USGS NSF GRIP Opportunity

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USGS Center:	Western Ecological Research Center
Project Title:	Prey attributes and predator control: how do sea urchin behavior, condition, size structure and habitat use influence predation rates by the sea otter, Enhydra lutris?
Project Hypothesis or Objectives:	Higher level predators can have very strong influences on the structure, functions and dynamics of ecosystems by controlling prey that are highly influential ecosystem engineers. One well known example of this is the sea otter-sea urchin-kelp trophic cascade described in the Aleutian archipelago and Southeast Alaska. When sea urchins are uncontrolled by predators in those systems, they can overgraze forests and create alternative “barrens” states, devoid of kelp. This keystone role of sea otters is contingent on how attributes of their prey and habitat (i.e. refugia from predators) influence the otter’s foraging rate, behavior, and distribution. Key prey attributes include (i) condition (largely determined by their gonad production), size-structure, density, and behavior (extent to which they are exposed or hidden in cracks and crevices). Key habitat factors are refuge availability (cracks and crevices) and cover of macroalgae. The purpose of this study is to determine the relative contributions of these prey and habitat attributes to sea otter foraging patterns (diet, distribution) and success (urchin biomass consumed per unit time). How sea otters respond to these variables is critical to their ability to control outbreaks of sea urchins. At high densities, urchins are often starved and poor condition. If otters avoid these prey to forage elsewhere, the will not control high density patches of urchins. The proposed project will expand on an existing experimental study aimed at teasing apart the additive and synergistic effects of multiple predators (sea otters and sea stars) in this system, and focus on examining how patchiness in otter foraging behavior and the abundance, accessibility, and quality of urchin prey are likely to influence the ability of otters to control urchin abundance. We will employ field surveys and lab experiments to determine whether and

	how sea otters respond to the separate and combined prey and habitat attributes described above. We will explicitly link observations of otter foraging behavior with targeted underwater surveys of prey characteristics and lab-based prey quality assessments to test the hypothesis that local rates of predation are related to one or more of these traits of urchin populations. In central California, high densities of exposed urchins have recently developed in concert with a sea star wasting epidemic along the West Coast. The results of this work will (i) advance our understanding of how aspects of prey populations and habitat features can influence critically important predator-prey interactions, (ii) how these variables interact via a predator-herbivore-alga trophic cascade to influence community structure, stability and resilience, and (iii) shed light on how these species interactions contribute to the stability of these forests that are the foundation of productive commercial and recreational fisheries.
Duration:	12 months
Internship Location:	Santa Cruz, CA
Field(s) of Study:	Community Ecology, Ecosystem Dynamics, Fisheries, Wildlife Biology
Expected Outcome:	Results of this project will advance our understanding of how sea otters and, more generally, trophic interactions ameliorate ecosystem-wide consequences of large scale perturbations (sea star epidemics, sea urchin population explosions) in marine ecosystems. This knowledge bears directly on a number of USGS Ecosystems Science Strategy objectives: in particular, to reveal ecological patterns and processes, explain how and why ecosystems change, and forecast change over different spatial and temporal scales.The intern will receive direct mentorship and hands-on experience in the design, implementation, analysis and writing of marine ecological research. They will also develop a firsthand understanding of the USGS mission and research efforts. This internship will result in the publication of at least one paper in the peer-reviewed literature.
Special skills/training Required:	Enrolled in a Master's or PhD program in ecology, marine biology or related discipline (environmental science, wildlife biology, etc.) required. Background in bio-statistics preferred. AAUS certified Scientific SCUBA diver required. MOTC small boat operator certification required.
Duties/Responsibilities:	1. Conduct SCUBA-based surveys to quantify the density, size, and accessibility of urchin prey over the distribution of sea otter foraging observations along the Monterey peninsula. 2. Perform lab-based gonad assessment for a subset of

urchins collected at each site as a measure of urchin condition (energy density).

3. Perform multiple regression analyses to determine how urchin density, size, accessibility, and condition explain variation in otter prey selection, foraging distribution and success (prey biomass per dive, dives per unit time) across the study site.

4. Generate a publication of project results in the peer-reviewed literature.