Ecological Assessment of Meadows in the Sierra Nevada

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EXECUTIVE SUMMARY:

Meadows are critical biodiversity hotspots within montane landscapes, and there is much interest in monitoring and restoring degraded meadows. Understanding the mechanistic relationships between hydrology and biodiversity in meadow ecosystems is very important, but many existing assessment tools use a one-time, visual survey of physical habitat and may not account for ecological processes. I conducted a field experiment that examines stream hydrology and the biodiversity of plants and aquatic invertebrates in healthy and degraded meadows of the Lake Tahoe Basin, California. I predicted that an assessment methodology that focuses more towards the process and function of hydrological and ecological attributes would better our understanding about the needs and benefits of meadow restoration projects. I hypothesized that measures of hydrologic functions will be more strongly correlated with aquatic and terrestrial biodiversity than rapid assessments of habitat conditions in montane meadows.

PROJECT OBJECTIVES:

Meadows play a critical role in the hydrologic and ecological processes of mountainous watersheds and provide numerous ecosystem services. In the Sierra Nevada of California, montane meadows are considered biodiversity hotspots because they provide habitat for a large number of animal and plant species, including endangered species (Ingram and Kocher 2015). Unfortunately, montane meadows throughout the Sierra Nevada are highly degraded. Degraded meadows often exhibit deeply incised stream channels, which causes lower water tables, reduces summer base flows, and reduces soil moisture (Hammersmark et al. 2008). However, few studies have directly examined the relationship between altered meadow hydrology and biodiversity loss.

Various approaches have been developed and implemented to assess the health and condition of montane meadows. For example, the non-profit organization American Rivers developed a rapid assessment scorecard based on six qualitative observations; bank height, bank stability, presence of gullies, vegetation cover, bare ground, and

conifer or upland shrub encroachment (Hunt and Nylen 2012). Additionally, fish and amphibian assemblages have been proposed as indicator species of meadow condition. However, the low richness of native species (<5 spp. throughout most of the Sierra Nevada) makes interpretation of amphibian and fish surveys problematic.

The passage of a large water bond in 2014 in California, which targets the restoration of montane meadows for water supply and habitat, will result in an even greater emphasis on meadow monitoring and restoration in the coming years. Thus, it is imperative that a mechanistic understanding of the linkages among meadow hydrology and biodiversity should inform future efforts to assess and restore these habitats.

Existing assessment approaches often fail to consider hydrological processes and biodiversity, instead using attributes such as bank height and the occurrence of an indicator species as proxies for more detailed measurements. The objective of this research project is to evaluate the influence of meadow hydrology on biodiversity in montane meadow.

This summer, the internship provided various opportunities for me to learn about the selected sites, as well as the about importance of collaborating with others. With consultation with LTBMU staff including a hydrologist, forest ranger, and GIS specialist, I was able to select total of 9 meadows in South Lake Tahoe, included at least 3 considered to be in healthy condition and at least 3 in degraded condition. Over the course of the internship my original proposed research did change slightly once I got out in the field.

PROJECT APPROACH:

Rapid Assessment:

Since I am using a rapid assessment tool (Meadow Scorecard) created by the American River organization, I contacted and shadowed the American Rivers staff on one of their projects so that I could learn how to use the Meadow Scorecard in the field.

Hydrology:

After all the sites were selected the Hobo Water temperature sensors were placed at each stream to log the water temperature at 15 minutes intervals. Using the laser level and stadia rod I measured three cross-sections to show the physical dimensions of the stream perpendicular to flow. I used the Pacific Southwest Region Stream Condition Inventory (SCI) Technical Guide methodology to collect data for the cross-section.

BMI:

I conducted a Benthic Macroinvertebrate (BMI) survey using the SWAMP (Surface Water Ambient Monitoring Program) Bioassessment Procedures. Since, riffles area often have high BMI diversity I used the TRC (Targeted Riffle Composite) method to collect eight individual samples of 1 ft^2 (0.09m2) of substrate using a D-framed from fast-water (riffle/run) habitat. The samples were randomly composited and preserved in a 500-mL bottle with 95% ethanol solution. At the end of summer, the samples were taken to the CSU Stanislaus Biology laboratory. I am currently identifying the samples from 9 sites to genus level.

Vegetation:

Terrestrial biodiversity was measured by conducting plant surveys along the cross-section. Our original plan was to use 1 x 1 meter sample plots to estimate the percentage cover. But unfortunately the sample plot was too large, and due to the time limitation out in the field I wasn't able to complete the survey on time. I contacted and met with Shanna Gross, the LTBMU botanist, to discuss an alternative approach. We decided to use 10cm-nested plots. Since each cross-section transitioned from aquatic to upland habitat I conducted 2 plant surveys at wet meadows and 2 plant surveys at dry meadow habitat (total of 12 at each site). I identified plants in the field using a book "*Plants of the Tahoe Basin"* by Michael Graf. Some plants were also collected and placed into plant press.

PROJECT OUTCOMES:

I have successfully completed the fieldwork and most of the lab work; I am currently analyzing my data. My preliminary findings are that biodiversity of the aquatic invertebrates and terrestrial vegetation was lower in meadows with incised stream channels. In particular, the abundance of the larval aquatic insects Simuliidae (blackflies), *Baetis* mayflies, and Plecoptera (stoneflies) were significantly lower in incised streams. Incised streams had lower richness and abundance of plants characteristic of hydric habitats, such as *Salix* (willow) and many forbs, and greater abundance of grasses. Incised streams also experienced greater declines in streamflow over the summer season, and warmer water temperatures during the late summer.

CONCLUSIONS:

We can conclude that strong linkages between channel geomorphology, hydrology, and riparian and aquatic biodiversity exist in our study system. The meadow scorecard did not capture the complex eco-hydrologic processes of meadow ecosystems, resulting in weaker correlations with the ecological and hydrological functions of the montane meadow. Assessment methodologies that focus more on ecological processes and the function of hydrological and ecological attributes may be needed in order to understand about the needs and benefits of meadow restoration projects.

This experiential learning internship has given me the opportunity to learn more about the Lake Tahoe's watershed and connected me to the community again, and has accelerated and assisted me in my thesis project. My first summer job was in 2009 with the USDA Forest Service, Lake Tahoe Basin Management Unit. I was employed through Generation Green Internship Program. Lake Tahoe is my second home, when I am there I feel connected to my village in Nepal, so after completing my Master Degree, I envision myself working with the US Forest Service in Lake Tahoe Basin where I first started the new chapter of my life. The mission of Forest Service is "caring for the land and serving people". I would like to give back to the community that has supported and

guided me throughout my life in the US. Through my project I was able to involve the local high school students (Forest Service-Generation Green Interns) and educate them about the importance of maintaining and restoring the montane meadows.

APPENDICES:

Photo 1: Collecting Benthic Macroinvertebrate in Angora Creek with Generation Green Interns.

Photo 2: Generation Green Intern, Sage Alexander measuring channel cross-section in Cookhouse Meadow.

Photo 3: Measuring late summer streamflow in Meiss Meadow.

Photo 4: Wildflowers along the stream channel in Meiss Meadow.

Photo 5: Channel cross-section in Big Meadow (Left). Channel cross-section in High Meadow (Right).

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