

## PROGRESS REPORT

### Hovel and Regan: Eelgrass in San Diego Bay: Assessing Eelgrass Habitat Function for Recreationally Important Species

Funding dates: February 1, 2008 – January 31, 2010

Progress report date: August 29, 2008

#### Summary of project:

The goal of this proposed project is to enhance our knowledge of the function of seagrass as a habitat for recreationally important species in San Diego Bay (SDB). In SDB, eelgrass serves as a habitat for a variety of species such as juvenile giant kelp fish, barred and spotted sand bass, calico bass, and spiny lobster. Eelgrass may serve as an important refuge for these species, particularly in their juvenile stages, and eelgrass houses many small invertebrates that provide food. Despite the widely cited function of eelgrass as a nursery habitat for species such as these, critical information regarding the function of this habitat is missing. We plan to conduct experiments focused on eelgrass habitat structure in the field and in the lab to provide a more complete understanding of how eelgrass functions as a foraging and refuge habitat for organisms in SDB. We will integrate these experiments with a mathematical model that allows us to greatly increase the scope of the results. We also plan to use our experiments and model to educate San Diego's youth about marine ecology and the importance of habitat in SDB. In addition to educational benefits for K-12 students, undergraduate, and graduate students, our project will benefit SDB by informing predictions of the consequences of eelgrass loss for SDB organisms, and will provide improved ability to restore seagrass in the event of habitat loss.

#### Expected results and progress:

The expected results listed in our proposal were:

1. By fall 2007, we will complete a field experiment in San Diego Bay that examines how seagrass habitat characteristics interact with predation to dictate the abundance and distribution of several seagrass-dependent species.
2. By summer 2008, we will complete laboratory experiments focused on the effects of organismal behavior on prey survival.
3. By winter 2008, we will complete a revised version of our predator-prey model using information gleaned from field experiments that predict the consequences of eelgrass loss for SDB. We also will meet with Port personnel to describe the scope of our findings, and submit recommendations for conservation and restoration of eelgrass in SDB based on our findings.
4. By spring 2009, we will complete a program in which SDSU graduate students and faculty teach K-12 students in two local afterschool programs about the value of SDB habitats for marine species and the value of using mathematical tools to study marine animals.

Our progress to date on these expected results is:

1. *Complete a field experiment in San Diego Bay that examines how seagrass habitat characteristics interact with predation to dictate the abundance and distribution of several seagrass-dependent species:* The field experiment in SDB has been completed. This study was the major portion of a master's thesis for a San Diego State University graduate student, Eliza Moore. In this study, sampling and experimentation were used to determine the preferred habitat of fishes (predators) and invertebrates (prey). We sampled within the edge and interior of eelgrass beds in three locations in SDB for fish abundance and diversity, abundance and diversity of invertebrates, and eelgrass habitat structure. Briefly, we found that eelgrass habitat structure increases from the edge to the interior of beds, that fish preference for edges or interiors varies by species, and that many epifaunal invertebrates prefer dense eelgrass, regardless of location within the bed. In an accompanying field experiment in which we controlled fish (predator) access to discrete areas of eelgrass beds, we found that eelgrass complexity (e.g. the density of eelgrass shoots, or relative biomass of shoots) was the overriding factor in dictating where most small invertebrates (that serve as food for fishes) would be found. However, variation in this trend was prominent, with different species having different preferences. We supplemented this field experiment with additional sampling and experimentation in 2008, the goal of which was to (i) provide another year of data on faunal distribution, and (ii) measure the movement rates of grass shrimp (prey) under different levels of habitat complexity (results are not finalized).
2. *Complete laboratory experiments focused on the effects of organismal behavior on prey survival:* The laboratory experiment is complete and data are being analyzed. In this experiment, we exposed grass shrimp (prey) to fish predators (juvenile giant kelp fish) in laboratory aquaria, and monitored the foraging behavior of fishes and the escape behaviors of shrimp as the amount of habitat structure in aquaria changed. Shrimp and fish were provided with 6 different levels of eelgrass structure, ranging from very low (e.g. 20 shoots per m<sup>2</sup>) to high (e.g. 320 shoots per m<sup>2</sup>). We determined whether the survival rate of shrimp varied with the amount of eelgrass structure (this is known as the "habitat-survival function") but also how fish altered their foraging strategies, and shrimp their escape strategies, with increasing habitat structure. For instance, fishes may have to hunt longer in dense eelgrass to find prey, or prey may rely more on hiding vs. swimming escapes depending on the level of eelgrass structure. The significance of this is that very rarely are the behaviors of organisms documented in experiments determining how habitat structure influences survival (and foraging efficiency). With this information, we can improve conceptual and mathematical models of how these species interact and how changes in eelgrass structure may influence these interactions and the value of eelgrass habitat.
3. *Complete a revised version of our predator-prey model using information gleaned from field experiments that predict the consequences of eelgrass loss for SDB:* In June 2008, PIs Hovel and Regan revised the existing initial mathematical model of how predator and prey organisms interact in eelgrass habitat and how this is influenced by habitat structure. The primary upgrade to the model was the inclusion of habitat complexity (e.g. shoot density and relative biomass) into the digital "landscapes" within which our digital "organisms" interact. Previously, we used the model to evaluate how seagrass habitat fragmentation influenced

predator-prey interactions among fishes (predators) and prey (invertebrates like grass shrimp). Now, we have incorporated variability in eelgrass habitat complexity into the landscapes, and based the patterns of habitat complexity on real maps of SDB eelgrass beds obtained from scans made by a scientific echosounder (data obtained by Hovel and Dr. Kwang-Young Kim of Chonham University in Korea). The scans, made in different seasons, have allowed us to structure the modeled landscapes to simulate those in SDB. We are now awaiting the final data analysis of the lab experiment and field experiment so that we can include those results in the model, specifically, aspects of predator and prey behavior and habitat preferences for each trophic level.

4. *Complete a program in which SDSU graduate students and faculty teach K-12 students in two local afterschool programs about the value of SDB habitats for marine species and the value of using mathematical tools to study marine animals.* This goal is set for completion by spring 2009, so we have not yet worked with K-12 students. However, we have spoken with personnel at Aquatic Adventures, a K-12 afterschool program, about doing this in the fall of 2008.