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Supporting Information for

Seagrasses impact sediments exchange between tidal flats and salt marsh, and the sediment budget of shallow bays

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Introduction

These supporting information include details about model setup and figures about changes in Submerged Aquatic Vegetation (SAV) from 1968 to 2009, changes in shear stress with plant density, and changes in total sediment mass within the bay for test cases with and without SAV.

Model setup

The numerical domain is defined by a grid having 160x800 cells, with cells resolution ranging from 40 m to 200 m with refinement at the inlets and areas with detailed coastal features. The water column is divided into 7 vertical and equally spaced layers. The model boundary is forced by tides defined using ADCIRC tidal constituents' database for the North Atlantic Ocean. The ROMS barotropic and baroclinic time steps are 0.1 s and 2 s respectively. The model has been implemented and calibrated by Defne and Ganju [2014]. The calibration of the model was made by changing the bottom roughness coefficient in order to obtain the best accordance with measurements from seven water level stations and three tidal discharge stations within the Barnegat Bay-Little Egg Harbor estuary. The Brier-Skill-Score [Murphy and Epstein, 1989] was used to evaluate the model performance. Skill assessment of the model varies from very good to excellent. As shown by Lathrop and Bognar [2001], natural and human drivers have drastically reduced the salt marsh area from around 14,850 ha to 9940 ha in Barnegat Bay-Little Harbor Estuary over the last century. Around half of the interior shoreline is eroding less than 0.5 m/yr, or is not eroding at all; the other half is eroding at around 0.5-2 m/yr and 2% of the marsh had erosion rates exceeding 2 m/yr. The highest erosion rate are found in the marshes surrounding Great Bay [Leonardi et al., 2016]. Based on that, the maximum marsh edge erosion has been around 80-160 m in the last 40 years. These values are comparable to cells size; therefore, the impact of marsh erosion has not been taken into account. This is in line with the goal of our manuscript which aims to evaluate the sole impact of seagrass and for which is thus convenient to maintain all other variables constant.

The suspended sediment transport is calculated by solving the advection diffusion equation, and by accounting for source/sink terms induced by downward settling or upward flux of eroded material. Sediment sources from the bed are computed following Arulanandan [1978], and sink terms are proportional to settling velocity values; the bed stress is calculated following a logarithmic bottom stress formulation [Warner et al., 2008].

References

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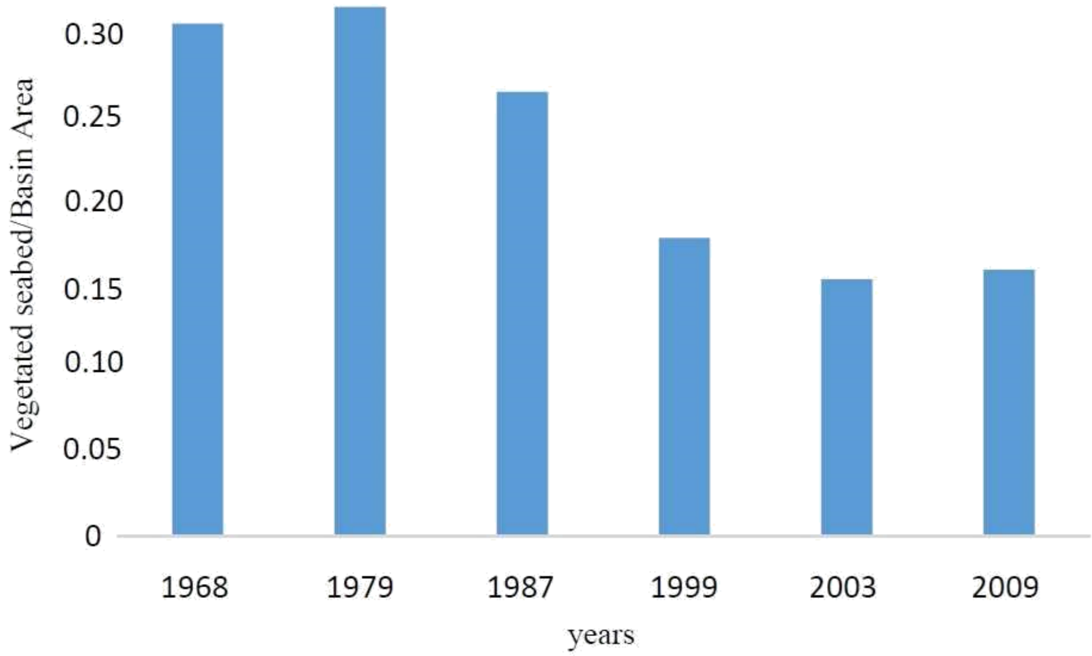

Figure S1. Changes in the ratio between vegetated seabed and basin area for the years from 1968-2009.

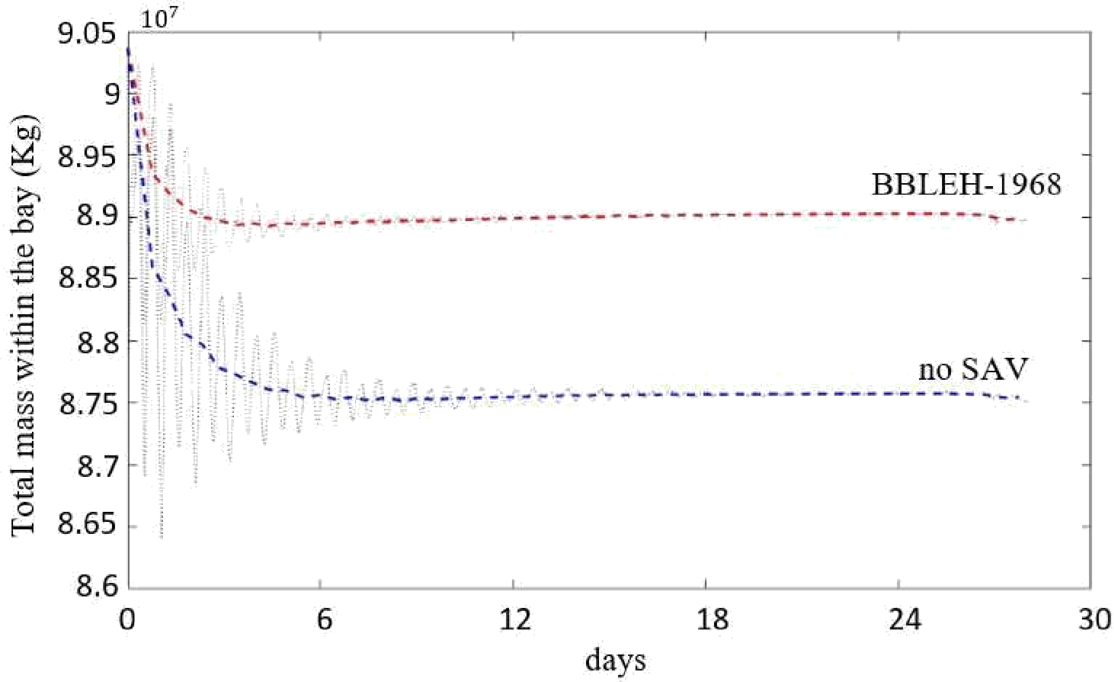

Figure S2. Time series of total sediment mass [kg] in time for the 1968 seagrass extent, and the no-SAV test case (figure 1).

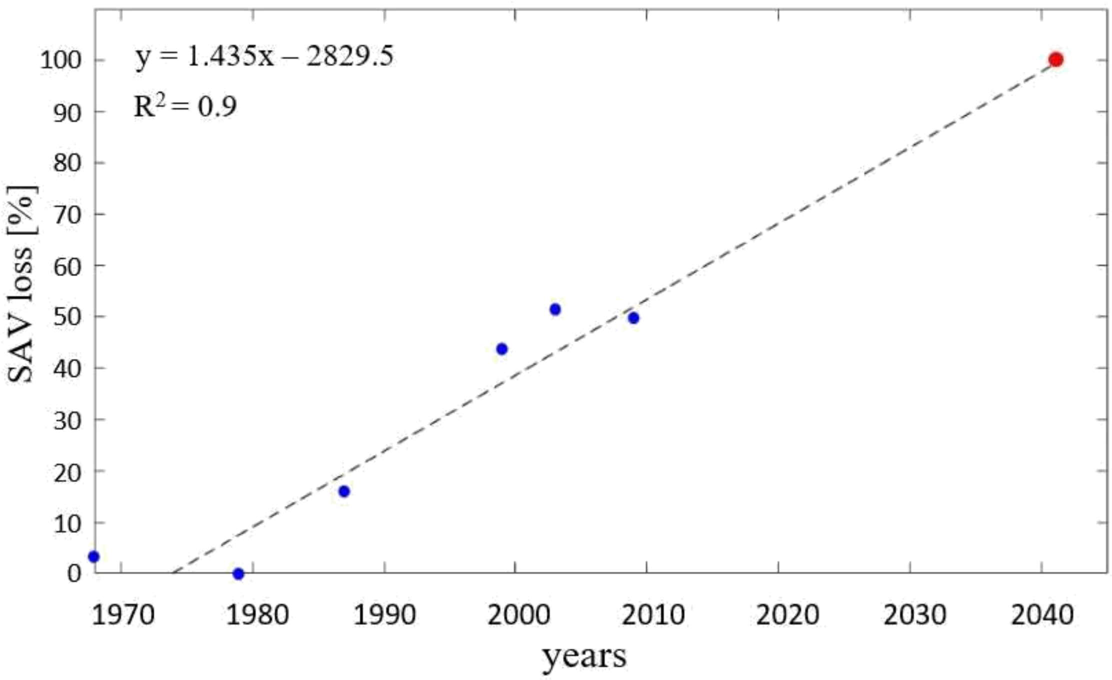

Figure S3. SAV loss [%] through time [years].

	Model scenario	Plant density (shoots/m2)	μ (bare beds)	σ (bare beds)	μ (meadows)	σ (meadows)
a	No-SAV	-	0.2003	0.5014	0.0994	0.1505
b	BBLEH-1968	251, 600 and 900	0.1912	0.4629	0.0027	0.0057
c	BBLEH-1968-run1	251	0.1939	0.4690	0.0078	0.0150
d	BBLEH-1968-run2	600	0.1920	0.4642	0.0038	0.0077
e	BBLEH-1968-run3	900	0.1913	0.463	0.0026	0.0054

Figure S4. Mean and standard deviation of shear stress [Pa] during spring tide within bare beds and meadows for: no-SAV case (a); BBLEH-1968 (b); 1968 seagrass distribution with a uniform plant density of 251 shoots/m2 (c); 1968 seagrass distribution with a uniform plant density of 600 shoots/m2 (d); 1968 seagrass distribution with a uniform plant density of 900 shoots/m2 (e).

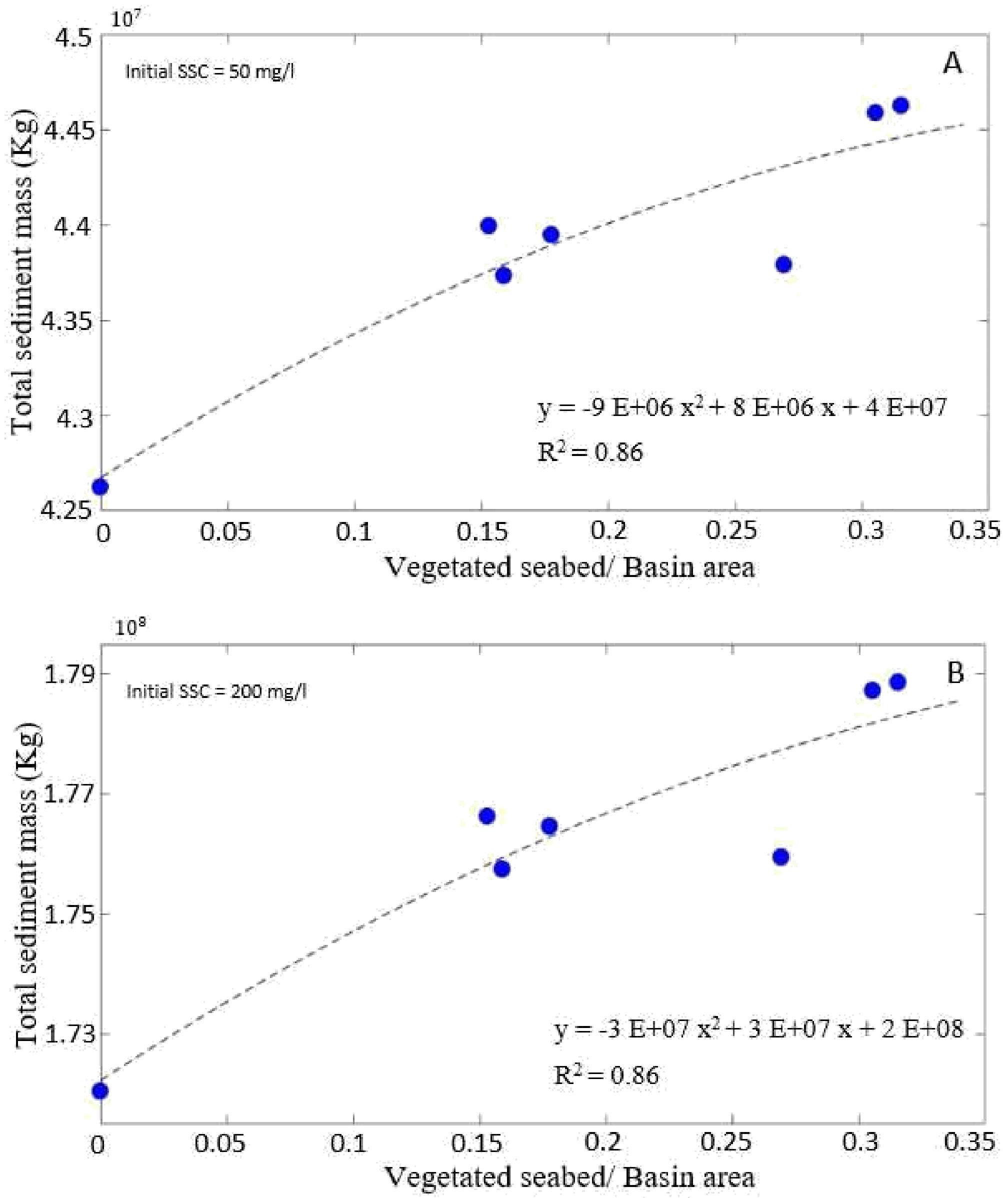

Figure S5. Total sediment mass within the lagoon as a function of vegetated bed/basin area ratios, after 30 simulated days: initial SSC = 50 mg/l (a); initial SSC = 200 mg/l. The vegetated bed/basin area ratios are calculated based on seagrasses extent presented in Figure 1.

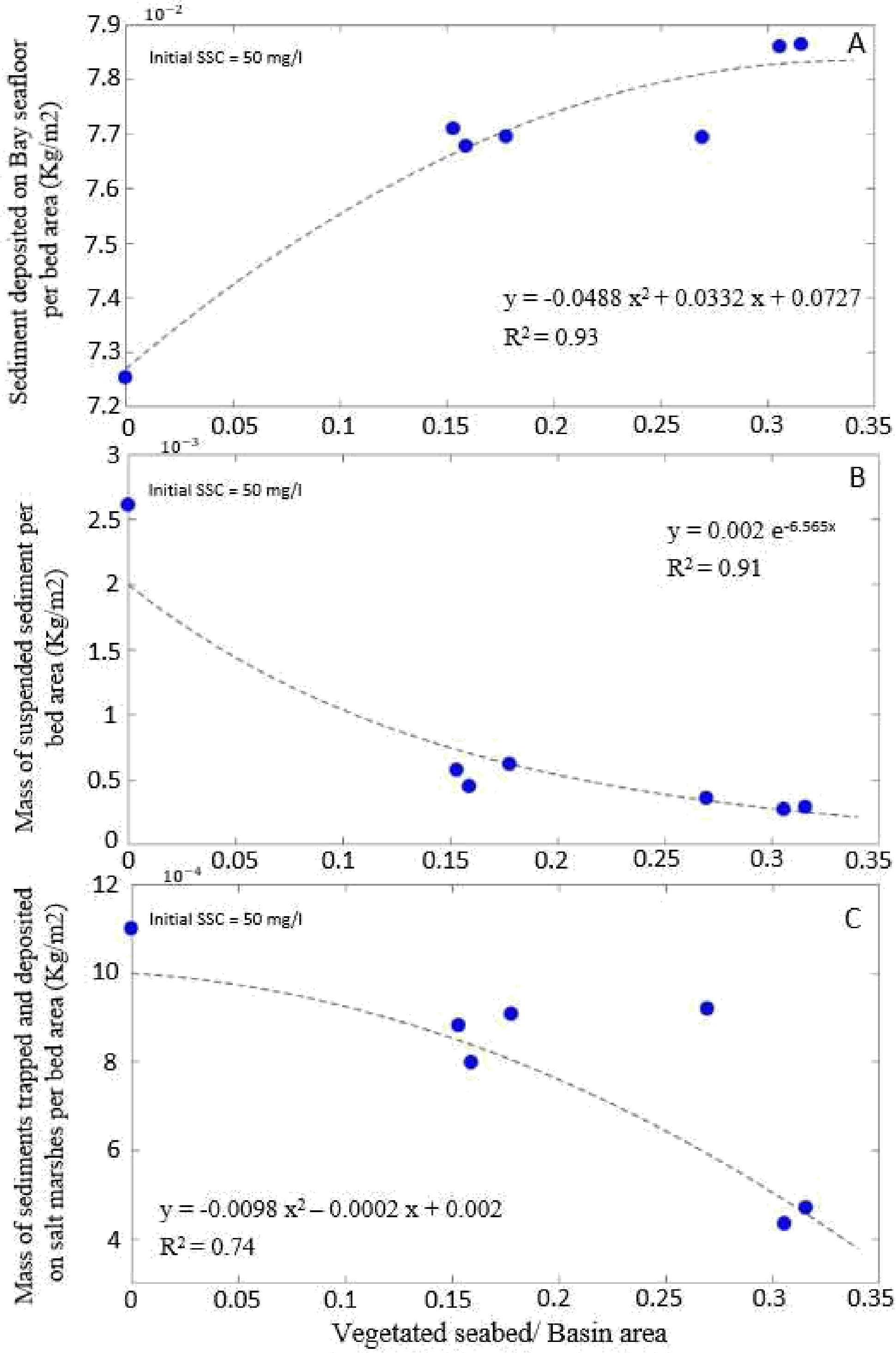

Figure S6. Mass of sediments (initial SSC = 50 mg/l) per bed area: deposited on the seafloor within the bay (a); in suspension (b); deposited on salt marsh platforms (c). Data are presented after 30 simulated days, and as a function of vegetated bed/basin area ratios obtained from the maps of figure 1 and corresponding to different years.

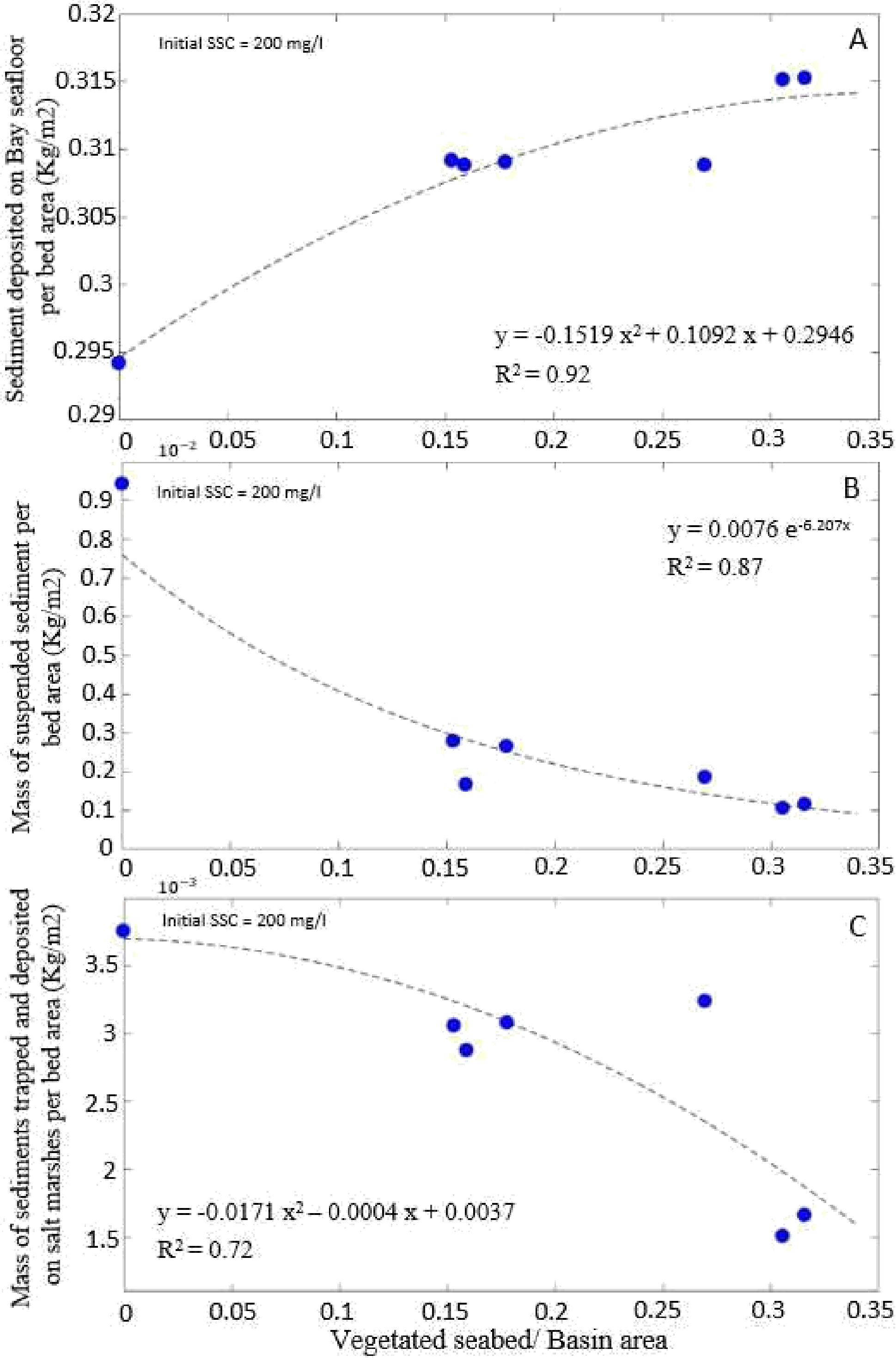

Figure S7. Mass of sediments (initial SSC = 200 mg/l) per bed area: deposited on the seafloor within the bay (a); in suspension (b); deposited on salt marsh platforms (c). Data are presented after 30 simulated days, and as a function of vegetated bed/basin area ratios obtained from the maps of figure 1 and corresponding to different years.

SSC values used in this manuscript are of the same order of magnitude than values measured in the field [Dickhudt et al., 2015]. As shown by our numerical investigations, the choice of the initial suspended sediment concentration in the water column does not significantly alter the sediment budget destinations, as changing initial SSC values doesn't alter the shape of the curves which are instead shifted up and down without any significant change in their trend (Figure 4, S4, S5 and S6). This is a comparative study aimed at determining changes in the bay sediment trapping potential as a function of different seagrasses-extent and such extent is the main independent variable. Since this is a comparative study, the initial SSC can be arbitrary, and SCC values have been therefore considered as spatially constant.

References

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