Text S1

Methods:

To achieve exact compaction levels, we developed the following experimental chambers: after cutting four 2 cm X's on the bottom of a clear ~7 gallon (28L) bin (labeled E in Figure S1) for drainage, we filled each bin with 18 cm of our peat/salt water mixture (not exposed to crabs) (labeled D in Fig S1) and leveled the peat/salt throughout the bin. The weights used for compaction, were separate ~7 gallon and ~17 gallon (66L) bins (labeled A and B in Figure S1) filled with varying levels of sand depending on the compaction needed [no sand for 0 psi, 42.9 kg for 10 psi (0.7 kg/cm^2), 80.8 kg for 20 psi (1.4 kg/cm^2), and 105 kg for 25 psi (1.8 kg/cm^2)]. The weight for the compaction process was approximated by using a formula developed by using several different weights of sand and testing what soil strength would result. A Humbolt proctor style penetrometer was used to find the resulting soil strength in five places in the media, which were then averaged. The formula we developed after numerous compaction attempts to determine the weight needed is $y = 4.1366x + 0.2966$ (where **y** is the desired soil strength in psi, and **x** is the weight used in kg).

We then cut three layers of cardboard to fit inside of the ~7 gallon bin, which were then made into one waterproofed piece using duct tape (labeled C). The cardboard plates were placed between the peat mixture and the weight bins to evenly distribute the compression weight onto the peat/salt mixture and provide an even burrowing surface. We nested a ~17 gallon bin (labeled F) with 3 cm spacers (labeled G) under the ~7 gallon bin with peat/salt to catch excess water. A black plastic bag was rolled under the water tray for easy unfurling during the experimental portion (labeled H). The weight was nested on top of the weight distribution plate and peat for 2 hours. At the end of this process, we tested whether the peat achieved the desired compaction level using a Humboldt proctor penetrometer fitted with a 6.45 cm^2 needle.

For the experimental portion of the trial, we attached collars to the top of each vessel (labeled I in Fig S2) to limit crab escape and minimize interference from outside the mesocosm influencing crab behavior. Each collar was made of 6 cm wide cardboard strips angled inward that were 30 cm long on the short sides of the bin, and 60 cm long on the long sides. Finally, we rolled a black plastic bag up around each vessel to further minimize outside disruption to crab behavior and mimic the light conditions in their *Spartina alterniflora* covered habitat (labeled J in Fig S2).

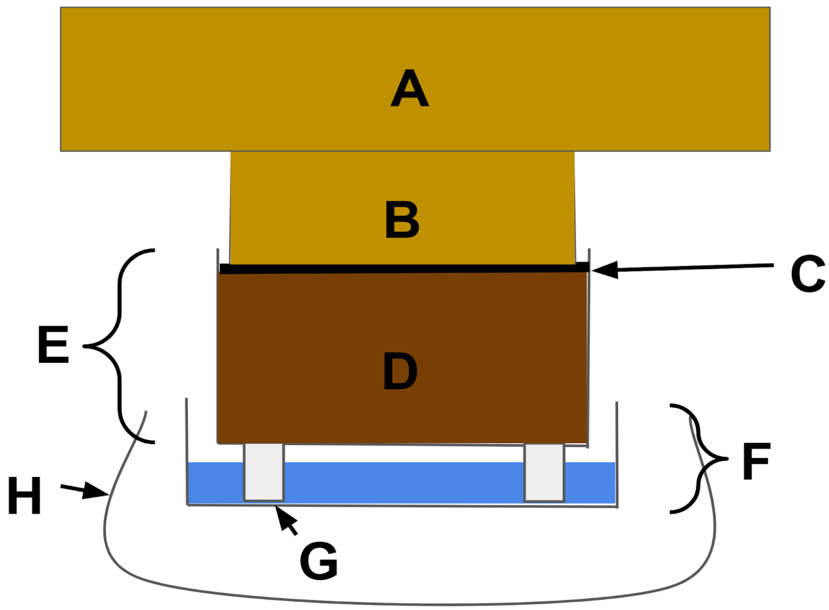

Figure S1: Cross section of the compression apparatus used to compact sediment. **A**: The supplementary weight, (i.e., sand), in a ~17 gallon bin that would not fit into the weight bin (B). **B**: A ~7 gallon bin filled with sand that was nested into the experimental chamber (E). **C**: A piece of cardboard with duct tape that was used to distribute the weight evenly to the peat/salt mixture. **D**: 18 cm of saltwater saturated peat moss that is being compressed. **E**: A ~7 gallon bin that is used as the experimental chamber. It has 4 drainage holes cut into the bottom to allow saltwater to escape. **F**: A ~4 gallon (14L) bin to collect excess saltwater from the experimental chamber (E). **G**: 3 cm tall plastic spacers in all four corners and the center to elevate the experimental chamber and allow the media to drain. **H**: A black plastic bag to be unfurled during the experiment used to block out visual stimuli.

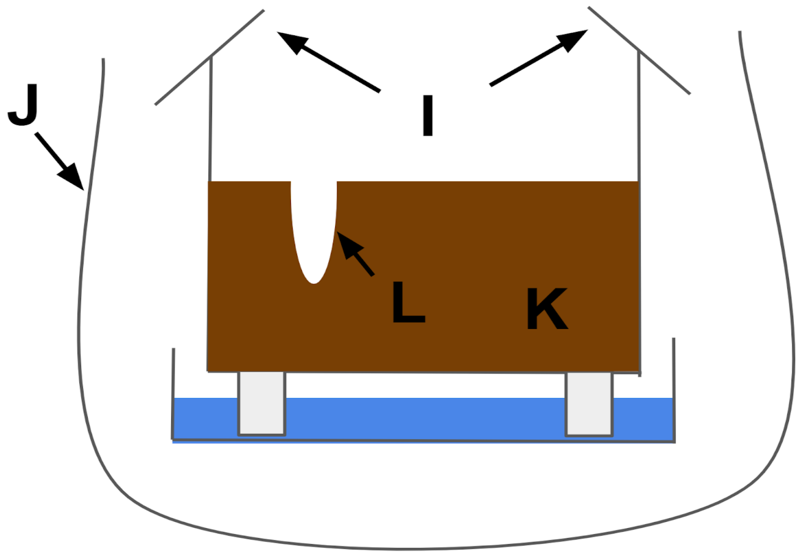

Figure S2: Cross section of the experimental chamber after a crab trial. **I**: Cardboard collars angled inward were used to prevent escape and minimize external stimuli. **J**: Unfurled black trash bags covered the sides of the transparent bins to further minimize stimuli and recreate light conditions under the *S. alterniflora.* **K**: Compressed peat moss. The soil strength is tested with a proctor penetrometer before and after trials in three places in the soil. **L**: Potential crab burrows. After a trial, the crab is removed, and its mass is taken. We then pour plaster in the burrow to derive burrow volume as a proxy for burrow depth

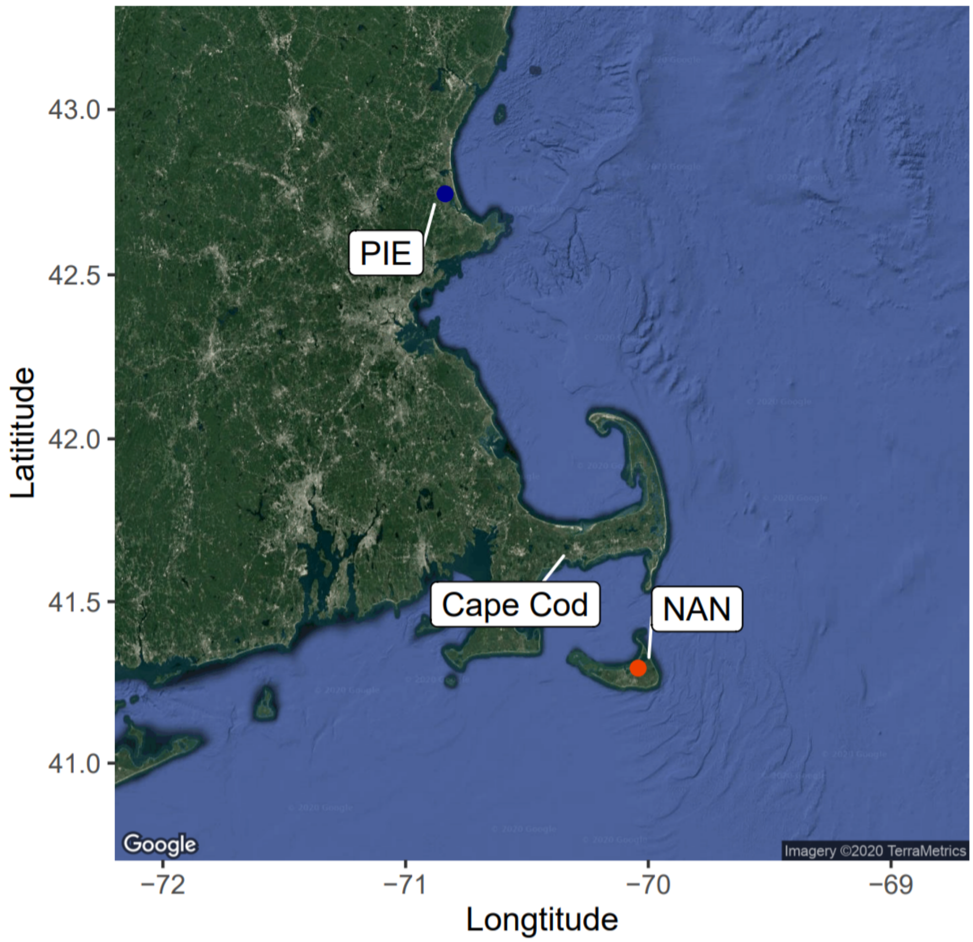

Figure S3: A satellite image of Massachusetts, USA showing our two collection sites. We collected at Carolton Creek in Plum Island Estuary (PIE) for fiddler crabs representing our expanded range population, and at Folger's Marsh in Nantucket (NAN) for crabs representing their historical range. Plum Island Estuary receives relatively colder water from the north in the Gulf of Maine; Nantucket is an island in the relatively warm Gulf Stream. As a reminder, these locations are only ~200mi (~322km) apart, separated by Cape Cod.

Results:

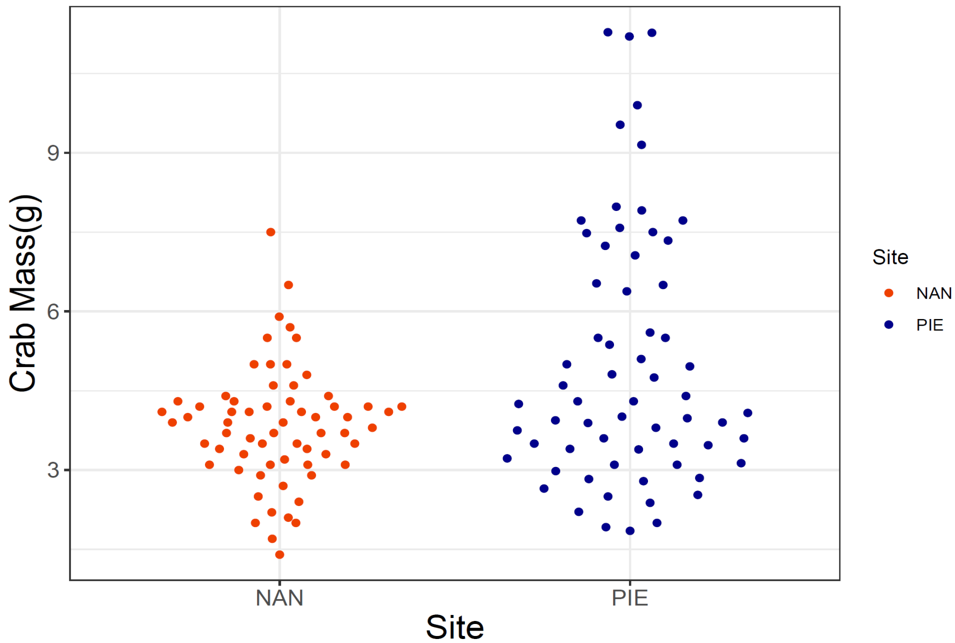

Figure S4: There was no significant different in mass of crabs used in one crab trials (p=0.363), but were significantly different in three crab trials. PIE crabs were larger than the crabs collected from NAN (p=0.000494). As a reminder, crabs were randomly collected from NAN and PIE and randomly selected for each trial. The beeswarm plot above shows that most of the individuals from both NAN and PIE are ~3 - 4.5 g, with the distribution of PIE crab individuals ranging up to 11.28 g. When the largest nine PIE crabs and nine random NAN crabs were removed, the two population had an insignificant difference in mean mass (p=0.0815).