***Overview:*** A primary goal of animal ecology is to understand how resources mediate population-level processes in consumer communities, which requires connecting physiological processes within individual animals to population- and community-level dynamics. We propose to use longitudinal data on primary production and diet composition of individual small mammals in a desert ecosystem to link seasonal variation in resource quality and quantity to consumer foraging, physiology, population size, and survival. We will then construct mechanistic foraging models in conjunction with an algorithmic mapping framework to generate a low-dimensional representation of consumer foraging strategies with known constraints, thereby quantifying the fundamental foraging niche. This representation, as well as fitness expectations generated therein, will be directly compared to realized niches quantified by our high-resolution empirical data on diet composition, forage quality, and measures of survival. Our framework thus couples a unique suite of empirical data with theory, allowing us to explore how climate-mediated shifts in resource landscapes impact consumer dynamics and community composition in rapidly changing ecosystems.

***Intellectual Merit:*** Our study will address three key questions: ***Q1) How does temporal variation in resource abundance and diversity influence individual- and population-level resource use in a desert mammal community?*** We will quantify resource selection by both primary and secondary consumers using a combination of fecal DNA metabarcoding and stable isotopes. This will enable us to distinguish foraging specialists from generalists with a high degree of taxonomic resolution across a resource landscape that varies in resource quantity (i.e., biomass) and quality (e.g., nitrogen content, metabolite diversity). ***Q2) Do resources of different nutritional quality––nitrogen content, seed size, secondary metabolites, non-structural carbohydrates––correlate with consumer functional characteristics, including body condition, gut microbiome composition, and survival?*** Understanding how the nutritional quality of resources is related to physiologically mediated functional characteristics of consumers is a critical but poorly resolved step in linking resource availability to population and community dynamics. We will combine the data generated in Q1with direct measurements of forage quality to quantify their impact on consumer physiological characteristics, survival, and population size, providing unprecedented insights into how resource selection influences fitness. ***Q3) How do realized dietary niches map onto the fundamental foraging niche manifold, and are associated fitness consequences predictable?*** We will incorporate the empirical data from Q1-Q2into an interpretive framework based on complementary theoretical approaches: (*i*) a set of mechanistic foraging models that combine resource and consumer constraints in a fitness-maximization framework, and (*ii*) a diffusion mapping approach that compares the empirical observations of rodent foraging to the nonlinear, multi-dimensional foraging strategies simulated by mechanistic models. This approach will establish a fundamental niche-space against which observed foraging data generated from *Q1* are compared, and from which consumer fitness can be predicted by utilizing relationships produced from answering *Q2*.

***Broader Impacts:*** Our field-based project lies at the interface between ecology, physiology, and theoretical biology. This will provide many opportunities to teach STEM undergraduate students across disciplines using combined hands-on and classroom learning. This research will engage three Ph.D. students and 6–10 undergraduates in research at two minority-majority universities with large Hispanic and Native American populations. Each spring we will also teach an open enrollment two-week field school at the UNM Sevilleta Field Station, where we aim to engage 10–20 undergraduates per year and introduce them to cutting-edge lab and field techniques in ecology and physiology. Postdoctoral scientists and graduate students will be involved in teaching and managing this course, and undergraduate students will be recruited from UNM, UCM, BU, and UW to take part in field and lab activities associated with our project, which we anticipate will produce publishable student-led independent research projects.