**Project Summary**
**Rocky Mountains Cooperative Ecosystem Studies Unit**

Project Title: Who's the Culprit? Food Web Structure and the Stability of Alternative Stable States on Yellowstone's Northern Range.

**Discipline:** Natural
**Type of Project:** Research
**Funding Agency:** National Park Service
**Other Partners/Cooperators:** Colorado State University
**Effective Dates:** 7/1/2010- 3/1/2012
**Funding Amount:** $17,643

**Investigators and Agency Representative:**
NPS Contact: Roy Renkin, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190; 307-344-2161; roy_renkin@nps.gov

Investigator: David Cooper, Department of Forest, Rangeland and Watershed Stewardship, Colorado State University, Fort Collins, CO 80523, Phone: 303-499-6441; dcooper@rm.incc.net

Researcher: Kristin Marshall, PhD Research Assistant, Graduate Degree Program in Ecology, **Colorado** State University, Fort Collins, CO 80523, kmarsh2@lamar.colostate.edu

**Project Abstract:** The idea that communities and ecosystems can exist in one of multiple, alternative states has provided an important theoretical framework for organizing thinking about broad-scale, ecological change in natural and human dominated systems. Historic observations suggest that herbivory by elk populations forced a state-transition on the landscape on the Northern Range in Yellowstone National Park. Two states appear to characterize this landscape. In the historic elk-beaver-willow state, streams were embedded in communities of tall willows that provided food and construction material to beaver. Beaver dams punctuated the stream network, creating conditions that were ideal for willow establishment and growth. Thus, beaver and willows formerly thrived as mutualists, but it appears that competition with elk during the last century excluded tall willows and beaver from the landscape. It has been widely suggested that trophic disturbance created by the reintroduction of wolves to Yellowstone has released hedged willows and triggered a change from an ungulate-grassland state to the former beaver-willow state.

Research by the PIs suggests that browsing intensity has remained relatively constant and intense (ca 70 percent of aboveground primary production) despite changes in predator-prey relations. These findings cast doubt on the operation of a trophic cascade on the Northern Range. However, there is a critical piece of evidence that is needed to interpret trophic effects in Yellowstone. Although a trophic cascade depends on an assumed food web linkage among wolves, elk, and willows, there is scant evidence that elk are, in fact, responsible for the majority of willow browsing on the Northern Range. Two potential explanations for the observation of intense and temporally constant browsing on willows are:

1. Elk herbivory is insensitive to predation risk and/or changes in elk numbers, and remains high in the face of declining elk numbers and purported behavioral effects.
2. Elk herbivory has declined due to numerical and behavioral effects of wolves, but an increasing bison population continues to maintain high browsing pressure on willows despite reductions in herbivory by elk.

Because bison are largely insensitive to predation by wolves on the Northern Range, the operation of a trophic cascade depends on identifying the species of herbivore browsing on willows. The proposed research identifies the species that are browsing willows on the Northern Range using remotely triggered cameras at riparian sites with known browsing history. A hierarchical Bayesian occupancy model will be used to estimate probabilities of occupancy of browsing or non-browsing elk and bison.

This research will lead to important inferences about the dominant browsers on willows on small streams across Yellowstone's Northern Range. Specifically, the occupancy analysis will discern between the two hypotheses and describe spatial and temporal variation in ungulate browsing. More broadly, results from this work inform the role of food web structure in mediating trophic cascades, alternate stable states, and regime shifts.

**Outcomes with Completion Dates:** December 31, 2011
The products include: 1. A report which characterizes and summarizes the digital images, resulting in an analysis of site occupancy status and probabilities, leading to inferences on the dominant overwinter browsers in willows of small streams on Yellowstone's northern range; 2. An article for the publication *Yellowstone Science* and relevant materials for inclusion in the

National Park Service Research Learning Center website, detailing the project work identified in this Task Agreement and including the implications for trophic interactions on Yellowstone's northern range; an 3. The (15) Reconyx 55 infrared motion-triggered cameras, (22) battery packs, (3) chargers, (15) memory cards, (15) cable locks, and (15) drying packs purchased for this effort will be returned to Yellowstone National Park, as is, and transferred to the property inventory of the Wildlife Section for use in future winter wildlife monitoring efforts. CSU will not be responsible for lost or damaged items.

**Keywords:** browsers, willows, Northern Range, food web structure, trophic cascades, alternate stable states, regime shifts, Yellowstone National Park, Colorado State University