University of Idaho – College of Natural Resources

Taylor Wilderness Research Center

Report to the DeVlieg Foundation:

RiverNET Instrumentation at TWRS – 2012

Streaming Environmental Data from Remote Locations

for the purpose of addressing broad questions about climate-ecosystem-human interactions

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Thanks to the DeVlieg Foundation for their continued support of research activities and infrastructure at the Taylor Wilderness Research Station. Their strong research based vision complemented and supported the activities that grew out of NSF awards between 2006 and 2010. Partial funding from an NSF field station improvement award in 2009 was designated to install RiverNET systems at Taylor Wilderness Research Station (TWRS) and Flathead Lake Biological Station (FLBS) to develop common understanding of the utility of streaming environmental data from remote locations for the purpose of addressing broad questions about climate-ecosystem-human interactions. The goal of RiverNET is to serve as a test-bed for gathering real time, fine-scale temporal (15 minute sensor downloads continuous) and local-to-regional data to substantially enhance resolution ongoing reach-scale ecological studies, notably the salmon work at TWRS and the flood plain studies at FLBS Nyack.

Doing this work in the wilderness area at TWRS is critical for a number of reasons. The selected study sites allow us to merge our spatially explicitly and temporally intensive field work from a select number of sites into the longer term data available for fish and aquatic systems in Big Creek (e.g. NOAA censuring, Idaho Department of Fish and Game (IDFG) snorkeling surveys). The relatively pristine streams and rivers near the TWRS in the Frank Church River of No Return Wilderness area represent one of the few areas in North America where the freshwater portion of the salmon life cycle exists as it has for thousands of years and allows for an understanding of individual performance and community interactions in a relatively unaltered evolutionary context. Our measurements of movements and migrations allow us to understand how these processes work in a wilderness system in the absence of other confounding effects that hamper other studies such as major hatchery influence and anthropogenic hydrologic alteration (outside of hydropower projects.)

The coupling of a wilderness system with a disturbed migration corridor allows us to place the Middle Fork system in the context of wilderness and wild salmon systems throughout the Northern Pacific. We will be casting our work along comparative gradients with wilderness systems in Kamchatka, Alaska and British Columbia. Additionally, studies are possible on the feeding behavior and physiology of native salmon in the absence of invasive species and without the effects of human disturbance on the banks and in riparian areas. Little is known about the long-term dynamics of fish populations within these expansive wilderness ecosystems. Using long-term data, we can begin to understand the spatial and temporal fluctuations in population and its relevance to a potentially larger metapopulation system. These studies will build significantly upon other aquatic research that has been established in the region, but will be the first of a projected long term sets of studies that attempts to establish consistent sampling sites, methods and protocols in order to address some of the fundamental questions of population dynamics of salmonids in this system.

The goals of the ongoing collective research and educational mission on Big Creek are:

1) to continue to develop a spatially explicit bioenergetics model that can be used to assess the potential impacts of food and habitat limitation on the growth and survival of juvenile Chinook in Big Creek (continuation of project from 2006-09, Cromwell and Kennedy 2011) and

2) to understand the ecological drivers of juvenile salmon movement, migration timing and adult salmon straying rates within the drainage of Big Creek and how it relates to the greater Middle Fork system (Hamann and Kennedy 2012),

3) to implement a basin wide temperature monitoring system, and 4) to integrate our aquatic and riparian research interests with a field-based graduate course that may be approved for funding and start as early as August 2010 (max 12 students). Different parts of these projects are collaborative with USFS-RMRS, NOAA-NMFS and IDFG. As part of this effort there will be at least two graduate student projects and possible subsequent undergraduate projects. **The two graduate projects have been funded by NOAA-NMFS and the DeVlieg Foundation.**

The two RiverNET installations at TWRS and FLBS have joined another RiverNET array (funded separately) operated by YERC in the Lamar River of Yellowstone National Park. Each aquatic sampling node has sensors for: water depth (discharge), dissolved oxygen, conductivity, and water temperature (Figs 2 – 4). Data streams from the RiverNET systems and a similar LakeNET system for Flathead Lake are web accessible from FLBS archival media provided by an NSF-EPSCoR grant. The recent power infrastructure enhancement at TWRS will prove crucial to the successful harvesting and storage of data as well as the distribution to UI servers and FLBS for integration and data management. Currently, RiverNET data from TWRS is uploaded twice daily to the University of Idaho server, thus allowing remote access to data in near-real time (Figs. 2 – 4).

The proposed research is being conducted in the three spatial dimensions where RiverNET will harvest data: upstream-downstream (km scale), including tributary junctions, site variation (multiple sensors per site, m-cm scale), river-to-riparian (air, soil m scale) and river-alluvial aquifer (via monitoring wells, m scale). For the first time anywhere, we will be obtaining multivariable, spatially-arrayed river data in real time using (testing) new, 100-channel Cisco routers (easy to add many more sensors) to stream the data by satellite (TWRS, YERC) and line-based (FLBS) uplinks. This links high speed computation into the bush (backcountry), which also motivates Cisco to work with us because they want to market the technology. Equally important, RiverNET data will provide much more robust field data to develop parameters, refine and verify our existing models of water, heat and nutrient fluxes at regional and floodplain scales and provide sensitivity data for GCM-based climate change predictions.

A special use permit from the US Forest Service (Payette National Forest) was issued for the infrastructure deployment of the RiverNET system in areas except for those entirely on Wilderness property. The application for this permit will be prepared in fall 2012 after the MESA-MRI project has been successfully permitted and deployed. Collectively, this permitting will also provide the basis for the MOU with the US Forest Service (Rocky Mountain Research Station) in developing research and education objectives for the Frank Church River of No Return Wilderness. The overarching study plan at TWRS describes the proposed sensor deployment and validation work for the next two years (2010-2012).

The sensors have been deployed at TWRS and will be deployed in Upper Big Creek in late fall 2012 or spring 2013 with landowner cooperation and participation. TWRS installations included Pioneer Creek, Cliff Creek and Rush Creek. Summer 2013 equipment acquisition and installation will proceed after permitting in the mid basin tributaries of Cave Creek and will include tributaries (e.g. Rush Creek, Cabin Creek, Monumental Creek) of Big Creek near TWRS. To the extent possible, field sites in Big Creek will be coordinated with those of NOAA scientists and Idaho Fish and Wildlife Department (IDFG) snorkeling crews to facilitate research coordination. This requires establishing one field site near TWRS, and an additional research site in Upper Big Creek, near the town of Big Creek. After establishing these two sites, 4 to 6 more 200-300 meter study reaches would be established along Big Creek within a hiking vicinity of TWRS. We will coordinate the establishment of these research reaches with other agencies and aquatic scientists doing research in the vicinity. Finally we will be working with USFS-Rocky Mountain Research Station as well as IDFG and Nez Perce Tribe to coordinate carcass monitoring in critical rearing sites throughout the drainage.

As NSF does not fund anything beyond the purchasing and installation of this equipment, decisions about station management and leadership at TWRS will be critical for the future maintenance and broad scale utility of this infrastructure. We are optimistic that the College and the University will maintain their support for the long term maintenance and data collection of this important monitoring equipment as it provides the possibility for building future funding opportunities – in the same way that visionary DeVlieg Foundation support has heralded our funding and research activities.

Calendar of milestones from 2011-2012

September 2011 – consultations with FLBS and many hours of conversations with Campbell Scientific resulted in the first round of ordering materials.

Winter 2011 – 2012 – First round of equipment arrives to Moscow, ID. Special use permits and landowner permission arranged for summer 2012 installation. Opening and beginning to assemble pieces of 8 RiverNET nodes.

April 15 – 19, 2012 – **Tom Bansak**, University of Montana, from our partnering collaborative institution, Flathead Lake Biological Station, visits for a workshop on assembling nodes, operating sensors and making radio communication among nodes functional.

June 8 – 10, 2012 – Five individuals, including assistant manager Landon Moore, were directly involved with me on the installation of 4 RiverNET nodes at TWRS. Several others at TWRS helped in different capacities including hauling materials, digging holes and mixing cement. One undergraduate intern, **Larry Hendren, funded as a Taylor Friends of Taylor Endowment Intern**, remained at TWRS for the summer providing maintenance support and establishing calibration curves for sensor data. In one intense day and a half, four RiverNET nodes were installed into concrete foundations on TWRS property. This would not have been possible were it not for the volunteer help and professional expertise of Mike Williams and his son, Jerry Bright, of Williams Construction in Moscow (See following pictures).

The whole crew hard at work on a rainy Friday, June 8 in order to get the footers poured for three sensor tower installations. The volunteer crew was treated to a barbeque after the hard work.

Sensor stations being constructed on the boulder at the mouth of Rush Creek on Saturday, June 9 and the finished products on the boulder as well as at Pioneer Creek on Sunday, June 10.

Even the next generation of field scientists took her first (and last) trip to Taylor in order to volunteer her services. Here she is installing some of her own "instrumentation towers". The boulder installation is being worked on in the background (June 9, 2012).

June 20, 2012 – Conference call with **Jody White**, Quantitative Consultants and ISEMP; **Ben Crosby** and **Colden Baxter**, ISU, in order to strategize about future RiverNET placements, data acquisition and data efficiency efforts for Big Creek.

June 27, 2012 – Data collected from the first networked array of sensors at TWRS is stored and available on University of Idaho servers.

July 2012 – request for No Cost Time Extension in order to assess effectiveness of installed sensors, accommodate needs of collaborators from partnering agencies and institutions and address lessons from summer 2012 installations.

July – August 2012 – Undergraduate intern, **Larry Hendren**, and lab manager, **Rick Hartson**, work collaboratively to maintain sensor, calibrate measurements and quality control RiverNET data.

August 31 – September 3, 2012 – Fish 314, *Ecology of Fishes*, is first class to visit TWRS and use RiverNET data on site in order to compare water measurements across tributaries and apply to their interpretation of fish abundance and distribution data.

Publications from current efforts

Cromwell, K.J. and Kennedy, B.P. 2011. Diel distribution, behavior, and consumption of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in a Wilderness stream. Ecology of Freshwater Fish 20:412-430.

Hamann, E.J. and Kennedy, B.P. 2012. Juvenile dispersal affects straying behaviors of adults in a migratory population. 93: 733-740.

Cromwell, K.J. and Kennedy, B.P. (*In review*) Benthic and drift production and the trophic transfer of energy to juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Journal of the North American Benthological Society.

E.J. HAMANN *[1] AND B.P. KENNEDY[2] (*In prep*) Landscape parameters influencing spawning habitat selection by Chinook salmon (Oncorhynchus tshawytscha)

Figure 1. Schematic of the RiverNET sensor distribution system.

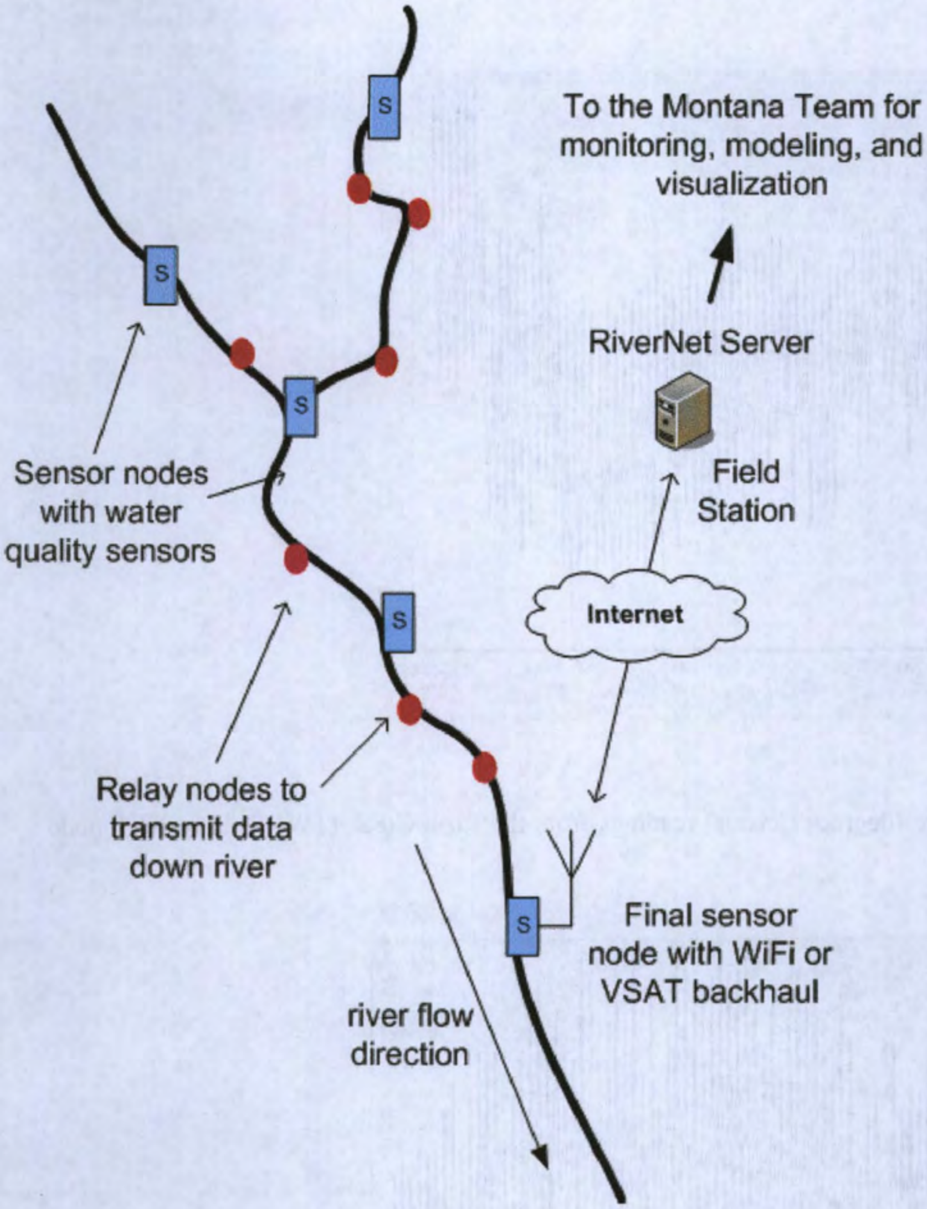

Figure 2. Dissolved oxygen (ppm) readings from the Rush Creek (TWRS) RiverNET node during summer 2012.

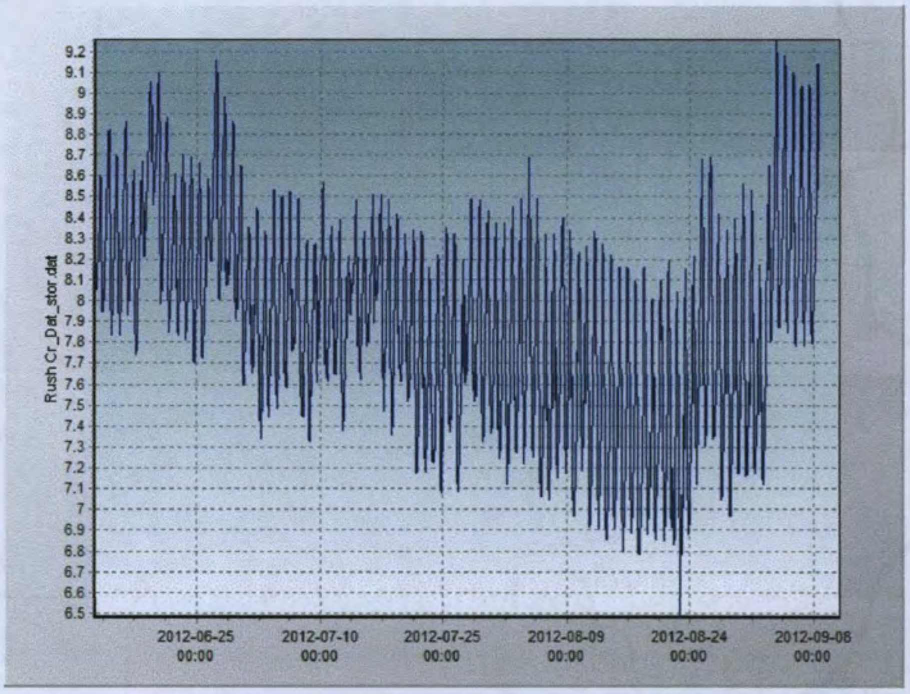

Figure 3. Stream temperature (degrees Celsius) readings from the Rush Creek (TWRS) RiverNET node during summer 2012.

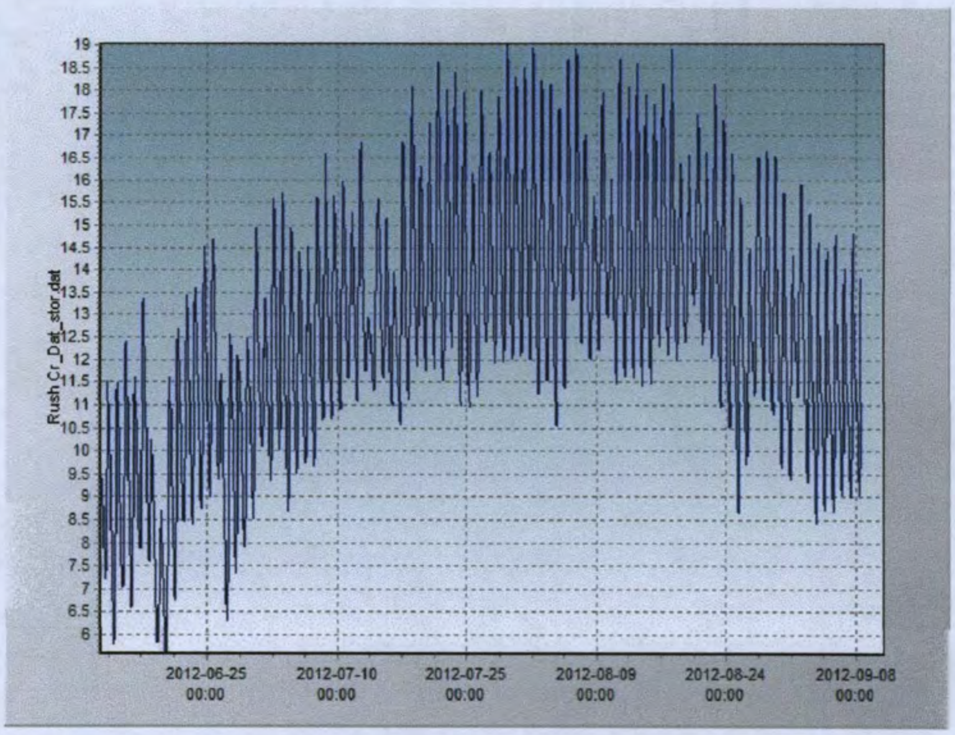

Figure 4. Stream depth (meters) readings from the Rush Creek (TWRS) RiverNET node during summer 2012. The value reflects the height of water above the pressure sensor and therefore depicts a river decreasing in depth throughout the season. These data will then be used to calculate daily discharge. Interestingly, it appears that one can see the end of snowmelt influence near July 20 as the stream becomes less variable through the day.