Final Report Executive Summary

Period Covered by the Report: January 2001-September 2003

Date of Report: September, 2004

Title: Effects of anthropogenic eutrophication on the magnitude and trophic fate of microphytobenthic production in estuaries

Investigators: Just Cebrian (DISL) and Jonathan Pennock (UA)

Institution: Dauphin Island Sea Lab

Research Category: SGER

Project Period: on paper (07/2000-06/2001); real period: 01/2001-present (non-cost extension granted till 09/2003).

Objective(s) of the Research Project: The goals of the project are two-fold. These two objectives are somewhat different from previous goals of this proposal. We have been re-evaluating our activities and aims as we have been learning more about the system and facing and resolving methodological issues. The final goals that we have accomplished are: (1) to examine the effects of simulated further anthropogenic eutrophication through increased sediment nutrient enrichment and water-column shading on the productivity and metabolism of microphytobenthic communities in Weeks Bay, an already eutrophic subestuary of the Mobile Bay system. The second goal is to elucidate the single and combined effects of sediment nutrient enrichment and grazing by the olive snail (*Neritina reclivata*), which is an important consumer of microphytobenthos in estuaries, on the biomass dynamics of microphytobenthic communities. This research is important to improve our understanding of how increasing human-induced eutrophication may affect the benthic microalgal communities in estuaries, and how consumption by herbivores interacts with eutrophication-induced impacts. Furthermore, because benthic microalgae are key components in estuaries, this research can also help our understanding of estuarine functioning and management under increased human development.

Summary of findings: As indicated below, two scientific papers have resulted from this effort. One has been submitted to the Marine Ecology Progress Series and the other one is in the works (estimated submission time, Spring 2005). Copies are attached. The summary of findings for each paper (corresponding respectively to Goals 1 and 2 above) is as follows:

Fist paper (Goal 1):"Effects of simulated anthropogenic eutrophication on the primary production and metabolism of estuarine microphytobenthic communities"

Microphytobenthic communities are important components of estuarine ecosystems, but the effects of human-induced eutrophication on these communities are not well known. In this study, we investigate the separate and combined effects of decreased light availability and sediment nutrient enrichment, two of the most prominent processes that often accompany human-induced eutrophication, on the primary production, community metabolism and biomass of microphytobenthic communities in two locations of the Weeks Bay estuarine system (Alabama, USA). Seasonally over one year, we ran a two-factorial experiment in 1 m^2 sediment plots for 6 days in each of the two locations. Decreased light availability (50% of natural levels) was achieved by covering treatment plots with shade cloth throughout the experiment and, to fertilize the sediment, we applied a known amount of nitrogen and phosphorus in treatment plots on days 0, 2 and 4 that represented a substantial, stoichiometrically-balanced increase in nutrient availability. The results show a preponderant negative effect of shading on the metabolism and productivity of the microphytobenthic communities examined; irrespective of nutrient enrichment, reduced light availability most often depressed community gross primary production, net production and benthic primary productivity in the fall, winter and spring experiments in the two locations studied. We also found depresses biomass under shaded conditions in the winter experiment in one of the sites. Contrary to the prominent negative effect of light reduction, we did not find any positive effect of nutrient enrichment on the microphytobenthic communities studied, except for a significant increase in biomass under enriched conditions in the spring experiment in one site. The apparent irrelevance of nutrient enrichment for microphytobenthic productivity in our study sites appears to be a consequence of the combination of seemingly growth-saturating ambient nutrient concentrations and natural light

levels that are frequently growth-limiting. These results improve our understanding of how further anthropogenic eutrophication may affect the productivity and metabolism of benthic microalgal communities in nutrient-rich, murky estuarine systems, which, in view of the important ecological roles that benthic microalgae play , represents valuable knowledge for the management and sustainability of these systems.

Second Paper (Goal 2):"Effects of sediment nutrient enrichment and grazing by the olive snail *Neritina reclivata* on microphytobenthic biomass"

Although it is now well known that benthic microalgae are trophically important in estuarine food webs, only a few number of studies have quantified the extent of consumption of benthic microalgal biomass by herbivores, particularly under the influence of nutrient enrichment brought about by anthropogenic eutrophication. The objective of this research is to determine the separate and combined effects of sediment nutrient enrichment and grazing by the olive snail *Neritina reclivata* on the biomass accumulation of microphytobenthic communities in two study sites in Weeks Bay, a subestuary of Mobile Bay (Alabama). To do that, we used rectangular clear and transparent acrylic 'cages' that were 37 cm x 22 cm x 25 cm in size. All cages had windows cut in the sides (four windows per cage) and covered with a translucent 500 µm polyester mesh to exclude the grazer tested. Control plots were rectangular plots on open sediment delineated by flags and the area included was equal to the area of the cages. The cages and control plots were arranged in a randomized block design with ten blocks, where each block included one cage and a control plot. In addition, the sediment of the plots in five out of the ten blocks was fertilized. The results show that herbivory by *N. reclivata* and nutrient enrichment have no major significant effects on microphytobenthic biomass. Specifically, herbivory by the snail had only a marginal negative effect on microphytobenthic biomass accumulation during the summer in one study site, while nutrient enrichment had a positive effect on biomass accumulation during the spring in both study sites and during the fall in one site, only. Thus, it appears that factors other than nutrient enrichment and grazing by the olive snail are more likely to control benthic microalgal biomass in Weeks Bay. The results of this study suggest important implications for this and other eutrophic estuaries. Namely it would appear that higher sediment nutrient enrichment into the bay would not significantly impact the biomass of

microphytobenthic communities. Grazing by *N. reclivata*, although the snail is abundant, also seems to play a minor effect.

Publications/presentations:

Publications:

Stutes, A. L., J. Cebrian and A. A. Corcoran. 2004. Effects of simulated eutrophication on the primary production and metabolism of estuarine microphytobenthic communities (Marine Ecology Progress Series, submitted)

Stutes, A. L., J. Cebrian, S. Phipps and J. R. Pennock. 2004. Effects of sediment nutrient enrichment and grazing by the olive snail *N. reclivata on microphytobenthos biomas*s in an eutrophic estuary (in progress, to be submitted in spring 2005)

Presentations:

Oral:

Stutes, A. L. and J. Cebrian. Measuring microphytobenthic production and consumption using a spectrophotometric technique. 16th Biennial Conference of the Estuarine Research Federation, November 2001, St. Pete (Florida).

Stutes, A. L. and J. Cebrian. Measuring microphytobenthic production and consumption using a spectrophotometric technique. 4 th Annual Graduate Student Symposium, January 2002, Ocean Springs, (Mississippi) (awarded with best presentation of work in progress).

Stutes, A. L. and J. Cebrian. Measuring microphytobenthic production and consumption using a spectrophotometric technique. 31st Annual Marine Benthic Ecology Meeting, March 2002, Orlando (Florida).

Stutes, A. L., A. Corcoran and J. Cebrian. Effects of anthropogenic eutrophication on the metabolism of estuarine microphytobenthic communities: do light levels and nutrient concentrations affect net community production, respiration and gross production?. 33rd Annual Marine Benthic Ecology Meeting. Mobile, Alabama. March 25-28, 2004.

Stutes, A. L., A. Corcoran and J. Cebrian. Effects of reduced light availability and nutrient enrichment on the metabolism of estuarine microphytobenthic communities. ASLO 2004 Summer Meeting, Savannah, Georgia, June 13-18.

Poster:

Stutes, A. L., A. Corcoran and J. Cebrian. Effects of anthropogenic eutrophication on estuarine benthic microalgal communities: Is net community production affected by light and nutrients? 17th Biennial Conference of the Estuarine Research Federation, Seattle, Washington. September 14-18, 2003.

Thesis:

The first publication mentioned above composes the MS. thesis of Adrienne L. Stutes :" Effects of simulated eutrophication on the primary production and metabolism of estuarine microphytobenthic communities ", which was successfully defended in April 2003

Supplemental keywords:

benthic microalgae, microphytobenthos, metabolism, primary production, biomass, eutrophication, sediment nutrient enrichment, light limitation, herbivory, olive snail, *Neritina reclivata*

Relevant web sites:

http://ecosystemslab.disl.org

http://www.disl.org