Sediment Organic Matter as a Primary Indicator of Summer Mortality

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Purpose: This study investigates the role of sediment organic matter (SOM) in temperature driven summer mortality events of hard clams (*Mercenaria mercenaria*). High temperatures in summer increase hard clam mortality events, as observed by growers, suggest these mass mortality events could be due to low oxygen (hypoxia), hydrogen sulfide toxicity or a combination that are brought about by increased temperatures. The presence of organic matter (OM) influences hypoxia by stimulating respiration in microorganisms and can similarly fuel production of hydrogen sulfide. Thus, this work aims to test that hypothesis that SOM, when combined with elevated temperatures, would result in clam mortality proportional to SOM concentration.

Methods: Participating growers sampled sediments monthly (June-August 2024, October 2024) from three leases at Dog Island (DI) and three leases at Gulf Jackson (GJ). Six replicate samples were taken alongside belts and three replicates from unfarmed (i.e., easements) area. Grower estimates of survival were reported at the time of sampling. Sediment organic matter (SOM) content was measured in laboratory by loss on ignition (LOI) method (combustion at 500 ˚C). SOM, water quality, and clam survivorship estimates were compared to investigate the influence of SOM in mortality.

Final Results: A total of 189 soil samples were tested for SOM. Regression analysis of categorical observations of percent survival versus organic matter did not reveal a relationship between the variables (R^2=0.081). Dog Island sites were found to have significantly better survivorship versus Gulf Jackson while organic matter is virtually the same for both sites (Fig 1).

Further, Dog Island was observed to have significantly better survivorship versus Gulf Jackson for June, August and October indicating different stressor conditions and responses. It is also important to note that post hurricane survival was much lower at both sites suggesting the dramatic influence of storms on clam aquaculture (Fig 2).

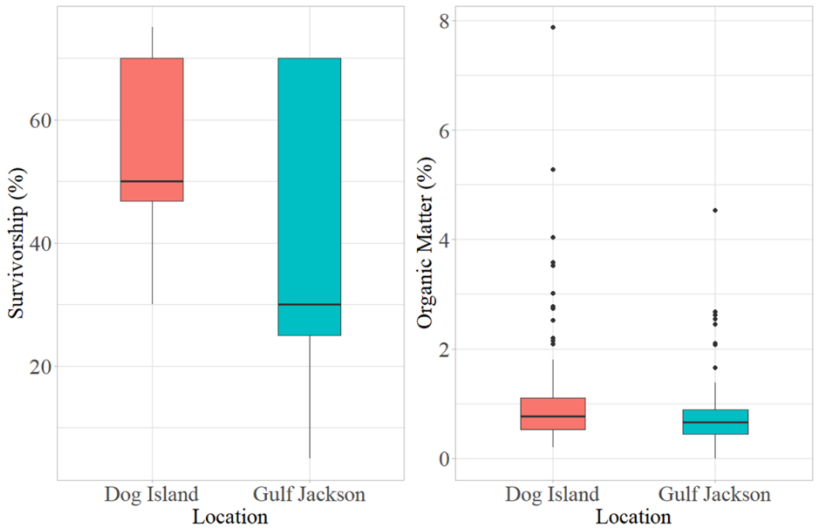

Figure 1. Box plots of percent survivorship at both Dog Island and Gulf Jackson sites (left) and percent SOM (as mass) for both sites (right). Kruskal-Wallis test for survivorship between sites = 4.5×10^{-10} while no significant difference was observed in percent SOM between sites.

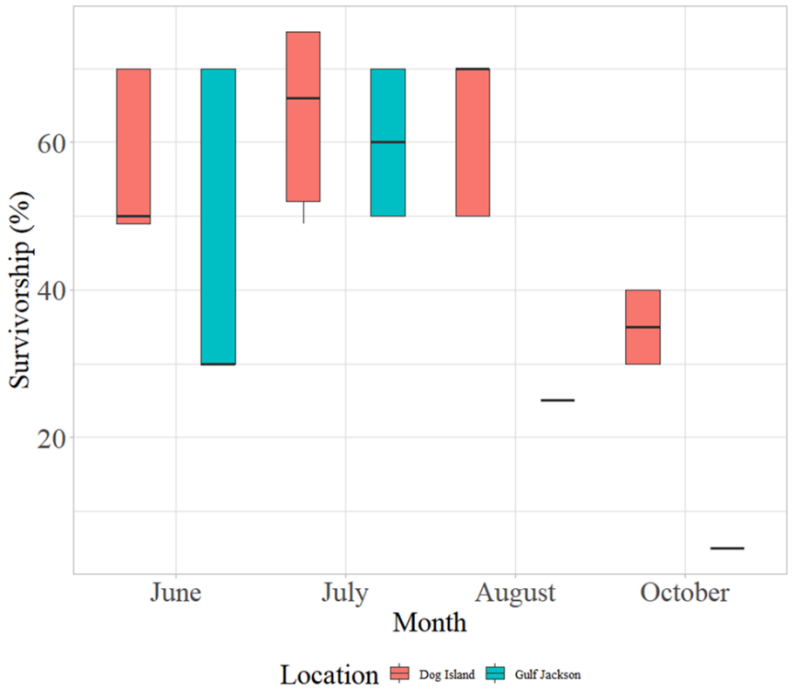

Figure 2. Box plots of percent survivorship at both Dog Island and Gulf Jackson sites during the months of June, July August and October. Sites were not monitored in September due to hurricane activity.

Water quality data collection was interrupted due to hurricanes which complicated direct comparisons of sites. However, it was clear that hypoxia events were more prevalent during high temperature months, but they were also episodic and not directly correlated with specific temperature at the time of measurement. The lack of direct correlation between temperature and

hypoxia, suggests additional, extant drivers are involved in hypoxia conditions. These drivers may be proximity of seagrasses, water depth, tidal velocity, suspended organic matter or other factors not accounted for in this study.

Findings and Outcomes: Sediment organic matter content was not found to be a significant factor in hypoxia or mortality at Dog Island or Gulf Jackson lease sites. Dog Island and Gulf Jackson had different bulk survival over the summer but were found to have statistically similar SOM characteristics suggesting other factors are more influential in hypoxia events that occur in the summer. Hurricane disturbance had a net removal effect for SOM and a marked negative impact on clam survival. Based upon available data, dissolved oxygen in July was lowest at both sites with temperatures peaking in August. Water quality did not support a direct temperature to dissolved oxygen relationship suggesting additional variables (perhaps suspended OM) are influencing hypoxic conditions during excessive heat. We concluded that impacts on clam survivorship were not clearly linked to SOM as previously suspected. We acknowledge Florida Sea Grant for continued support of clam aquaculture in Florida and for funding these investigations, Cedar Key Aquaculture Association for organizational support, and all clam growers who participated in these studies.

Relevance: Elevated summertime water temperatures create hostile conditions for the hard clam aquaculture industry in the Gulf of Mexico. Better defining the role of sediment characteristics, such as organic matter content and its influence on hypoxia / sulfide stress enable improved forecasting of mortality events.

Response: We investigated the relationship between sediment organic matter (SOM) on participating leases and the resulting survivorship of clams harvested from those sediments.

Results: No statistically relevant relationship was observed between SOM and hypoxia or survivorship of clams. Observations of survivorship post hurricane events indicated higher mortality from the storm versus heat stress in the summer months.

Recap: While SOM may be known to influence oxygen and sulfide conditions in sediments, the extent of that influence does not extend very far as no linkage was observed between clam mortality and SOM. Hence, variable SOM in lease sediments is not a predictor of stress during seasonal high water temperatures.