Appendix S1: Supplementary Figures and Tables

Journal Name: Ecosphere

Article Title: Bivalve facilitation mediates seagrass recovery from physical disturbance in a temperate estuary

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Figure S1. The two species studied in the experiments, (left) *Zostera marina* and (right) *Halodule wrightii* (right). Note the small scar indicated by the arrow on the *Z. marina* shoot caused from the marking method for growth described in the Methods section.

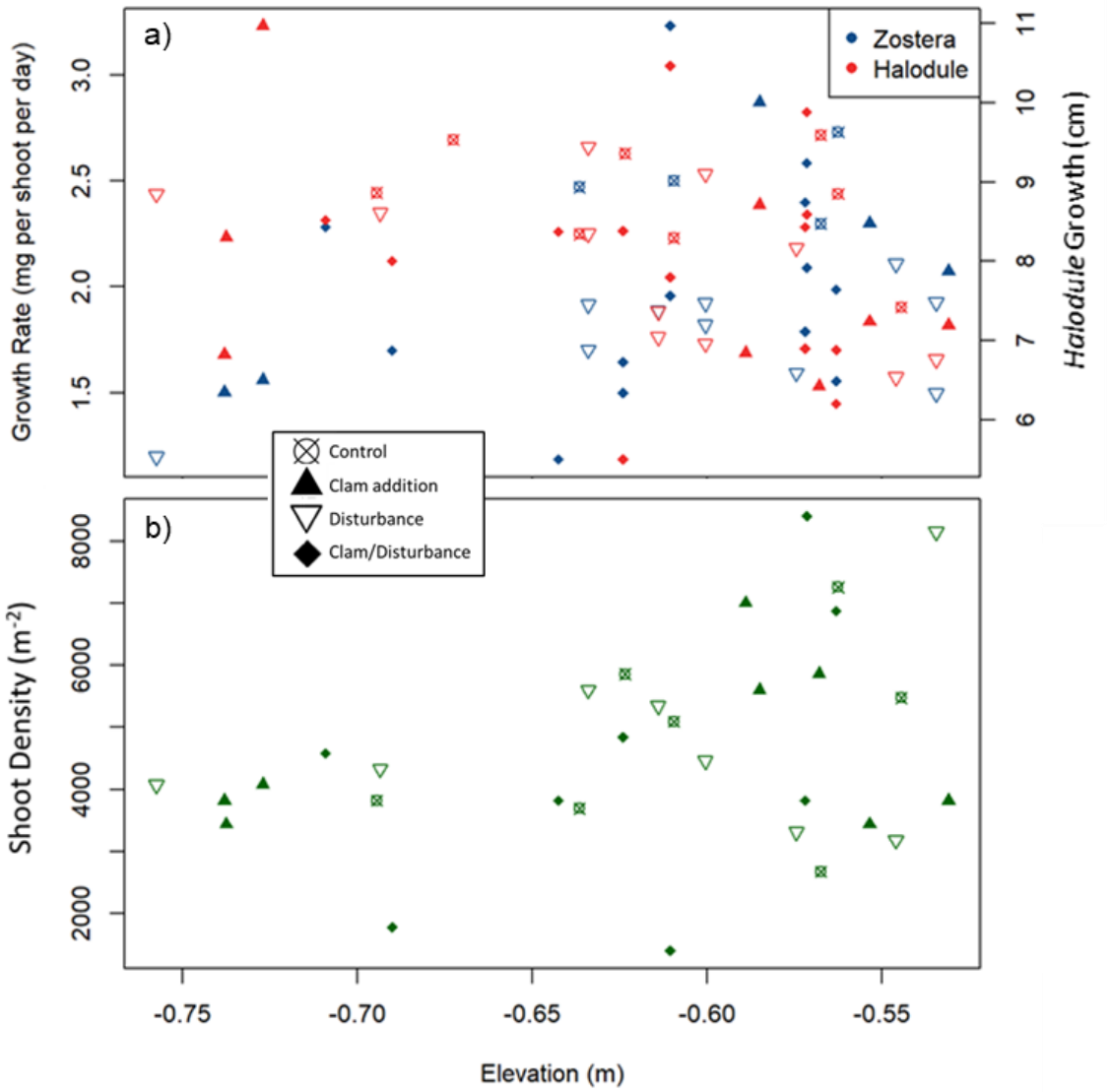

Figure S2. Experiment 2 relationship between plot elevation (measured in NAVD88 coordinates) and (a) June 2019 *Z. marina* and May 2019 *H. wrightii* growth rate and (b) June 2019 combined species shoot density. June cores were taken from April-disturbed subplots.

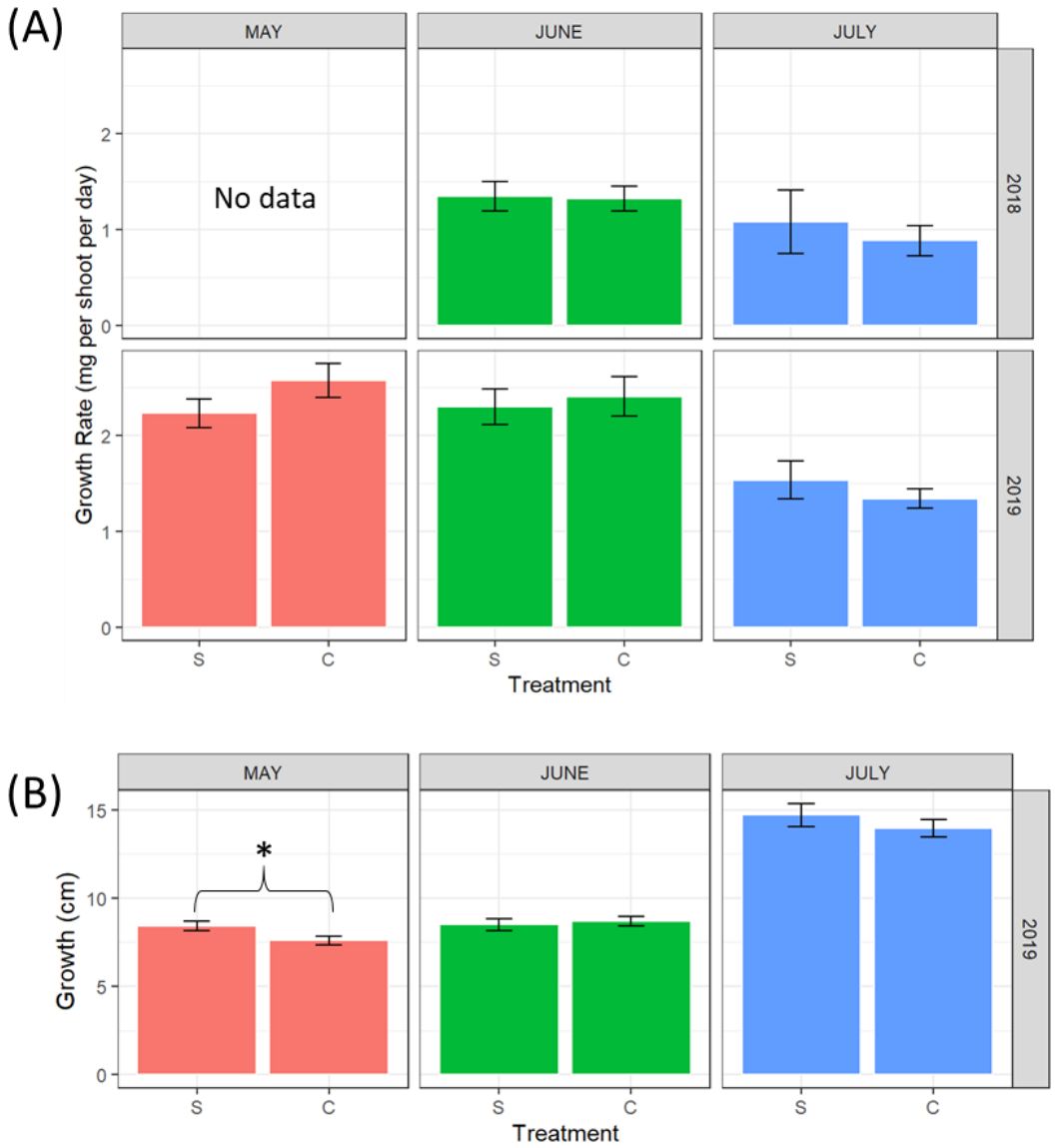

Figure S3. Experiment 1 summer growth rates for (A) *Z. marina* and (B) *H. wrightii* shoots by treatment (S – control; C – clam addition). Bars represent standard error. Asterix indicate statistically significant effect of clam addition at an alpha of 0.05.

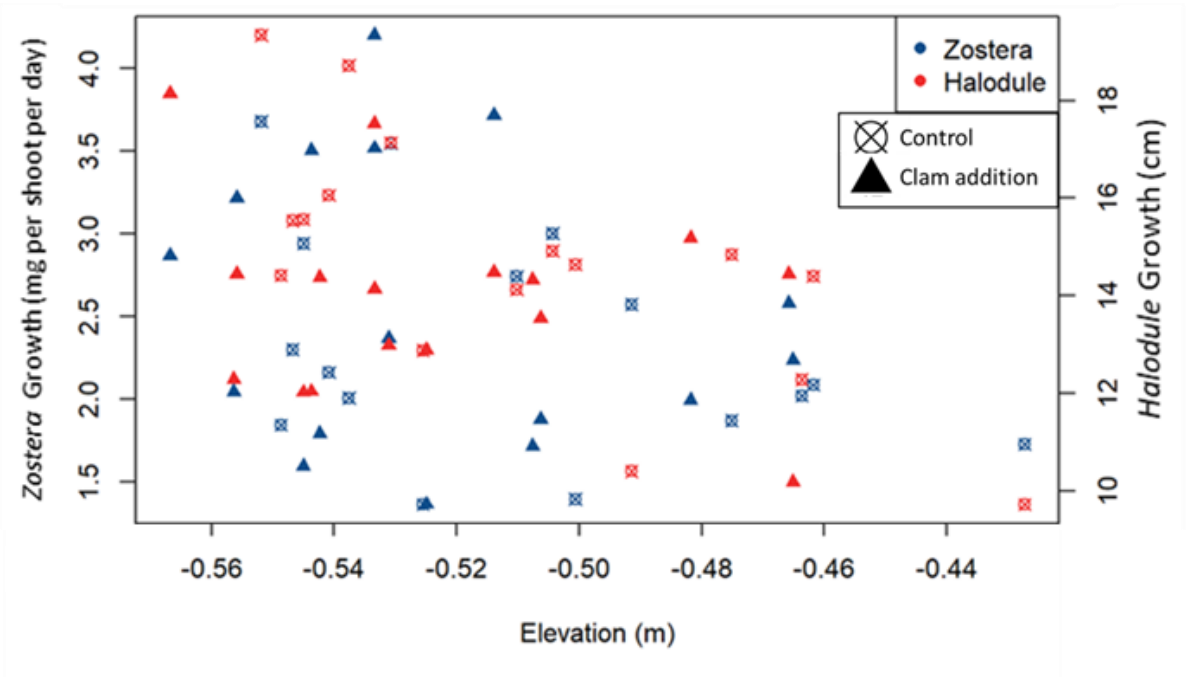

Figure S4. Experiment 1 relationship between plot elevation (measured in NAVD88 coordinates) and May 2019 *Z. marina* and July 2019 *H. wrightii* growth rates.

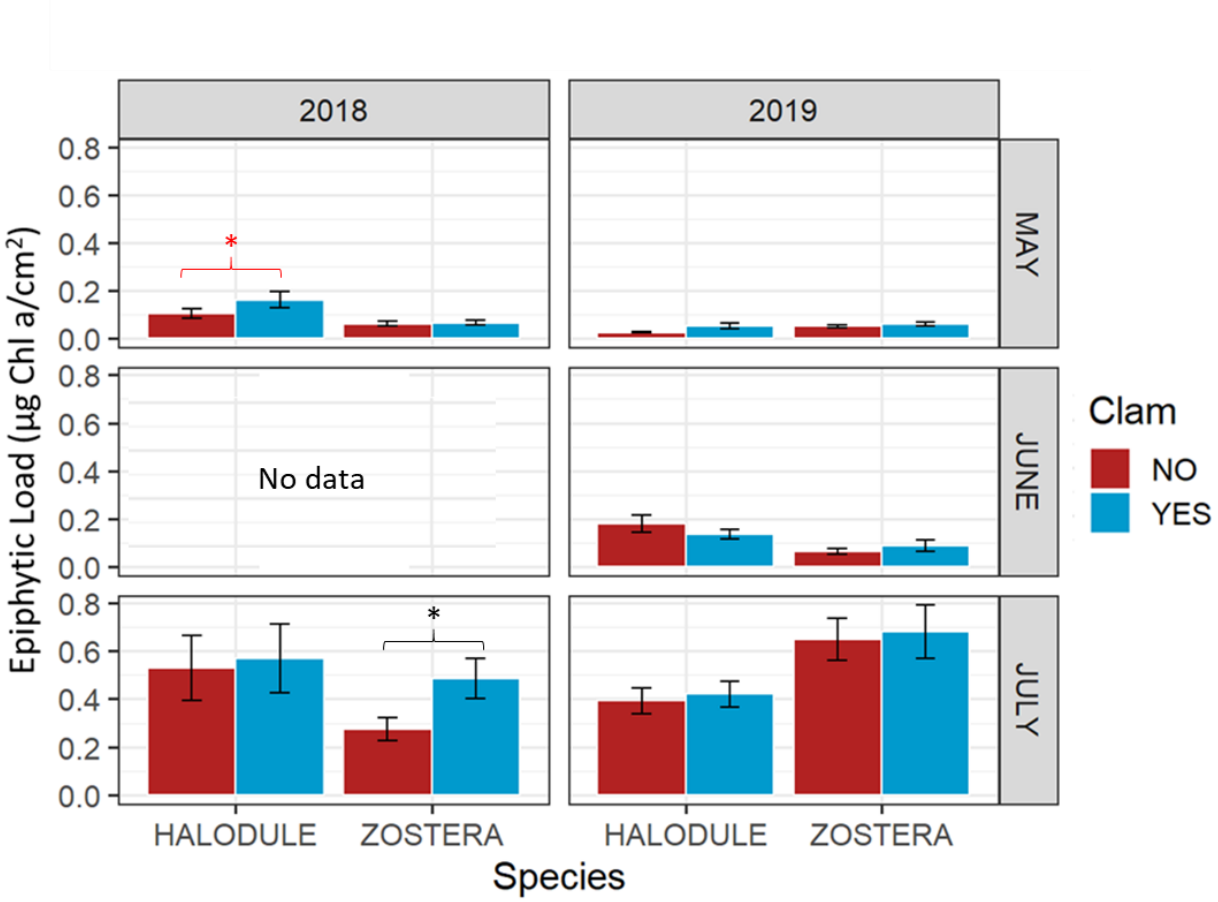

Figure S5. Experiment 1 epiphytic load among treatments (NO – control; YES – clam addition on *H. wrightii* and *Z. marina* species in 2018 (left) and 2019 (right) during May (top), June (middle), and July (bottom). Bars represent standard error. Asterix indicate statistically significant effect of clam addition at an alpha of (black) 0.05 or (red) 0.10.

Table S1. ANCOVA results for Experiment 1 seagrass biomass core variables (shoot density, aboveground biomass, belowground biomass).

Sampling Month	Response Variable		df	Sum of Squares	Mean Square	F ratio	Prob > F
May 2019	*Z. marina* shoot density	Elevation	1	2.05	2.0457	0.1202	0.7313
		Clam	1	16.32	16.3208	0.9589	0.3356
		Residuals	29	493.60	17.0208		
	Z. marina aboveground	Elevation	1	0.00151	0.00151	0.0165	0.8985
		Clam	1	0.09260	0.092601	1.0136	0.3224
		Residuals	29	2.64945	0.091360		
	H. wrightii shoot density	Elevation	1	217.9	217.89	0.9221	0.3449
		Clam	1	582.9	582.95	2.4669	0.1271
		Residuals	29	6852.9	236.31		
	H. wrightii aboveground	Elevation	1	0.01904	0.019035	0.4902	0.4894
		Clam	1	0.10533	0.105326	2.7124	0.1104
		Residuals	29	1.12610	0.038831		
	Total belowground	Elevation	1	3.601	3.6014	1.3145	0.2613
		Clam	1	4.746	4.7459	1.7322	0.1988
		Residuals	28	76.713	2.7397		
July 2019	*Z. marina* shoot density	Elevation	1	57.60	57.601	2.8017	0.1053
		Clam	1	5.44	5.436	0.2644	0.6111
		Residuals	28	575.67	20.560		
	Z. marina aboveground	Elevation	1	0.01691	0.016914	0.1886	0.6674
		Clam	1	0.00304	0.003035	0.0338	0.8554
		Residuals	28	2.51142	0.089694		
	H. wrightii shoot density	Elevation	1	251.3	251.33	0.4538	0.5059
		Clam	1	137.5	137.53	0.2483	0.6220
		Residuals	29	16060.0	553.79		
	H. wrightii aboveground	Elevation	1	0.3433	0.34330	1.7057	0.2030
		Clam	1	0.0141	0.01408	0.0700	0.7935
		Residuals	26	5.2329	0.20126		
	Total belowground	Elevation	1	0.015	0.0148	0.0040	0.9504
		Clam	1	1.670	1.6701	0.4475	0.5102
		Residuals	23	85.830	3.7317		

Table S2. ANCOVA results for Experiment 2 seagrass biomass core variables (shoot density, aboveground biomass, belowground biomass).

Sampling Month	Response Variable		df	Sum of Squares	Mean Square	F ratio	Prob > F
June 2019 (early season disturbances)	*Z. marina* shoot density	Elevation	1	3.603	3.6028	0.2991	0.5891
		Clam	1	27.122	27.1220	2.2514	0.1455
		Disturbance	1	2.827	2.8267	0.2346	0.6322
		Clam * Disturbance	1	4.718	4.7183	0.3917	0.5369
		Residuals	26	313.214	12.0467		
	Z. marina aboveground	Elevation	1	0.00181	0.001810	0.0608	0.807132
		Clam	1	0.24942	0.249416	8.3811	**0.007582**
		Disturbance	1	0.00099	0.000990	0.0333	0.856663
		Clam * Disturbance	1	0.11419	0.114186	3.8370	*0.060941*
		Residuals	26	0.77374	0.029759		
	H. wrightii shoot density	Elevation	1	547.9	547.94	3.4561	*0.07437*
		Clam	1	2.0	2.00	0.0126	0.91148
		Disturbance	1	12.1	12.14	0.0766	0.78416
		Clam * Disturbance	1	2.0	2.02	0..0127	0.91105
		Residuals	26	4122.1	158.54		
	H. wrightii aboveground	Elevation	1	0.0438	0.04378	0.2826	0.5995
		Clam	1	0.0432	0.04319	0.2788	0.6020
		Disturbance	1	0.4000	0.40001	2.5821	0.1202
		Clam * Disturbance	1	0.2525	0.25249	1.6298	0.2130
		Residuals	26	4.0279	0.15492		
	Total belowground	Elevation	1	0.135	0.13517	0.0945	0.7611
		Clam	1	0.174	0.17359	0.1214	0.7305
		Disturbance	1	0.486	0.48573	0.3396	0.5653
		Clam * Disturbance	1	0.749	0.74909	0.5238	0.4760
		Residuals	25	35.756	1.43023		
July 2019 (late season disturbances)	*Z. marina* shoot density	Elevation	1	17.254	17.254	1.5183	0.23149
		Clam	1	0.139	0.139	0.0122	0.91314
		Disturbance	1	49.409	49.409	49.409	**0.04945**
		Clam * Disturbance	1	7.941	7.941	7.941	0.41259
		Residuals	21	238.642	11.364	11.364	

	Z. marina aboveground	Elevation	1	0.02201	0.022009	0.6534	0.4301
		Clam	1	0.0045	0.000447	0.0133	0.9097
		Disturbance	1	0.00094	0.000938	0.0278	0.8695
		Clam * Disturbance	1	0.01707	0.017070	0.5068	0.4862
		Residuals	17	0.57263	0.033684		
	H. wrightii shoot density	Elevation	1	8.05	8.05	0.0676	0.79737
		Clam	1	667.69	667.69	5.6061	**0.02578**
		Disturbance	1	489.36	489.36	4.1088	*0.05554*
		Clam * Disturbance	1	10.15	10.15	0.0852	0.77319
		Residuals	21	2501.10	119.10		
	H. wrightii aboveground	Elevation	1	0.3045	0.30451	1.3222	0.26709
		Clam	1	0.0237	0.02371	0.1030	0.75246
		Disturbance	1	0.2042	0.20419	0.8866	0.36039
		Clam * Disturbance	1	0.7334	0.73340	3.1845	*0.09331*
		Residuals	16	3.6848	0.23030		
	Total belowground	Elevation	1	0.545	0.5454	0.2216	0.6446
		Clam	1	3.290	3.2901	1.3368	0.2657
		Disturbance	1	0.405	0.4048	0.1645	0.6908
		Clam * Disturbance	1	3.930	3.930	1.5969	0.2256
		Residuals	15	36.919	2.4612		
June 2020 (early season disturbances)	*Z. marina* shoot density	Elevation	1	19.6	19.644	0.3289	0.5687
		Clam	1	25.2	25.248	0.4227	0.5183
		Disturbance	1	0.3	0.332	0.0056	0.9408
		Clam * Disturbance	1	72.2	72.242	1.2096	0.2763
		Residuals	54	3225.2	59.726		
	Z. marina aboveground	Elevation	1	0.1436	0.143631	2.3456	0.1315
		Clam	1	0.1304	0.130436	2.1301	0.1502
		Disturbance	1	0.0192	0.019161	0.3129	0.5782
		Clam * Disturbance	1	0.0232	0.023241	0.3795	0.5404
		Residuals	54	3.3066	0.061233		
	H. wrightii shoot density	Elevation	1	186.2	186.20	0.3748	0.5430
		Clam	1	138.7	138.74	0.2792	0.5994
		Disturbance	1	220.5	220.53	0.4439	0.5081

		Clam * Disturbance	1	292.3	292.29	0.5883	0.4464
		Residuals	54	26829.1	496.84		
	H. wrightii aboveground	Elevation	1	0.0073	0.00729	0.0585	0.80974
		Clam	1	0.0032	0.00322	0.0259	0.87275
		Disturbance	1	0.0601	0.06009	0.4825	0.49025
		Clam * Disturbance	1	0.4177	0.41770	3.3544	*0.07255*
		Residuals	54	6.7243	0.12452		
	Total belowground	Elevation	1	0.738	0.7382	0.5267	0.471177
		Clam	1	1.783	1.7830	1.2722	0.264431
		Disturbance	1	0.320	0.3201	0.2284	0.634691
		Clam * Disturbance	1	11.682	11.6821	8.3353	**0.005616**
		Residuals	53	74.281	1.4015		
June 2020 (late season disturbances)	*Z. marina* shoot density	Elevation	1	12.9	12.917	0.1693	0.68264
		Clam	1	0.5	0.458	0.0060	0.93857
		Disturbance	1	228.2	228.229	2.9916	*0.09041*
		Clam * Disturbance	1	1.8	1.825	0.0239	0.87775
		Residuals	46	3509.4	76.251		
	Z. marina aboveground	Elevation	1	0.0686	0.06862	0.4776	0.49300
		Clam	1	0.0047	0.00465	0.0324	0.85799
		Disturbance	1	0.8337	0.83371	5.8022	**0.02007**
		Clam * Disturbance	1	0.1334	0.13343	0.9286	0.34027
		Residuals	46	6.6097	0.14369		
	H. wrightii shoot density	Elevation	1	2075.8	2075.77	4.1112	**0.0482**
		Clam	1	465.8	465.76	0.9225	0.34185
		Disturbance	1	1201.6	1201.63	2.3799	0.12976
		Clam * Disturbance	1	1409.1	1409.13	2.7909	0.10159
		Residuals	46	23225.6	504.90		
	H. wrightii aboveground	Elevation	1	0.3874	0.38745	4.1475	**0.04748**
		Clam	1	0.0004	0.00042	0.0045	0.94653
		Disturbance	1	0.3725	0.37246	3.9870	*0.05179*
		Clam * Disturbance	1	0.6383	0.63833	6.8331	**0.01206**
		Residuals	46	4.2972	0.09342		
	Total belowground	Elevation	1	0.127	0.1274	0.0600	0.8076
		Clam	1	6.825	6.8246	3.2148	0.2254

Disturbance	1	3.966	3.9660	1.8682	0.1785
Clam * Disturbance	1	2.566	2.5661	1.2088	*0.0797*
Residuals	46	93.531	2.1229		

Table S3. ANCOVA results for Experiment 1 seagrass growth rates for *Z. marina* (mg per shoot per day) and *H. wrightii* (cm).

Species	Year	Month		df	Sum of Squares	Mean Square	F ratio	Prob > F
Zostera marina	2018	June	Elevation	1	0.398	0.39791	0.6746	0.4150
			Clam	1	0.027	0.02662	0.0451	0.8326
			Residuals	54	31.850	0.58981		
		July	Elevation	1	3.7737	3.7737	4.2288	0.04953*
			Clam	1	0.6807	0.6807	0.7629	0.39014
			Residuals	27	24.0940	0.8924		
	2019	May	Elevation	1	3.356	3.3564	4.2806	0.04326*
			Clam	1	0.836	0.8363	1.0666	0.30624
			Residuals	55	43.126	0.7841		
		June	Elevation	1	1.271	1.27069	1.300	0.2599
			Clam	1	0.021	0.02064	0.0211	0.8851
			Residuals	48	46.916	0.97743		
		July	Elevation	1	0.8423	0.84225	2.3285	0.1382
			Clam	1	0.5004	0.50039	1.3834	0.2494
			Residuals	28	10.1279	0.36171		
Halodule wrightii	2019	May	Elevation	1	0.315	0.3145	0.1561	0.69422
			Clam	1	10.388	10.3883	5.1553	0.02684*
			Residuals	59	1118.890	2.0151		
		June	Elevation	1	6.6754	6.6754	2.6069	0.1121
			Clam	1	0.031	0.0314	0.0123	0.9123
			Residuals	55	140.839	2.5607		
		July	Elevation	1	37.913	37.913	9.5888	0.004315**
			Clam	1	11.469	2.9006	2.9006	0.099240
			Residuals	29	3.954			

Table S4. ANCOVA results for Experiment 2 seagrass growth rates for *Z. marina* (mg per shoot per day) and *H. wrightii* (cm).

Species	Month	Disturbance Month		df	Sum of Squares	Mean Square	F ratio	Prob > F
Z. marina	May	April	Elevation	1	0.356	0.3556	0.5085	0.47798
			Clam	1	0.516	0.5164	0.7384	0.39288
			Disturbance	1	0.002	0.0024	0.0034	0.95375
			Clam * Disturbance	1	3.548	3.5479	5.0734	0.02718*
			Residuals	76	53.147	0.6993		
	June	April	Elevation	1	1.5454	1.5452	4.0195	0.04902*
			Clam	1	0.0139	0.01386	0.0360	0.8500
			Disturbance	1	2.5271	2.52711	6.5729	0.01260*
			Clam * Disturbance	1	1.5325	1.53252	3.9860	0.04995*
			Residuals	67	25.7599	0.38448		
	July	June	Elevation	1	0.7106	0.71060	1.6674	0.2149
			Clam	1	0.1207	0.12069	0.2832	0.6019
			Disturbance	1	0.0992	0.09922	0.2328	0.6360
			Clam * Disturbance	1	0.9515	0.95146	2.2326	0.1546
			Residuals	16	6.8187	0.42617		
H. wrightii	May	April	Elevation	1	16.173	16.1729	7.9432	0.006003**
			Clam	1	5.343	5.3435	2.6244	0.108936
			Disturbance	1	2.415	2.4154	1.1863	0.279156
			Clam * Disturbance	1	7.568	7.5683	3.7171	0.057197
			Residuals	85	173.066	2.0361		
	June	April	Elevation	1	24.89	24.8949	2.7120	0.1038
			Clam	1	3.34	3.3422	0.3641	0.5481
			Disturbance	1	10.41	10.4127	1.1344	0.2903
			Clam * Disturbance	1	15.03	15.0260	1.6369	0.2047
			Residuals	75	688.46	9.1794		
	July	April	Elevation	1	0.151	0.1507	0.0189	0.8924
			Clam	1	18.240	18.2893	2.2893	0.1510

	Disturbance	1	6.277	6.2774	0.7879	0.3887
	Clam * Disturbance	1	2.463	2.4632	0.3092	0.5864
	Residuals	15	119.508	7.9672		
June	Elevation	1	0.071	0.0706	0.0247	0.876768
	Clam	1	0.070	0.0698	0.0245	0.877401
	Disturbance	1	1.681	1.6812	0.5894	0.452608
	Clam * Disturbance	1	29.411	29.4108	10.3110	0.004843**
	Residuals	18	51.343	2.8524		

Table S5. ANOVA results for Experiment 1 epiphytic load (µg Chl a/cm^2).

Species	Year	Month		df	Sum of Squares	Mean Square	F ratio	Prob > F
Z. marina	2018	May	Clam	1	0.00028	0.0002752	0.186	0.669
			Residuals	30	0.04442	0.0014805		
		July	Clam	1	0.01278	0.012783	4.933	0.0343*
			Residuals	29	0.07515	0.002591		
	2019	May	Clam	1	0.000202	0.0002015	0.19	0.666
			Residuals	29	0.030797	0.0010620		
		June	Clam	1	0.00225	0.002249	1.611	0.216
			Residuals	25	0.03490	0.001396		
		July	Clam	1	0.00001	0.0000075	0.003	0.955
			Residuals	29	0.06837	0.0023576		
H. wrightii	2018	May	Clam	1	0.00557	0.005575	3.415	0.0745
			Residuals	30	0.04897	0.001632		
		July	Clam	1	0.00031	0.000313	0.08	0.779
			Residuals	30	0.11767	0.003922		
	2019	May	Clam	1	0.00804	0.008043	2.392	0.132
			Residuals	30	0.10086	0.003362		
		June	Clam	1	0.00106	0.001061	0.363	0.551
			Residuals	30	0.08776	0.002925		
		July	Clam	1	0.000158	0.0001575	0.153	0.699
			Residuals	28	0.028872	0.0010312		

Table S6. ANCOVA results for Experiment 2 seagrass percent cover.

Response Variable	Timepoint	Disturbance Month		Sum of Squares	Mean Square	Mean Square	F value	Pr (>F)
Percent Cover	Pre-Dorian	April	Elevation	1	1236	1236	2.573	0.116
			Clam	1	597	597	1.244	0.271
			Disturbance	1	16092	16092	33.508	8.65e-07***
			Clam * Disturbance	1	6	6	0.013	0.908
			Residuals	41	19690	480		
		June	Elevation	1	13	13	0.065	0.8004
			Clam	1	80	80	0.403	0.5293
			Disturbance	1	51486	51846	259.119	<2e-16***
			Clam * Disturbance	1	891	891	4.486	0.0408*
			Residuals	38	7550	199		
	Post-Dorian	April	Elevation	1	322	322	1.072	0.306
			Clam	1	3	3	0.011	0.916
			Disturbance	1	18125	18125	60.335	5.67e-10***
			Clam * Disturbance	1	22	22	0.074	0.787
			Residuals	47	14119	300		
		June	Elevation	1	6	6	0.021	0.885
			Clam	1	17	17	0.054	0.818
			Disturbance	1	51452	51452	167.232	<2e-16***
			Clam * Disturbance	1	557	557	1.811	0.185
			Residuals	44	13538	308		
	October	April	Elevation	1	3025	3025	3.971	0.0588
			Clam	1	1345	1345	1.766	0.1975
			Disturbance	1	730	730	0.958	0.3382
			Clam * Disturbance	1	4984	4984	6.544	0.0179*
			Residuals	22	16757	762		

		June	Elevation	1	0	0	0.00	0.990
			Clam	1	54	54	0.120	0.734
			Disturbance	1	18612	18612	41.151	1.61e-05***
			Clam * Disturbance	1	650	650	1.436	0.251
			Residuals	14	6332	452		
	June 2020	April	Elevation	1	674	674.1	1.808	0.184
			Clam	1	184	183.8	0.493	0.486
			Disturbance	1	825	825.0	2.212	0.143
			Clam * Disturbance	1	632	631.9	1.695	0.199
			Residuals	54	20136	372.9		
		June	Elevation	1	887	887	2.823	0.09953
			Clam	1	16	16	0.052	0.82052
			Disturbance	1	9256	9256	29.467	1.95e-06***
			Clam * Disturbance	1	2630	2630	8.372	0.00576**
			Residuals	47	14764	314		

Table S7. ANOVA results for Experiment 2 percent cover.

Response Variable	Timepoint	Disturbance Date	Sum of Squares	Mean Square	Mean Square	F value	Pr (>F)
Percent Cover	Pre-Dorian	Disturbance Month	2	55246	27623	62.27	9.5e-15***
		Residuals	54	23955	444		
	Post-Dorian	Disturbance Month	2	56879	28439	82.42	<2e-16***
		Residuals	62	21392	345		
	October	Disturbance Month	2	17754	8877	11.04	0.000256***
		Residuals	30	24128	804		
	June 2020	Disturbance Month	2	9612	4806	12.88	1.8e-05***
		Residuals	68	25368	373		