

# Top-down and Bottom Forces Interact to Cause Massive Marsh Die Back

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**Study Site Location(s):** Sapelo Island GA and Louisiana

**Keywords:** Fauna, Microbes, *Spartina*

**Project Type:** Experimental

## **Project Outline:**

**Specific Aims:** To experimentally examine how consumers and bottom-up factors interact to cause marsh die back.

**Methodology:** Consumer exclusions and tethering experiments, Small and large scale surveys, Long-term data analysis.

## **Results to Date:**

For nearly 5 decades, the prevailing theory of salt marsh ecology has been that bottom-up forces are the primary factors regulating plant production. However, experimental manipulation of the dominant marsh grazer (periwinkle – *Littoraria irrorata*) and its predators showed that top-down forces are also strong determinants of marsh plant growth. Periwinkle grazing can convert one of the most productive grasslands in the world into a barren mudflat in 8 months. Marine predators regulate abundance of this plant-grazing snail. Thus, top-down control of grazer density is a key regulatory determinant of marsh grass growth. The discovery of this trophic cascade implies that over-harvesting of snail predators (e.g. blue crabs) may be an important factor contributing to massive die-off of marshes across southeastern U. S. We have surveyed and installed exclusion cages at 4 die off areas in GA and LA (with L. Stanton and I. Mendelssohn) and found 100 m long snail fronts with  $>2,500$  ind./ m<sup>2</sup> grazing down marsh grass at up to 14 m/ year. Large-scale, multi-site snail tethering experiments and monitoring of predator abundances over three years in GA marshes showed that top-down control of *Littoraria* decreases significantly with local blue crab declines. These results show that (1) successful management of crab fisheries may be critical for long-term persistence of salt marshes and (2) the bottom-up paradigm of marsh ecology and its application to other systems needs to re-evaluated.

## Lessons Learned:

- 1) Experiments are key to unraveling causal factors of marsh die back.
- 2) Top-down forces as well as bottom-factors drive marsh die off and the relative importance of these factors varies from site to site.

## Publications, reports, or web-accessible materials

**Silliman, B. R.** and S. Y. Newell. Fungal-farming in a snail. *In press*. Proceedings of the National Academy of Sciences (USA).

**Silliman, B. R.**, C. A. Layman, K. Geyer and J. C. Zieman. *In press*. Predation by the black-clawed mud crab, *Panopeus herbstii*, in mid-Atlantic salt marshes: Further evidence for top-down control of community structure. *Estuaries*.

Bertness, M. D., **B. R. Silliman** and R. Jefferies. *In press*. North American salt marshes under siege. *American Scientist*.

**Silliman, B. R.** and A. Bortolus. 2003. Underestimation of *Spartina alterniflora* production in Western Atlantic salt marshes. *Oikos* 143: 549-555.

**Silliman, B. R.** and M. D. Bertness. 2002. A Trophic Cascade Regulates Salt Marsh Primary Production. *Proceedings of the National Academy of Sciences (USA)* 99: 10500-10505.

**Silliman, B. R.** and J. C. Zieman. 2001. Top-down control of *Spartina alterniflora* growth by periwinkle grazing in a Virginia salt marsh. *Ecology* 82: 2830-2845.

Suggested citation: Georgia Coastal Research Council, 2004. Proceedings of the Marsh Dieback Workshop, held February 3-4, 2004, Savannah Georgia.