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Supporting Information for

Impacts of Seagrass Dynamics on the Coupled Long-Term Evolution of Barrier-Marsh-Bay Systems

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Additional Supporting Information (Files uploaded separately)

Introduction

Supporting figures include a schematic illustration of the model's effective fetch calculation algorithm, graphical representation of the look-up tables, a representative simulation exhibiting a positive feedback for marsh expansion in a coupled marsh-seagrass system, an expansion of Figure 3 from the main text to include varying Percent Bay Cover (PBC), and the impacts on model results of using a shorter model time step.

Supporting tables include the parameter values used in the GEOMBEST++Seagrass simulations of the main text, the data extracted and sorted to construct the lookup tables, as well as the final widths derived from the Marsh Width experiments of section 3.1.

Additional information on data processing is given in the main text.

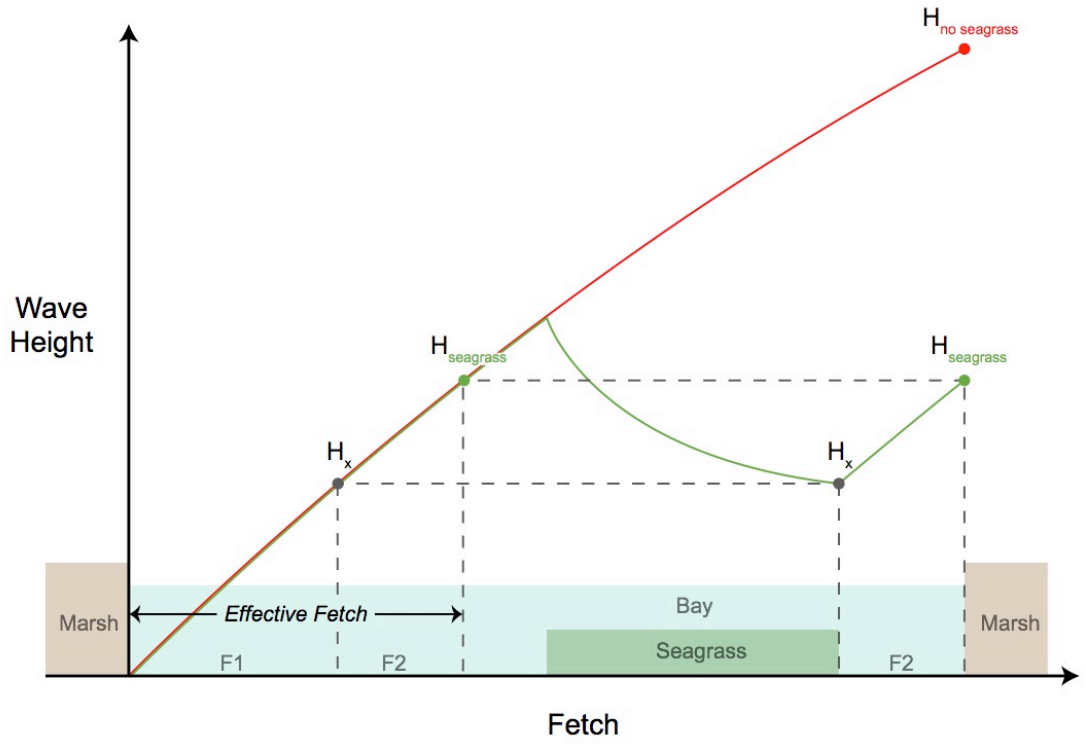

Figure S1. *Schematic illustration of wave height as a function of fetch with (green) and without (red) attenuation from seagrass. Following decay from seagrass, wave height continues to regrow along the same curve starting at the attenuated height (Hx) over the distance F2 until it reaches the far opposite marsh edge. When seagrass is present in the bay, the model calculates the final wave height reaching the far marsh edge using the effective fetch, which is equal to the sum of F1 (the fetch that would produce the height H_x in the absence of seagrass) and F2 (the fetch of the regrowth area). When no seagrass is present, the full fetch of the basin is used to calculate the final wave height in the model.*

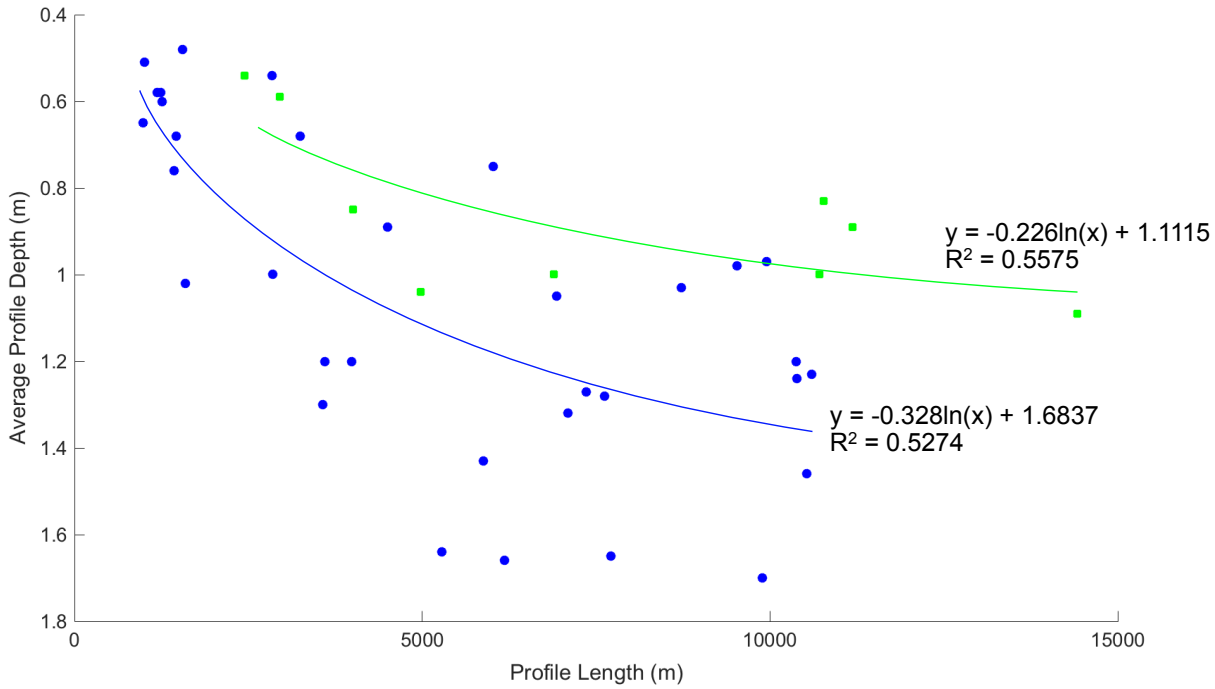

Figure S2. *Average depth of bathymetric profiles extracted from VCR back-barrier basins plotted over profile length for both bare (blue) and seagrass-covered (green) segments to establish a relationship between equilibrium depth and fetch in the model. The fetch-depth lookup table was constructed by extracting values along the fitted curves for cases with and without seagrass. Raw data is given in table S1.*

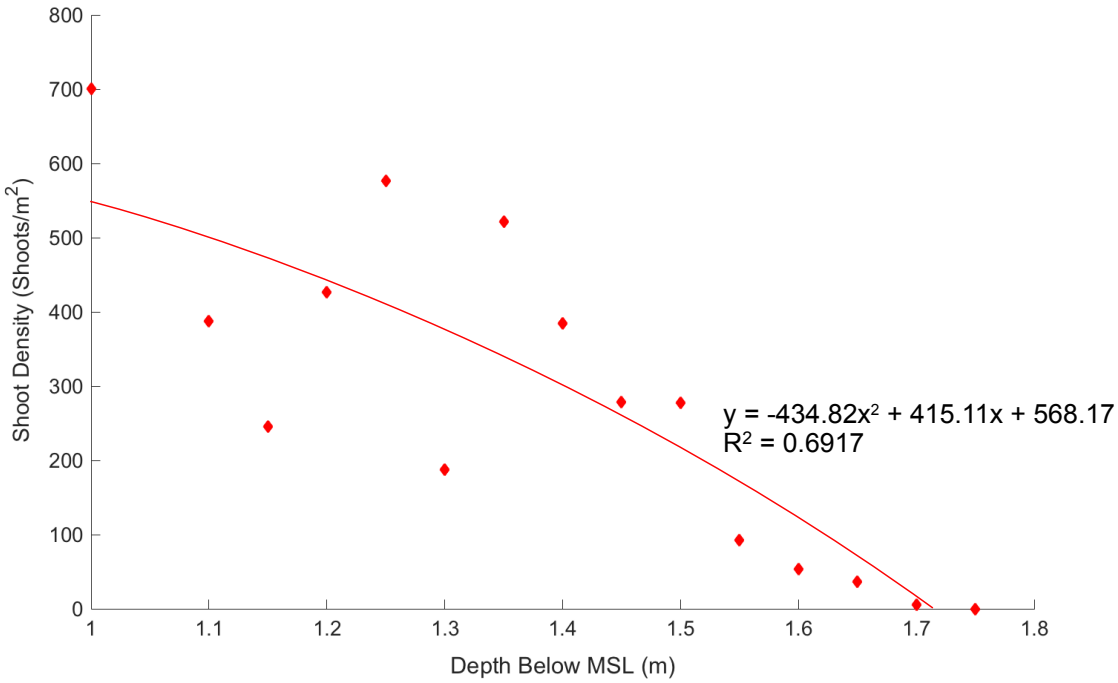

Figure S3. *Maximum shoot density as a function of bay depth from a 7-year chronosequence of structural seagrass data in Hog Island Bay (McGlathery, 2013) to establish a relationship between depth and shoot density for seagrass growth in the model. The shoot density look-up table was constructing by extracting values along the curve. Raw data is given in Table S1.*

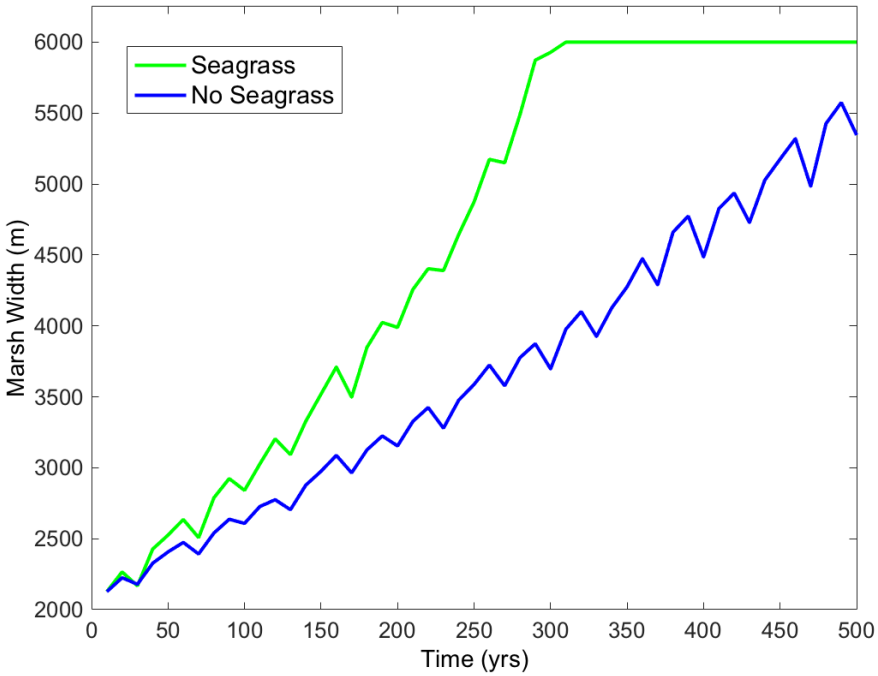

Figure S4. *Marsh width over time for a representative simulation with and without seagrass (RSLR = 4 mm/yr; BSF = 60 m^3/m/yr). While marshes in the absence of seagrass tend to prograde linearly, marshes in the presence of seagrass tend to prograde exponentially. This occurs because of a positive feedback whereby expansion of the marsh towards seagrass habitat causes the seagrass meadow to shrink and release additional sediment available to the marsh, causing the marsh to expand further.*

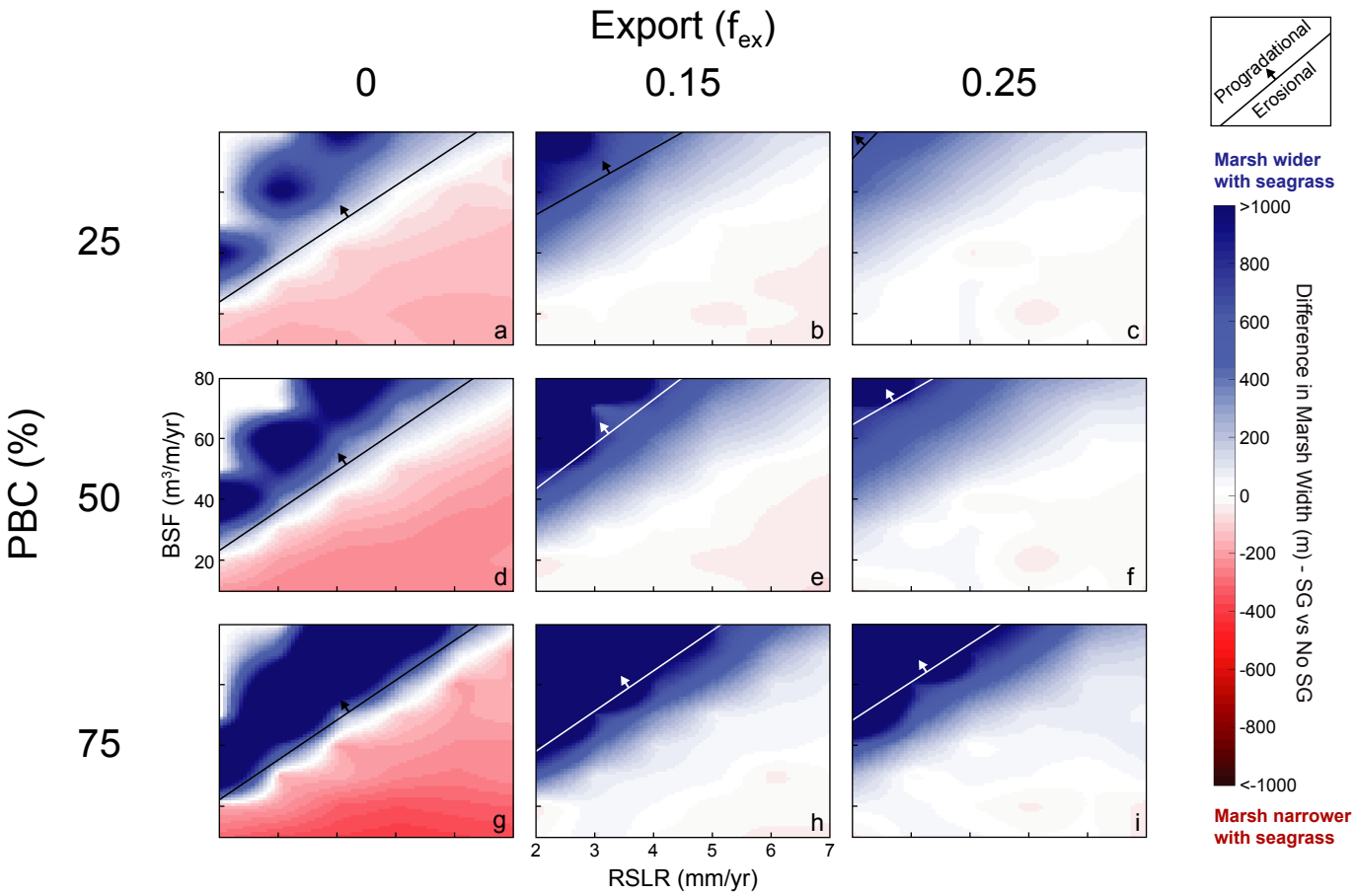

Figure S5. *Difference in marsh width after 1 m of relative sea level rise (RSLR) between simulations with seagrass and without across a range of Bay Sediment Flux (BSF) volumes and RSLR rates. Parameter spaces are varied by PBC (percent of the bay covered by the seagrass meadow) in addition to f_{ex} (percent of suspended inorganic sediment lost from the system). Marshes prograde in the simulations within the parameter space above the diagonal line and erode in the simulations within the parameter space below the line. Parameter space panels (d), (e), and (f) comprise Figure 3 in the main text. The effects of seagrass become more pronounced with increasing size of the seagrass meadow, but varying the PBC does not change the general findings of these experiments.*

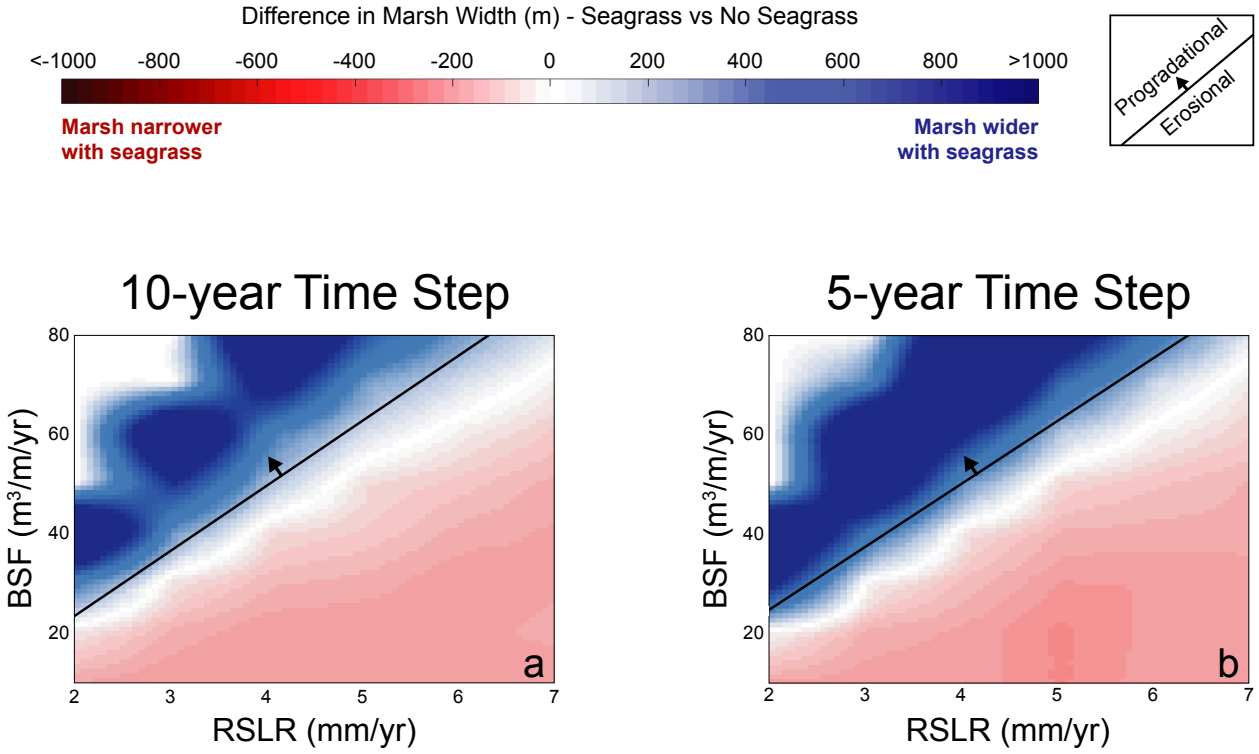

Figure S6. *Comparison of (a) the parameter space from Figure 3a, simulated with a 10-year time step (consistent with all other simulations presented in this study), and (b) the same parameter space from Figure 3a but simulated with a 5-year time step. With a time step that is half as long, there is little change quantitatively in the results and no change in general conclusions we draw from them.*

Table S1. *Parameter Values Used in the GEOMBEST++Seagrass Simulations*

Scenario	RSLR (mm/yr)	BSF (m^3/m/yr)	Initial marsh width (km)	f_{ex} (%)	PBC
Add/Remove Experiments					
Add – Eroding	2	30	3	0.15	50
Add – Prograding	4	60	3	0	50
Remove – Eroding	2	30	1	0.15	50
Remove – Prograding	4	60	1	0	50
Island Migration Experiments					
No Marsh, No Seagrass	4	30	0	0	50
No Marsh, Seagrass	4	30	0	0	50
2 km Marsh, No Seagrass	4	50	2	0	50
2 km Marsh, Seagrass	4	50	2	0	50
Full Marsh, No Seagrass	4	50	Full	0	50

Table S2. *DepthFetch tab: Length, depth, and type (seagrass or bare sediment) of all bathymetric transects used to construct the depth-fetch lookup table. Transects were extracted from all VCR basins using the bathymetry from Richardson et al. (2014).*
ShootDensity tab: Shoot densities of restored Zostera marina plots in Hog Island Bay binned by depth for years 3-6 of seeding. Data originally from McGlathery (2013). The maximum density of each bin is used as a representative shoot density based on depth and plotted in Figure S3.
File name: reeves-ts02.xlsx

Table S3. *Back-barrier marsh widths derived from the Marsh Width experiments of section 3.1of the main text. Simulations are varied by RSLR, BSF, and f_{ex} input parameters, as well as the presence or absence of seagrass. The difference in final marsh width between corresponding seagrass and no seagrass runs is calculated and represented in Figure 3 of the main text.*
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