Supplementary Information for

Sea-level rise and the emergence of a keystone grazer alter the ecology and geomorphic evolution of southeast US salt marshes

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Web of Science Literature Review.

**Literature Search.** We conducted a Web of Science search using the key words “Sesarma” and “salt marsh”. We then constrained the search to those papers published prior to 2009 (46 total papers). We selected this time frame given that the Hughes et al. 2009 paper was the first that studied the expansion of crab-grazed creeks in a single South Carolina salt marsh. We searched each paper for any mention of Sesarma marsh crab densities, spatial patterning, or effects on any ecosystem function. We did not find a single mention of these crabs creating grazing and burrowing fronts along creekhead margins within the salt marsh in any region.

Accretion measurements.

**Surface Elevation Table (SET) Method.** Soil surface elevation was measured in tidal marshes across the South Carolina coastline (2010-2017, W. Doar) and estuaries surrounding the Georgia Coastal Ecosystem (GCE) Long Term Ecological Research (LTER) station (2002-2018, C. Craft) using a sediment elevation table (SET) method. Long-term rates of accretion (mm per year) across seven marsh platform locations in Georgia and nine platform locations in South Carolina are presented in the SI Appendix, Table S1 (below). At one site in Georgia, rod SETs were added to replace broken SETs in 2014.

**Feldspar Marker Horizon Method.** Following Cahoon and Turner (1989), feldspar marker horizon plots were established at seven sites surrounding the Georgia Coastal Ecosystem (GCE) Long Term Ecological Research (LTER) station (2002-2018, C. Craft). Feldspar was crushed into a powder and was deployed onto the substrate surface of marsh platform locations to establish feldspar marker horizons (thickness of 0.5 cm - 1 cm). Feldspar marker layers were deposited in 0.25m by 0.25m quadrats in the marsh platform at each site in 2002, then replicate soil cores were removed at approximately 6-month intervals to measure accretion above the marker layer. Sediment accumulation atop the marker horizon was measured to the nearest millimeter. These data are presented in SI Appendix, Table S1 (below).

Creek Morphology, Tidal Submergence and Marsh Softening

**Regional Ocean Modeling System (ROMS) Parameters.** Models consisted of a main channel, marsh platform, tidal creek, and outer marsh levees. The morphologies and relative elevation of each of these elements were based on GPS field measurements taken on Sapelo Island (GA) in 2018 and 2019. In all scenarios detailed below, the elevation of the marsh platform, levee, and main channel were set to 0.7m, 1.0m, and -3.0m relative to mean sea level, respectively. A 15-m transition zone from the main channel to the marsh platform was included by linearly interpolating across their respective elevation values. The levees were located on the marsh fringes adjacent to the main channel. The tidal creek bed elevation was linearly interpolated from the main channel to the marsh platform over the length of the tidal creek for each drainage ratio scenario. The thalweg of the channel was 4-m wide and the bathymetry was smoothed using a Gaussian filter. Grid resolution in the y-direction was 10-m in the main channel and 5-m for the rest of the domain, while grid resolution in the x-direction increased hyperbolically to the center from 15-m to 5-m. The total domain (Dimensions: 46 x 116 cells or 102m x 600m) used 5 equally-spaced vertical layers. Effects of vegetation were incorporated in the model by increasing the bottom roughness on the marsh platform (0.25 drag coefficient), but not for the tidal creek and main channel (0.025 drag coefficient) (Mariotti & Fagherazzi 2011). The tidal amplitude was selected from the nearest NOAA station (Daymark #185, Rockedundy River Entrance) to Sapelo Island (GA) and the eastern boundary was phase lagged by 0.005 radians from the western boundary to produce an along channel velocity representative of the natural system (Fagherazzi et al. 2008).
Ground Truthing Geomorphology-Based Predictions.

Creek Selection. To evaluate predictions about how enhanced tidal inundation is distributed across marsh landscapes, we selected four sets of creeks on Sapelo Island (GA), each containing one grazed, one un-grazed, and one incipient-grazed creek. Grazing status of each creek was assessed using historical imagery in GoogleEarth. Incipient-grazed creeks were those where grazing was initiated in the past 3-5 years, while grazed creeks were established >10 years ago. At each creek, we established four zones: inner tidal creekhead (i.e. non-vegetated pathways of water flow where the marsh creekhead connects the platform to the tidal creek), creekhead-platform border (i.e. vegetated marsh platform areas immediately adjacent to the tidal creekhead), as well as with 10 m and 20 m distance from the creekhead onto the vegetated marsh platform (SI Appendix, Fig. S7).

Inundation Time. To quantify differences in tidal inundation at inner creekhead locations, we measured submergence time (i.e. the duration the surface is submerged by the tide) using HOBOware TidBit devices set to measure surface temperature every minute during a midday low tide with no precipitation. The inner creekhead was chosen for these measurements because they are the location of current (or most recent) burrowing activity, and therefore most reflect the physical characteristics experienced by Sesarma fronts as they advance into marsh platforms. Sudden and sustained increases in recorded temperature (>95F) coincident with timing of ebb tide were classified as “exposed” periods of time (i.e. not tidally inundated) and summed for a 12-hour deployment on each creek. One device malfunctioned and another was dislodged during ebb tide, leaving 10 total data sets for analysis.

Time-Integrated Water Flow Rates. In the same inner creekhead locations, we additionally placed one magnesium calcite chalk block to measure time-integrated water flow rates (Yund et al. 1991). Chalk blocks were pre-weighed and deployed for one month in the field, after which time they were returned to the lab, cleaned of any surficial sediment, dried at 60°C, and re-weighed for chalk loss.

Elevation, Burrow Density & Substrate Hardness. To next quantify how the elevation of creeksheds differs across marsh platforms and by creek grazing regime, we collected measurements of marsh surface elevation in all four zones using a Trimble R6 Real Time Kinematic device (N = 5 replicates per area per creek; N = 240 measurements). In each location, we randomly placed a quadrat (0.33 m x 0.33 m; each >1 m apart) and counted each Sesarma burrow. Finally, within the center of each quadrat, we quantified substrate hardness using a 5-kg Pesola penetrometer.

Substrate Cores. To assess potential mechanisms through which increased tidal submergence leads to softening of marsh platforms, we collected cores from grazed and un-grazed tidal creekhead borders (0 m) and marsh platforms (20 m). Cores measured 7 cm in diameter and were taken to a depth of 30 cm (N = 15 cores per area). At each core location, we measured substrate hardness using a 5 kg Pesola penetrometer. Sites were selected based on elevation, such that marsh platforms (20 m) occurred at the same elevation in each case (adjacent to both un-grazed and grazed creeks). Each core was taken back to the lab, where aboveground cordgrass was cleaned, clipped at the base, dried at 60°C, and weighed. The belowground portion was washed and separated into three distinct groups: fine roots, rhizomes, and dead plant material. All sediment was cleaned off of the plant material, and each group was dried at 60°C and weighed. Root to rhizome ratios were calculated by dividing the dry biomass of rhizomes by the dry biomass of fine root material.

Statistics. To next assess how submergence time, chalk dissolution, and substrate hardness each vary separately with elevation, we assessed the fit of null, linear, and polynomial relationships using elevation as the predictor variable and selected best-fitting models based on $P$ and $R^2$ values. Aboveground cordgrass biomass, belowground dead material, fine roots, rhizomes, and root:rhizome were all separately analyzed with a two-way ANOVA with main
factors, grazing status and distance from creekhead. All post-hoc analyses were conducted with Bonferroni-corrected P-values. Finally, we use a multiple regression model to assess how changes in plant belowground growth strategy (i.e. root:rhizome), creek grazing status (i.e. grazed or un-grazed) and distance to creekhead (i.e. border, 0m and platform, 20m) affect substrate hardness (response variable), a key factor controlling the proliferation of Sesarma grazing fronts.
Fig. S1. *Sesarma* tethering results. *Sesarma reticulatum* crabs were tethered along tidal creekbanks within 10m of creekheads to evaluate potential variation in predator access to different creeks (‘creek’) and on adjacent vegetated creekhead border zones to the marsh platform (‘border’) to evaluate potential differences in predator access to marshes adjacent to those creeks (A). Tethered crabs were deployed on three sets of grazed and un-grazed creeks at each of the Sapelo Island experimental creek locations on July 2, 2019 (N = 10 replicates / area / creek; 120 individuals). Sites included Airport Marsh (B), Beach Road Marsh (C), and Little Sapelo Marsh (D). Predation rates (% consumed in 24-hour deployment) are presented on the y-axis, while the x-axis shows data collected within tidal creeks (left side; ‘Creek’) and at the creekhead border zones (right side; ‘Border’). Data collected from grazed creeks are presented in blue bars, while data from un-grazed creeks are presented in green.
Figure S2. Inundation time and proliferation of grazed creek heads. As sea level rises, creekheads oriented at lower marsh elevations are submerged for longer periods of time (A) and experience higher flow rates as crab grazing is first initiated (B). Border zone grazing (C) occurs within a narrow substrate hardness range (0.9 and 1.9 kg/cm²) characteristic of grazed borders and marsh platforms. In contrast, crab burrow density is minimal in all ungrazed zones, where water flow and submergence time is lower and substrate is harder, typically outside the optimal burrow hardness of *Sesarma reticulatum*. The relationship between elevation and substrate hardness is shown for (D) ungrazed creeks, (E) incipient-grazed creeks, and (F) grazed creeks. The landscape distribution of physical factors (G) shows the softening of high marsh peat far onto grazed and incipient-grazed platforms.
Fig. S3. Cordgrass Biomass Allocation Results. At grazed and un-grazed creekheads (light blue and light green, respectively) and adjacent marsh platforms (20m; dark blue and dark green, respectively), cores measuring 7cm in diameter were taken to a depth of 30cm (N = 15 cores per area). At each location, we measured substrate hardness using a 5kg Pesola penetrometer. (A) Aboveground cordgrass biomass (green background), belowground dead plant material (gray background), belowground fine root material (yellow background), and rhizome (brown background) biomass data are presented as mean ± SE, as is (B) root:rhizome ratio (light blue background). Letters denote significant differences (Tukey HSD, all p<0.001). (C) The linear relationship between root:rhizome and substrate hardness. Color data points and larger circles indicate location of cores. (D) Results of multiple regression analysis between predictor variables—creek type, distance from creekhead, and root:rhizome—and the response variable, substrate hardness. All significant P-values are highlighted in bold print.
**Fig. S4.** The abundance (number of individuals per 0.33m² quadrat) of each macroinvertebrate functional group (figures in the left panel) and the invertebrate community biomass (kg per 0.33m²) derived from abundance data (figures in right panel) at each regional site. Data are shown as the mean ± SEM of eight replicate quadrats per creek type and zone at each site. The column colors denote which creek type and zone are represented, as noted by the legend at the bottom.
Fig. S5. Daily maximum temperature, in degrees Celsius, and cumulative daily precipitation, in millimeters, recorded at the Marsh Landing weather station on Sapelo Island, GA in summer 2016. The periods of the mussel mortality assay (here noted as the mussel aggregation experiment) and field experiment are denoted on the top of the graph. These data are freely available through the Georgia Coastal Ecosystems LTER online data portal.
**Fig. S6. Scale-Dependence of Sesarma's Keystone Status.** Conceptual diagram adapted from Power et al. 1996 (5) depicts the roles of community members as well as keystone, foundation, dominant, and rare species along the axes of proportional biomass and total community impact (A). Under this framework, we present the roles of dominant marsh organisms in a historical marsh, prior to accelerated rates of sea level rise (B). At the local, creekhead scale (m$^2$), we suggest that Sesarma and their direct effects are approximately proportional to their increase in biomass, elevating them from a relatively rare community member to a dominant species (C). In contrast, when considered at the creekshed scale (km$^2$), Sesarma acts as a keystone species given that it has disproportionately large effects on marsh ecology and geomorphology that extend far beyond the spatial footprint of the grazing front (D).
Fig. S7. Transect Data Collection. At creeksheds associated with un-grazed, incipient-grazed, and grazed creeks, we measured marsh surface elevation, *Sesarma* burrow density, and substrate hardness along transects spanning four marsh zones: the unvegetated inner creekhead (1), the creekhead border (2), and marsh platform locations at both 10m (3) and 20m (4) distances from creekhead. Five replicate measurements were taken for each response variable in each zone of each creek (N = 12 total creeks).
Fig. S8. Geospatial Drivers of Sesarma-Grazed Creekhead Distribution. To assess whether the spatial distribution of Sesarma-grazed creekheads are non-random, we selected a subset of grazed, un-grazed, and incipient-grazed creeks from the aerial image analysis. For each creek, we utilized GoogleEarth to scan the marsh area landward of the creekhead and then measured the straight-line distance (L) from the creekhead to either the next creekhead, creekbank, or high marsh border, selecting whichever feature was closest to the creekhead. Next, at a 90-degree angle relative to the line-feature ‘L’, we measured the width, ‘W,’ or distance on both sides of the creekhead to the nearest edge feature (i.e. creek, creek head, or marsh border) (A). A minority of tidal creeks have historically experienced grazing (B, left panel), but have recently transitioned to an un-grazed state (B, right panel). We describe these creeks as ‘zipping up’, as the cordgrass in these creeks is actively expanding into the previously denuded, fan-shaped mudflat. This revegetation process leaves only a narrow (<0.5m wide) band of burrowed marsh at the creekhead (B).
Fig. S9. Temperature and evaporative water loss associated with predator exclusion caging treatments. A) Temperature data was collected across grazed and un-grazed creek border and platform zones in open controls (green), procedural cage controls (light blue), and full cage (dark blue) treatments ($N = 6$ replicates / treatment / zone / creek). B) Evaporative water loss data was collected across the same set of locations and was measured as the weight loss of water from wet sponges elevated above the marsh surface by 2-5cm. Water loss was measured in the field every 30 minutes for 4 hours. Data presented are across the full 4-hour deployment (all mean ± SEM; $N = 6$ replicates / treatment / zone / creek).
Table S1. Salt marsh vertical accretion data site coordinates, methods, estimated vertical accretion rate and source. Data sources are presented both inset (rightmost column) and in full detail below table. Accretion rate is presented in units of mm per year.

| STATE | LATITUDE  | LONGITUDE  | METHOD | YEAR CORE COLLECTED | YEARS OF SET | ELEV. (NAVD88) | MARSH ZONE | RATE (MM/YR) | SOURCE                          |
|-------|-----------|------------|--------|----------------------|--------------|----------------|------------|-------------|---------------------------------|
| GA    | 31°21'4.10"N | 81°20'1.42"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 1.4         | Loomis & Craft 2010             |
| GA    | 31°23'14.80"N | 81°16'50.39"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 0.6         | Loomis & Craft 2010             |
| GA    | 31°26'7.72"N | 81°20'30.55"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 1.4         | Loomis & Craft 2010             |
| GA    | 31°27'7.52"N | 81°21'56.94"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 0.3         | Loomis & Craft 2010             |
| GA    | 31°31'7.65"N | 81°13'45.93"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 0.8         | Loomis & Craft 2010             |
| GA    | 31°32'9.39"N | 81°17'44.17"W | 137 Cs | 2001                 | 1964-2001    | NA             | Platform   | 4           | Loomis & Craft 2010             |
| GA    | 31°21'4.03"N | 81°20'1.44"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 2.5         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°23'14.77"N | 81°16'50.35"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 3.2         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°26'7.70"N | 81°20'30.53"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 4.3         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°27'7.53"N | 81°21'56.94"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 1.8         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°28'37.35"N | 81°16'16.38"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 3.1         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°31'7.65"N | 81°13'45.91"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 3.7         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°32'9.41"N | 81°17'44.17"W | Feldspar| NA                   | 2002-2018    | NA             | Platform   | 6.4         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°21'4.03"N | 81°20'1.44"W | SET    | NA                   | 2014-2018    | NA             | Platform   | -1.5        | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°23'14.77"N | 81°16'50.35"W | SET    | NA                   | 2002-2018    | NA             | Platform   | 0.2         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°26'7.70"N | 81°20'30.53"W | SET    | NA                   | 2002-2018    | NA             | Platform   | 0.3         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°27'7.53"N | 81°21'56.94"W | SET    | NA                   | 2002-2018    | NA             | Platform   | 0.1         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°28'37.35"N | 81°16'16.38"W | SET    | NA                   | 2002-2018    | NA             | Platform   | 0.5         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°31'7.65"N | 81°13'45.91"W | SET    | NA                   | 2002-2018    | NA             | Platform   | -0.3        | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°32'9.41"N | 81°17'44.17"W | SET    | NA                   | 2002-2018    | NA             | Platform   | 2.9         | (C. Craft) Crotty et al., this manuscript |
| GA    | 31°57'58.61"N | 81°1'21.25"W  | 210 Pb | 2011                 | NA           | 0.5            | Platform   | 1.3         | Alexander et al. 2017           |
| GA    | 31°58'12.54"N | 81°1'11.57"W  | 210 Pb | 2005                 | NA           | 0.65           | Platform   | 2.7         | Alexander et al. 2017           |
| GA    | 31°58'16.07"N | 81°1'20.82"W  | 210 Pb | 2005                 | NA           | 0.67           | Platform   | 1.1         | Alexander et al. 2017           |
| GA    | 31°58'16.54"N | 81°1'20.54"W  | 210 Pb | 2005                 | NA           | 0.6            | Platform   | 1.7         | Alexander et al. 2017           |
| GA    | 31°58'18.70"N | 81°1'16.90"W  | 210 Pb | 2011                 | NA           | 0.59           | Platform   | 1.9         | Alexander et al. 2017           |
| GA    | 31°58'21.90"N | 81°1'32.95"W  | 210 Pb | 2011                 | NA           | 0.67           | Platform   | 1.8         | Alexander et al. 2017           |
| State | Latitude | Longitude | Isotope | Sample Year | Sediment Type | Index | Coefficient | Reference |
|-------|----------|-----------|----------|-------------|---------------|-------|--------------|-----------|
| GA    | 31°58'22.51"N 81° 0'56.45"W | 210 Pb | 2011 | NA | 0.97 | Platform | 2.9 | Alexander et al. 2017 |
| GA    | 31°58'24.06"N 81° 1'13.12"W | 210 Pb | 2011 | NA | 0.87 | Levee | 3.4 | Alexander et al. 2017 |
| GA    | 31°58'27.48"N 81° 1'17.62"W | 210 Pb | 2011 | NA | 0.71 | Levee/Platform | 1.7 | Alexander et al. 2017 |
| GA    | 31°58'4.87"N 81° 0'55.48"W | 210 Pb | 2011 | NA | 0.69 | Platform | 3.7 | Alexander et al. 2017 |
| GA    | 31°58'5.41"N 81° 1'29.50"W | 210 Pb | 2011 | NA | 0.63 | Platform | 1.2 | Alexander et al. 2017 |
| GA    | 31°58'8.04"N 81° 1'45.48"W | 210 Pb | 2002 | NA | 0.23 | Mudflat | 1 | Alexander et al. 2017 |
| SC    | 32°20'43.10"N 80°27'56.80"W | SET | NA | 2010-2017 | 0.878 | Platform | 2.01 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°22'54.51"N 80°26'42.67"W | SET | NA | 2010-2017 | 1.036 | Platform | 4.33 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°29'41.15"N 80°26'42.67"W | SET | NA | 2010-2017 | 0.835 | Platform | 9.62 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°30'19.61"N NA | SET | NA | 2008-2014 | NA | Platform | 2 | Raposa et al. 2016 |
| SC    | 32°32'54.66"W 80°35'42.02"W | SET | NA | 2010-2017 | 0.835 | Platform | 2.5 | Sharma et al. 1987 |
| SC    | 32°32'54.94"N 80°35'44.70"W | SET | NA | 2010-2017 | 1.036 | Platform | 4.33 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°32'54.94"N 80°35'44.70"W | SET | NA | 2010-2017 | 0.835 | Platform | 9.62 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°32'54.94"N 80°35'44.70"W | SET | NA | 2010-2017 | 0.835 | Platform | 2.04 | (W. Doar) Crotty et al., this manuscript |
| SC    | 32°33'19.56.18"N 79°10'18.07"W | 137Cs | 1982 | NA | NA | Platform | 2.5 | Sharma et al. 1987 |
| SC    | 32°33'19.56.18"N 79°10'18.07"W | 137Cs | 1982 | NA | NA | Platform | 1.3 | Sharma et al. 1987 |
| SC    | 32°33'19.56.18"N 79°10'18.07"W | 137Cs | 1982 | NA | NA | Platform | 3.5 | Vogel et al. 1996 |
| SC    | 33°19'36.89"N 79°12'6.41"W | 210 Pb | 1982 | NA | NA | Platform | 4.5 | Sharma et al. 1987 |
| SC    | 33°19'36.89"N 79°12'6.41"W | 210 Pb | 1982 | NA | NA | Platform | 2.4 | Sharma et al. 1987 |
| SC    | 33°19'36.89"N 79°12'6.41"W | 210 Pb | 1982 | NA | NA | Platform | 1.6 | Sharma et al. 1987 |
| SC    | 33°19'36.89"N 79°12'6.41"W | 210 Pb | 1982 | NA | NA | Platform | 2.9 | Vogel et al. 1996 |
| SC    | 33°20'45.73"N 79°11'44.01"W | SET | NA | 2008-2014 | NA | Platform | 2.7 | Raposa et al. 2016 |
| SC    | 33°20'45.73"N 79°11'44.01"W | SET | NA | 2008-2014 | NA | Platform | 2.97 | Morris et al. 2002 |
| SC    | 33°20'45.07"N 79°11'43.68"W | SET | NA | 2008-2014 | NA | Platform | 2.6 | Raposa et al. 2016 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.4 | Sharma et al. 1987 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.9 | Vogel et al. 1996 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.97 | Raposa et al. 2016 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.6 | Raposa et al. 2016 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.4 | Sharma et al. 1987 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.9 | Vogel et al. 1996 |
| SC    | 33°21'0.39"N 79°11'31.66"W | SET | NA | 2008-2014 | NA | Platform | 2.97 | Raposa et al. 2016 |
Table S2. Locations of regional sites used for aerial image analysis ($N = 9$ total sites). Site abbreviations and coordinates of the center of 1-km\(^2\) replicate areas are presented.

| Site       | Abbreviation | Latitude     | Longitude    |
|------------|--------------|--------------|--------------|
| Cape Romain| CR           | 33°01'21.46" N | 79°25'09.97" W |
| Beaufort   | BE           | 32°22'12.10" N | 80°48'08.79" W |
| Pulaski    | PU           | 32°05'00.68" N | 80°54'15.19" W |
| Bluff      | BL           | 32°00'02.50" N | 81°00'35.41" W |
| Sapelo 1   | S1           | 31°25'20.67" N | 81°18'05.26" W |
| Sapelo 2   | S2           | 31°24'24.96" N | 81°17'40.13" W |
| Brunswick  | BR           | 31°10'26.05" N | 81°24'58.44" W |
| Jekyll     | JE           | 31°02'27.44" N | 81°26'04.93" W |
| Fernandina | FE           | 30°33'40.48" N | 81°30'17.00" W |
Table S3. Locations and the associated creek length and width (measured at the mouth and midpoint of the tidal creek) of the three marsh sites on Sapelo Island, Georgia where the mortality assay and tethering experiments were conducted, and where cordgrass biomass was harvested and environmental conditions were measured.

| Site          | Creek Type | 1km² Area Center | Creek Length (m) | Creek Width (m) |
|---------------|------------|------------------|------------------|-----------------|
|               |            | Latitude         | Longitude        | Mouth           | Midpoint        |
| Airport       | Grazed     | 31°25'13.54"N   | 81°17'33.18"W   | 280.55          | 5.31            | 2.96            |
|               | Ungrazed   | 31°25'28.41"N   | 81°17'29.74"W   | 275.58          | 4.95            | 2.13            |
| Beach Road    | Grazed     | 31°23'30.74"N   | 81°16'41.95"W   | 108.52          | 2.84            | 1.34            |
|               | Ungrazed   | 31°23'34.75"N   | 81°16'46.55"W   | 111.71          | 1.41            | 1.13            |
| Little Sapelo | Grazed     | 31°25'13.56"N   | 81°18'13.36"W   | 216.51          | 2.67            | 2.51            |
|               | Ungrazed   | 31°25'08.59"N   | 81°18'03.93"W   | 238.97          | 2.71            | 1.84            |
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