

Annual Report Summary Format

Period Covered by the Report: January 2006- May 2007

Date of Report: June 27, 2007

Title: Effect of eutrophication on ecological services provided by a shoalgrass (*Halodule wrightii*)/widgeongrass (*Ruppia maritima*) meadow in the north-central Gulf of Mexico: An experimental assessment

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Institution: Dauphin Island Sea Lab

Research Category: SGER

Project Period: January 2006- May 2007

Rationale and objective(s) of the Research Project:

It is well accepted that seagrass meadows provide several important ecological services to coastal communities (Hemminga and Duarte 2000, Heck et al. 2003). First, they constitute suitable habitat for many species of animals. The tridimensional structure of the vegetation offers numerous hiding loci that protect organisms from predation during certain developmental stages or during their entire life-span (Hemminga and Duarte 2000, Heck et al. 2001). Moreover, seagrass beds serve as important nurseries for the juveniles of many fish species (including some important commercial species of juvenile finfish and shellfish) (Heck et al. 2003). Second, seagrass meadows are highly productive communities and support large and complex food webs, as illustrated by the diverse communities that are often encountered in seagrass meadows (Greenway, 1995, Hemminga and Duarte 2000). The organic matter produce by seagrasses and other primary producers in the seagrass meadow may be utilized by animals living in the meadow or by non-resident species. Herbivorous and detritivorous animals consume live or death seagrass blades, epiphytes and macroalgae, transferring organic matter from primary producers to the next trophic level (Hemminga and Duarte 2000). In fact, seagrass leaves and epiphytes are an essential trophic base for the organisms that live within or nearby the meadow. Third, seagrass meadow accumulate large pools of above and below ground biomass and detritus, thereby acting as significant sinks for carbon and nutrients in coastal ecosystems (Duarte and Cebrian 1996).

Seagrass meadows have historically been a predominant feature of many nearshore coastal environments. However, over the past several decades, shifts in producer structure of coastal communities, including loss of seagrass habitat, has been a reoccurring phenomenon worldwide in coastal areas (Fletcher 1996, Hauxwell et al. 2003). As nutrients are increasingly delivered to coastal waters, response by assemblages of primary producers in shallow waters seems to follow a consistent pattern: nutrient-limited macroalgal producers respond by growing at faster rates, macroalgal standing stocks increase and seagrass decline (Duarte 1995, Worm et al. 2000).

The overarching objective of this proposal is to evaluate the effect of increasing nutrient loading (with or without associated macroalgal blooms) on some ecological roles provided by a seagrass meadow composed by shoalgrass and widgeongrass. Specifically,

- First, to assess the effect of nutrient addition on the role of the meadow as habitat.
- Second, to evaluate the effect of nutrient addition on the trophic support provided by the meadow through changes in herbivory and detritivory.
- Third, to determine the effect of nutrient addition on the storage of carbon and nutrients in the meadow.

Hypothesis: The null general hypothesis of this study is:

H0: Nutrient enrichment of the water column in a seagrass meadow does not alter the ecological services provided by the meadow:

- H01: Nutrient enrichment does not change the structural complexity of the meadow and the provision of refuge to organisms.
- H02: Nutrient enrichment does not alter the trophic support of the associated food web through changes in herbivory and detritivory.
- H03: Nutrient enrichment does not modify carbon and nutrient storage in the meadow.

Progress Summary/Accomplishments: The project is now concluded. All field and lab work has been completed satisfactorily. Andrea Anton, the graduate student working on this project, defended her MS on June 13 2007. Her defense and all the work done over the past two years under the scope of this project was highly praised by all her thesis committee members. We have found very interesting results of how increased nutrient loading affects the ecological services offered by the seagrass meadow studied. The results are disparate, ranging from positive to neutral to negative. Andrea's work significantly advances our understanding of how anthropogenic eutrophication affects the functioning of coastal ecosystems and contribute to our ability to develop efficient policies for environmentally-sustainable coastal development.

Publications/Presentations/Students Graduated:

Publications:

Turner, J., L. Allen, A. Anton, M. Miller, R. Swann and J. Cebrian. 2005. SAVING the Gulf: Education, Restoration, Conservation. Mobile Bay National Estuary Program and Mississippi-Alabama Sea Grant Consortium, 32 pages.

Andrea, A., Cebrian, J., Duarte, C. M. and Heck, K. L. 2007. The effects of nutrient enrichment on the ecological services of a mixed seagrass meadow (in preparation)

Andrea, A. and J. Cebrian. The effects of Hurricane Katrina on the ecological functioning of a mixed seagrass meadow (in preparation).

Presentations:

Anton, A., J. Cebrian, C. M. Duarte, C. D. Foster, K. Sheehan, J. Goff and M. E. Miller. The effects of Hurricane Katrina on the Metabolism and Primary Productivity of Seagrass (*Halodule wrightii* and *Ruppia maritima*) meadows. 8th Annual Graduate Student Symposium, Dauphin Island Sea Lab, Alabama, February 3-4, 2006.

Anton, A., C. D. Foster, K. Sheehan, J. Goff, M. E. Miller and J. Cebrian. The effects of Hurricane Katrina on the ecological services provided by seagrass (*Halodule wrightii* and *Ruppia maritima*) meadows. 35th Annual Marine Benthic Ecology Meeting, Quebec City (Canada), March 8-12, 2006.

Anton, A., J. Cebrian and C. D. Foster. The effect of eutrophication on the ecosystem services provided by mixed seagrass (*Halodule wrightii* and *Ruppia maritima*) meadows. 1st Alabama-Mississippi Bays and Bayous Symposium, Mobile (Alabama) November 27-29 2006

Students Graduated: Andrea Anton, MS thesis, June 13 2007

Future Activities: Along with publishing more papers and giving more presentations from the work done with this project, we plan to use the information obtained here as grounds for future proposals.

Supplemental Keywords: Shoalgrass, Ecosystem Services, Eutrophication, Coastal Ecosystems

Relevant Web Sites: <http://ecosystemslab.disl.org>

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Literature Cited:

Duarte, C. M. 1995. Submerged aquatic vegetation in relation to different nutrient regimes. *Ophelia* 41. 87-112.

Duarte, C. M. and J. Cebrian. 1996. The Fate of Marine Autotrophic Production. *Limnology and Oceanography*, Vol. 41, No. 8. Pages 1758-1766.

Fletcher, R. L. 1996. The occurrence of "Green tides"- a review. In *Marine benthic vegetation: recent changes and the effects of eutrophication*, W. Schramm and P. H. Nienhuis (eds). Berlin: Springer, 7-43.

Greenway, M. 1995. Trophic relationships of macrofauna within a Jamaican seagrass meadow and the role of the echinoid *Lytechinus variegatus* (Lamarck). *Bulletin of Marine Science*, 56. Pages 719-736.

Hauxwell, J., Cebrian, J. and I. Valiela. 2003. Eelgrass *Zostera marina* loss in temperate estuaries: Relationship to land-derived nitrogen loads and effect of light limitation imposed by algae. *Marine ecology Progress Series*. Vol 247. pages 59-73.

Heck, K.L., Pennock, J. R., Valentine, J. F. Coen, L. D. and S. A. Sklenar. 2000. Effects of nutrient enrichment and small predator density on seagrass ecosystem: An experimental assessment. *Limnology and Oceanography*, 45(5). 1041-1057.

Heck, K.L, Coen L. D. and S. G. Morgan. 2001. Pre- and Post-settlement factors as determinants of juvenile blue crab *Callinectes sapidus* abundance: results from north-central Gulf of Mexico. *Marine Ecology Progress Series*. Vol. 222. pp. 163-176.

Hemminga M. A. and C. M. Duarte. 2000. *Seagrass ecology*. Cambridge University Press.

Worm, B., T. B. H. Reusch and H. K. Lotze. 2000. *In situ* nutrient enrichment: Methods for Marine Benthic Ecology. *International Review Hydrobiology*. 85. 359-375.