Levi Lewis
12-18-2007
San Diego State University

Student Grant to Conduct Research on San Diego Bay

Mid-point Progress Report

Project title:

Trophic ecology of seagrass beds in San Diego Bay: *Do predator manipulations result in cascading effects?*

Introduction:

As the human population continues to expand, we are witnessing rapid changes in the environment due to anthropogenic impacts. One of these marked effects has been the global degradation and loss of seagrass habitats (Short and Wyllie-Echeverria 1996, Orth et al. 2006), including those within San Diego Bay (Browning and Speth 1973). Seagrasses are marine flowering plants that construct highly productive and complex habitats that function as important "nursery grounds" for many fish and invertebrate species. The loss of these nursery habitats, concurrent with global declines in fish populations (Pauly et al. 1998, Worm et al. 2006), has resulted in numerous efforts to restore and conserve these essential fish habitats (Heck et al. 2003, Orth et al. 2006).

Many studies have demonstrated the negative effects of nutrient pollution (i.e. eutrophication) and subsequent algal blooms that smother seagrasses; however, others have demonstrated that these effects are regulated by strong 'top-down' (consumption) effects of herbivorous invertebrates that preferentially graze algae (Hughes et al. 2003). Predators of these mesograzers, however, can have significant effects on grazer-epiphyte-seagrass relationships, resulting in trophic cascades that ultimately have negative consequences for seagrasses (Duffy *et al.* 2005). As a result, it has been suggested that the wide-spread overexploitation of top predators (e.g. piscivorous fishes) in aquatic ecosystems could be indirectly contributing to the loss of seagrass habitats (Williams and Heck 2001). Eelgrass *(Zostera marina)*, common to San Diego Bay, has been the most widely studied seagrass species throughout the world; however, relatively few studies have examined how small predators (such as fishes) influence the functioning of eelgrass ecosystems (Duffy et al. 2005), and to my knowledge, none have been conducted in a field setting. While eelgrass restoration and conservation are of great interest within San Diego Bay, the long-term success or failure of these efforts may be strongly influenced by trophic interactions such as grazing and predation.

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Progress Report:

My masters thesis examines the effects of small carnivorous fishes (a 3rd trophic level) on ecosystem function in eelgrass beds within San Diego Bay (Figure 1). I began my masters in Fall 2005 and completed my coursework in Spring 2007 (GPA = 4.0). I completed pilot studies in San Diego Bay in 2006, and conducted the main component of my thesis research in Summer 2007. In May 2007, I manipulated the abundance of microcarnivorous fishes (that eat invertebrate grazers) using a field caging experiment (Figure 2). After 12 weeks, I observed the responses in abundance and biomass of invertebrate grazers and algal epiphytes, and eelgrass performance, to address how small predators affect the functioning of San Diego Bay eelgrass ecosystems via top-down trophic interactions (Figure 3). My results suggest that small predators (e.g. fishes) may facilitate healthy seagrass beds by limiting the grazing and/or tube-building activities of productive invertebrate populations.

I presented my results at the 2007 annual meeting of the Western Society of Naturalists in Ventura CA; the research was well-received. I am currently processing final samples from my Summer 2007 field experiment and plan to conduct complementary laboratory experiments in Spring 2008. I aim to graduate in Spring 2008 and subsequently publish my results in a peer-reviewed journal.

Budget:

Budget forTrophic Ecology of Seagrass Research
(May 25 2006 - Dec 18 2007)

	Category	Total
Expenses	interns	4400.00
	field supplies	5724.34
	lab supplies	1292.18
	travel	1012.62
	various	121.50
	dive costs	48.87
	Grand Total	**12599.51**

	Source	Total
Funding	PADI Grant	5000.00
	SDSU Grant	1000.00
	SCAS Grant	1000.00
	1/3 Port SD Grant	3333.00
	Grand Total	**10333.00**

Net Costs	**-2266.51**

Literature Cited:

Browning, B.M. and Speth, J.W. 1973. The natural resources of San Diego Bay: their status and future. Coastal Wetlands Series #5, Calif. Dept. Fish and Game.

Duffy J.E., Richardson, J.P. and France, K.E. 2005. Ecosystem consequences of diversity depend on food chain length in estuarine vegetation. Ecology Letters. 8: 301-309.

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Hughes, A.R., Bando K.J., Rodriguez. L.F., and Williams, S.L. 2004. Relative effects of grazers and nutrients on seagrasses: a meta-analysis approach. Mar. Ecol. Prog. Ser. 202: 87-99.

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Pauly, D., Christensen, V., Dalsgaard, J. Froese, R. Torres, F. Jr. 1998. Fishing down marine food webs. Science. 279: 860-863.

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Figures:

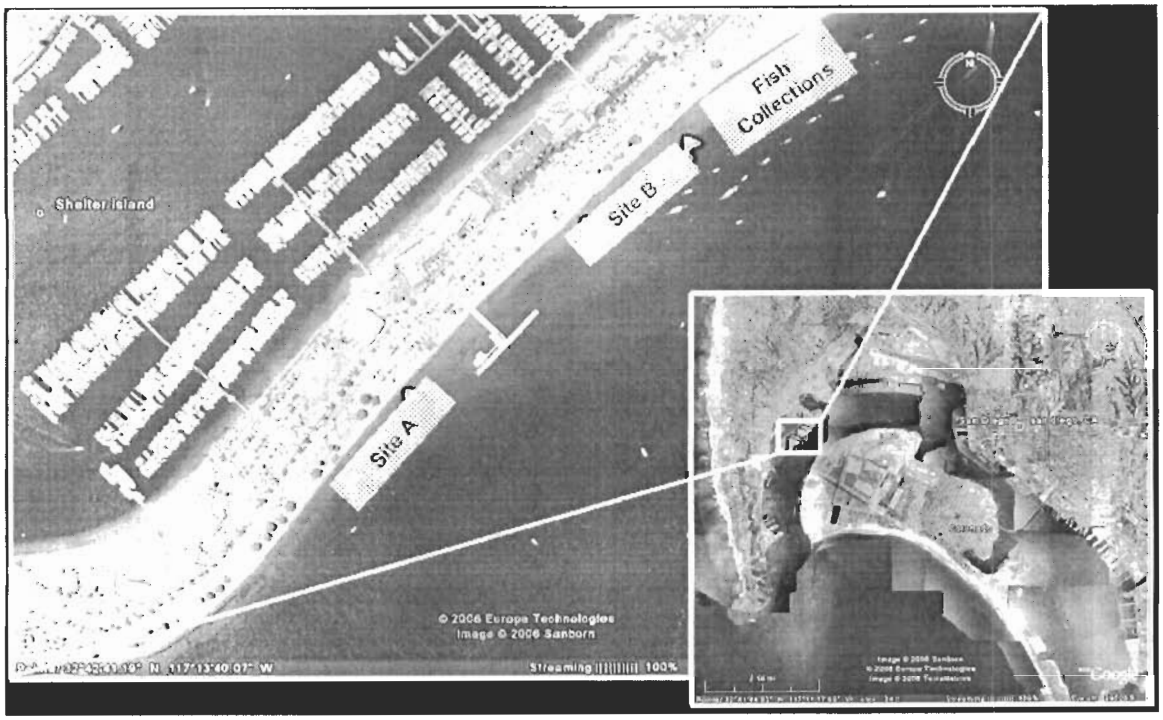

Figure 1 - Study sites near Shelter Island Fishing Pier within San Diego Bay, CA. Experimental plots were established at Sites A and B. Fish collections were conducted northeast of the experimental arrays.

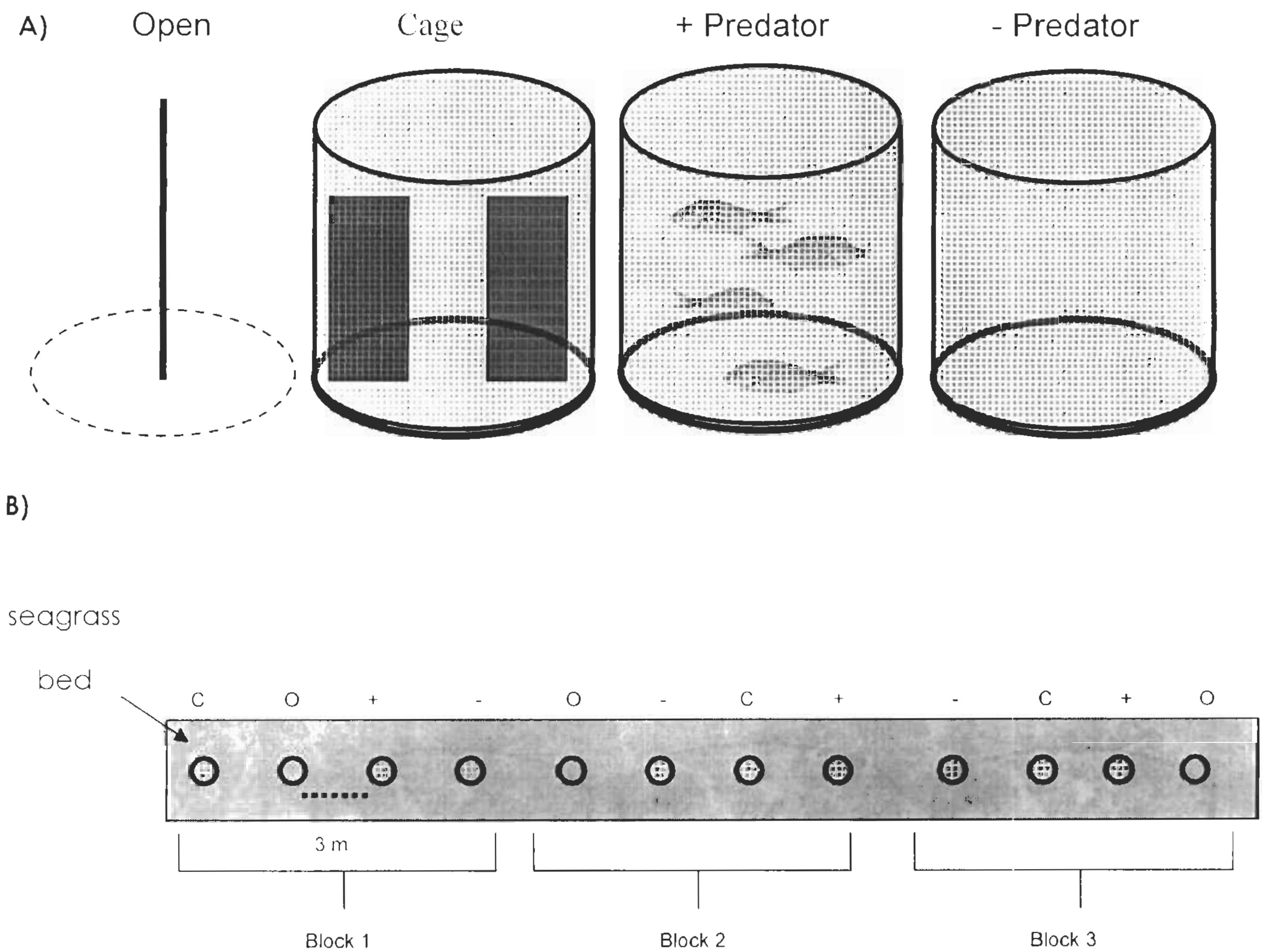

Figure 2 - Experimental Design

(**a**) Illustration of treatments used in field experiment (open plot, cage control, predator presence, predator absence). Predator enclosures received 4 dwarf perch (*Micrometris minimus*) and 2 juvenile kelp bass (*Paralabrax clathratus*). Species were selected based on their relatively high abundances and different feeding habits (determined by preliminary studies in 2006).

(**b**) Illustration of complete randomized block design in Experiment 1 for Blocks 1-3. Treatments = open plot (O), cage control (C), predator enclosure (+), predator exclosure (-). The effects of predator manipulations on invertebrate grazer abundances, algal epiphytes, and seagrass performance were evaluated at the beginning and end of the experiment to address whether microcarnivorus fishes cause trophic cascades in eelgrass.

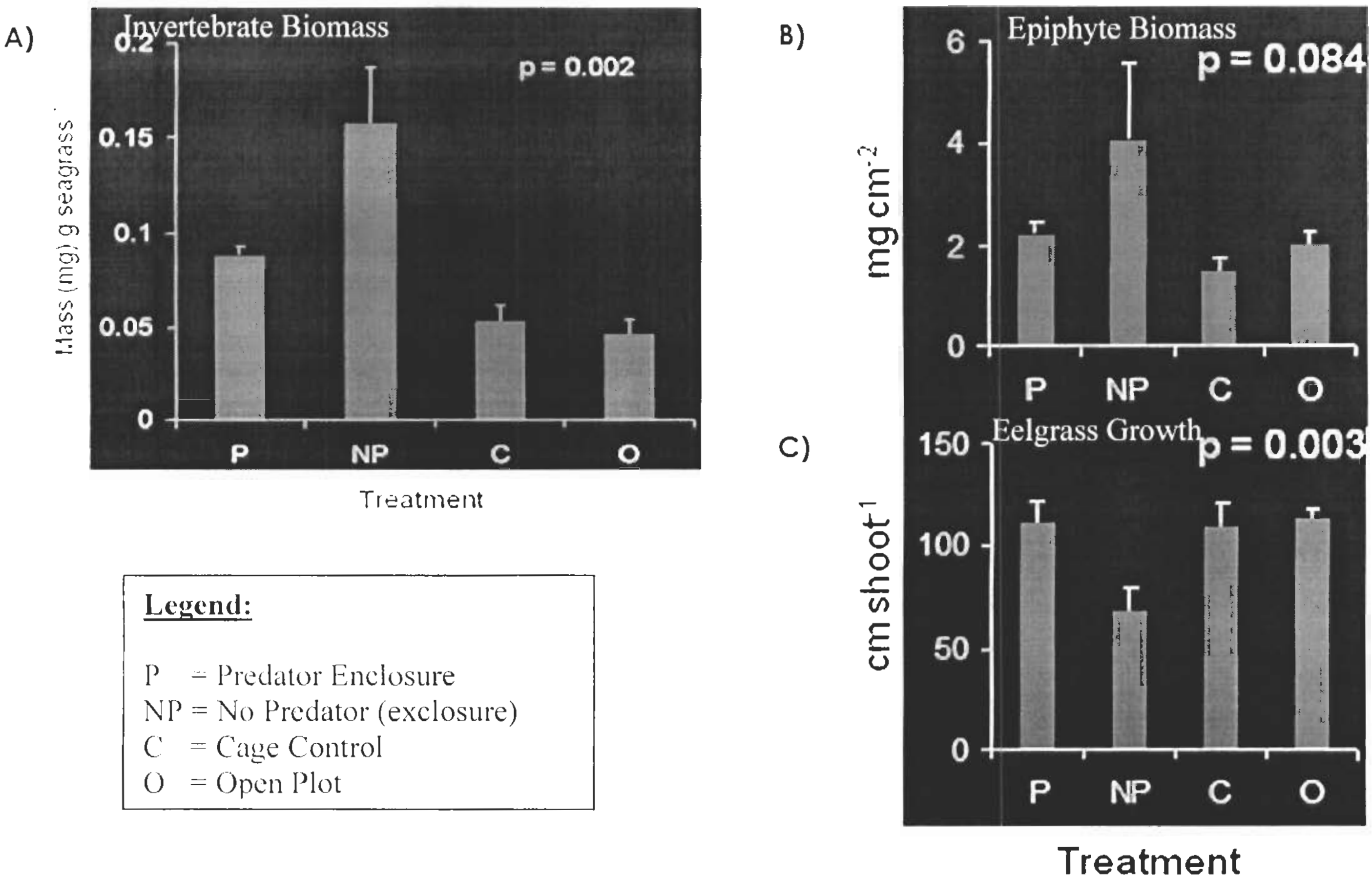

Figure 3 - Results

(a) Invertebrates were 2-3 times more abundant when fishes were excluded than any other treatment. I am continuing to identify the species within the community to evaluate any differences in community structure between treatments.

(b) Epiphyte biomass appeared 2 fold higher in no-predator (NP) treatments, likely due to an accumulation of invertebrate tubes on eelgrass leaves. These differences, however, were not quite significant due to substantial variability.

(c) When fishes were excluded (and invertebrate and epiphyte biomasses were high), eelgrass performed poorly with growth being reduced by 40-50 percent, possibly due to both fouling by invertebrate tube masses and overgrazing.