. We will demonstrate the current applications on a series of test lakes using synthetic water management decision examples.

Designing Adaptive Management Approaches for Summer Water Use of Arctic Lakes

Lilly, Michael
GW Scientific
Coauthors: Gerald Sehlke, Idaho National Laboratories; Jeffrey Derry, GW Scientific;
Horacio Toniolo, University of Alaska, Fairbanks

There are many industry requirements for summer water use of lakes and reservoirs on the North Slope. Water use needs can include road watering, drilling support, and facility water supplies. Water permitting and management goals may include protection of overwintering habitat, meeting annual recharge characteristics, fish passage to spawning or summer habitat locations. The application of synthetic water use models can help in the design of water management practices and permitting approaches. We will show how summer water use models can help identify potential water use limits and the management issues that need to be considered.

Session 3: Mining & Water - From Permitting to Monitoring

Water Quality and Water Management at Hard Rock Mines

McGee, William
Environmental Engineer, Alaska Department of Environmental Conservation

To understand water quality and water management at hard rock mines the place to start is with the Alaska Water Quality Standards (18 AAC 70). Those standards begin with protecting designated uses, both existing and attainable. Where multiple standards apply, the most stringent is the controlling standard. The standards are made up of narrative standards which describe a required level of protection such as, “no measurable increase” or “may not pose hazards”, and numeric standards such as, ”D.O. must be greater than 7 mg/L”. Natural conditions at hard rock mines frequently exceed water quality standards. Adequate baseline water quality data is needed to support any request for flexibility in the water quality standards and to document surface and groundwater quality and quantity. Baseline data is also needed to identify any metal leaching (ML) or acid rock drainage (ARD) that may be predicted based on geochemistry.

There are a number of sources of water that must be managed at mines. They include: diverted water (storm water), dewatering water (pit or underground), process water, tailings pore water, recycled water, and discharged water. Water and load balances are important for predicting and managing water quality and quantity. They predict the amount of stored water required, and the need for dams, tanks, and liners, as well as treatment requirements. There are also limits in 40 CFR 440, Subpart J, that restrict new source facilities from discharging more than the volume of the net precipitation gain that falls on the contributing area to the treatment facility.

APDES and Waste Management permits contain language dealing with effluent limits, mixing zones, antidegradation, reclamation and closure plans, long term water treatment, and financial assurance. They also include requirements for surface water, ground water, and biologic monitoring plans, all of which are related to protecting the waters of the state.

A slide show with pictures of examples of water management at several Alaskan mines concludes this presentation.

Successful Coexistence of Mining and Fish

MacCay, Charlotte
Permitting Manager, Pebble Partnership

Mining, using modern technology and careful environmental planning, can coexist with clean streams and a healthy fishery. This has been demonstrated at several mines in Alaska and recently in record Sockeye returns in Canada's Fraser River.

The Pebble Project is conducting some of the most extensive environmental baseline studies in the state's history. This robust data set will enable mine design and planning at Pebble that will provide for protection of the local fisheries. Studies include extensive fish surveys to understand which fish species are present, how they are distributed, the timing of their life cycles, and how they utilize habitat in the study area. Surface and groundwater hydrology studies are conducted to understand the flow regime in the rivers, lakes, and off-channel water bodies. Data are also collected to understand and model the relationship between changes in flow and the extent of usable fish habitat.

Understanding fish and their habitat is important in order to design for minimal impact, and to develop proactive fish mitigation strategies. However, fish and particularly salmon, with their migratory cycles, is not the most effective parameter to monitor a waterbody once operations have begun. Fish may not exhibit indicators of impact for several years; and for migratory species, linking cause and effect becomes complicated due to exposure to factors at sea and enroute to and from the spawning and rearing grounds in the study area. Changes in fish health and population size may be related to global warming, reduced populations of prey species at sea, marine pollution, fishing pressure or numerous other possibilities not easily distinguished from local factors. Macroinvertebrates and microorganisms, however, have shorter life cycles, are resident to the area, and are highly sensitive to environmental change making them excellent indicator species for the local aquatic ecosystem. Pebble is developing a thorough baseline understanding of these organisms, along with water quality conditions, to set the platform for a strong, responsive, and effective monitoring program that in turn enables timely and effective mitigation should unexpected conditions arise.

Pebble studies set the stage for responsible mine design, proactive mitigation, monitoring, and response; the necessary ingredients to ensure a successful coexistence between mining and fish.

Evaluating effects of potential flow modifications on fish habitats in the vicinity of the Pebble Project

Reiser, Dudley
President, Senior Fisheries Scientist - R2 Resource Consultants
Coauthors: Chiming Huang, Stuart Beck - R2 Resource Consultants

The development of the Pebble Project has the potential to affect the current hydrology of one or more of three watersheds in the project study area - the North Fork Koktuli River, South Fork Koktuli River, and Upper Talarik Creek. These effects may include temporal and spatial changes in the frequency, magnitude and duration of hydrologic conditions as well as rates of flow change. Changes in flow can influence the function of various salmonid life stages via alterations in both the quantity and quality of associated habitats. These changes could be beneficial or detrimental depending on their timing, magnitude, and location. This paper describes the results of baseline studies contracted by the Pebble Limited Partnership (PLP) to characterize the baseline relationships between flow and fish habitat and to evaluate potential effects of changes in flow on the fishery resources of the three study streams. This paper focuses on the mainstem portions of these systems. The primary method of analysis was patterned after the Physical Habitat Simulation (PHABSIM) method developed by the USFWS. Field data (depth, velocity and substrate) have been collected from 117 cross channel transects distributed within different habitat types located throughout the systems. We developed hydraulic models for each cross-section and linked these with Habitat Suitability Curve (HSC) criteria that define species and life stage habitat use to derive habitat-flow relationships for six target fish species. In addition, mesohabitat mapping was completed using a combined field and GIS-based approach for each system and resulted in the delineation of over 1800 habitat units. We then synthesized habitat – flow relationships for each habitat unit delineated. A computer model was developed using Microsoft Visual Basic and provides the platform for evaluating spatial and temporal changes in habitats resulting from flow modifications at the habitat unit scale. Sub-routines in the model allow for generation of predicted habitat gains and losses under different flow conditions by habitat type, stream reach, river, and all rivers combined scale. This model provides a powerful tool for evaluating fish habitats under baseline conditions, analyzing potential flow modification effects on those habitats, and for evaluating flow mitigation options.

Producing and Protecting

Gillespie, Clyde
Environmental & Surface Operations Manager, Coeur

After many years of studying the fisheries, planning for their protection and implementing measures to assure spawning habitat remains productive along with preserving fresh and marine water quality the Kensington Mine in Southeast Alaska has begun production. Measures are taken to assure the anadromous fish spawning in streams, resident fish populations in lakes and streams and marine mammals are protected. Active water treatment and Best Management Practices are used to assure sediment control is adequate to protect the spawning habitat and water quality in the lakes and streams associated with the mine. The Kensington transportation plan includes several procedures that are implemented to protect marine mammals while transporting personnel and freight to the site during the Eulachon spawning period. Ongoing monitoring indicates Kensington has been developed and is producing gold in a manner that is protective of the fisheries existing in lakes, streams and marine waters near the mine.

Session 4: Mining & Water - Monitoring & Looking Back

Aquatic Bio-Monitoring at the Red Dog and Fort Knox Mines, Alaska

Morris, Bill
Habitat Biologist, Alaska Department of Fish & Game
Coauthors: Alan Ott, Alaska Department of Fish & Game

Development activity in northern Alaska often occurs in areas where there is potential for impacts to aquatic habitats and both anadromous and resident fish populations. The Alaska Department of Fish and Game has developed and implemented site specific aquatic bio-monitoring programs at several large mines to help document and ensure appropriate aquatic resource protection. Basic monitoring programs rely on relatively simple, cost effective techniques that produce comparable results and can be implemented over the life of a project. Basic monitoring often includes tracking periphyton densities in area streams (index to primary production), aquatic invertebrate densities including measures of percent Ephemeroptera, Plecoptera and Trichoptera (% EPT), measures of fish distribution and/or relative abundance as well as tracking water quality and, in some cases, metals concentrations in fish. Bio-monitoring programs are designed specific to a project or mine based on the aquatic resources in the vicinity of each project and the possible effects on aquatic resources from the project design. The Red Dog Mine is located along Red Dog Creek in northwest Arctic Alaska approximately 50 miles from the Chukchi Sea; the mine discharges treated effluent into Red Dog Creek. Arctic grayling (Thymallus arcticus) rely on Red Dog Creek for spawning and anadromous species including Dolly Varden (Salvelinus malma) and Chum salmon (Oncorhynchus keta) rely on habitats downstream from the mine for spawning. Several resident fish species and Dolly Varden winter in habitats downstream from the mine. Over fifteen years of aquatic bio-monitoring have been conducted at the Red Dog Mine. Aquatic productivity data including periphyton standing crop, invertebrate densities, % EPT, whole body metals concentrations in juvenile Dolly Varden, tissue metals concentrations in adult Dolly Varden, Arctic grayling spawning and population characteristic data, and general fish distribution data have been collected annually, most, for well over a decade. The Fort Knox Mine, located north of Fairbanks, was constructed in a drainage heavily mined in the early 1900s; Fort Knox is a no discharge operation. A stunted population of Arctic grayling had survived the historic mining activity in the drainage and was present at the time of construction as was a population of primarily juvenile burbot (Lota lota). Reclamation work conducted by the Fort Knox Mine has resulted in enhanced Arctic grayling habitat and has appreciably altered the size and structure of the Arctic grayling population. The population has been sampled annually since 1992. We illustrate the types of monitoring employed at these very different operations and highlight the uses and applicability of various simple techniques for long term monitoring and summarize the long term results of each project.

Water quality and biology of streams draining abandoned and reclaimed mined lands in the Kantishna Hills area, Denali National Park and Preserve, Alaska

Ourso, Bob
Ecologist, USGS
Coauthors: Tim Brabets, USGS

Past mining activities in the Kantishna Hills, in the northwest part of Denali National Park and Preserve, degraded local stream water quality. All mining ceased in 1985, but recovery through natural processes has been limited due to a short growing season, and thus the National Park Service has implemented reclamation projects on a number of streams in the Kantishna Hills area. Streams in the Kantishna Hills have been monitored since 2008 to determine the effects of reclamation on water quality. Mining in the Kantishna Hills increased some trace element concentrations in streambed sediments to concentrations that may be harmful to aquatic life. For example, the probable effect level (PEL) at which arsenic exposure would cause adverse effects to aquatic life is 17.0 milligrams per kilogram dry weight (mg/kg) and the arsenic concentration for Slate Creek was 3,900 mg/kg. All sites with mining exceeded the PEL for arsenic. Two unmined sites – Moose Creek and Rock Creek - were slightly over the PEL limit. Some of the mined sites also exceeded the PEL for lead. Water samples were analyzed for 23 trace elements at 15 sites. Most concentrations of these elements were less than published USEPA guidelines for drinking water. However, antimony concentrations in Slate Creek, Eldorado Creek, and Eureka Creek, exceeded the USEPA drinking water guideline of 6 micrograms per liter. Concentrations of arsenic and lead were also elevated at these sites but did not exceed the drinking water guidelines. Turbidity was monitored continuously during open-water conditions at 6 sites. Rock Creek, the control site, and Caribou Creek, site 5, the most downstream site on this mined stream, showed nearly identical patterns in turbidity throughout the summer of 2009. Periods of elevated turbidity were due to rainfall and the turbidity patterns indicated that much of the mined land in the Caribou Creek watershed has become vegetated, reducing the amount of sediment entering the stream. Macroinvertebrate samples yielded 104 taxa among 7 sites over 2 years. Eighty- six percent of the taxa were insects, with 49 percent from the order Diptera. Compared to samples collected in other parts of Alaska using the same protocols, 14 taxa were unique to Kantishna Hills. Oligochaetes and the stonefly, Zapada oregonensis, were ubiquitous. Caribou Creek site #5 (mined) and Rock Creek (unmined) exhibited the best overall stream conditions according to the USGS National Invertebrate Community Ranking Index (NICRI). Slate and Friday Creeks (mined watersheds) scored lowest according to the NICRI, which indicates that the Kantishna Hills sites, except Slate and Friday Creeks, exhibited macroinvertebrate community structure associated with minimal disturbance

A retrospective view of the water connections of the Kennecott Mines and Copper River Salmon 100 years after the first ore shipments

Munter, James
Hydrogeologist, J.A. Munter Consulting, Inc.

The Copper River Delta yields what is arguably Alaska's most valuable fish. The mid-May run of King Salmon are becoming ever-more prized in America's kitchens and restaurants, with recent fillet prices of $37/lb or $43.95 per entrée for lunch and dinner. This creates a value chain for fishermen, transporters, processors, and retailers of well over $500 per fish. Copper River salmon are also an important subsistence fishery. Part of the aura of the Copper River salmon stems from the perception and fact of the low degree of development and water quality impairment in the basin

The Copper River is aptly named because some of the world's richest copper ores were found at the Kennecott mines within the drainage basin. The mines shipped their first ore exactly 100 years ago, and operated over a 27-year span, yielding over 500,000 metric tons of copper ore. These operations occurred virtually without any baseline data collection, water monitoring, permitting, closure or reclamation work. Today, few people think about the potential for water quality impairment from the mines, or even the perception that the existence of a significant hard-rock mine in the drainage basin can reduce the special market or subsistence value of Alaska's wild salmon.

Prior to mining, political battles over the mining and subsequent railroad were fought in the office of U.S President Theodore Roosevelt between conservationists and those having a financial interest in the copper. USGS Professional Paper 1619 provides results of the analyses of water samples taken in the vicinity of the Kennecott mines during the 1990's. The samples are reported to have low total dissolved solids, low metals concentrations, near-neutral pH, and are "generally comparable to worldwide average surface water concentrations". The authors attribute the lack of water quality impairment to the fact that the host rocks for the mineralization are limestone, which created a well-buffered calcium-bicarbonate water type resistant to acidification. Also, there was an absence of pyrite and other unstable sulfide minerals that could cause acidification.

In conclusion, the Kennecott mines and the modern day Copper River salmon fisheries demonstrate that it is possible for robust fisheries and hard-rock metallic mining to coexist in the same drainage basin in Alaska. Geologic conditions can create the absence of significant water quality impairment, even in the absence of any monitoring, permitting, or reclamation work at the mines or waste rock areas. Separately, high-level political debates over resource development versus preservation in wild areas are nothing new. Finally, 100 years after a major mining project in an area now part of a National Park, the mining site is considered to have environmental values as: 1) a tourist and cultural interest within a large National Park; and 2) as a historic site worthy of preservation activities. The railroad infrastructure built for the project is still in use by many people for accessing recreational, educational, and subsistence fishing activities around the geologic and water resources of the Copper River Basin.

Keynote Address

Large Mines: Overview of six and the challenges and successes with a focus on water quality issues.

Fogels, Ed

Deptuy Commissioner, Alaska Department of Natural Resources

The state of Alaska maintains five hardrock, metal mines and one coal mine. Although the Usibelli Coal Mine has been mining coal in the Healy area since the 1940's, Alaska's modern hardrock mining era began with the opening of the Red Dog Mine for zinc, lead and silver and the Greens Creek Mine for silver, zinc, lead and gold in 1989. Due to permitting complexity for major mining projects, the State of Alaska initiated the Department of Natural Resources' coordinated team approach in the early 1990's for the permitting process of the Fort Knox Gold Mine. Construction began in 1995 and achieved commercial production in 1997. Subsequently, the Large Mine Permitting Team completed the permitting of the Pogo Mine for gold and the Kensington Mine for gold. Currently in the state of Alaska, multiple mining projects are under development with specific challenges and success to each.

Ed Fogels has been with the Alaska Department of Natural Resources for the last 24 years, and is currently the Deputy Commissioner. Prior to that, Commissioner Fogels served as the Director of the Office of Project Management and Permitting, and also as the State's Mining Coordinator responsible for the permitting and administration of all large mining projects in Alaska. Commissioner Fogels has managed the Alaska Coal Regulatory Program and the Department's Land Disposal and Homesteading Programs, and spent several years as the Resource Planner in the Fairbanks office location. Commissioner Fogels earned a degree in Environmental Sciences from the University of Virginia. He is married to Luann, a school nurse with South Anchorage High School, and they have a 21 year old daughter named Avery. Commissioner Fogels enjoys skiing, mountain biking, and fly-fishing.

Session 5: Fish in Our Rivers

Using Hydrodynamic Modeling and Fish Passage Windows to Evaluate Barriers in River Systems Under Changing Climate Regimes

Cox, Mike
OASIS Environmental, Inc.
Coauthors: Matt Blank - OASIS Environmental

Connectivity is vital for fish and other aquatic species to persist and thrive in river and stream environments. Increasing connectivity by removing or reducing barriers is one of the most promising adaptive management strategies for addressing the impacts of climate change on water ecosystems. Over the past decade, interest in the effect of barriers on aquatic systems has grown; accordingly, various passage assessment techniques have been used to determine whether a structure is a barrier, to what species it acts as a barrier and under what flow conditions. Recent research has shown that determining the status of a barrier is not trivial, and that different methods are often not congruent in their classification of barriers.

The presentation will describe an assessment technique that used 3-D hydrodynamic measurements and modeling to assess potential barriers to upstream fish movement. The approach quantified the 3-D velocity field using acoustic Doppler measurements and/or computational fluid dynamics. A range of potential paths through the barrier were identified using an algorithm that estimates energy paths. Passage along the paths was assessed by combining the swim speed–fatigue time relationship with the 3-D velocity field. Passage windows were developed to determine the flow range and amount of time that a structure may be acting as a barrier to upstream movement. Results from the 3-D approach were compared to an approach that used the 1-D velocity field to estimate passability. Comparisons between estimated passage and measured passage showed that the 3-D method more accurately predicted passage through the barrier than did the 1-D method. Examples of how this approach can be used to evaluate how barriers respond to climate change scenarios, specifically changes in the magnitude and timing of runoff, will be presented.

The Trans-Alaskan Strontium Isotope Survey (TASIS) – geochemically characterizing Alaskan watersheds to track salmon migrations in River Systems Under Changing Climate Regimes

Brennan, Sean
School of Fisheries & Ocean Sciences and Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Fernandez, D., Mackey, G., Cerling, T.E. - University of Utah; Vanlaningham, S. - University of Alaska, Fairbanks; Zimmerman, C. - USGS; Wooller, M.J. - University of Alaska, Fairbanks

We present strontium isotopic (87Sr/86Sr) composition of water from 25 Alaskan Rivers ranging from the Chugach and Wrangell Mountains to the North Slope of Alaska, representing the first Trans-Alaskan Strontium Isotope Survey (TASIS). A challenging issue in watershed ecology is tracking fish population response to perturbations. This is especially difficult when studying population dynamics of anadromous fish such as, salmon of the North Pacific. Pacific salmon stocks (e.g. Chinook salmon - Oncorhynchus tshawytscha) have shown dramatic changes in returns into Alaskan rivers. Salmon not only maintain an important mechanism of nutrient transport between marine, aquatic and terrestrial ecosystems, but are also a valuable resource to humans. The population structure of salmon is a complex genetic hierarchy and perturbations such as over-fishing by humans pose real threats to the biodiversity and overall success of these species, and to subsistence human communities. Tools are being developed to track the natal origins of salmon to better conserve salmon biodiversity and the natural resource they represent to coastal communities.

Spawning salmon exhibit high site fidelity with their natal freshwater streams, which allows genetic differentiation between populations from different rivers (i.e., genetic stock identification; GSI). However, in regions where there is little genetic divergence between populations, current genetic markers lack sufficient resolution to identify the multitude of breeding populations, which constitute the "genetic stock". Thus, when GSI information is used to track and manage population response to a fishery, the relative contributions of local breeding populations (basic reproductive unit of salmon) is unknown, and there exists a risk of driving distinct breeding populations to extinction.

Recent studies have indicated the potential of using naturally occurring isotopic markers to discern salmon population structure at much finer scales (tributary level vs. large river). Isotopic markers, such as strontium (Sr) isotope ratios (87Sr/86Sr) in otoliths (the auditory structure of fish), are fundamentally different than genetic markers. 87Sr/86Sr in otoliths continually record environmental variation experienced during the migratory life history of salmon in distinct accretionary bands of calcium carbonate. The utility of otoliths to identify salmon natal sources is a function of intra- and inter-basin geologic diversity. Western Alaskan Rivers drain a very geologically diverse landscape and support some of the world's largest wild salmon populations – thus, ideal for applying this tool. To evaluate using 87Sr/86Sr ratios to track salmon migrations in Alaskan watersheds we have geochemically characterized waters from some of the main rivers across the state. The range of values we report is 87Sr/86Sr: 0.70540 - 0.71850 (average 2σ error = 0.00004). The lowest ratios are found in the Chugach and Wrangell Mountains, while the highest ratios are found in Interior Alaska, Brooks Range and North Slope. This large range of variability indicates that this isotopic approach will likely serve as an effective tool for distinguishing the rivers used by fish populations.

Summary of Instream Protection in Alaska

Klein, Joe
Alaska Department of Fish & Game

The State of Alaska has abundant and diverse fisheries that are of considerable recreational importance to anglers and others. The continued production of these fishery resources depends, in part, upon sufficient amounts of good quality water to maintain seasonal fish habitat requirements in rivers, lakes, and related habitats. Reservations of water to retain water in lentic and lotic habitats can be acquired to protect instream flow uses and values by a private individual, organization, or government agency.

Alaska Department of Natural Resources (DNR) received 359 applications for reservations of water from Alaska Department of Fish and Game (ADF&G), federal agencies, and the private sector as of December 2009. ADF&G completed reservation of water applications on 112 river systems and 1 lake. DNR issued certificates of reservations for 26 ADF&G applications for rivers and one for a lake; one BLM application for a river; and for one river and lake under the water export provision.

In 2002, a Memorandum of Understanding was signed between DNR and ADF&G to assist with the increasing backlog of reservation of water applications needing adjudication and to improve the overall process. ADF&G performed hydrologic investigations on 72 sites to provide the necessary data to complete reservation of water applications. Stream gages were operated at 44 sites, discharge measurements were collected at 27 sites, and stage readings were collected from one site. ADF&G also monitored 68 existing and proposed Federal Energy Regulatory Commission hydroelectric and hydrokinetic projects and participated in the Alaska Clean Waters Actions program for the recovery and stewardship of Alaska's water bodies.

Fish Habitat Restoration and Education in Alaska

Bethe, Amber
Habitat Biologist, Alaska Department of Fish & Game
Coauthors: Dean Hughes, Alaska Department of Fish & Game

ADF&G works to conserve fish and riparian habitat through regional restoration and protection cost share programs. In these programs, staff work cooperatively with private land owners, public land managers, nonprofit organizations and others to complete shoreline projects. Financial incentives are provided through cost sharing of fish-friendly bank stabilization and riparian revegetation projects. This work began on the Kenai River in 1995, since then over 500 shoreline rehabilitation projects have been installed throughout the Kenai Peninsula. Starting in 2008, program areas expanded to include the Matanuska-Susitna, Anchorage and Fairbanks areas. Most projects are completed using a combination of revegetation and shorelines stabilization techniques including coir logs, dormant willow cuttings, brush layering, transplanted native vegetated mat and elevated, light penetrating walkways. Educational outreach is a key component of the program, and staff teach habitat rehabilitation workshops to a variety of participants including state and federal entities, local government, nonprofit organizations, private landowners, university students and staff, and other interested parties. To date, 17 of these two day workshops have been presented across the state. An overview of ADF&G's fish habitat restoration and protection work across Alaska will be presented.

Session 6: Water Sources for Alaska

Sources of Drinking Water in Alaskan Villages

Bendlova, Tereza
University of Alaska, Fairbanks
Coauthors: Chris Arp, William Schnabel, David Barnes - University of Alaska, Fairbanks

Across Alaska, problems related to the sources of municipal drinking water for villages can range widely because of the state's large size and associated variation in climate and geology. For example among Alaska's five major climate zones, mean annual precipitation varies from up to 5000 mm in the maritime zone to less than 150 mm in the arctic zone. Alaska's climate, along with geology and land cover, has a great influence upon other environmental conditions as well including presence and type of permafrost, vegetation, and water availability. Our project is focused on understanding the environmental, economic, and cultural factors influencing water supply vulnerabilities for Alaska villages and we begin here by first comparing and contrasting how climate and geology relates to the types of drinking water sources and treatment facilities in Alaska. Information on types of water systems was obtained from the Community Database Online provided by Alaska Division of Community and Regional Affairs. Information from this database was statistically summarized by village according to major categories of source (i.e. natural lakes, reservoirs, rivers, and groundwater), and delivery system (i.e. wells, piped water system, treatment and storage in a tank). We then analyzed these categories in terms of climatic and geologic characteristics, such as climate zones, bedrock geology, and presence and type of permafrost. Preliminary results show that in northern Alaska, where continuous permafrost exists, lakes are the predominant source of drinking water and in interior Alaska water is mainly obtained from groundwater wells. In southeastern Alaska, characterized by a maritime climate and rainforests, water is often acquired through individual surface water collection systems. Rivers are another important source of water to many villages and this source is common among many regions of the state. Geographic variation in sources of drinking water throughout Alaska can be well related to climatic and geologic characteristics and each presents differing aspects of vulnerability and resilience to environmental and socioeconomic change. Future work will focus on how socioeconomic factors, such as population size, accessibility, and income, relate to village water systems.

Spatially telescoping measurements for efficient characterization of groundwater contribution along a small stream in south-central Alaska

Kikuchi, Colin
University of Arizona
Coauthors: Paul Ferre - University of Arizona

The suite of measurement methods available to characterize fluxes between groundwater and surface water (GW-SW) is rapidly growing. However, there are few studies that examine approaches to design of field investigations that include multiple methods. We propose that performing field measurements in a spatially telescoping sequence improves measurement flexibility and accounts for hydrologic scale while still allowing for parsimonious experimental design. We applied this spatially telescoping approach in a study of GW-SW interaction during baseflow conditions along Lucile Creek, south-central Alaska. Catchment-scale data, including geomorphic indices for the stream and geologic transects, were used to screen areas of potentially significant GW-SW exchanges. Specifically, the geomorphic and hydrogeologic assessment indicated increasing groundwater contribution from a deeper regional aquifer along the middle to lower reaches of the stream. This initial assessment was tested using reach-scale estimates of groundwater contribution during base-flow, including differential discharge measurements and chemical tracers, analyzed in a three-component mixing model. The reach-scale measurements indicated a large increase in discharge along the middle reaches of the stream accompanied by a shift in chemical composition towards the regional groundwater end member. Finally, point measurements of vertical water fluxes – obtained using seepage meters as well as newer temperature-based methods – were used to evaluate spatial and temporal variability of GW-SW exchanges within representative reaches. The spatial variability of upward fluxes, estimated using streambed temperature mapping at the sub-reach scale, was observed to vary in relation to both streambed composition and the magnitude of groundwater contribution from differential discharge measurements. The spatially telescoping approach improved the efficiency of the field investigation along Lucile Creek. Beginning with large scale data allowed us to plan measurements at representative field sites that would best answer our scientific questions of interest. This approach is directly applicable to field investigations at remote sites in Alaska, for which time and equipment may be limited.

Glacial Influences on Water Resources of the Eklutna Basin, Alaska

Larquier, Ann Marie
Alaska Pacific University
Coauthors: Michael Loso, Louis Sass - Alaska Pacific University

The Municipality of Anchorage relies on the Eklutna Glacier for drinking water and hydroelectric power. Monitoring and predicting changes in glacier volume, and the distribution, amount, and timing of glacial meltwater and sediment runoff, both of which affect reservoir storage in Eklutna Lake, is critical to developing feasible and effective long-term water-resource management plans. With updated detailed bathymetric mapping of Eklutna Lake, we have created a model for lake volume storage analysis at numerous lake level elevations. This model is based on daily streamflow from two stations gaging runoff from glaciated and non-glaciated subwatersheds draining into Eklutna Lake. Streamflow data from the non-glaciated river are intended to provide insight into what the runoff characteristics of the glacially fed river may be in the future as the percentage of glacier cover in the basin diminishes. Using records of municipal water withdrawal from the lake, and projected water use demand, we have considered the future water budget across a variety of scenarios of diminished glacial ice volume.

The effect on glacier wastage on streamflow

Hock, Regine
Geophysical Institute, University of Alaska

Glaciers significantly modify streamflow both in quantity and timing, even with low percentages of catchment ice cover. Glaciers cover roughly 90,000 km2 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. In the context of evaluating plans for the Susitna dam it is crucial to quantify and project the effects of continued glacier wastage on river runoff. 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.

Session 7: Poster Session

Biosorption of Cd (II) from single and binary metal solutions using protonated citrus peels in a fixed bed column reactor

Chatterjee, Abhijit
University of Alaska, Fairbanks
Coauthors: Silke Schiewer

Biosorption is a low cost technique that employs dead biomass (microorganism, agricultural residue) to adsorb pollutant (heavy metals, dyes) from water. In comparison with conventional metal removing process, such as chemical precipitation, membrane filtration and ion exchange, biosorption is economical if a waste product is used as the sorbent and is particularly efficient as a polishing step, that is, to produce high quality effluent from a dilute feed whose bulk of the metal has been removed by other process. Being the largest producer of zinc-lead in USA, mining is one of the main industries in Alaska. Biosorption may potentially be used for onsite treatment of mining effluent to prevent its contamination with surface water and subsequent harmful effect on aquatic organism and also on human beings due to accumulation of toxic metal in food chain. In the present study, biosorption of cadmium by protonated citrus peels was investigated in a fixed bed column reactor. The column was made of clear extruded polyacrylic with a length of 30 cm and a diameter of ¾ inch. Each of three main parameters (flow rate: 2-15 ml/min, feed: 5-15 mg/L, bed height: 24-72 cm) was varied within a practical range keeping others constant and breakthrough curve (effluent concentration versus time profile up to saturation of the bed) was determined for each set of condition. Experimental data was modeled mathematically. Reusability of protonated peels was studied using a desorption agent (0.1(N) nitric acid). An 8 % weight loss of peels was found after second cycle of desorption. Decrease in the maximum uptake capacity after first cycle was slightly more than 10% although uptake capacity before breakthrough remains almost unaltered.

Finally, the effect of presence of other competitive heavy metal cations (expected to be present in real mining effluent) was studied. Continuous biosorption experiments were repeated using binary metal mixture containing Cd/Pb, Cd/Zn, and Pb/Zn. Cd and Zn break through the column faster than Pb. An overshoot in the exit concentration of Zn and Cd was also observed in the presence of Pb. Using 0.1(N) nitric acid, almost 100% desorption efficiency can be achieved in all cases.

Changes in water isotopes from Lake Selby in the southwestern Brooks Range during the last 14,000 years of climate change.

Gagliotí, Ben
University of Alaska, Fairbanks
Coauthors: "Matthew J. Wooller, Ken D. Tape - University of Alaska, Fairbanks; Adrienne K. Wilbur - Carelton College; Jeff T. Rasic - National Park Service

Moisture is a critical component of arctic climate change, influencing ecosystem structure, disturbance regimes and the geomorphology of the landscape. Forecasting precipitation changes due to anthropogenic warming could benefit from historical perspectives that indicate the scope of natural variation. Lake sediments are archives of past environmental conditions and can be cored to provide a stratigraphic timeline that can span thousands of years. Several environmental proxies can be analyzed from lake sediments, including oxygen isotopes (δ18O) of aquatic invertebrate fossils, which can be used to reconstruct the past isotopic composition of lake water and subsequently the isotopic composition of past precipitation. Chironomids (Diptera) are non- biting midges whose larval head capsules are well preserved and common in arctic lake sediments. Oxygen isotopes in lakes and precipitation vary over geographic climate gradients today, which can be used to infer climate change over time in lake cores. We present environmental proxy results from a radiocarbon-dated lake sediment core from Lake Selby, Alaska in the Gates of the Arctic National Park. We analyzed the δ18O values of the modern water in Lake Selby from spring and fall and it is consistent with estimates of the local precipitation. Our sediment record spans the past 14,000 (calibrated 14C) years of climate change, indicating significant variation in lake water isotopes over time. Notable is a dynamic δ18O record at the end of the Pleistocene (13-10,000 years ago) and a climate-change oscillation that may be associated with the Younger Dryas (~13,500 years ago). Most recently, δ18O values have become significantly higher. Our record from Lake Selby indicates that this region of Alaska has experienced significant moisture changes over the last 14,000 years.

Tanana Valley Adopt A Stream Program: Managing our Watershed One Volunteer at a Time

Everett, Christy
Tanana Valley Watershed Association
Coauthors: Fairbanks Stormwater Advisory Committee, Fairbanks Soil & Water Conservation District

Since 2007, the Tanana Valley Watershed Association (TVWA) and Fairbanks Storm Water Advisory Committee (FSWAC) have worked collaboratively to develop and implement an Adopt-A-Stream (AAS) program in the middle Tanana Valley watershed. The AAS program is a community-based program with an array of volunteer monitoring and restoration activities that provide residents and local businesses and organizations with the opportunity to become active stewards of the watershed. Volunteers can sign up to help remove litter and other debris, monitor water quality, and/or improve stream bank vegetation along any reach of stream they select.

Training and sampling kits containing all necessary materials and supplies are furnished each spring to volunteers who choose to monitor water quality. These volunteers are committed to sample at a particular location throughout the open water season, beginning at spring breakup. The goal is to acquire some baseline data to monitor and improve the overall water quality in the watershed, as well as raise public and agency awareness of water quality issues.

Individuals or groups can also pledge to clean up a designated section of stream, at least twice a year, to provide members of the community a sense of ownership in local water quality issues. An AAS sign listing their name is posted in a visible location to acknowledge their contribution. In addition, the FSWAC sponsors a large clean-up event every year along Noyes Slough and the downtown stretch of the Chena River; and TVWA has participated in all of them, as well as sponsoring events on additional streams such as Chena Slough.

The TVWA was organized in 2006 by members of several community restoration groups, notably the Noyes Slough Action Committee and the Chena Slough Restoration Committee. The TVWA's mission is to promote and improve the health of the Tanana Valley Watershed through education, restoration, collaborative research and diverse community involvement. Partners other than FSWAC include the Fairbanks Soil and Water Conservation District, U.S. Fish & Wildlife Service, and Alaska Department of Environmental Conservation. The TVWA has been involved in several efforts to learn more about our streams, educate the public about issues regarding them, and restore flow and habitat where it has been degraded.

The FSWAC is comprised of agency representatives from the Fairbanks North Star Borough, City of Fairbanks, City of North Pole, University of Alaska Fairbanks, and Alaska Department of Transportation & Public Facilities and two representatives from the general public. These agencies work together to develop a collaborative and comprehensive storm water management program in the Fairbanks area, which includes year-round efforts for public education and outreach and public involvement/participation. These efforts integrate well with the goals of TVWA, leading to a synergistic relationship between the groups.

Arctic Snow Distribution Patterns at the Watershed Scale

Homan, Joel
University of Alaska, Fairbanks
Coauthors: Douglas L. Kane - International Arctic Research Center, University of Alaska, Fairbanks; Matthew Sturm -U.S. Army Cold Regions Research and Engineering Laboratory, Ft. Wainwright, Alaska

Watershed scale hydrologic models require good estimates of the spatially distributed snowpack. 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 generally perform inadequately when used to predict the snowpack distribution at winters end.

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 differences that may vary as a whole, but not relative to each other, from year to year.

This study intends 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 in three ways: (1) numerous field survey points from end of winter field campaigns, (2) through the relationship between the snow and more easily established replacement patterns like topography, and (3) by using remote sensing to produce binary images of snow coverd areas (SCA) and snow free (SF) areas during ablation. The integration of all three 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.

Integrating remote sensing, field studies, and traditional knowledge to assess hazardous river conditions

Jones, Chas
International Arctic Research Center, University of Alaska, Fairbanks
Coauthors: Larry Hinzman, Knut Kielland - University of Alaska, Fairbanks

This research relies upon scientific collaborations and traditional knowledge to gain a comprehensive understanding of hazardous river conditions facing subsistence users in rural Alaskan communities. River conditions are projected to become increasingly variable in interior Alaska and increased variability in river conditions (e.g. timing of break-up and freeze-up, flood magnitude and frequency, ice conditions) may have adverse impacts on many rural Alaskan residents. The winter of 2010-2011 was our first winter for data collection and this poster describes our research methods and presents some preliminary results. Our field measurements include vertical temperature profiles, water surface elevations, and daily time-lapsed photography. Our research combines remote sensing, field studies, and traditional knowledge to examine the seasonal influence of groundwater on the conditions of river ice on the Tanana River in Alaska.

Seasonality in water, carbon, and nitrogen fluxes from an upland boreal catchment underlain by continuous permafrost

Koch, Josh
Hydrologist, USGS
Coauthors: Rob Striegl, Rob Runkel - USGS; Stephanie Ewing - Montana State University; Diane McKnight - University of Colorado

The balance between runoff and catchment residence time is critical to the biogeochemical processing of carbon (C) and nitrogen (N) in boreal ecosystems. Whether C is mineralized in soils or flushed from catchments depends on hydrologic fluxes and has implications for ecosystem productivity and climate change feedbacks. By measuring water fluxes and organic matter concentrations, we hope to elucidate the hydrologic and biogeochemical processes controlling C and N fate and transport in an upland boreal catchment underlain by permafrost.

To understand the seasonal dynamics of water, C, and N fluxes, we monitored soil moisture, water chemistry, stream and subsurface flow, and conducted five conservative tracer additions in an upland catchment in the Yukon River Basin, Alaska. Tracer was added to a 1st – order stream draining the north-facing hillslope during varying flow regimes in the summers of 2008 and 2009. Synoptic sampling and transient storage modeling results were used to explore the dynamics between hydrologic flux, and organic matter biogeochemistry in the soils and streams of this watershed. Silty hillslope soils were typically unsaturated, indicating that flow occurs predominantly through shallow, organic soils. Seasonal increases in runoff coefficients and major ion concentrations indicate greater contact with mineral soils later in the season, providing evidence that there is some flow through thawing preferential flowpaths (ie. soil pipes and/or thermokarst features) in the silt. Stream dissolved organic carbon (DOC) and nitrate concentrations were proportional to discharge at all but the lowest flows, indicating that precipitation leaches material from organic soils and transports it from the catchment. Stream DOC and nitrate concentrations were lower than expected given in-stream transport and inflows, suggesting that biogeochemical reactions were occurring. These reactions were modeled as first order decay of DOC and nitrate concentrations, and decreased seasonally, despite the fact that DOC became more labile. We believe that this indicates decreased reaction potential in the deeper subsurface flowpaths that develop later in the season, precluding water/organic soil contact.

Our results highlight the importance of small surface streams and preferential flowpaths to water, C, and N export in the frozen silt uplands of interior Alaska, and identify a seasonal trend that controls stream C and N loads. Such hydrologic data is critical to our understanding of C fate and transport and provides important insight relevant to predicting boreal ecosystem changes that will likely occur as the arctic becomes warmer and wetter.

Balancing Preservation & Development of Aquatic Resources

McBride, Heather
Regulatory Specialist, US Army Corps of Engineers Regulatory Division

The Corps of Engineers Regulatory Program regulates the placement of dredge and fill material into waters of the United States (U.S.) through permits issued under Section 404 of the Clean Water Act. Waters of the U.S. include rivers, streams, lakes, marine waters, and special aquatic sites including wetlands. Wetlands and other waters provide important functions and ecosystem services such as habitat for fish and wildlife, flood water storage, biogeochemical processes such as organic carbon export and nutrient cycling, and they add aesthetic value to the landscape. Wetlands filter storm water runoff, remove contaminants, reduce downstream particulate loading and peak discharge, contribute to groundwater recharge, maintain base flows and downstream water quality, and support aquatic food webs . Heavy development during the 20th century has caused irreversible damage to many of these waters across the country. Since 2008, the Corps of Engineers has adopted a watershed approach when reviewing impacts associated with dredge and fill permits; working to avoid and minimize impacts to watersheds to ensure they maintain their functions. Impervious surfaces, such as concrete, asphalt, rooftops, or severely compacted soil, impede the infiltration of water into soil. These surfaces can decrease groundwater recharge leading to increased storm water runoff, flooding, and nonpoint source pollution. Additionally, developed areas provide less vegetated buffers to filter out pollutants and sediments which can impact the health of the stream, and the aquatic life that depends on it. Streams become noticeably impaired when approximately 10% of land within the water shed is covered by impervious surfaces. As this percentage rises closer to 25%, there is severe ecosystem and water quality impairment. Some watersheds in Alaska have reached this threshold, and others are approaching it. The best time to reduce our cumulative impacts on the watershed is during the planning phases prior to construction. Increasing the amount of open natural spaces, directing storm water into vegetated filters or manmade detention basins, using alternative materials which allow drainage, and considering the use of green bank parking areas for overflow, as opposed to paving, are all ways to maintain infiltration and reduce impacts to the watershed.

Mitigating impacts to aquatic resources is a requirement of all permits issued by the Corps of Engineers. Mitigation is a sequential process: First, avoid impacts if possible, second, minimize necessary impacts, and third, compensate for the unavoidable impacts. The goal of compensatory mitigation is to replace the lost aquatic resource functions. Compensatory mitigation may be accomplished through purchase of credits at mitigation banks or in lieu fee programs, or permittee responsible mitigation projects. Compensatory mitigation may include restoring, enhancing, establishing, or preserving aquatic resources. The goal of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of our nation's waters. The Corps of Engineers works to achieve this mission while allowing reasonable development. Restoration, enhancement, establishment, and preservation of aquatic resources help meet this goal, and prevent us from having to develop manmade solutions to replicate their functions.

Hydrologic & Hydraulic Modeling and Flood Hazard Mapping Tools in Support of FEMA's National Flood Insurance Program (NFIP)

McBroom, Mark
Michael Baker Jr, Inc.

Currently 33 Alaska cities and boroughs participate in FEMA's National Flood Insurance Program (NFIP). As part of FEMA's map modernization initiative a whole suite of computer based tools are currently being used to assist in flood hazard mapping and floodplain management in participating communities nationwide. Nearly all industry accepted hydrologic and hydraulic modeling tools interface with ArcGIS providing a universal platform for data integration, analysis, mapping, and sharing. Baker has developed and currently implements RiverSystems, a tool which greatly increases the efficiency and accuracy of data management, terrain development, hydrologic and hydraulic modeling, and flood inundation mapping. These tools go far beyond the NFIP map modernization initiative, providing advanced methods for a wide range of water resource related studies.

Profusions of Evaporation Pan Observations on the Alaskan North Slope

Mumm, John
Research Assistant, University of Alaska, Fairbanks
Coauthors: Doug Kane, Water & Environmental Research Center, University of Alaska, Fairbanks

Evapotranspiration (ET) plays a significant role in the hydrologic cycle of all basins, yet is only occasionally measured in the Arctic. One simple index method to evaluate ET is the evaporation pan. The energy environment surrounding the simple evaporation pan varies considerably from that of the natural environment. Yet, an evaporation pan is a sound way to estimate the potential ET and also determine an ET pan coefficient (assuming there is also a complementary estimate of actual ET). The few existing ET estimates in the Arctic are based on water balance, energy balance and methods like the Priestley-Taylor method that require less input data.

An Evaporation pan was initially installed in 1986 on the North Slope of Alaska with the intention of collecting data for only 3 years; but in reality, pan evaporation data has been collected for 22 years. The summer maximum, average, minimum and standard deviation of pan evaporation are 420 mm, 324 mm, 280 mm and 40 mm, respectively from 1986 to 2008 (1989 missing). Both the seasonal water balance and the Priestley-Taylor method of the 2.2 km2 Imnavait Creek catchment were used to produce seasonal estimates of actual ET. When used in conjunction with the pan evaporation measurements, a pan coefficient of 0.57 was found in both cases; typically the pan coefficient in temperate regions is 0.5. The pan evaporation results can also be correlated with other measured variables (such as air temperature, wind direction and speed, summer precipitation, Net Radiation, Shortwave Radiation, etc.). For example, we see a very strong correlation (r2 > 0.94 for each of the 22 summer seasons) between pan evaporation amount and thawing degree days (TDD). A Best-fit equation for TDD is used to estimate potential ET through measurements of TDD, and tested against past summer estimates of Pan Evaporation. This should not be too surprising as TDD is an indicator of the thermal regime side of the equation, but it does not account for the amount and timing of summer precipitation that has ranged from a seasonal low of 53 mm to a high of 342 mm at this site.

Influences on the current planform of the braided Toklat River, Alaska

Podolak, Chuck
USGS

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 the challenges of protecting infrastructure in the vicinity of a dynamic braided river. 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 USGS. The preliminary analysis of a large airborne LiDAR dataset conducted using MATLAB, Quick Terrain Modeler, and ArcGIS revealed several patterns to the planform of the Toklat River. 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. Relative discharge was estimated from two basins using a USGS-developed empirical method. The estimated discharges along with confluence geometry constrain likely planform patterns downstream of a significant tributary junction. Research continues on the magnitude of the anthropogenic influences of bridge building, bank hardening, and gravel extraction on the river planform.

Eagle River, Alaska

Using Hydrology Equations to Estimate a Water Budget and Examine Data Gaps, Eyak Lake, AK

Rothwell, Eric
Hydrologist, NOAA
Coauthors: Allison Bidlak - Ecotrust

Eyak Lake is a valuable natural ecosystem adjacent to the vast Copper River Delta in south-central Alaska. The lake is habitat for salmon and resident fish, including coho, pink, and sockeye salmon, cutthroat trout, Dolly Varden, stickleback, eulachon, and sculpin. The fishing town of Cordova is situated on the shore, and much of the town's float plane traffic uses the lake, while Eyak River supports both sport and subsistence fisheries. The lake and river are used recreationally by residents all year, and many homes are situated within their floodplains. Because of the lake's diverse wildlife, scenic beauty, and economic value, in 1981 Eyak Lake was recommended for designation as an "Area Meriting Special Attention" by the Alaska Coastal Policy Council; this designation was approved in 1986. Eyak Lake has undergone many changes since the founding of Cordova in the late 1800s. Odiak Slough, which probably served as a secondary drainage (after Eyak River) during times of high water, was filled in during the early part of the 20th century. Road building and commercial and residential development has occurred along two sides of the lake, increasing sediment run-off and disrupting fish access to streams as a result of poor culvert installation. A weir at the mouth of the lake was constructed after the 1964 Good Friday earthquake to stabilize the water level, and while salmon and other species of fish still have access to the lake over this weir, it is unclear how it has impacted the natural functioning of the lake and its future as fish and wildlife habitat.

An understanding of the habitat and physical processes occurring in the Eyak Lake watershed are necessary to guide restoration and preservation work, particularly in regards to the maintenance of fish habitat, the transportation and dilution of pollutants, and flood control. Little hydrologic data has been collected in the basin, and in this context we attempt to model a surface water budget for the lake by using hydrology models and available flow, weather, and spatial data. The Eyak Lake tributary monthly mean flows are modeled using an inverse distance weighted method and statistical equations developed by the US Forest Service (R10 FlowMod); both methods are compared to the few local stream flow records available. The inverse distance weighted method uses the few local gages and scales them based on distance from the stream of interest and by drainage area. The R10 FlowMod statistical equations were developed relating basin characteristics and stream flow, and the equations for the Cordova area relate drainage area and basin relief. In addition to tributary inflow, we estimate evaporation, incidental precipitation, and Eyak Lake outflow using National Weather Service weather stations and Alaska-Pacific River Forecast Center data.

The results from this project provide a rough baseline of the hydrologic conditions of Eyak Lake, identify data gaps, help prioritize issues, and will guide data collection and restoration efforts.

Monitoring Turbidity in Goldstream Creek, Alaska for TMDL Development

Stevens, Catlin
Department of Mining and Geological Engineering, University of Alaska, Fairbanks
Coauthors: Margaret Yngve, Debasmita Misra - University of Alaska, Fairbanks;
Brock Tabor - AK Dept of Env. Conservation

Goldstream Creek was listed on the State of Alaska Section 303(d) list as impaired for turbidity in 1992. Subsequent study has determined that potential sources of turbidity in Goldstream Creek to be both point sources (active placer mining), non-point sources (runoff from abandoned and active mine sites), stream bank erosion, and re-suspension of deposited sediment. No water quality monitoring data has been collected since an initial Water Quality Assessment report in 1994. In the absence of data, it is difficult to ascertain whether the waterbody is currently meeting its designated use and state water quality standards. In July of 2010 The University of Alaska Fairbanks in partnership with the Department of Environmental Conservation embarked upon an intensive data collection process. Two sites (one upstream, one mid-stream) are being monitored for turbidity, pH, dissolved oxygen, conductivity, temperature, discharge and climatic data using continuous dataloggers. Grab samples and samples obtained using ISCO samplers are also being collected to validate the data obtained from automatic samplers and background conditions. Data obtained indicate that the total suspended solids (TSS) have no direct correlation with change in temperature and conductivity. However, a positive correlation was observed between water depth and TSS. It was also observed that the turbidity responds well to the precipitation events at the upstream site while the downstream site shows no direct effect from any such event. The data and results will be presented and assessed for the necessity of developing a total maximum daily load (TMDL) for the waterbody

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

Stuefer, Sveta
Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Joel Bailey - Water & Environmental Research Center, University of Alaska, Fairbanks

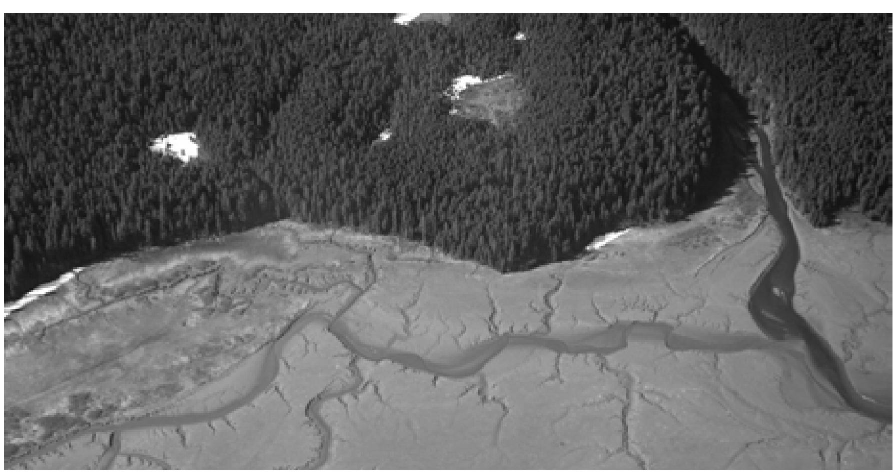
Arctic lakes are often the main fresh water source for humans and industries in polar regions. The hydrological regime of these lakes is characterized by a large spring snowmelt providing much of the recharge, followed by a subsequent drying of the lake in summer, when evaporation generally exceeds precipitation. This study evaluates the use of snow management and snow fences to augment lake water supplies in northern Alaska. Two lakes with similar water balances were selected and monitored in 2009. Afterwards, a snow fence was installed in the watershed of the experimental lake, while the second lake served as a control lake. Snow drift in the watershed of the experimental lake significantly affected its water balance in summer 2010. The effects of snow drift on lake water balance are discussed in terms of (i) "new" water available due to reduced sublimation losses from blowing snow; (ii) duration of snowmelt runoff from the snow fence's drift, and (iii) lake-volume net increase. These characteristics are examined using a full suite of field observations, modeling of snow transport by wind, and water balance assessment.

Simulations of discharges at Arctic Alaskan runoff basins using minimal input data sets

Youcha, Emily
Hydrology Research Staff, University of Alaska, Fairbanks
Coauthors: Douglas Kane, Horacio Toniolo - Water & Environmental Research Center,
University of Alaska, Fairbanks

Currently, the majority of baseline hydrological information on the North Slope of Alaska comes from the Kuparuk River Basin, a treeless region underlain by continuous permafrost and covered in snow for 7 to 9 months each year. Peak hydrological activity in headwater or foothills streams is characterized by two main events, the annual snowmelt producing 30 to 40% of the total discharge and flashy summer flooding events where high discharges may also be observed. In the low gradient Coastal Plain area, snowmelt is the only significant runoff event of the year.

Development of roads in this region for future oil and gas infrastructure is a good possibility. Feasibility studies are underway for a road from Galbraith to Umiat, crossing three major rivers and several smaller tributaries. Limited field data is available in this region and current flood frequency equations commonly used for design are only based on basin area and may not adequately predict peak discharge in this region. We are using the Swedish HBV model (SMHI, 2009) to predict discharge on various Arctic Alaskan streams with limited input datasets. The USGS and UAF have collected air temperature, precipitation, and discharge in the Upper Kuparuk, Kuparuk, and Putuligayuk river basins for over a decade. We develop HBV model parameter sets for theses rivers and apply them to several nearby basins (Sagavanirktok, Shaviovik, Kadleroshilik, No Name River [Unnamed Creek], and the Anaktuvuk) where we have been collecting air temperature and precipitation throughout the region. Results are promising, particularly for the higher gradient foothills rivers, where peak discharge for both snowmelt and summer is predicted relatively well for 2009 and 2010.



Turnagain Arm, Cook Inlet, Alaska

Session 8: Alaskan Hydropower - Opportunities Large & Small

Susitna Hydroelectric: Past, Present, and Future

Beebee, Robin
Hydrologist, HDR Engineering
Coauthor: Jim Gill, Cardno-Entrix

The Susitna River drains the southern Alaska Range, traverses a broad lowland, then cuts into a series of canyon reaches which have long interested hydroelectric prospectors. The Corps of Engineers originally identified at least 4 viable dam sites in the canyon reach. The largest push for Susitna Hydroelectric came in the early 1980s, when the State of Alaska completed feasibility, design, and extensive environmental studies for a multi-dam project. The project was cancelled in 1986 for economic reasons.

Between 2008 and 2010, the State of Alaska began to focus on planning energy alternatives to oil, coal, and natural gas, identifying a goal of 50% renewable energy by the year 2025. The Regional Integrated Resource Plan (2010) concluded that one or more large hydroelectric projects would be needed to provide this much renewable energy. In late 2010, the state released a Preliminary Decisional Document identifying the Susitna River as the most viable large hydroelectric source for the Railbelt.

The current proposal is a single, 700-ft high dam at Watana Canyon on the Susitna River, 90 miles upstream from Talkeetna and 184 miles upstream from Cook Inlet. The dam would impound a 39-mile long lake. Flow from about 20% of the Susitna watershed would be regulated. The reaches of river most affected by flow regulation would be the impounded reach upstream of the dam, and the reach between the dam and Talkeetna. At Talkeetna, major tributaries more than double the flow and sediment load of the river. At the Yentna River confluence downstream, flow is again doubled.

The Susitna River has a typical snowmelt and glacial melt hydrograph, with low flows and ice cover in the winter, a snowmelt peak in late May and June, and sustained glacial melt flows throughout the summer. A second peak often occurs during late summer rainstorms. Proposed operation plans from the 1980's would have retained the general shape of the hydrograph, but increased winter flow and decreased summer peak flow. The environmental flow requirements for the current project have not been identified, although some increase in winter flow and some attenuation of flood peaks are almost certain.

The Susitna watershed is a highly productive salmon fishery, hosting all five species of Pacific salmon in the main river and tributaries, thus environmental flow requirements will be driven by the need to maintain or improve fish habitat. Rapids in Devil Canyon create a velocity barrier for most fish migrating upstream toward the proposed dam site, although a handful of Chinook have been observed in Devil Canyon tributaries, and some juveniles have been observed in Watana Canyon. Side channels and side sloughs were identified as the most productive mainstem fish habitat in previous studies, thus maintaining channel morphology and access to side sloughs in the reach between Talkeetna and Devil Canyon will likely be key considerations in selecting environmental flows. In addition to main channel flow, groundwater, sediment transport, and ice all contribute to the development and maintenance of fish habitat in this reach.

Although the formal study process has not begun, the Alaska Energy Authority (AEA) is conducting several preliminary studies. The current engineering effort includes furthering alternate dam designs, especially roller-compacted concrete, a relatively new concept in tall embankment-type dams. Existing wildlife and aquatic data in the watershed are being reviewed in order to identify further study needs. The USGS has begun a streamflow synthesis study to fill in missing streamflow records for 8-14 gage sites in the Susitna watershed, and AEA has teamed with the Matanuska-Susitna Borough to obtain aerial imagery and LiDAR topography in spring of 2011.

A comprehensive approach to estimate hydrokinetic resources on the Tanana river at Nenana, Alaska

Toniolo, Horacio
Professor, Water & Environmental Research Center, University of Alaska, Fairbanks
Coauthors: Jack Schmid, Rowland Powers, Paul Duvoy, and Jerry Johnson - University of Alaska, Fairbanks

We present a comprehensive approach to explore the river conditions for installing hydrokinetic devices. The methodology includes: a) extensive field measurements, b) numerical modeling, and c) turbulence analysis. Field work efforts encompass bathymetric surveys, velocity measurements, and sediment sampling. Modeling involves a 2D-dimensional hydrodynamic model, which describes specific discharge and velocity distributions. Power density is also calculated. Turbulence analysis provides insights on river stability. We report results of activities conducted on the Tanana river, near Nenana during 2009 and 2010.

Establishing Hydroelectric Networks for Assessing Small Stream and River Hydropower Potential, Cosmos Hills, Alaska

Brailey, Dave

Coauthors: Michael Lilly, Jeffrey Derry, Austin McHugh, Jeff Murray - Geo-Watersheds Scientific

Rural villages in Alaska face high energy costs, which are likely to continue to increase in the future. These higher energy costs make small-scale hydropower development more of a potential solution for energy providers. A hydrologic network was setup in the Cosmos Hills region in 2010 to collect the next phase of hydropower-evaluation information need for design and permitting. Cosmos Creek, Wesley Creek and Dahl Creek are high gradient streams that flow out of the Cosmos Hills and drain into the Kobuk River. Surface-water gaging stations were established in each stream to begin the development of rating curves and improve the understanding of early winter flow conditions that may be critical to electrical generation demand cycles. Additionally, a station was installed on the Kokoluktuk River to evaluate its hydropower potential and hydrologic conditions. A combination of stream discharge measurements, insitu sensors and remote cameras have been used to both record basic hydrologic properties and winter flow conditions important for the planned evaluations.

Session 9: Alaskan Hydropower - Optimizing Under Uncertainty

Understanding the impacts of changing hydro-climate extremes to hydropower resources in SE Alaska

Bennett, Katrina

University of Alaska, Fairbanks

Coauthors: Jessica Cherry, John Walsh - International Arctic Research Center, University of Alaska, Fairbanks

Understanding hydrologic extremes and their associated impacts is a major challenge owing to the difficulty in predicting the interactions between synoptic events and the complex physiographic domain of Alaska's watersheds. Damaging flood events, or alternatively, low flows can impact industrial infrastructures and change hydro-electric demands and requirements. These changes may be better managed through the application of a hydrologic modeling tool for informed water resource planning.

One of the major challenges facing hydrologic modeling in Alaska is the lack of good quality, long term data records on which to calibrate and validate models. The objective of this work is to develop collaboration with researchers at the University Alaska Southeast campus, the National Weather Service and the Alaska River Forecasting Center and run a hydrologic forecasting model that incorporates improved estimates of variable and extreme events that can lead to either floods or low flows in Alaskan watersheds. The first stage in this work is selection of a hydrologic model for simulation of major processes at work on the landscape (i.e. permafrost, glaciers, and runoff) that performs with limited observational data at a variety of scales. The next step is to incorporate available observational data (e.g. USGS stream gaging), supplemented with assimilated products (such as satellite imagery and isotope records) for improved parameterization of uncertain and/or poorly monitored aspects of the climate and hydrologic regime (namely, snow cover extent, snow melt and glacier contributions to streamflow). Analysis of improved modeling and parameterization will determine the success of the approach to enhance hindcasting and forecasting ability in Alaskan watersheds.

An improved hydrologic model for Alaskan watersheds will be useful for a number of applications. In particular, the model may be used in conjunction with weather model output for synoptic typing of hydrologic responses. This typing can be applied to watersheds located in regions that are affected differently by synoptic events through variable responses to dominant hydro-climate processes and variable effects of topography and distance from the coast. Watersheds proposed for this work are the basins feeding SE Alaskan hydropower facilities in Juneau and Sitka.

Impacts of Climate Change and Variability on Hydropower Systems: results from Southeast Alaska and Scandinavia providing lessons for Susitna

Cherry, Jessica
International Arctic Research Center, University of Alaska, Fairbanks
Coauthors: Susan Walker - NOAA; Nancy Fresno - University of Alaska, Fairbanks

While Southeast Alaska and Norway share similar climates and fjord geography, the management of their hydropower infrastructure could not be more different. This presentation describes how differences in resource monitoring, grid interconnectedness, ownership, and risk management impact the resilience of each system to variability and long-term changes in climate. The results from the author's studies in Southeast Alaska and Scandinavia are discussed in light of the proposed development of the Susitna hydropower project.

Optimization of Bradley Lake Hydropower using Lake Elevation Rule Curve Modeling

Parvin, Edmund
Hydrologist, USGS; University of Alaska, Anchorage

Bradley Lake Hydropower Facility does not currently operate under any controlled system to optimize power production. This study simulated power production during a six year period from 2003 to 2009, to determine an optimal rule curve based operational system to increase power production. Numerous lake elevation rule curves were tested as operational constraints to determine maximum power production and determine the role of seasonal operational shutdowns have on overall power production. Moving Bradley Lake from a need based power generation facility to rule curve based power generation will lead to 3-4% increase in power generation. Instead of using hydro power secondary and complimentary to natural gas generation, Bradley Lake, a renewable resource, would be only run if predetermined rule curve lake elevations are met.

Selecting appropriate techniques for evaluating effects of hydroelectric project development and operation on aquatic resources

Reiser, Dudley
President, Senior Fisheries Scientist - R2 Resource Consultants
Coauthors: Stuart Beck, MaryLouise Keeft - R2 Resource Consultants

Hydroelectric projects can range widely in their size, design, operational characteristics and environmental settings, and as a result, their potential impacts on aquatic resources, including habitat related flow effects, will likewise vary. These can include changes in the timing, frequency, magnitude and duration of flows that can affect the quantity and quality of habitats, off-channel habitat connectivity, channel morphology and sediment transport capacity, and riparian habitat structure. Careful identification of these flow effects early on in project licensing/relicensing is key to selecting appropriate assessment methodologies. This paper describes four case studies that serve to illustrate a range of flow related resource issues that can accompany hydroelectric projects and describes various methods used to address such issues. The studies include two small scale projects in Alaska (Whitman Lake and Connell Lake) and two larger scale projects, one in Washington (Baker River Hydroelectric Project) and one in Oregon (Clackamas River Project). Flow related issues included anadromous fish passage at falls and cascades, flow fluctuation effects, side channel connectivity, provision of mainstem habitats, and issues associated with fluvial geomorphology and sediment transport. This paper provides guidance in the selection of appropriate methods for addressing these types of effects. In all cases, although the methods used may vary by flow related issue, the most appropriate methods are those that allow for the synthesis and integration of results within an operations model framework that enables comparative assessments between flow related impacts and different operational scenarios.

Session 10: Flooding, Foreign Invaders, and Future Research

Hydrologic controls on the recruitment of riparian plants and the maintenance of flood plain wildlife habitat

Mouw, Jason

Wildlife Biologist, Alaska Department of Fish & Game, Sport Fish/Research & Technical Services Section

Woody plant recruitment patterns, age data and community successional dynamics were surveyed on laterally expansive flood plains of the middle Susitna River Basin and one tributary of the lower Kuskokwim Basin to assess interactions between flooding, plant reproduction, and riparian habitat formation processes. Plant age and compositional surveys were used to assess patterns of propagule (e.g. seed, root, shoot and branch fragments) deposition to show that dispersal strategies of species were an important factor influencing recruitment patterns. The ages of species and the spatial extent and composition of the cohorts they formed, were used to demonstrate the importance of flooding to reproduction and assess the flood history of each of the flood plains surveyed. Historic hydrologic records were analyzed to identify relationships between plant recruitment and flooding to evaluate the characteristics of flooding processes that control riparian habitat formation. These relationships are applied in the context of riparian wildlife habitat needs for species utilizing flood plains for all or portions of their life history. Implications for the development of water resources in river systems are also discussed.

Floodplain Mapping on a Braided Northern River, Alaska Considering Debris, Ice and Groundwater

Beebee, Robin

Hydrologist, HDR Engineering

Coauthors: Mark Forest, Brian Doeing, Mark Collins - HDR Engineering

HDR is preparing a CLOMR on behalf of the Alaska Railroad Corporation (ARRC) as part of a proposed new bridge and levee construction on the Tanana River near Salcha, Alaska. The proposed 3300-foot long rail bridge would be the longest in Alaska.

The project is in an NFIP community with recurring flood damages. The geometry of the river and side channels , heavy debris load of the river, rapidly eroding banks, frequent ice jams, and high hydraulic conductivity of the alluvial material in the floodplain all contribute to a complex modeling, mapping, and engineering analysis.

River Geometry: The Tanana River at Salcha consists of a 4,000 foot wide active braidplain and a several-mile wide forested floodplain cut by slough channels. Overbank flow also becomes divided flow for long distances before rejoining the main channel. Sloughs convey groundwater (or hyporheic flow) during low water and overbank floodwaters during high flow events. The longest of these sloughs, Piledriver Slough, branches off from the main Tanana in the study reach and continues flowing down the right overbank for 20 miles. The original highway and development in the area is concentrated around Piledriver Slough, thus, when Piledriver Slough floods, flooding of roads and residential structures occurs. In order to quantify flow entering Piledriver Slough from various points on the riverbank, an unsteady split flow model was developed in HEC-RAS with a series of lateral structures.

Debris: The Tanana River is flanked by heavily forested floodplains for several hundred miles upstream of the project area. Trees are recruited into the braidplain by constant bank undercutting and migration. Bridge piers on the Tanana River regularly accumulate large logs, which have the potential to increase pier scour and water surface elevations. Because the proposed bridge would have 19 piers in the active braidplain, the potential for debris accumulation on piers was considered in setting the height of the levee upstream of the bridge.

Ice Jams: The Tanana River freezes every winter. Although spring snowmelt discharges are low compared to open-water floods, locally severe flooding has occurred when ice jams in subchannels near residential neighborhoods. Ice jams were also considered in setting the height of the levee.

Groundwater: The Tanana Basin underlying the river and floodplain is composed of permeable sand and gravel up to 600 feet deep. The proposed levee, a sand and gravel embankment, is designed to prevent overbank flow from entering Piledriver Slough, but it would not prevent hyporheic flow from seeping through the course alluvial material under the levee. A combined MODFLOW and the new feature in HEC-RAS that computes channel seepage using the MODFLOW results levee was developed to estimate post-project flooding from fluctuations in groundwater

Potential impacts of Elodea canadensis on freshwater ecosystems of Alaska

Larsen, Amy
Aquatic Ecologist, National Park Service
Coauthors: Tricia Wurtz, Nicholas Lisuzzo - USDA Forest Service

Late in 2010, we located a large population of Elodea canadensis, a non-native aquatic plant, growing in Chena Slough, a tributary to the Chena River. This species was recently described as a potential invasive species in Alaska by USFWS. Although systematic surveys could not be conducted before freeze-up, Elodea was found in several places in the Chena River. Surveys showed the plant was growing in large dense patches in Chena Slough and small populations inhabit the lower portion of Chena River. This is an aggressive species that has invaded much of Europe, Asia and New Zealand. The plant has several life history characteristics that allow it to spread rapidly: it easily breaks into reproductively viable fragments, can withstand short periods of desiccation, and can survive in ice. Once fragments contact the sediment fine roots develop. It has a high potential to invade many of Alaska's aquatic ecosystems because it thrives in cold, slow-flowing waters and non-flowing systems where light is not limited due to turbidity. Although the plant does not grow well in turbid or fast-flowing systems it can survive here until it is transported to more suitable habitats such as clear water sloughs, oxbows and wetlands connected to these systems. It is easily spread unintentionally by people, and could be spread to lakes and other habitats via boats and floatplanes. Elodea canadensis has had negative impacts on salmon spawning in northern California and likely impacts salmon rearing activities as well. Widespread invasion by this species in Alaska's freshwaters could have profound impacts on the water quality, flow regime, fish habitat and navigability.

Overview of Current Research Efforts and Interests at the UAF Water and Environmental Research Center

Schnabel, Bill
Director, Water and Environmental Research Center, University of Alaska, Fairbanks

The UAF Water and Environmental Research Center (WERC) has been serving Alaska's water resource research needs since 1963. Today, the center consists of approximately 50 faculty, staff, and students working collaboratively or independently on over 60 research projects per year. This presentation will highlight and summarize some of the major WERC research efforts undertaken in the past year, and provide a glimpse into future research directions.

Knik Glacier, Alaska

Registered Attendees (as of March 30th):

Arp, Chris	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-2783	cdarp@alaska.edu
Bailey, Joel	Institute of Northern Engineering, University of Alaska, Fairbanks	Fairbanks	(907) 474-6151	fnjpb@uaf.edu
Beebee, Robin	HDR Inc.	Anchorage	(907) 644-2000	robin.beebee@hdrinc.com
Bendlova, Tereza	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		tbendlova@alaska.edu
Bennett, Katrina	Water & Environmental Research Center, International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks		bennett.katrina@gmail.com
Bethe, Amber	Alaska Department of Fish & Game	Fairbanks	(907) 474-1939	amber.bethe@alaska.gov
Betts, Erica	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-2758	betts.erica@gmail.com
Bidlack, Allison	Ecotrust	Cordova		abidlack@ecotrust.org
Bolton, Bob	International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-6421	bbolton@iarc.uaf.edu
Brailey, David	Brailey Hydrologic Consultants	Anchorage		dbrailey@alaska.net
Brennan, Sean	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		srbrennan@alaska.edu
Burger, Paul	National Park Service	Anchorage		paul_burger@nps.gov
Burkart, Greta	International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-5813	gburkart@alaska.edu
Callaway, Sarah	MWH Global	Anchorage	(907) 248-8883	sarah.callaway@mwh-global.com
Campana, Michael	President, AWRA; & Oregon State University	Corvallis, OR	(541) 737-2413	aguadoc@live.com
Cappiello, Thomas	Sport Fish Division, Alaska Department of Fish & Game	Anchorage	(907)267-2395	thomas.cappiello@alaska.gov
Chatterjee, Abhijit	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		achatterjee@alaska.edu
Cherry, Jessica	Water & Environmental Research Center, International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-5730	jcherry@iarc.uaf.edu
Cox, Mike	Oasis Environmental	Livingston, MT	(406) 222-7600	m.cox@oasisenviro.com

Attendees (con't):

Curley, Carolyn	Division of Mining, Land and Water, Alaska Department of Natural Resources	Fairbanks	(907) 451-2790	carolyn.curley@alaska.gov
Curran, Janet	USGS	Anchorage	(907) 786-7128	jcurran@usgs.gov
Daigneault, Mike	Habitat Division, Alaska Department of Fish & Game	Anchorage	(907) 267-2172	michael.daigneault@alaska.gov
Deats, Ted	Division of Mining, Land and Water, Alaska Department of Natural Resources	Juneau	(907) 465-2533	ted.deats@alaska.gov
Everett, Kristine	Tanana Valley Watershed Association	Fairbanks		tvwatershed@gmail.com
Frohbieter, Derek	USGS	Fairbanks	(907) 479-5645	dfroh@usgs.gov
Gaglioti, Ben	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		bengaglioti@gmail.com
Hertrich, Daniel	Hatch Associates Consultants, Inc	Anchorage	(907) 229-2249	dhertrich@hatchusa.com
Homan, Joel	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		jwhoman@alaska.edu
Ireland, Roy	Alaska Department of Natural Resources	Anchorage	(907) 269-8639	roy.ireland@alaska.gov
Jones, Chas	International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-1963	chas.jones@iarc.uaf.edu
Kane, Doug	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-7808	dlkane@alaska.edu
Kaucic, Chuck	Alaska Rural Water Association	Wasilla	(907) 357-1155	chuck@arwa.org
Kikuchi, Colin	University of Arizona	Tucson, AZ	(602) 909-3960	ckikuchi@email.arizona.edu
Klein, Joe	Sport Fish Division, Alaska Department of Fish & Game	Anchorage	(907) 267-2148	joe.klein@alaska.gov
Koch, Josh	USGS	Boulder, CO	(303) 541-3074	kochjc@colorado.edu
Lamb, Erica	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		elamb3@alaska.edu
Larquier, Ann Marie	Alaska Pacific University	Anchorage		alarquier@alaskapacific.edu
Larsen, Amy	National Park Service	Fairbanks	(907) 455-0622	amy_larsen@nps.gov
Liljedahl, Anna	Water & Environmental Research Center, International Arctic Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-1951	akliljedahl@alaska.edu
Lilly, Michael	Geo-Watersheds Scientific	Fairbanks	907-479-8891	mlilly@gwscientific.com

Attendees (con't):

MacCay, Charlotte	Pebble Partnership	Anchorage	(907) 339-2608	charlottemaccay@pebblepartnership.com
Mahan, Wendy	Conoco Phillips	Palmer		wendy.mahan@conocophillips.com
McBride, Heather	US Army Corps of Engineers	Fairbanks		heather.e.mcbride@usace.army.mil
McBroom, Mark	Michael Baker Corporation			mmcbroom@mbakercorp.com
McCall, Erica	Ecotrust	Talkeetna		scouttiboron@yahoo.com
McGee, Chandra	Division of Water, Alaska Department of Environmental Conservation	Fairbanks	(907) 451-2140	chandra.mcgee@alaska.gov
McGee, Pete	Division of Water, Alaska Department of Environmental Conservation	Fairbanks	(907) 451-2141	william.mcgee@alaska.gov
McKinley, Lee	State Pipeline Coordinator's Office, Land and Water, Alaska Department of Natural Resources	Anchorage	(907269-6411	lee.mckinley@alaska.gov
Meyer, Dave	USGS	Anchorage	(907) 786-7141	dfmeyer@usgs.gov
Mouw, Jason	Sport Fish Division, Alaska Department of Fish & Game	Anchorage	(907) 267-2179	jason.mouw@alaska.gov
Mumm, John	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-5396	jpmumm@gmail.com
Munter, Jim	J.A. Munter Consulting	Anchorage	(907) 345-0165	jamunter@arctic.net
Nakanishi, Allan	Division of Water, Alaska Department of Environmental Conservation	Anchorage	(907) 269-4028	allan.nakanishi@alaska.gov
Nelson, Karen	US Army Corps of Engineers	Anchorage		Karen.L.Nelson@usace.army.mil
O'Brien, John	Oasis Environmental	Fairbanks	(907) 458-8272	j.obrien@oasisenviro.com
O'Neal, Sarah		Anchorage		sarahlouiseoneal@ak.net
Ourso, Bob	USGS	Anchorage	(907) 786-7148	rtourso@usgs.gov
Parvin, Ed	USGS	Anchorage	(907) 786-7152	eparvin@usgs.gov
Plett, Kristina	Division of Mining, Land and Water, Alaska Department of Natural Resources	Anchorage	(907) 269-8641	kristina.plett@alaska.gov
Podolak, Chuck	USGS	Anchorage	(907) 786-7175	cpodolak@usgs.gov
Prokosch, Gary	Division of Mining, Land and Water, Alaska Department of Natural Resources	Anchorage	(907) 269-8645	gary.prokosch@alaska.gov
Reiser, Dudley	President, Senior Fisheries Scientist, R2 Resources Consultants, Inc.	Redmond, WA	(425) 556-1288	dreiser@r2usa.com

Attendees (con't):

Rethamel, Ceila	WH Pacific	Anchorage	(907) 339-6500	crethamel@whpacific.com
Rice, Bill	US Fish & Wildlife Service	Anchorage	(907) 271-1798	William_Rice@fws.gov
Rothwell, Eric	Alaska Regional Office, NOAA	Anchorage	(907) 271-1937	eric.rothwell@noaa.gov
Schellekens, Matt	USGS	Fairbanks	(907) 479-5645	matts@usgs.gov
Schewman, Julie	Michael Baker Corporation	Anchorage	(907) 273-1600	jshewman@mbakercorp.com
Schnabel, Bill	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-7789	weschnabel@alaska.edu
Simmons, Trey	National Park Service	Fairbanks	(907) 455-0666	trey_simmons@nps.gov
Smith, Corinne	The Nature Conservancy	Anchorage	(907) 276-3133	corinne_smith@tnc.org
Stevens, Catlin	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		castevens@alaska.edu
Stuefer, Sveta	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-2714	sveta.stuefer@alaska.edu
Tedesche, Molly	Three Parameters +	Anchorage	(907) 248-1500	mtedesche@3ppi.net
Toniolo, Horacio	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-7977	hatoniolo@alaska.edu
Trimble, Stephen	MWH Global	Anchorage	(907) 248-8883	stephen.trimble@mwh-global.com
Walton, Michael	Division of Mining, Land and Water, Alaska Department of Natural Resources	Anchorage	(907) 269-8609	michael.walton@alaska.gov
Wilson, Ken	Alyeska	Fairbanks		wilsonk@alyeska-pipeline.com
Yngve, Margaret	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks		mjyngve@alaska.edu
Youcha, Emily	Water & Environmental Research Center, University of Alaska, Fairbanks	Fairbanks	(907) 474-2713	ekyoucha@alaska.edu

Notes:

We Would Like To Thank Our Sponsors:

Conference Sponsors:

U.S. Fish & Wildlife Service — Department of the Interior

International Arctic Research Center — IARC — University of Alaska Fairbanks

Reception Sponsor:

MWH — Building a Better World

Transportation Sponsor:

HATCH

Session Sponsors:

National Park Service

GW Scientific

HDR Alaska

Break Sponsor:

R2 Resource Consultants, Inc.

Exhibitor:

Campbell Scientific — When Measurements Matter

In-Kind Sponsors:

US Permafrost Association

Alaska Rural Water Association

Alaska Miners Association