

## Zostera marina

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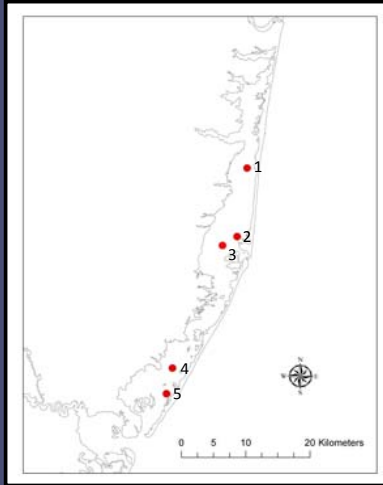


Figure 1. Locations of StowAway Tidbit Underwater Data Loggers: 1-Island Beach, 2-Sedge Island, 3-Barnegat Light, 4-Northern Little Egg Harbor, 5-Southern Little Egg Harbor

### Background and Justification

*Zostera marina*, eelgrass, is the most abundant seagrass species in the Barnegat Bay-Little Egg Harbor Estuary. It provides a number of important ecosystem services as a major primary producer and a vital nursery area for fish and shellfish. Nitrogen loading and eutrophication of the estuary have impacted *Zostera marina* beds in the estuary (Kennish and Haag 2007). High water temperatures may also have adverse effects on *Z. marina*. If *Z. marina* beds continue to decline, their essential habitat for juvenile fish and numerous invertebrate species will also be impacted.

The objective of this study was to investigate *Zostera marina* root vs blade dynamics in terms of blade ejection caused by stressful environmental conditions. Various factors may cause the blade ejection of *Z. marina*, such as cuts or overgrowth of epiphytes that will eventually reduce the blade integrity such that repair is impossible and photosynthetic function fails. More commonly in massive blade ejection, physicochemical parameters are responsible, the most notable being temperature. In the Mid-Atlantic region, *Zostera marina* occurs in its southern range. Temperatures in the New Jersey coastal bays can exceed 30 degrees Celsius in the summer, which is beyond the normal temperature range for the species. When these high temperatures are reached, massive floating mats of *Zostera* blades commonly occur in the estuary. This study aimed to assess the correlation between elevated temperatures and blade ejection of *Z. marina* in the Barnegat Bay-Little Egg Harbor Estuary.



Figure 2. Stowaway Tidbits after retrieval



Figure 3. Stowaway Tidbit Temp Logger

### Methods

An attempt was made to find a correlation between blade ejection and temperature using weekly observations in conjunction with the Buoy 139 datalogger and several StowAway Tidbit temperature recorders (Figure 2, Figure 3). Temperature was sampled every 15 minutes. Mass blade ejection events were identified by searching on the water's surface for large floating rafts of healthy eelgrass blades devoid of roots. Personal observation coupled with correspondence with local fishermen, life guards on bay beaches, and other research crews in the Barnegat Bay-Little Egg Harbor system led to early identification of mass blade ejection events. The dates of mass blade ejections were then compared with temperature readings from the StowAway Tidbit recorders and Buoy 139. The five sites were visited as often as possible (usually once a week) to inspect the state of the StowAway Tidbit temperature recorders. Some recorders were taken out of the field early due to heavy epiphytic growth. When suspected areas of blade ejection were identified (areas observed with floating mats of blades (Figure 4) or areas that were once dense beds but are now barren), the sites were marked with GPS and revisited at later dates to examine the possibility of re-growth.



Figure 4. Floating mat of ejected *Zostera* blades

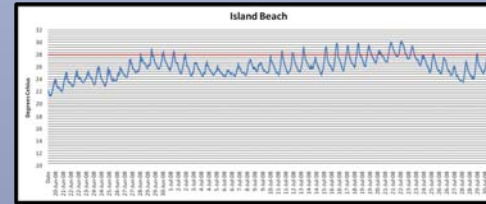


Figure 5. Temperature at Island Beach site

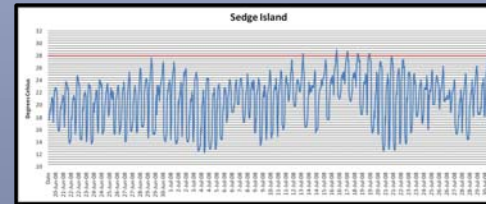


Figure 6. Temperature at Sedge Island site

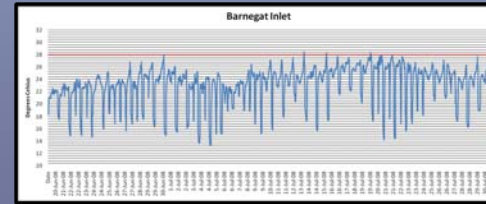


Figure 7. Temperature at Barnegat Inlet site

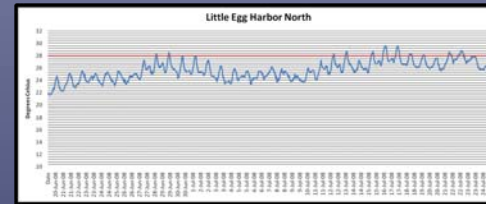


Figure 8. Temperature at L.E.H. North Site

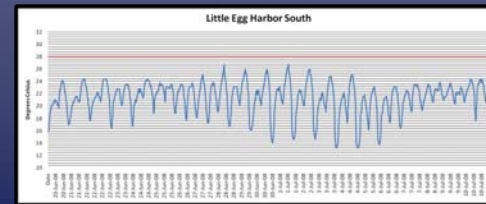


Figure 9. Temperature at L.E.H. South site

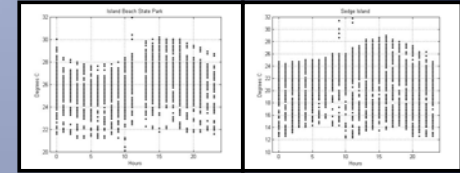


Figure 10. Daily temperature range at Island Beach and Sedge Island

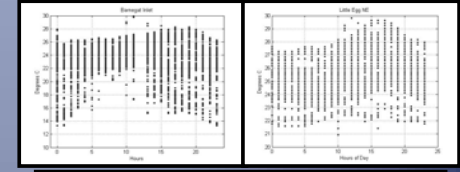


Figure 11. Daily temperature range at Barnegat Inlet and Little Egg Harbor North

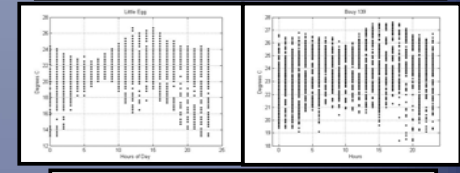


Figure 12. Daily temperature range at Little Egg Harbor South and Buoy 139

### Discussion

Prior research has established that 28 degrees Celsius is the critical temperature in terms of blade ejection in laboratory settings (Nejrup and Pederson 2007; Abe, Kurashima, Maegawa 2008). This was denoted by the red line on Figure 5-9. This has not been examined thoroughly in the field where temperatures are not constant. The actual cause of temperature stress blade ejection is an imbalance of oxygen and carbon dioxide within the plant itself.

The Sedge Island and Barnegat Inlet sites temperature graphs closely mirror each other due to their close proximity to each other. The Little Egg Harbor South site exhibits a similar pattern. These sites were dominated by the influx of cold ocean water on higher tides, funneled directly from Barnegat Inlet and Little Egg Harbor Inlet. Upwelling occurred more frequently than normal years, providing significantly colder water temperatures than normal on high tide and keeping average temperatures below 28 degrees Celsius. The Island Beach and Little Egg Harbor North sites were further away from the influence of ocean water and therefore were more susceptible to higher average temperatures. The temperature data for the five sites was compared to the temperatures from the datalogger at Buoy 139 in neighboring Great Bay to make sure there were no anomalies (Figures 10-12).

*Zostera* declined noticeably at Island Beach, shallow areas near Sedge Island, and Little Egg Harbor North. All three sites had temperatures that rose above 28 degrees Celsius. Island Beach, which had the highest temperatures, had the most dramatic change with nearly all *Zostera* replaced by *Ruppia*. Little Egg Harbor South and Barnegat Inlet had little to no change in *Zostera* cover. During the study period, two noticeable peaks in temperature occurred around June 28 and July 21. These peaks coincided with an increase of *Zostera* blades floating in the water and washing up on local beaches.

Although 28 degrees Celsius was reached at four out of the five sites, total mass blade ejection did not always occur. Since blade ejection is a result of homeostasis failing inside the plant, it is likely that the 28 degrees Celsius mark must be maintained for an extended amount of time before blade ejection occurs. Further experimentation in the laboratory setting is necessary to investigate the dynamics of blade ejection further.

### Study Area

Barnegat Bay-Little Egg Harbor is a shallow back-bay, lagoon-type estuary (Lathrop et al. 2004) with a slow flushing time in excess of 70 days during summer (Kennish et al. 2007). Heavy boat traffic, particularly in summer, often results in prop scarring of seagrass beds. Prop scars can have a significant impact on areal coverage of seagrass in some locations. As noted above, two types of seagrass occur in the estuary. *Zostera marina* is the most dominant species, forming lush beds throughout the eastern part of the estuary. It grows at depths from 0.5-2 m, though it has been observed at other depths. *Zostera* prefers a mixture of sand and detritus substrate and higher salinities. *Ruppia maritima*, widgeon grass, can tolerate a wider range of conditions than *Zostera* but seems to be outcompeted by eelgrass. In areas where *Zostera* does not meet its ideal conditions, *Ruppia* is more prevalent.

Three well-defined *Zostera* beds will be investigated in this project. Historically, Little Egg Harbor has had the most extensive *Zostera* beds. Sampling conducted in June 2008 showed that the distribution of *Zostera* appears to be significantly reduced from previous years in this area. *Zostera* beds in proximity to Barnegat Inlet have had the largest and most epiphyte free plants in past few years. However, June sampling in 2008 revealed heavy macroalgal growth which seems to be eliminating many of the plants. While eelgrass predominates throughout much of Little Egg Harbor, farther north at the border of Seaside Heights and Island Beach State Park, *Zostera* and *Ruppia*, form mixed-species beds.

Five sites were selected for monitoring. In the north, the Island Beach site is known as one of the areas where *Zostera* and *Ruppia* coexist. At Barnegat Inlet, the Sedge Island site lies on the border of tidal flats and a channel with a heavy influx of ocean water while the Barnegat Light site lies further away from the influence of the channel. The two Little Egg Harbor sites represent the northern and southern ends of one of the largest *Zostera* beds in the state. The northern site receives less ocean water on high tide than the southern site which borders a major channel.

### Acknowledgments

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# *Zostera marina* Blade Ejection