Report for 2003TX89B: Biotic Responses to Reduced Freshwater Inputs into Texas Bays: Hypersalinity Effects on Benthic Microalgal Community Structure and Function

- Other Publications:
  - Gould, D. M. & E. D. Gallagher. Field measurement of specific growth rate, biomass, and primary production of benthic diatoms of Savin Hill Cove, Boston. Limnology and Oceanography, v.35, n.8, 1990, p.1757-1770. 1990.
  - Lee, Alyce, Pinckney, James. "A Spatial Study of Benthic Microalgae in an Intertidal Sandflat at East Beach in Galveston, Texas." (Poster)

Report Follows

Biotic Responses to Reduced Freshwater Inputs into Texas Bays: Hypersalinity Effects on Benthic Microalgal Community Structure and Function

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This report addresses the important research being done under this grant, experiments performed and the preliminary results, progress on my degree plan, papers or poster presentations and any publications, expenditures of the funds, and other work supported by this grant. The primary focus of this project is the impact that salinity in Galveston Bay, Galveston, TX will have on benthic microalgae (BMA) should it increase due to decreased freshwater into Galveston Bay. Freshwater entering the Bay is expected to decrease in the future because of an increase in the human population within the Galveston Bay watershed, thereby increasing freshwater consumption.

BMA may be a significant source of carbon in Galveston Bay, which helps to support the higher trophic levels. Marine food webs are very dynamic and susceptible to change; therefore, any change in BMA production could alter carbon and energy flow to higher trophic levels. A change in salinity could affect BMA production, which is the basis for this project's null hypotheses. The hypotheses to be examined are; $\boldsymbol{H_{01}}$**:** A 25% increase in salinity will not result in a significant shift in BMA community composition at an intertidal sandflat at East Beach, Galveston Island, Galveston, TX., and $\boldsymbol{H_{02}}$**:** A 25% increase in salinity will not result a reduction in BMA biomass and primary production at an intertidal sandflat at East Beach, Galveston Island, Galveston, TX.

The preliminary phase of this study has been completed. Two salinity manipulation experiments have been performed, one within the laboratory at Texas A&M University, College Station, TX, and the other *in situ* at East Beach. An additional experiment is scheduled to be done *in situ*, in March 2004. The results from these two experiments have led to improvements in the experimental design which will be implemented in March, 2004.

The first experiment was done under controlled conditions (incubator) in the laboratory. A total of 12 sediment cores (7.8 cm ID) and four 2-liter containers of ambient water were collected from an intertidal sandflat at East Beach, Galveston, TX June 10, 2003. The samples and field water were transported to the laboratory in College Station, TX, where the cores were placed in shallow containers, put into an incubator with an average irradiance of 75 µE m^{-2} s^{-1}, which was significantly lower than ambient

irradiance of approximately 2200 µE m^{-2} s^{-1}. Although the lights in the incubator could not mimic the irradiance level at East Beach, the ambient temperature at East Beach was easily controlled.

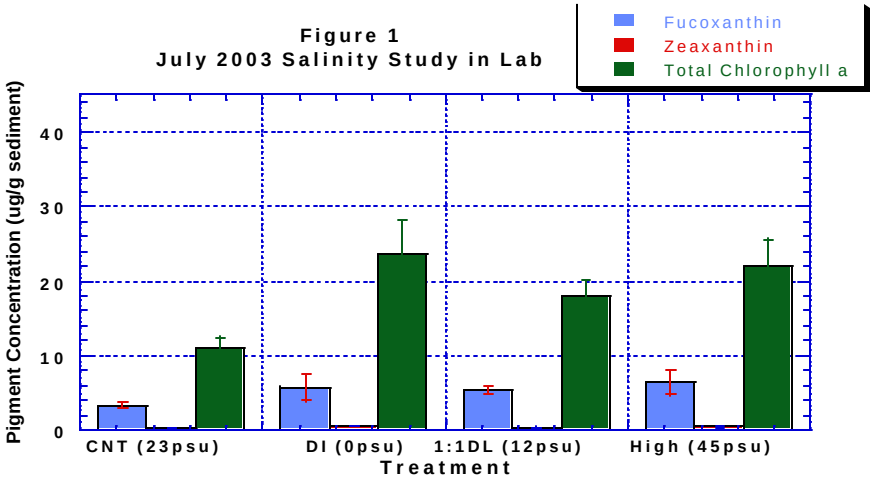
The experiment design consisted of four treatments, control (23psu), deionized water (0psu), 1:1 DL (12psu), and high (45psu) with 9 replicates for each treatment. The field water was placed in the shallow container for the control and for the 1:1 DL treatments was diluted by an equal amount of laboratory deionized water. This water was exchanged every third day. The deionized water treatment used laboratory deionized water and the high treatment used a laboratory mixture of Instant Ocean® and deionized water. The experiment was allowed to run for 22 days.

The second study was performed in the field at an intertidal sandflat at East Beach, Galveston, TX, latitude 29° 20.024 N longitude 094° 44.200 W. The field study allowed for ambient temperature and light to be maintained. A total of 6 sediment cores were collected in petri dishes, placed in shallow containers with 2 petri dishes in each container, and left at the site where the cores were collected.

This experimental design consisted of 3 treatments, control (28psu), deionized water (0psu), and 1:1 DL (14psu) with 6 replicates for each treatment. A high salinity treatment was not added to this bioassay because of insufficient volume of Instant Ocean® and deionized water. As in the previous experiment the field water was placed in the shallow containers for the control and for the 1:1 DL treatments were diluted by an equal amount of laboratory deionized water. This water was exchanged with new water every morning before 9 am. The experiment was allowed to run for 3 days.

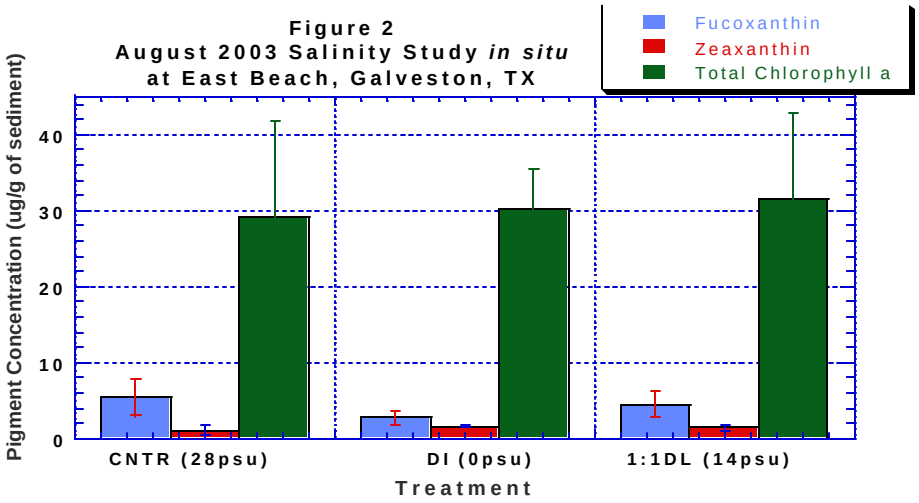
At the end both experiments 3 subcores were collected from each sediment core and petri dish using a 1.1 cm ID polyethylene core tube. The top 3 mm of each subcore was extruded and collected into a microfuge tube, which was then placed in a -80?C freezer until further analysis. The samples were extracted and analyzed by high performance liquid chromatography (HPLC) for photopigment (chlorophylls and carotenoids) determinations. The different pigments concentrations provide a measure of the different algal groups in the sediment and their relative abundances.

Figures 1 and 2 summarize the results of the previous two experiments. In figure 1, there is an increase in total community biomass, indicated by the total chlorophyll *a* pigment, in the DI, 1:1 DL, and high compared to the control. The relative abundance of the diatoms and cyanobacteria, indicated by the pigments fucoxanthin and zeaxanthin, respectively, show very little change between the 4 experimental treatments. BMA showed growth, but community composition did not change. Growth at 45psu was similar to growth at 0psu. Control showed little growth relative to others. Addition of water, regardless of salinity, enhanced growth.



The results from the laboratory are circumspect because of concerns that were observed during the bioassay, which need to be addressed. First, the samples were taken from the field with a light intensity of approximately 2000 µE m^{-2} s^{-1} and placed in an incubator with irradiance intensity approximating 75 µE m^{-2} s^{-1}. The samples might not have been acclimated to the lower light intensity prior to starting the bioassay. Second, the salinity in the field water containers kept increasing during the duration of the bioassay; therefore, the salinity of the samples fluctuated as well. Third, the water in the containers might not have been changed frequently enough, also leading to the fluctuations in salinity. Finally, the experiment might have been allowed to run for too long, which could lead to the salinity fluctuation within the containers.

Figure 2 for the *in situ* experiment illustrates that there is very little significant change in the relative abundance of all three pigments, fucoxanthin, zeaxanthin, and total chlorophyll *a*. This lack of change indicates that the relative abundance of the community has not shifted to favor another algal group nor is the relative abundance of the community as whole affected by the different treatments.



The samples collected for the *in situ* experiment were maintained at an ambient temperature and irradiance. The salinity did not vary between water exchanges for the duration of the bioassay. However, the experiment might have benefited from being allowed to run for one week to see if the biomass doubled. While the growth rate has not been verified for BMA in Galveston Bay, an estimated rate using Gould's (Gould & Gallagher, 1990) results, using a growth rate of 0.21 μ^{-d} indicate that the relative abundance of the total biomass would double in approximately 6 days. Although, the water was exchanged daily, one night during the experiment a storm front moved in and diluted the treatments. Finally, for the last two days of the experiment, morning showers occurred and the water had to be exchanged twice during a 24 hour period.

The results from these two experiments are preliminary and have not been published. The bases of these two studies have illustrated what requirements are needed for future studies for a better assessment of BMA's biotic response to changes in salinity. Irradiance levels and temperature are better represented when the bioassay is conducted in the field than in a laboratory setting. Therefore, future studies will be done in the field. In addition, productivity measurements using microelectrodes will be done on the sediment cores at the end of the experiment and compared to the results from the HPLC analysis. This measurement will also demonstrate if BMA primary productivity is responding to the change in salinity, and if so, by how much. Also, an additional treatment will be added to the experiment, which will be a 25% increase in salinity above the control treatment. This will be done by determining the salinity of the control and adjusting a saline solution of Instant Ocean® to 25% greater than the control.

My dissertation will include a chapter on the effects of salinity on BMA, which is expected to be completed by the end of 2005. I have completed the majority of my coursework as outlined on my degree plan, with the final course being completed in the fall of 2004. Preliminary written and oral exams were completed on November 5, 2003, approved by my committee and the Dean of the Oceanography Department, and

submitted to the Office of Graduate Studies. The proposal defense for my dissertation is tentatively scheduled for sometime in March, 2004.

With respect to the original $4,182, there is $1,775 left in the account as of February 13, 2004. A request for a no cost extension will be submitted in a separate letter addressed to you. The majority of the funds were utilized for travel expenses to and from East Beach, Galveston, TX for sample collection. The remaining funds will also be used for travel costs to East Beach, Galveston, TX in March to repeat the August 2003 *in situ* experiment.

In conclusion, the results of these two experiments were preliminary and allowed me to determine what requirements are necessary for future experiments in order to better address the hypotheses stated. Finally, a final report will be submitted to your office at the end of my dissertation, as well as copies of any papers, abstracts, and citations that come of the work funded by this grant.