

1. PROJECT INFORMATION

Title:	Fish Creek Watershed Hydrology Monitoring
Report period	<i>July 1, 2011 – June 30, 2012</i>
Report submission date	<i>July 30, 2012</i>
Author of Report	Christopher D. Arp

Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):

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2. PROJECT OVERVIEW

a. Briefly (4-5 sentences) describe both the research purpose and the underlying need for this research.

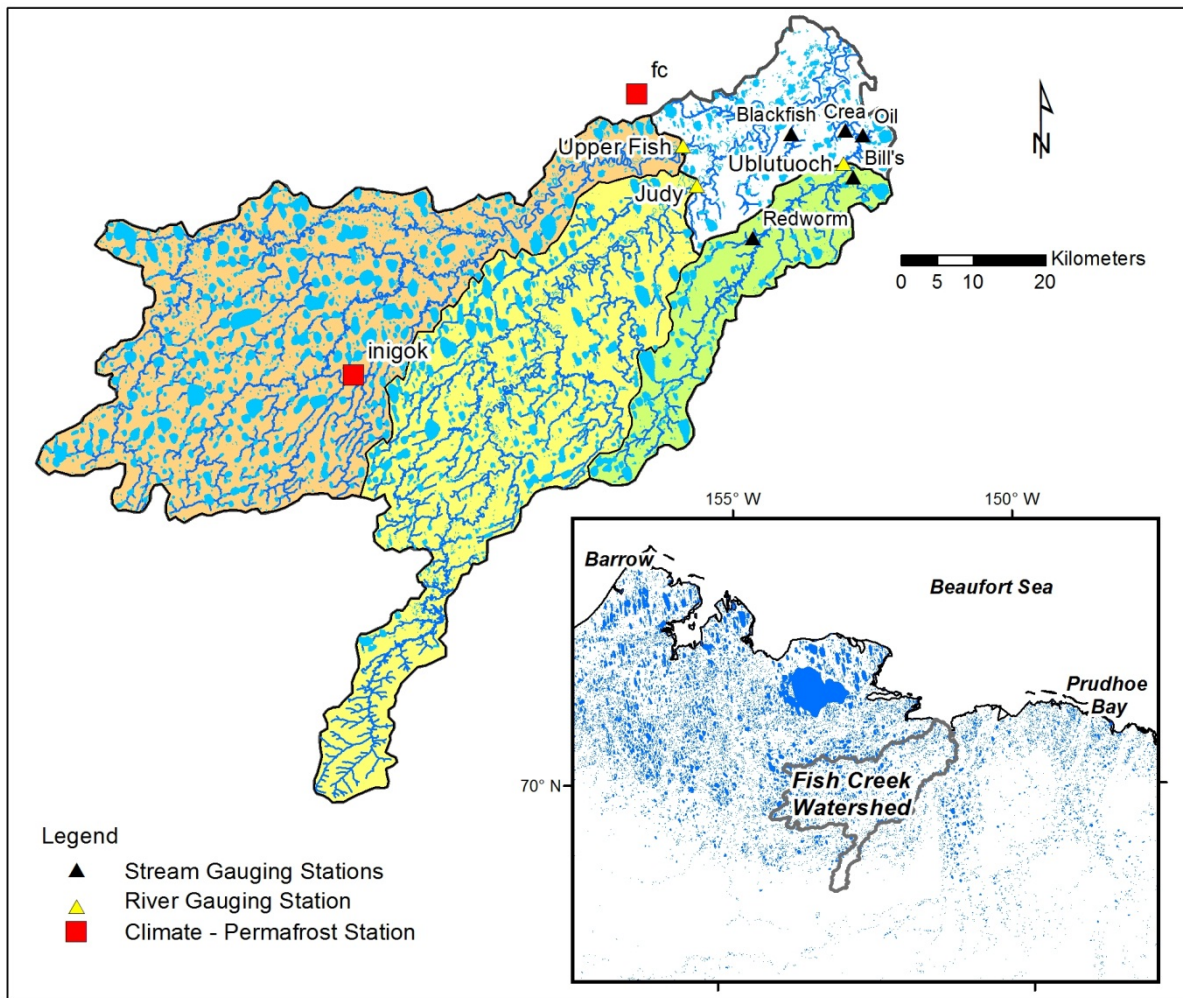
Beaded Stream & Lake Hydrology Monitoring - This research is focused on collecting and analyzing baseline hydrologic data for the Fish Creek watershed located in the National Petroleum Reserve – Alaska (NPR-A) in coordination with on-going and future petroleum development, fish and wildlife studies, and permafrost and climate monitoring and analysis. The Bureau of Land Management (BLM) and the U.S. Geological Survey began this monitoring program in 2004 and our efforts are to continue this monitoring program of the three river systems draining this regions including more detailed monitoring of select catchments with varying degrees of planned petroleum development. Data collection and analysis is focused on understanding seasonal and interannual variability in water supply and quality particularly with respect to fish habitat and hydrologic connectivity of streams and lakes. These data are also being used to develop process models and geospatial analyses to project changes in water resources and aquatic habitat to make improved projects with respect to climate change and extreme conditions (e.g., drought). This region represents an important area for such monitoring and research because of its location in the inner coastal plain and sand sea with abundant lakes that range from very shallow to deep along an inland gradient and thus supports a diverse range of aquatic habitat types. Additionally, climate records maintained since 1998 and streamflow data since 2004 make this an important watershed to develop reference concepts of hydroclimatic response and serve as a key area to assess future change in the Arctic.

River Hydrology Monitoring - There is a renewed interest in developing the NPR –A for oil and gas exploration and hydrological data is critical to the design of structures crossing rivers such as pipelines, roads, and bridges. This research is focused on collecting baseline hydraulic data, in stations established by BLM, on Fish and Judy Creeks, and Ublutuoch River. Specifically, we conducted, in cooperation with BLM personnel, a set of hydraulic measurements in 2011, which included discrete discharge measurements, during the water open season, using Acoustic Doppler Current Profiler (ADCP) and current meters, water slope, suspended sediment sampling, and basic weather data in these streams.

b. List the objective(s) of the project, exactly as described in your Statement of Work.

Beaded Stream & Lake Hydrology Monitoring (dominant habitat type within the watershed): in 5 stream/lake complex watersheds (Redworm, Blackfish, Crea, Oil, and Bills creeks), continuous water level and temperature (in lakes, streams, and confluences), discrete discharge measurements, and continuous water quality (specific conductivity, pH, DO, turbidity, chlorophyll *a*).

River Hydrology Monitoring: in the three primary higher-order channels of the watershed (Fish and Judy creeks and the Ublutuoch River), continuous water level, continuous weather data (air temperature, precipitation, wind speed and direction) for Fish Creek, and discrete discharge measurements.



3. PROGRESS SUMMARY

a. Describe report period progress.

Beaded Stream & Lake Hydrology Monitoring - Beaded stream and lake hydrologic monitoring continued into 2011 with the collection of streamflow, lake-level, stream and lake temperature and water quality,

and geomorphic surveys at four study catchments that have been monitored since 2008. A new catchment (Redworm Creek) and monitoring network was also established where an oil drilling pad and corresponding road are being planned by ConocoPhillips as part of the Alpine Satellite Development. Field activities included March lake ice, snow, and water quality surveys and sensor deployment, June peakflow discharge and water quality measurements, July and August discharge, water quality and fish surveys, and pre-freeze-up measurements and sensor downloads in late September. This strategy proved effective at gaining full datasets during the open-water season for all five catchments. Additional work included a synoptic analysis of headwater channels throughout the entire Fish Creek watershed to address variability in habitat and to begin developing models of channel initiation and runoff response. In April 2012 in coordination with the new NSF-AON Circumarctic Observation Network (CALON) we visited several of the study watersheds and made synoptic measurements at three study lakes (ice and snow thickness, surface elevation with DGPS, water chemistry measurements and sample collection, and sediment cores). During this visit, we also serviced our weather station and collected a sediment core from one stream bead to analyze stratigraphy, C/N ratios, and sediment accumulation and initiation dates using C14 analysis. We hope this sediment core will provide us with insight into beaded stream formative processes that will lead to a more comprehensive coring effort in stream beads to assess the evolution of these important landforms and aquatic habitat.

River Hydrology Monitoring - Water level measurements for Fish Creek, Judy Creek, and Ublutuoch River gauging stations were recorded at 15-minute intervals using pressure transducers placed to record both low-water and high water levels. Together with data from meteorological sensors, the pressure transducer data was transmitted via the National Satellite, Information and Data Service's Geostationary Operational Environmental Satellite (GOES) system to servers maintained by BLM and UAF-WERC. The pressure transducer measurements were verified using "tapedowns" or level loop surveys from established reference points (RPs). Tapedowns involved measuring the water surface elevation relative to RPs (typically a rebar) using a folding tape. We performed a level loop survey of all RPs to check for any datum changes. Depending on the size of the stream, discharge measurements were performed using either an acoustic Doppler current profiler (ADCP) or by conventional current meter instruments. Computation of daily streamflows was performed using corrected stage data and updated existing rating curves for each station.

b. Describe preliminary results.

Beaded Stream & Lake Hydrology Monitoring - All major datasets (stream discharge and water temperature) from 2011 have been organized, quality controlled and summarized. These are publically available at <http://ine.uaf.edu/werc/projects/arp-fishcreek/data.html>. Additional datasets (continuous water quality data from streams and lake-level and temperature data) will be made available as time and interest permits. Ongoing research from this project has resulted in a comprehensive analysis of the distribution of the drainage network (all lakes, drained lake basins, streams, and rivers) of the Fish Creek watershed using aerial photography, DEMs, and field observations. This network classification and analysis was then compared to discharge data from the three major watersheds (Upper Fish, Judy, and Ublutuoch) to understand how they modified runoff behavior from 2007-2009. This has resulted in a conceptual model describing how lake basins impact streamflow during snowmelt and summer baseflow conditions and across years ranging from drought to deluge conditions. A related analysis of lake ice regimes in this watershed from 2003-2011 suggests a shift towards more lakes with intermittent- and floating-ice regimes and fewer lakes with bedfast-ice regimes. This inventory was compared with data on ice thickness and water balance to understand the mechanisms responsible for this shift and provide managers an understanding of how these changes will likely impact aquatic habitat in the future, as well as permafrost, winter heat flux, and carbon emissions from this region.

River Hydrology Monitoring – Stream discharge data and weather data collected from Fish Creek, Judy Creek, and Ublutuoch River for 2011 has been processed, quality controlled, and organized. Weather and flow data are publically available at <http://ine.uaf.edu/werc/projects/npra-hydrology/> Mean and daily flows were computed with Aquarius Workstation. The highest discharge measured for Fish Creek was 2443 ft³/s (69.2 m³/s) on June 7, for Judy Creek was 4320 ft³/s (122.3 m³/s) on June 2, and for Ublutuoch was 1692 ft³/s (47.9 m³/s) on June 2. The lowest discharge for all three streams was measured in the fall and it was: 154 ft³/s (4.4 m³/s) for Fish Creek on August 27, 66.1 ft³/s (1.9 m³/s) For Judy Creek on August 28, and 7.5 ft³/s (0.2 m³/s) for Ublutuoch River on August 27. The discharge data was processed together with pressure transducer data, suspended sediment, and available water slope data to better understand how river discharge and sediment load change throughout the open season.

c. Publications, conference papers, and presentations.

Beaded Stream & Lake Hydrology Monitoring

1. Arp, C. D., B. M. Jones, Z. Lu, and M. S. Whitman. In Press. Shifting balance of thermokarst lake ice regimes on the Arctic Coastal Plain of northern Alaska. *Geophysical Research Letters*.
2. Arp, C. D., M. S. Whitman, B. M. Jones, R. Kemnitz, G. Grosse, and F. E. Urban. In Press. Drainage network structure and hydrologic behavior of three lake-rich watersheds on the Arctic Coastal Plain, Alaska. *Arctic, Antarctic, and Alpine Research*.
3. Arp, C. D., B. Jones, F. E. Urban, G. Grosse, and M. Whitman. 2011. Shifting ice regimes of Arctic thermokarst lakes and implications for permafrost and surface-water dynamics American Geophysical Union Fall Meeting, San Francisco.
4. Whitman, M. S., C. D. Arp, B. Jones, W. Morris, G. Grosse, F. Urban, and R. Kemnitz. 2011. Developing a long-term aquatic monitoring network in a complex watershed of the Alaskan Arctic Coastal Plain. Pages 15-20 in C. N. Medley, G. Patterson, and M. J. Parker, editors. *Proceedings of the Fourth Interagency Conference on Research in Watersheds: Observing, Studying, and Managing for Change*. USGS, Reston.

River Hydrology Monitoring -

1. Vas, D., H. Toniolo, R. Kemnitz, D. Brailey, P. Prokein, and E. Lamb. 2011. Hydrological measurements in several streams during breakup in the national petroleum reserve – Alaska American Geophysical Union Fall Meeting, San Francisco.
2. Toniolo, H., D. Vas, P. Prokein, E. Lamb, and D. Brailey. In review. Hydraulic characteristics and suspended sediment loads during breakup in several streams located in the national petroleum reserve in Alaska, USA. (*Cold Regions Science and Technology*)

d. Education and outreach.

Beaded Stream & Lake Hydrology Monitoring - Chris Arp attended 2012 SEARCH Workshop in Anchorage in March 2012 with the primary goal of educating participants about and raising awareness of research efforts in the Fish Creek watershed. This included presenting a poster highlighting ongoing and proposed research that integrates the Arctic Observing Networks with work in the Fish Creek watershed.

River Hydrology Monitoring –Horacio Toniolo used basic hydraulic data in his classes at University of Alaska Fairbanks.

e. Other products resulting from the project.

Nothing to report.

f. Describe any concerns you may have about your project's progress.

Beaded Stream & Lake Hydrology Monitoring - Major concerns are the ability to maintain this monitoring program at its current level without interruption due to funding and logistical support. A new NSF-AON project to monitor lakes began in April that incorporate a portion of this study within its scope, which should help give this program added longevity and incorporate these datasets into a larger context of North Slope hydrologic science. Similarly a different AON proposal was submitted to monitor a representative set of Arctic Alaskan watershed including a catchment Fish Creek near Inigok.

River Hydrology Monitoring - Similarly to the Beaded Stream & Lake Hydrology Monitoring, the major concerns are related to the ability to maintain this monitoring program at its current level without interruption due to funding and logistical support

4. PROGRESS STATUS

Beaded Stream & Lake Hydrology Monitoring - Overall, progress towards establishing a robust monitoring program (i.e., measuring the right things in the right places) is going very well, as we now have five catchments with equivalent monitoring infrastructure (headwater lakes and watershed outlet streams) that represent varying hydrographic features and expected levels of petroleum development activities ranging from no planned development (reference or control site), to winter and permanent road construction, to oil drilling pads and lake water extraction. The incorporation of other monitoring programs (i.e., CALON and potentially Arctic-FLOW) will build on the goal to understand watershed responses in the context of climate change and variability. Additionally, the Arctic LCC recently funded a planning team to develop an integrated science plan focused on the Fish Creek watershed and information on habitat change relevant to management needs. This will provide an important framework to identify and advance future scientific research and adaptive management in this area. Also, a separate NSF proposal was submitted to integrate regional climate models with lake and watershed models to forecast Arctic lake change and Fish Creek would be an intended focus area for this work. Besides maintaining our networks during the period when we expect ConocoPhillips to begin development activities in the lower watershed, we hope to follow up on completed studies with more detailed work on the functioning of lakes with varying ice regimes and on the long-term evolution and short-term behavior of beaded stream systems.

River Hydrology Monitoring – progress towards collecting and processing the continuous hydrological data for Fish Creek, Judy Creek, and Ublutuoch River is also going very well as we had a good field season in 2011 and we processed and quality controlled the hydrological data. The 2012 field season is going well. We plan to expand our data collection efforts by adding an ISCO autosampler at the Fish Creek gage site.