Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Upland Processes and Controls on September 2013 Mass Movements, Rocky Mountain National Park

Discipline: Natural
Type of Project: Research
Funding Agency: National Park Service
Cooperators: Colorado State University
Student Involvement: yes, Master's student
Effective Dates: 5/1/2014 – 12/31/2016
Funding Amount: $77,837 [FY15: $10,000; FY14: $67,837]

Investigators and Agency Representatives:
NPS ATR: Paul McLaughlin, Ecologist, RMNP, 1000 Hwy 36 Estes Park, CO 80517, Paul_Mclaughlin@nps.gov, 970-586-1282

Investigators: Sara Rathburn, Department of Forest, Rangeland and Watershed Stewardship, Colorado State University, Fort Collins, CO 80523, Phone: 970-491-6956, sara.rathburn@colostate.edu

Project Abstract: In mountainous areas of the world, abrupt mass movements occur frequently and are important geomorphic disturbance processes that shape high-relief landscapes. These mass movements are the primary sediment transport processes in high alpine environments, and a key mechanism for sediment reaching low-order stream channels The large sediment volumes transported during mass movements result in debris fans at tributary junctions within valley bottoms that may alter main stem channel slopes and geometries (Wohl, 2014) and generate diverse spatial arrangements of channels in drainage networks (Korup et al., 2010; Korup, 2013). Over time, the results of these mass movements create spatial and temporal variations in sediment delivery to downstream receiving waters (Benda, 1990; Korup et al., 2004, 2010). In addition, mass movements can pose a significant hazard to people, structures, and infrastructure. Understanding how mass movements are triggered and the dynamics of sediment transport can significantly increase public safety.

One factor that influences the occurrence of mass movements includes intense or long-duration rainfall. Extreme rainstorms in September 2013 initiated numerous mass movements and flooding of major rivers within the northern Colorado Front Range. Rainfall was especially intense in mountainous regions surrounding Estes Park and nearby Rocky Mountain National Park (RMNP), with precipitation over a 10 hour period totaling more than 12 cm (Colorado Climate Center, 2013). Numerous mass movements occurred in RMNP as a result of the extreme rainfall, and the associated debris deposits are of great concern because of impacts to public and park buildings and infrastructure both inside and outside RMNP boundaries, and the prospect of ongoing hazards.

Previous work on mass movements in RMNP has focused on a qualitative assessment of debris flows (Caine, 1984), debris flow-induced aggradation in high elevation ponds (Menunous, 2000), wetland aggradation attributed to debris flows (Rubin et al., 2012), the role of Grand Ditch and/or bedrock hydrothermal alteration in initiating debris flows within the Upper Colorado River valley (Grimsley et al., submitted), and initial mapping of the extent of landslides resulting from the September storms, including affected areas in RMNP (Godt et al., 2014). The Caine (1984) analysis designated debris flows as "slight" within the subalpine forests (between 2800m and tree line), and Godt et al. (2014) conclude that the widespread, extensive nature of the September-storm induced landslides is "rare." One goal of this research is to evaluate whether the mass movements were low probability events, precipitated by anomalous hydroclimatic conditions, or are likely to recur in the future.

Two areas of mass movements in RMNP triggered by the September 2013 storms are ideal locations to explore many of the issues within the context of immediate Park management concern. These include debris deposits at Twin Sisters and Cabin Creek, and a subbasin of Bighorn Creek, both of which pose continued hazards to park structures and adjacent private property. Initial post-flood work indicates the Bighorn Ranger Station is built on older debris fan deposits (E. Bilderback, pers. comm.), suggesting a history of mass movement and subsequent deposition in that area.

The goals of this research are to evaluate the geomorphologic factors that contributed to the recent mass movements in RMNP, and to assess the history of debris fan deposition. As such, the main research objectives are to (i) evaluate the conditions that contributed to initiation of mass movements from the September storms, and look for similar landscape relationships in other areas of RMNP, and (ii) develop a chronology from debris fan deposits at sites with park structures to establish mass movement history and fan deposition.

Outcomes with Completion Dates: A timeline of May 2014 – May 2016 is proposed, with a Masters student in the Department of Geosciences at Colorado State University completing two field seasons within the study site. One Master's thesis within Geosciences at CSU will result from this project.

Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Keywords: Mass movement, fan deposition, Rocky Mountain National Park, AK, Colorado State University