Collaborative Research: Modeling the Tradeoffs within Food-, Fear-, and Thermal-Scapes to Explain Habitat Use by Mammalian Herbivores

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Project Summary

Understanding factors that shape patterns of habitat use and resource selection is a central issue in animal ecology. Specifically, how individuals balance conflicts between foraging, predation risk, and the challenges posed by the abiotic environment is a classical question in animal behavior. Numerous studies in both terrestrial and aquatic systems have demonstrated that foraging behavior, and thus habitat use, is constrained by chemical and physical traits of food (including food quantity and quality, and spatial and temporal variation), predation risk (both direct and indirect), and the thermal environment. Although theory predicts that animals can integrate constraints of these habitat characteristics through a series of tradeoffs, balancing costs and benefits to achieve solutions that maximize fitness, few studies have adequately assessed how multiple variables interact at scales functionally relevant to a foraging animal.

Here, we offer a new and synthetic approach for understanding functional links between habitat features and habitat use that allow us to predict resource selection and infer habitat quality. This approach uses both theoretical and empirical work in the laboratory and field, and combines behavioral, nutritional, chemical, spatial, and physiological ecology to comprehensively evaluate the factors that influence habitat use by both a generalist and specialist herbivore. Our overall goal is to elucidate the functional relationships between mammalian herbivores and four interacting habitat features: nutrients and toxins in food (food-scape), security cover (fear-scape), and thermal cover (thermal-scape) to understand how individuals trade off resources, and to predict behavioral responses to habitat heterogeneity.

We will evaluate tradeoffs using sagebrush (*Artemisia* spp.) and two sympatric mammalian herbivores that vary on their reliance on sagebrush for food and cover: the specialist pygmy rabbit (*Brachylagus idahoensis*) and the generalist mountain cottontail rabbit (*Sylvilagus nuttallii*). We will leverage our unique study system to pursue two integrative objectives central to meeting our goal. **Objective 1:** Develop and test a theoretical model that predicts the perceived value of food and cover by captive specialist and generalist mammalian herbivores based on interactions among nutrients, toxins, security and temperature by expanding current giving-up density (GUD) models. **Objective 2:** Develop and test a spatially-explicit hierarchical model of tradeoffs made by foraging animals by simultaneously quantifying how heterogeneity in the quality of food, security and the thermal environment influences habitat use by free-ranging mammalian herbivores.

The intellectual merit of this project includes development of a new approach for evaluating habitat value based on experimental manipulations and observational work with captive and free-ranging animals that will facilitate both mechanistic and comprehensive tests of functional habitat relationships. Use of integrative models to identify potential tradeoffs and unexpected interactions among habitat features will enhance the ability to predict and plan for the consequences of environmental change. The approach for evaluating habitat quality in our relatively simple study system will provide a model for building functional understandings of animal responses to environmental changes in more complex systems.

The broader impacts of this project include a novel educational model that trains graduate, undergraduate, and high school students who will conduct research collaboratively across three Universities, participate in a tiered mentoring program, and engage with the community and regional biologists. This research and educational program is designed to broaden the scientific experience of students, to foster collaborations between academia, land management agencies and the public, and to contribute to society by providing models that predict how animals will alter their use of habitats in rapidly changing ecosystems.