The Impacts of Ocean Warming on the Growth of Seagrass and Blue Mussels

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Climate change induced warming and ocean acidification are disturbing the ecology of marine environments along the coast of Maine. Ocean acidification is caused by the increase in CO2 in seawater resulting in a reduction of pH and the concentration of carbonate ions (Caldeira and Wickett 2003). This low pH is especially harmful to calcifying organisms like blue mussels (Mytilus edulis) because they rely on carbonate ions to form their shells, which are primarily made from calcium carbonate (Kroeker et al. 2013). Interactions between local species could mitigate the harmful impacts from a changing ocean pH level. One promising candidate is eelgrass (Zostera Marina), because seagrass photosynthesizes it can ameliorate local conditions by uptaking excess carbon and in effect creating spatial refuges from ocean acidification (Nielsen et al. 2018). Eelgrass is known as a foundation species in the Atlantic northeast. It forms the structural habitat of the ecosystem and can facilitate other species in the ecosystem. There is evidence that the amelioration of pH that eelgrass provides through photosynthesis enhances bivalve growth (Lowe et al. 2021). It is possible the ability of eelgrass to locally ameliorate stressful pH conditions could improve blue mussel resilience to multiple stressors, including ocean warming. Worldwide ocean temperatures are rising due to greenhouse gas emissions. These rising temperatures can change species community diversity and ecosystem function (Brierly and Kingsford 2009). Climate change is a disturbing reality and a force that will shape the future of all marine organisms.

We had two main goals for our experiment. First, to understand how different populations of eelgrass respond to predicted future ocean warming. Second, to determine the ability of different eelgrass populations to ameliorate these future conditions and how this affects bivalve growth.

We built a flowthrough seawater mesocosm array from sixty buckets separated into ten groups within six trays. Each tray was divided in half. Each half tray contained eelgrass from one of four populations and the control group of mud. Within each tray an overhead manifold brought ambient seawater from Harpswell sound into five of the buckets on one side, while a separate manifold brought water heated 2°C above ambient temperature to the other five buckets on the other side. Manifolds were checked daily to ensure even water flow rates (of ~10 ml/s) were entering each bucket. We measured several variables throughout the experiment. We used YSI sensors to measure daily cycles of pH and temperature. We clipped 3 seagrass leaves from each bucket weekly and used pulse amplitude modulated (PAM) fluorometry to get a sense of the plants photosynthetic activity. We measured blue mussel growth over the experiment using calipers on the first and last days of the experiment to measure the initial and final length, width and height of mussels. I will continue to gather data and work on data analysis during an independent study this fall, before helping to write up our findings and publish them by summer 2023.

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Works Cited: Caldeira, K., Wickett, M. Anthropogenic carbon and ocean pH. Nature 425, 365 (2003); Kroeker, K.J., Kordas, R.L., Crim, R., Hendriks, I.E., Ramajo, L., Singh, G.S., Duarte, C.M. and Gattuso, J.-P. (2013), Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. Glob Change Biol, 19: 1884-1896; Brierley, A.S., M. J. Kingsford, Impacts of climate change on marine organisms and ecosystems, Current Biology, Volume 19, Issue 14, 2009, Pages R602-R614, ISSN 0960-9822; Lowe, A. & Kobelt, J &M Horwith, & J Ruesink. (2018). Ability of eelgrass to alter oyster growth and physiology is spatially limited and offset by increasing predation risk. Estuaries and Coasts. 42. 743-754.