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Variability in sediment-water carbonate chemistry and bivalve abundance after bivalve settlement in Long Island Sound, Milford, Connecticut

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ABSTRACT

Cues that drive bivalve settlement and abundance in sediments are not well understood, but recent reports suggest that sediment carbonate chemistry may influence bivalve abundance. In 2013, we conducted field experiments to assess the relationship between porewater sediment carbonate chemistry (pH, alkalinity (A_t), dissolved inorganic carbon (DIC)), grain size, and bivalve abundance throughout the July–September settlement period at two sites in Long Island Sound (LIS), CT. Two dominate bivalves species were present during the study period *Mya arenaria* and *Nucula* spp. Akaike's linear information criterion models, indicated 29% of the total community abundance was predicted by grain size, salinity, and pH. When using 2 weeks of data during the period of peak bivalve settlement, pH and phosphate concentrations accounted 44% of total bivalve community composition and 71% of *Nucula* spp. abundance with pH, phosphate, and silica. These results suggest that sediment carbonate chemistry may influence bivalve abundance in LIS.

1. Introduction

As bivalves transition from pelagic larvae to benthic juveniles, settlement cues are known to aid in substrate selection (Hadfield, 1984; Marinelli and Woodin, 2002; Woodin, 1986; Woodin et al., 1998). On a broad scale, settlement is dependent upon physiochemical properties of habitat (Rhoads, 1973; Sanders, 1958; Weinberg and Whitlatch, 1983), whereas on a local scale, recruitment can be influenced by sediment type (Hunt, 2004; St-Onge and Miron, 2007), organism size (St-Onge and Miron, 2007), and sediment biogeochemistry (i.e., porewater gradients). Decomposition of organic matter may result in steep solute gradients (Thayer, 1983), altering oxygen concentration, ammonia levels, redox potential, and metal and calcite/aragonite saturation state (Burdige, 2006) that can affect infaunal recruitment and survival. These chemical changes at the sediment-water interface may influence the nutritional characteristics and physiological environment of the benthos on a micro-scale of mm to cm (Levin and Edesa, 1997; Marinelli, 1994; Meyers et al., 1987).

Acceptance or rejection of habitat by bivalves is not well understood, but previous studies have examined which factors may contribute to habitat selection and bivalve abundance. Research studies have focused on environmental, chemical, and physical variables at the sediment-water interface which promote settlement and abundance of bivalves. Experiments with *Mercenaria mercenaria* observed an increase in burrowing of juveniles at temperatures ranging from 25 to 30 °C (Savage, 1976). In laboratory experiments, surf clam larvae, *Spisula solidissima*, preferred coarser-grained sandy sediments over finer-grained muddy sediments (Snelgrove et al., 1998). Sediment porewater carbonate chemistry has been linked to larval settlement and survival in life stages of many other marine bivalves (Clements and Hunt, 2014, 2017; Clements et al., 2016; Green et al., 2004; Green et al., 2013). Even after successful site selection, high shellfish morality can occur from micro-scale changes in the chemical composition of sediment geochemistry (i.e., hypoxia, pH changes, and/or carbonate saturation changes), predation, or disease.

During larval development, the initial form of calcium carbonate is amorphous calcium carbonate (ACC), which rapidly develops into aragonite during shell construction (Gazeau et al., 2013). Most bivalves begin benthic existence with an aragonite shell, with the transition from ACC to an aragonite shell occurring before transformation to a motile veliger larva (Harper et al., 1997; Taylor, 1973). Upon reaching adulthood, bivalves either maintain an aragonite shell or shift to a calcite shell or a combination of calcite/aragonite shell, depending upon species. Most adult bivalves have aragonite shells, which has been demonstrated as stronger than calcite, potentially providing greater protection from predation (Green and Aller, 2001; Green et al., 1998).

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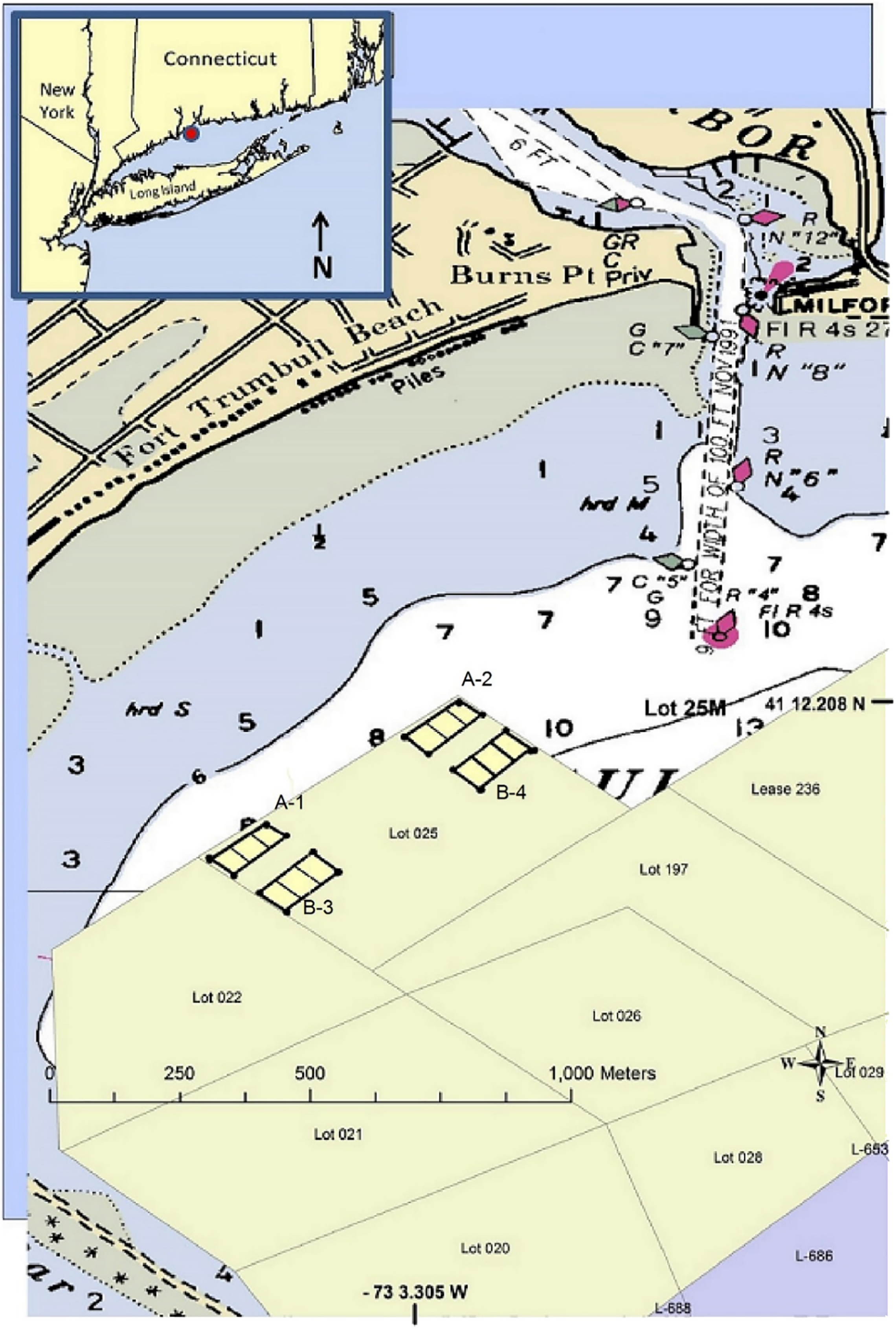

Fig. 1. Map of sampling locations nearshore (A) and offshore (B) within Long Island Sound, CT, USA. Each location contains two nearshore (1-A and 2-A) and far-shore (3-B and 4-B) sites. Each site was further divided into three subsets for sampling, indicated by the lines within each plot.