

Long term changes in wetland and riparian areas in Rocky Mountain National Park, Colorado

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Introduction

Most hydrological and ecological studies last for the duration of a funding cycle, two to five years. While these studies can provide ideas and information useful for understanding resource management issues, they typically provide only a snapshot of nature's variance. Important but slowly occurring long term changes may be missed by these short-term studies. Longer-term analyses using data collected over 10, 20 or 30+ years can bring critical perspectives and provide a meaningful and realistic understanding of ecological variance and change. The authors of this proposal have worked in Rocky Mountain National Park for 10 to more than 33 years, and we are proposing to replicate several sets of ecological and hydrological measures we made in the past to provide long term information on the condition and trends of wetland and riparian areas in the park. We also propose to use these analyses to provide options for management and restoration, including possible strategies for climate smart conservation into the future (Stein et al. 2014). We will focus on the west side of RMNP in the Colorado River watershed where our research began in 1987. Our overall goal is to assess the character and condition of fens and riparian areas over this time, pull all existing data together for this effort, write several publishable papers, and provide all data to the park for archive and use by future researchers.

Work Plan

Our research began in Big Meadows in 1987 with an analysis of the vegetation, soils and hydrologic regime (Cooper 1990). This was part of an effort by the U.S. Fish and Wildlife Service to begin to characterize wetlands of the U.S. that were poorly known and understood. This analysis revealed that a human created ditch was dewatering parts of the Big Meadows fen. Working with RMNP staff the ditch was blocked with metal sheets beginning in 1989 (Connor 1989). We monitored the short-term hydrologic effects of this restoration (Cooper et al. 1998), and aspects of soil organic matter loss (Schimelpfenig et al. 2014) but we have not analyzed the long-term hydrologic recovery or vegetation changes following restoration. An un-ditched

natural portion of Big Meadows as well as the natural Green Mountain fen were analyzed for hydrologic regime and carbon dynamics (Chimner and Cooper 2003a) and provide an excellent reference for comparing the hydrologic regime and C-fluxes to the historically ditched and drained portions of Big Meadows. Long term monitoring by the Rocky Mountain Inventory and Monitoring (I&M) Network (Schweiger et al. 2015) has adopted some of these 1980s wells as sentinel sites in Big Meadows and Green Mountain fen (plus other locations as noted below), collecting continuous hydrologic data since 2007 as well as annual vegetation, soils and disturbance indicators. Most of the monitoring wells that were installed in Big Meadows in the 1980s have been removed, but we know their precise location and will be able to relocate them for sampling using satellite-based survey equipment operated by Dr. Edward Gage.

At each well we will recreate the original plot to analyze the vegetation composition and replicate data collected in 1987, 1989 and other years over the past 3 decades. This will allow us to analyze vegetation composition trends and mid-summer water table levels and do a 33-year time series of vegetation composition to determine how Big Meadows has recovered from being ditched for approximately 80-100 years prior to 1989. In addition, we will identify any changes that may have occurred due to ungulate browsing in recent decades, particularly effects on woody plants. We anticipate using these data to produce a manuscript suitable for a journal article with the preliminary title: “Long term vegetation changes in a subalpine fen due to hydrologic restoration”. We will also use these data to provide perspectives for RMNP resources management staff on the beneficial effects of restoration, and changes that may have occurred due to herbivory. All data will be assembled and provided to RMNP and the I&M program for archiving and use by staff and scientists in the future. We will also digitize circa 1987 ground photographs, rephotograph as many as possible, and make these available for archiving.

We began work in the Kawuneeche Valley in 1993 to investigate the effects of the Grand Ditch on the Colorado River and its riparian and wetland ecosystems. The first effort with lead by Shaunda Wenger, and we established ground water monitoring wells and vegetation plots that were analyzed for many years through the 1990s. Some of these wells are now used as sentinel sites for the NPS I&M program. These, and other data, have been used to analyze factors affecting willow seedling establishment (Woods and Cooper 2005), the key role of beaver on riverine and floodplain hydrologic regimes (Westbrook et al. 2006, 2011), and the effects of the Grand Ditch on wetlands (Chimner and Cooper 2003). The patterns and causes of willow dieback were also studied in a set of analysis that identified *Cytospora* fungus as a key component along with browsing (Kaczynski et al. 2013, 2014a, b). Other work identified the influence of vegetation and water table on fen soil properties (Crockett et al. 2015) to begin to understand the drivers of fen biodiversity. The sensitivity of fens to water table position was experimentally tested to understand hydrologic controls on fen carbon dynamics (Chimner and Cooper 2003b). Kawuneeche Valley sites were also important in understanding the relationships between the long history of human disturbance in the park and how wetlands have responded (Schweiger et al. 2016). Wetland condition across the park is a product of both ‘natural’ processes such as herbivory as well as how vegetation and hydrology has been impacted by anthropogenic land use and hydrologic modification. Moreover, this dynamic continues to unfold as the park is visited by over 3 million people a year.

In the Kawuneeche Valley we propose a set of analyses that will be invaluable for RMNP resources management. First, we will replicate our vegetation analyses at monitoring wells conducted in the 1990s, especially a 1997-1998 data set collected by Cooper and Chimner. It should be noted that in the 1990s, the Kawuneeche Valley had a nearly continuous tall willow community. The 1990s data were analyzed and provided in a report to RMNP (Cooper, Chimner, Woods, McDonald 2000) but were never published. Earlier wells and data from Shaunda Wenger in 1993 and 1994 (Wenger 1996) will also be integrated. We will relocate all wells, sample the vegetation, install loggers into many wells to evaluate modern water table depth and dynamics relative to those of the 1990s, and early 2000's as analyzed by Scott Woods and Cherie Westbrook, and later analyses by the NPS I&M program. We anticipate producing two or three reports and manuscripts suitable for peer review journal publication.

The first report would be preliminarily titled "Changes in riparian vegetation of the upper Colorado River over 25 years: effects of herbivory and hydrology", and will quantify long term changes in vegetation composition in the Kawuneeche valley based on the observations and measurements of Shaunda Wenger, Scott Woods and Rod Chimner in the early to middle 1990s and more recent analyses of Kristen Kaczynski, and Jeremy Sueltenfuss. There have been dramatic and significant changes during this period, and we will quantify those changes and their importance to the functioning of the Kawuneeche Valley. We will also digitize ground photographs, rephotograph as many as possible, and make these available for archive.

A second paper will be foundational for quantifying the major vegetation and soil types of the valley and their distribution along hydrologic and topographic gradients. The goal of this paper is to create a hydrogeomorphic model of the valley showing the patterns of ground water movement from slopes to the valley center and the role of river dynamics and beaver in creating the alluvial valley center.

A third paper will expand on the Westbrook et al. (2006) model of beaver influence of the hydrologic regime of the Colorado River. In the original work, data collected in 2002-2004 were used to identify the role of beaver vs. Colorado River floods in raising water tables and inundating the Colorado River floodplain. In this paper we will use those concepts to identify and map areas of the Colorado River valley that can be flooded by high stream flows events, and those that can only be inundated by main stem Colorado River beaver dams, and those controlled by ground water inflow from the valley walls. These data can help identify areas where riparian vegetation restoration and preservation to support beavers is essential for restoring the hydrologic regime and vegetation of the Colorado River valley.

Ongoing work by the I&M program is also linking water supply and wetland hydrology to beaver habitat use at many of the sites we propose to resample here. How water moves through wetland systems as precipitation, ground water input, runoff and evapotranspiration plays an important role in wetland water table depths. Beaver directly impact water balance (i.e., Fairfax et al. 2018; Fesenmyer et al. 2018) and the current lack of beaver in the park will likely play an important role - especially as precipitation and temperature shifts with climate change.

Synthesis

Long term perspectives, particularly when based on quantitative data collected over many decades, provide an invaluable information base to understand ecosystem dynamics and changes. We propose to develop several long-term data sets by resurrecting historic data sets and resampling to provide a quantitative analysis of change over time. All data will be archived with the National Park Service and all analyses will be provided as reports to RMNP and all will be published in peer-review journals. These data and analyses will provide an invaluable baseline resource for RMNP. We proposed to conduct these analyses during the summer of 2020, with the vegetation data being collected primarily during the first full week in August.

Budget and Budget Justification

ITEM	TOTAL COST
Salary	
PI/AP	6000
 Travel	
Shaunda Wenger	700
Rod Chimner	200
Cherie Westbrook	1100
Kristen Kaczynski	750
Ed Gage	200
Jeremy Sueltenfuss	200
David Cooper	200
Billy Schweiger	200
 Housing	2400
Rental cars	804
 Subtotal	12754
Indirect Costs	2232
TOTAL REQUESTED	14986

This effort will bring together critical scientific players in the hydrology and vegetation of the Colorado River and its wetlands and riparian areas, including Big Meadows and other fens. We request salary for Erin Cubley who will just have finished her PhD and will work as a post doc for this project, and Ed Gage who will act as surveyor for all projects requiring considerable effort before and during the studies as well as the PI. Erin will organize all data prior to the meeting and assist with all analyses and writing for all papers in this project, and install data loggers in wells as soon as the snow melts in spring 2020. Other participants will not receive salary for this

effort, and volunteer to assist RMNP in this effort. All participants who live outside of Colorado will be provided with funds for airline travel (Westbrook, Kaczynski, Wenger). All members of our team will receive a small stipend for per diem (\$200) and other expenses to conduct this work. We will rent one house near the Kawuneeche Valley Visitors Center to house all participants for an entire week that we will conduct these field studies.

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