

Annual Performance Report

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Title: Predicting Seagrass Survival in Nutrient Enriched Waters: Toward a New View of an Existing Paradigm

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Institution: Dauphin Island Sea Lab

Research Category: Estuarine Studies

Project Period: Year 1 of 3

Objectives:

Global riverine discharges of nitrogen may have as much as doubled over the past two centuries due in large part to the 2-3 fold increase in human fixation of nitrogen since 1960 (NAS 2000). This increasing input of nutrients to the coastal ocean has been closely linked to a variety of negative impacts on biological resources (NSF 2000). In fact, eutrophication is arguably the most serious of man's impact on nearshore waters and a variety of recent summaries document the extent of this problem (Bricker et al. 1999; Howarth et al. 2000; NSF 2000; NAS 2000). The most obvious consequences of eutrophication of the coastal ocean include increasing occurrences of hypoxic and anoxic events, elevated frequencies and extents of harmful algal blooms (HABs), both of which are often associated with extensive fish kills, and the overgrowth of extraordinarily productive seagrass meadows and coral reefs by rapidly growing algae (Howarth et al. 2000).

In contrast to freshwater lakes, where phosphorus is primarily responsible for the negative consequences of nutrient over-enrichment, nitrogen is the nutrient that appears to cause most of the harmful effects of nutrient over-enrichment in coastal waters. This conclusion has been reached in the last ten years after a variety of studies in different estuaries demonstrated that nitrogen was most often the nutrient whose availability limited algal growth (Howarth et al. 2000).

An important recent finding is that different types of herbivores can differentially affect algal abundance and species composition because of preferential feeding by different herbivore species on different algal types (Jernakoff et al. 1996; Gacia et al. 1999; Duffy et al. 2001; Hillebrand et al. 2000; Duffy and Harvilecz, 2001). The important implication of these studies is that different suites of herbivores (e.g., gastropods versus amphipods, caridean shrimp or small herbivorous fishes) may have very different effects on the accumulation of algae in areas receiving nutrient enrichment, and that these herbivores may be primary determinants of the degree to which algal overgrowth occurs in the presence of eutrophication. At this time, however, we have inadequate knowledge to predict how adding or subtracting different types of herbivores will influence algal species composition or abundance.

To date, the few existing studies that have simultaneously evaluated the effects of nutrient enrichment and herbivory in the field (most of them referenced above) have all

been restricted to intermediate-sized (one to several square meters) field enclosures. While one can load nutrients at high rates in such experimental plots, it is difficult to sustain water-column nutrient concentrations above the micromolar levels (cf. Heck et al. 2000, Miller et al. 1999) that are characteristic of highly eutrophic coastal waters. In addition, an important limitation of these studies, which greatly restricts their predictive power, is that none of them has tested the effects of herbivore species composition on algal responses to nutrient addition. Therefore, there is reason to question the generality of these few studies, especially since their conclusions are in conflict with the conventional wisdom that eutrophication usually results in algal overgrowth of both the water column and the benthos.

The goal of this project is to test the generality of previous experimental studies, including our own, that found that consumption by small herbivores could greatly reduce the incidence of algal overgrowth in eutrophic coastal waters. We are focusing on seagrass-dominated ecosystems because they are well-documented to serve as nursery habitats for a broad variety of economically valuable finfish and shellfish (see Heck et al. 1997 and Williams and Heck 2001 for reviews), and because eutrophication is strongly implicated in the disappearance of these critically important habitats in the Gulf of Mexico, and the nation as a whole (e.g., Howarth et al. 2000; Bricker et al. 1999). We are testing the ability of different types of small grazers (both individually and collectively) to buffer the effects of eutrophication by conducting field studies at small spatial scales that will allow us to sustain elevated nutrient concentrations at levels that will mimic those of up to the most highly eutrophic of coastal waters. Therefore, we will test the degree to which different types and abundances of herbivores can explain the observed variation in algal responses to eutrophication.

Progress Summary/ Accomplishments:

The first accomplishment of year 1 was the construction of the experimental enclosures. The enclosures were constructed out of clear fiberglass cylinders (12" diameter), and 2' tall. Each enclosure had 5-6 holes drilled in the sides that were covered with 500 μ m mesh to allow water exchange while maintaining grazer treatments within the enclosure. Four PVC pipes were attached equidistant to each other to the outside of the cylinder with fiberglass, so that rebar could be inserted into the PVC to secure the enclosure in the desired location for experimentation.

Following the construction of the enclosures, a Pilot study was conducted from March 18, 2002 to April 19, 2002 to ensure that the integrity of the enclosures could be maintained for the duration of the experiment and to determine the nutrient levels that could be maintained within the enclosures. We also used the pilot study to examine the effectiveness of the suction sampling method to "empty" the enclosures of grazers prior to stocking. We found that the integrity of the enclosures could be maintained and that we could maintain nutrient levels within the proposed range of 10x – 100x. We also found that suction sampling successfully decreased the number of grazers present inside the enclosures by approximately 75%.

Two concurrent, one month studies were conducted in both *Halodule* and *Thalassia* grass beds during the spring and fall of 2002 (year 1). The spring experiments were conducted from June 21, 2002 to July 19, 2002 (*Halodule*) and July 6, 2002 to

August 1, 2002 (Thalassia). The fall experiments were conducted from October 13, 2002 to November 8, 2002 (Thalassia) and October 22, 2002 to November 21, 2002 (Halodule). Due to the depth of the experimental grass beds, the enclosures became submerged at high tide and this presented two issues for the experiment: 1) nutrient levels were not maintained as high as those during the pilot study due to the additional flushing caused by the submergence of the enclosures and 2) the added stress of water rising and receding within the enclosures caused some of the mesh tops to loosen, which could allow grazer ingress and egress. To address these issues we will try to find shallow study sites for year 2 that will prevent the enclosures from being submerged and we will try a different top design to prevent the tops from loosening during the experiment.

Samples from the experiments during year 1 were collected and are currently being processed. Data will be analyzed for grazer and nutrient effects, as well as any interactions.

Expenditures to date are \$73,131.27 of the \$100,825 allotted for year 1. These expenditures include salaries, enclosure construction, experimental supplies and some of the laboratory analyses.

During year 1 there was one personnel change, Dr. Jonathon Pennock was removed as a Principal Investigator, due to his assumption of a new position at the University of New Hampshire. We replaced his expertise with that of Laura Linn. Ms Linn is in charge of the analytical instrumentation at the Dauphin Island Sea Lab.

Publications/ Presentations:

N/A

Future Activities:

During the second year of this study, similar experiments will be conducted in both spring and fall. A new mesh top design will be tested during a pilot study and if successful will be implemented. The QAPP will be completed, as well as sample processing for year 1. Following the completion of the sample processing, the data analysis will begin. Metadata will be created to accompany the data from year 1.

Supplemental Keywords:

Eutrophication, grazer diversity, submerged aquatic vegetation (SAV), Gulf Coast, estuary

Relevant Web Sites:

<http://www.southalabama.edu/aces/>
<http://mas.usouthal.edu/Faculty/heck/index.html>
<http://mas.usouthal.edu/Faculty/valentine/index.html>
<http://www.disl.org/~faculty/kheck.html>
<http://www.disl.org/~faculty/jvalentine.html>

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