LIZA MITCHELL - Fall 2012 Report

2011-2013 DeVlieg Taylor Graduate Research Assistantship

M.S. Water Resources
Waters of the West Program
University of Idaho College of Natural Resources

To The DeVlieg Foundation:

It is hard to believe that I am already a year into my research and graduate studies as a DeVlieg Graduate Scholar at the University of Idaho! The amount of knowledge I have gained in the last 13 months is incredible. The classes that I have taken at UI have been informative and challenging, but the extracurricular strides I have made in the process have been equally as informative. I have learned valuable lessons about:

- how to create a research project from the ground up
- what it takes to design a professional science project
- how to conduct fieldwork in a very remote setting
- how to communicate my science and work with other researchers
- how to manage responsibilities as a teacher, student, researcher and citizen at the same time!

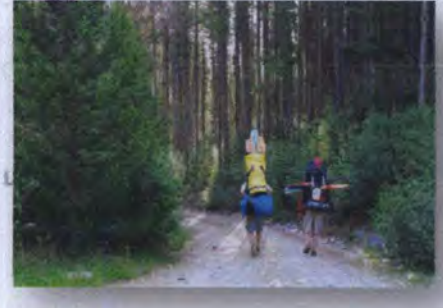
I would love to take this opportunity to give you an update on the progress made over the past year and share some of my experiences from this past summer I spent conducting research at Taylor Wilderness Research Station.

Last fall semester I took a heavy load of classes, including physical hydrology, stream ecology, a water resources seminar series, and an interdisciplinary methods course. I explored the current literature and research in the field of marine derived nutrients and began formulating research questions. During the spring semester I further developed and refined my research questions and then presented these at an international conference for interdisciplinary graduate students in Canmore, Alberta (Confor West 2012). I continued with my coursework, which included statistics fundamentals, stable isotope ecology, and environmental education, and began preparations for the summer field season. As a result of a course project I found some interesting results on the stable isotope values of aquatic bugs found in Big Creek that suggest distinct differences across the landscape. This influenced the direction of my research and so I am now also exploring regional drivers of isotopic variation outside of the streams. In May I took a trip into the upper basin at Big Creek and Taylor Ranch to gather some preliminary samples and test my field methods for data collection. After the early summer floods and high flows subsided I traveled back into the wilderness for an extended stay (2 months).

The summer was filled with adventures, misadventures, challenges, successes and an overall experience of a lifetime. In order to complete the fieldwork necessary to start answering my research questions, I needed to travel across distances of more than 20 miles with quite a bit of equipment. The first major sampling 'campaign' (when I visited all 16 sites in 4-5 days) was undertaken via kayak. I had three other scientists along with me and we worked 12 hour days, walking through the cold streams early in the morning to collect all the necessary data and then packing up the inflatable kayaks and paddling downstream to the next site. The second sampling campaign was facilitated by air travel and hiking with another graduate student studying at Taylor Ranch, and the third involved a backpacking expedition all the way down the drainage (the water levels in September are too low to allow kayaking). In between these major sampling campaigns I sampled the sites immediately surrounding Taylor Ranch, and spent other days in the lab filtering my algae samples and using the microscope to identify the aquatic bugs I collected.

I also took advantage of the incredible location of Taylor Ranch and explored the surrounding peaks, valleys, hiked to the Middle Fork of the Salmon, started trail running, and learned how to fly fish! Some of the best moments from the summer involved the people. There were great visits from professors of all different disciplines that shed insight into the human history, ecology, geology, and opportunity of the area and it was nice to share my experiences and my field of expertise with all the visitors that came throughout the summer. I am hoping to send along some pictures, as they capture the experience far better than words.

Now that I have completed my first full field season, I have some daunting tasks in front of me for the fall, but it is quite exciting that I will start getting some real results and data in the near future. I turned in over 50 water samples to the lab that are currently being analyzed for detailed nutrient information: the levels and forms of nitrogen and phosphorous. I have finished sorting, identifying and cleaning over 150 different samples of macroinvertebrates (aquatic bugs) and they are in the process of being dried so that I can move forward with the more detailed steps in stable isotope analysis. By the end of the semester I hope to have all that completed, along with the algae stable isotope analysis so that I can begin to explore the data and look for important relationships through GIS and statistical analysis next semester.



Thank you again for your support and I hope that this letter helps you understand that your grants and scholarships are having a positive impact on both people and places!

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Description of Research Project:

Liza Mitchell is pursuing a M.S. in Water Resources through the interdisciplinary Waters of the West Program at the University of Idaho in Moscow. She completed her B.A. in Environmental Science at Colorado College and graduated with honors in 2008. Since then she has worked with watershed conservation non-profits in Colorado and Alaska doing fieldwork, education and outreach, monitoring and writing. She also worked in the Alaskan wilderness as a field guide and instructor on canoeing and mountaineering expeditions for at-risk youth.

Currently she is researching the impacts of spawning Chinook salmon on nutrient dynamics in the Big Creek watershed, Idaho. Through the use of stable isotope analysis, her study will identify the presence and relative importance of marine-derived nutrients (MDNs) for different plant and invertebrate species in this wilderness ecosystem. Specifically, she will be exploring the effect of spawning density on the spatial extent and temporal uptake of marine-derived nitrogen and on nutrient levels in the stream water. This data has important applications for informing nutrient restoration projects that are being employed throughout the Pacific Northwest to mitigate the effects of diminished salmon runs.

The study is being conducted at the Taylor Ranch Wilderness Research Station with funding from the **DeVlieg Foundation**.

Report Prepared for the DeVlieg Foundation Annual Meeting, October 2012:

Objective 1: Exploring the relationship between salmon spawning activities and evidence of marine derived nutrients in an inland wilderness watershed.

Management efforts to restore wild salmon runs throughout the Pacific Northwest have typically focused on habitat restoration and improved fish passage. Recent research indicates that productivity and cross-ecosystem subsides are also important for fish recovery. Productivity in stream ecosystems is fueled by nutrients through terrestrial, atmospheric and hydrologic pathways. Spawning activities and remnant carcasses from anadromous salmon provide a pulsed nutrient input and disturbance in typically oligotrophic (nutrient poor) headwater streams. Using a paired watershed approach within a wilderness watershed (Big Creek, ID), this study will quantify MDN incorporation into headwater food webs in the presence and absence of salmon-derived nutrient subsidies. We will analyze the distribution of MDNs around known spawning grounds to determine if higher spawning densities create hotspots of MDN incorporation. Stable isotope analysis of biotic material sampled across the aquatic system will be used to determine relative levels of MDN incorporation into the food web via its distinct nitrogen isotope ratio of $^{15}N/^{14}N$. When coupled with spatial spawning densities at the watershed scale, we aim to quantify patterns of cross-ecosystem nutrient cycling. This has many implications for multi-scale natural resource management, specifically stream to watershed nutrient movement, and will advance our understanding of how MDNs function as biotic feedbacks in a natural system. As nutrient enrichment becomes an increasingly common restoration practice where salmon runs have declined, it is crucial to gain a baseline understanding of MDN incorporation patterns at the basin scale.

Objective 2: Exploring regional scale drivers of isotopic variation throughout the basin.

Stable isotope analysis focused on nitrogen and carbon is frequently used in aquatic ecology to explore the feeding relationships between members of a given community. The carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopic ratios have also been used extensively in resource partitioning studies to help identify contributions from distinct food and nutrient sources. As mentioned above, this technique has been applied to ecological studies of anadromous fish and how they influence freshwater nutrient dynamics when they return from the marine environment to spawn. The seasonal nutrient input into freshwater streams in the Pacific Northwest provided by salmon has been shown to influence the productivity, community structure and mechanisms of nutrient uptake in the aquatic system. However, there is little agreement within the field on the relative importance of marine derived nutrient (MDN) incidence and additional factors controlling the net impact on the ecological system. A lack of research on how stable isotopes (as indicators of MDNs) are distributed at a regional, watershed scale may be limiting our understanding of how this cross-ecosystem subsidy influences productivity, and to what degree stable isotopes are an appropriate measure of influence. This study will investigate how various landscape level factors including geology, land cover, fire

history, salmon spawning and water quality drive patterns in isotopic composition over time and space in a wilderness watershed in central Idaho.

Knowledge Gaps, Scientific Justification and Broader Implications.

Relatively few studies have explored the connection between isotopic ratios and MDNs in Pacific Northwest inland streams, yet such information for headwater spawning and rearing grounds is needed to understand how these nutrients boost productivity in systems with dwindling salmon populations. These findings have important consequences for the integrity of ecosystem processes and the viability of salmon populations, and thus have drawn increased attention from scientists and managers alike over the past two decades. Results from many studies suggest that marine derived nutrients from spawning salmon are part of a critical biological feedback that influences stream productivity and juvenile survival (Achord et al. 2003; Zabel et al. 2005, Schindler et al. 2003, Scheuerell 2005). This study will explore the spatial distribution of marine derived nutrients in a unimpacted watershed and provide insight into the natural presence and location of biogeochemical hotspots to facilitate future work comparing the spatial relationships of spawning grounds, rearing grounds and biogeochemical hotspots. The population of Chinook salmon in the Big Creek watershed, still considered purely wild stock, is part of the Snake River-Fall Run Evolutionarily Significant Unit that is listed as threatened under the Endangered Species Act (ESA) meaning that this information is particularly valuable for management actions for this and other similar populations. Nutrient restoration is an increasingly common practice in the region (Kootenai Project 2007, Slaney 2003) targeting stream productivity for fish population recovery. Research is ongoing to determine how nutrient additions may be delivered at the appropriate spatial scale or at the right time and most of these include isotopic analysis in their methods (Cram 2011, Kohler 2008). However, a lack of research on what drives nutrient and isotopic variation over time and space in undisturbed inland systems limits the power of conclusions drawn from past studies that directly link isotopic enrichment to marine derived nutrient incidence. The Big Creek watershed in the Frank Church-River of No Return Wilderness, Idaho, offers a pristine laboratory with a natural gradient of salmon spawning density, and distinct areas of varying geology, vegetation and wildfire history to explore these questions.

This study also has significant implications for the field of stable isotope ecology. Evidence from recent studies suggests that sulfur isotopes can significantly improve identification of source nutrients, and that sulfur isotope ratios are less susceptible to complications associated with fractionation and sample preservation. This study will take a novel approach and test the utility of combining ^{15}N, ^{13}C and ^{34}S stable isotope analysis to investigate the spatial variability of isotopic composition in the Big Creek watershed. Results may elucidate patterns in $\delta^{15}N$, $\delta^{34}S$ and $\delta^{13}C$ values that can be useful in geographically separating samples that are representative of landscape level factors. This study will identify areas for further research within the basin, within the field of salmonid population dynamics, and has the potential to identify a more effective method to identify patterns of marine derived nutrients across space.