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Is a Native Macroalga Threatening Seagrass Survival in Tomales Bay?

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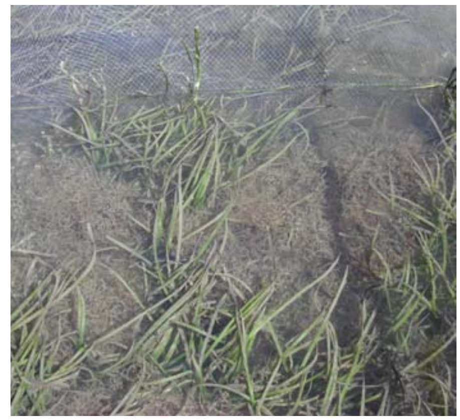
The Question: *Why is a native macroalga increasing in Tomales Bay? What effect does the macroalga have on eelgrass beds?*



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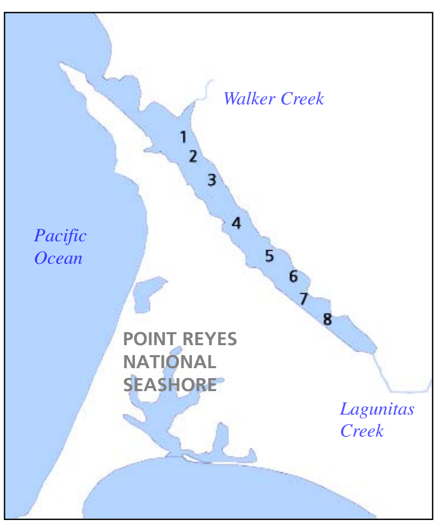
Gracilariopsis **macroalgae, a red seaweed, is starting to cover eelgrass beds in Tomales Bay.**

Tomales Bay is a site with historically healthy eelgrass meadows covering 965 acres of the bay. Twenty years ago, ecologists considered it pristine, but is it still? Seagrass beds are highly productive nearshore habitats that support a complex food web, stabilize nearshore sediments, and filter coastal waters. In Tomales Bay, eelgrass habitat serves as a crucial nursery for spawning herrings that deposit their eggs on the eelgrass blades. Degraded eelgrass beds are very difficult to restore.

In recent years, the California Department of Fish and Game has recorded a shift in the species composition of two bottom-dwelling primary producers—eelgrass and macroalgae. Some eelgrass (Zostera marina) beds are becoming dominated by the macroalga Gracilariopsis andersonii, a red seaweed native to the bay. This macroalga can out compete eelgrass because it grows more effectively in low light and quickly uptakes nutrients. In many estuaries on the East Coast, increased nutrient inputs have caused macroalgal blooms of species similar to *Gracilariopsis*. However ecologists had not yet examined if nutrients inputs are causing the *Gracilariopsis* bloom in Tomales Bay and how the bloom could affect eelgrass beds and the overall health of the bay.

The Project: *Determine if nutrient patterns in the bay are contributing to the macroalgal bloom and if macroalgae affects eelgrass growth.*



To determine how nutrient levels vary over space and time in Tomales Bay, scientists sampled nutrients at these eight locations numbered on the map during April, May, July and September.

Outplanted macroalgae were used to measure the nutrient levels in Tomales Bay. Macroalgae starved of nutrients in the lab were then outplanted in eight spots along the length of the bay. The macroalgae *Gracilariopsis* acts like a sponge to absorb available nutrients in the water. The outplanted macroalgae were collected after one week and the nutrients in the macroalgae tissues were measured. The macroalgae incorporate nutrients into their continuously, so the final nutrient concentrations in the tissues average out variation in nutrients over time. Traditional water quality sampling provides a series of snapshot measurements that may capture an unusually high or low value that would skew the calculated average. Water nutrients were measured in April, May, July, and September at the eight locations to gauge the temporal and spatial patterns of nutrients in the bay. These nutrient patterns were then compared to data collected approximately 15 years ago.

The second part of this project was to evaluate the effects of *Gracilariopsis* on eelgrass development and productivity. Thirty 1m^3 cages enclosed with mesh netting were established in the intertidal seagrass beds. Different abundances of macroalgae in the cages were planted and light reaching the eelgrass shoots was measured. At the end of the experiment the shoot density and biomass of the eelgrass were measured.

Results: *The macroalgae bloom may be caused by a new nutrient source close to Lagunitas Creek. Macroalgae impedes eelgrass growth at high abundances.*

The seasonal patterns across the eight locations along the bay follow the expected patterns - high nutrient levels in the winter when heavy precipitation causes the water to be well-mixed and low nutrient levels in the summer when the climate is dry.

However the spatial patterns of nutrient levels did differ from expected patterns in the summer. A new nutrient peak occurred in July near the bay head close to Lagunitas Creek. Stable isotope tests indicate that the nutrients came from a terrestrial source, which suggests that a new source of wastewater may be seeping into the bay. The nutrient levels are not alarming relative to degraded estuaries, but they may be enough to cause the shift in species composition from eelgrass to macroalgae.

Macroalgae does affect eelgrass growth, but only at high densities. The cage experiments showed that high densities of macroalgae decreased eelgrass shoot density by half. However average densities of macroalgae did not significantly affect eelgrass growth. Under high macroalgal densities the estimated light reaching new eelgrass shoots was near the lower limit of light required for eelgrass to survive. The likely explanation given the current data for how macroalgae affects eelgrowth growth is that the macroalgae shades young eelgrass shoots and the shoots cannot survive under this severe light limitation.

These results raise many new questions. Future research should investigate the exact density threshold when macroalgae starts to impact eelgrass, how macroalgal abundance and nutrient patterns are linked and whether light limits seedlings the same way that it limits cloned shoots that sprout from rhizomes (horizontal underground stems). Other explanations for the vegetation shift should be explored: for example a top-down impact, like the loss of a species that grazes on macroalgae, would allow macroalgal populations to grow unchecked.

This study is unique because it explores the mechanisms of a major ecological shift before it occurs. Further monitoring of Tomales Bay will help to understand the subtle changes that could cause macroalgae to become a dominant primary producer in Tomales Bay and might prevent a complete shift from occurring.

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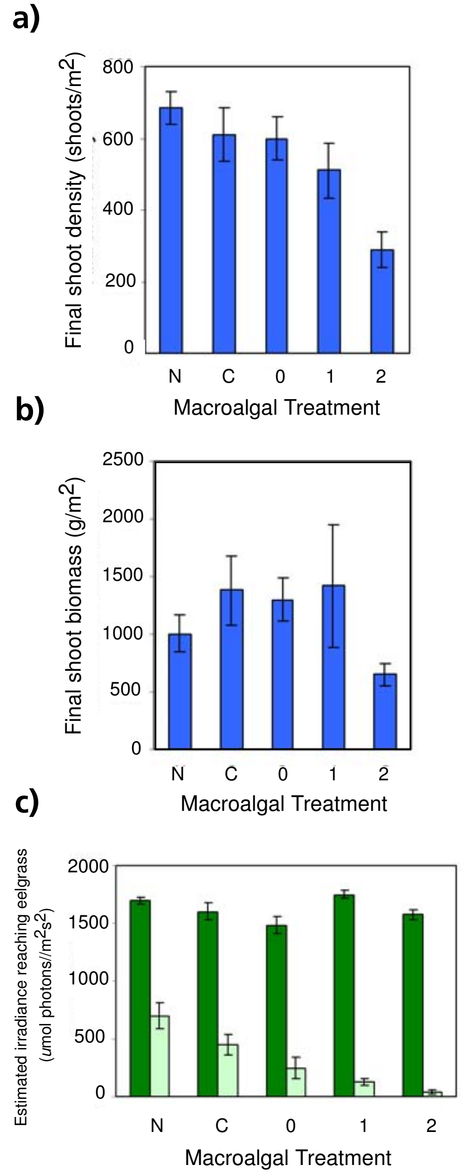

The three charts summarize the results from the cage experiments with planted macroalgae. The treatment codes are as follows: N = open seagrass plot, C= control plot, 0= macroalgae removed, 1= average density of macroalgae planted, 2= high density of macroalgae planted. For c), dark green bars are established shoots and light green bars are new shoots. Eelgrass shoot density and biomass were significantly lower when macroalgal density was high.

Additional Resources

Huntington, B. 2006. Is a macroalga bloom threatening seagrass survival? Responses of seagrass to increased macroalgal dominance in a Northern California Bay. M.S. Thesis. San Francisco State University. To request a copy, contact Ben_Becker@nps.gov.