

The organizing effects of elevated CO₂ on competition among estuarine primary producers

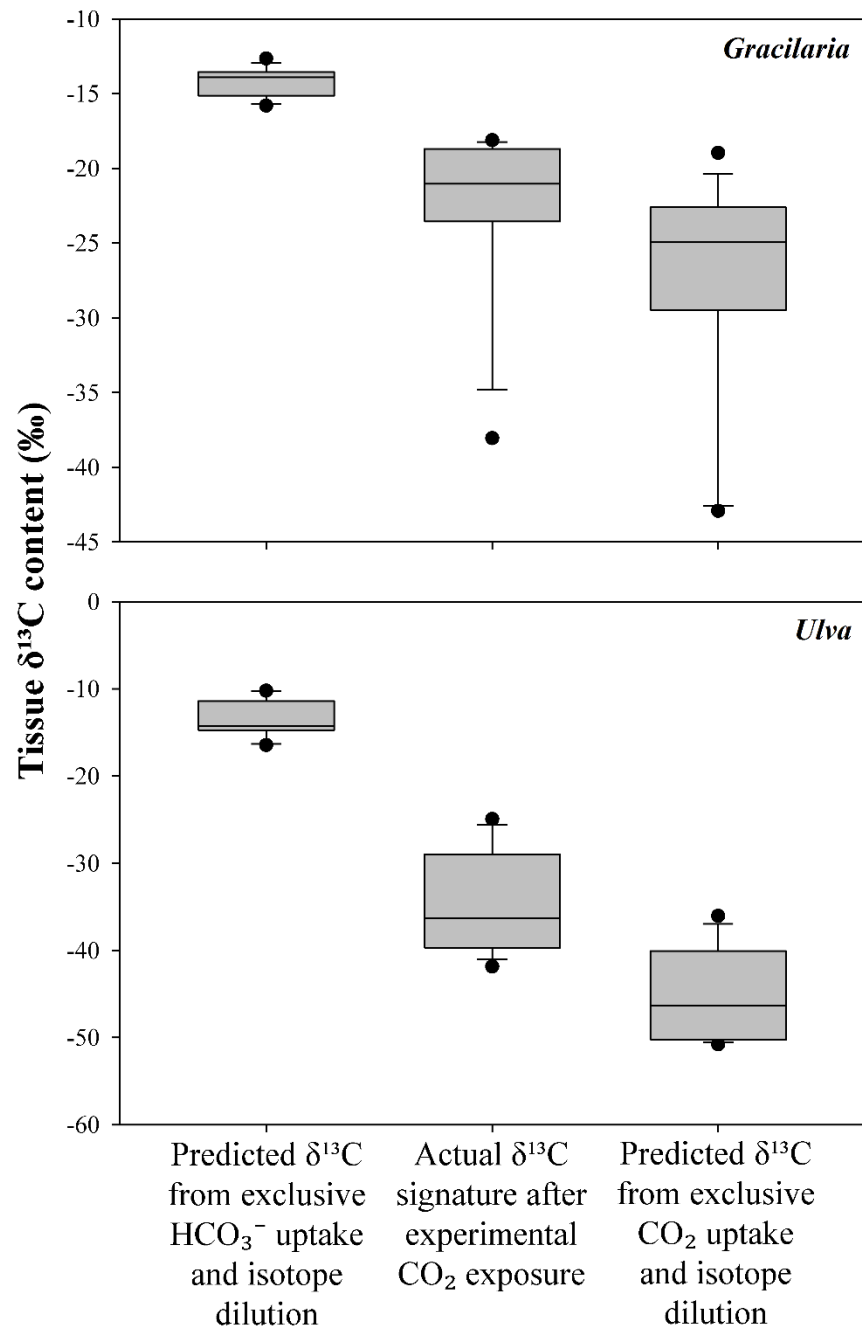
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Supplementary Figure S1

The $\delta^{13}\text{C}$ content of *Gracilaria* and *Ulva* exposed to elevated CO_2 concentrations compared to $\delta^{13}\text{C}$ signatures expected from the exclusive use of HCO_3^- or CO_2 . Box plots depict the mean median (line within the boxes), 25th and 75th percentiles (lower and upper edges of the boxes), and 10th and 90th percentiles of the data (lower and upper error bars).



Supplementary Tables S1

Values of pH (NBS scale), salinity (g kg⁻¹), temperature (°C), and pCO₂ (µatm) for *Gracilaria* and *Ulva* for July through October experiments. Values represent means ± standard deviation.

Ulva

Early July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.23±0.11	31.0±1.4	16.9±0.9	210±20
Ambient/Unfiltered	8.38±0.10	30.0±0.0	17.1±0.9	190±10
CO ₂ /Filtered	7.19±0.10	31.0±1.4	16.3±0.7	2790±30
CO ₂ /Unfiltered	7.32±0.03	30.5±0.7	16.7±0.9	2580±60

Late July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.26±0.11	32.0±0.1	15.7±0.6	220±60
Ambient/Unfiltered	8.23±0.02	32.0±0.0	16.4±0.6	290±30
CO ₂ /Filtered	7.14±0.02	30.0±0.1	15.8±0.4	2760±20
CO ₂ /Unfiltered	7.21±0.02	32.0±0.0	16.5±0.2	3140±350

August

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.10±0.04	29.4±0.1	17.9±2.6	290±50
Ambient/Unfiltered	8.22±0.02	29.4±0.3	17.5±3.3	260±20
CO ₂ /Filtered	7.10±0.01	29.3±0.1	17.1±1.1	2490±260
CO ₂ /Unfiltered	7.21±0.01	29.4±0.1	17.5±1.3	2990±100

September

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.11±0.10	32.0±0.1	17.4±3.5	280±40
Ambient/Unfiltered	8.20±0.11	32.0±0.1	17.3±2.4	240±60
CO ₂ /Filtered	7.11±0.10	31.0±0.1	15.0±0.4	3090±230
CO ₂ /Unfiltered	7.20±0.02	32.0±0.2	14.8±0.1	2840±10

October

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.02±0.02	30.0±0.1	15.0±0.7	350±30
Ambient/Unfiltered	8.10±0.02	29.9±0.0	14.0±0.7	350±1
CO ₂ /Filtered	7.32±0.01	30.1±0.2	14.2±1.7	1890±210
CO ₂ /Unfiltered	7.38±0.03	30.0±0.0	14.0±1.0	1760±180

Gracilaria

Early July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.19±0.15	31.5±2.1	16.1±0.6	230±10
Ambient/Unfiltered	8.35±0.10	30.0±0.1	17.8±1.3	210±10
CO ₂ /Filtered	7.18±0.13	31.0±1.4	15.2±0.6	2850±160
CO ₂ /Unfiltered	7.32±0.12	30.0±0.1	15.4±0.6	2370±170

Late July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.17±0.01	32.0±0.1	15.7±0.6	270±20
Ambient/Unfiltered	8.19±0.04	32.0±0.1	15.8±0.1	300±40
CO ₂ /Filtered	7.17±0.01	30.0±0.2	14.8±0.1	3380±220
CO ₂ /Unfiltered	7.20±0.02	32.0±0.1	15.1±0.1	3150±10

August

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.12±0.07	29.4±0.1	17.8±2.7	280±60
Ambient/Unfiltered	8.19±0.02	29.4±0.5	17.8±2.8	260±10
CO ₂ /Filtered	7.08±0.02	29.3±0.2	17.0±1.3	2470±240
CO ₂ /Unfiltered	7.20±0.01	29.3±0.1	17.3±1.6	3000±20

September

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.04±0.04	31.5±0.2	16.6±3.8	370±20
Ambient/Unfiltered	8.16±0.02	32.0±0.2	16.7±4.1	410±100
CO ₂ /Filtered	7.11±0.11	31.5±0.1	13.3±0.4	2850±10
CO ₂ /Unfiltered	7.18±0.03	32.0±0.0	15.3±0.2	2500±490

October

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.00±0.01	30.2±0.0	13.6±0.8	370±20
Ambient/Unfiltered	8.07±0.02	30.0±0.1	14.5±0.8	390±10
CO ₂ /Filtered	7.31±0.02	30.1±0.1	14.4±0.4	1800±220
CO ₂ /Unfiltered	7.39±0.01	30.0±0.0	14.2±2.5	1750±50

Gracilaria and Ulva

Early July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.25±0.10	31.0±1.4	16.6±0.6	210±10
Ambient/Unfiltered	8.45±0.11	30.0±0.1	17.0±0.6	160±10
CO ₂ /Filtered	7.18±0.12	31.5±2.1	16.3±0.8	2800±60
CO ₂ /Unfiltered	7.33±0.10	30.0±0.0	16.4±0.6	2740±110

Late July

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.23±0.09	32.0±0.2	15.7±1.1	230±60
Ambient/Unfiltered	8.22±0.04	32.0±0.1	15.6±0.6	290±40
CO ₂ /Filtered	7.13±0.02	30.0±0.0	15.2±1.3	2610±10
CO ₂ /Unfiltered	7.22±0.01	32.0±0.1	15.6±0.8	2950±80

August

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.07±0.01	29.4±0.1	17.9±2.6	310±20
Ambient/Unfiltered	8.22±0.02	29.4±0.1	17.7±3.0	270±10
CO ₂ /Filtered	7.09±0.01	29.3±0.1	17.0±1.3	2435±190
CO ₂ /Unfiltered	7.20±0.01	29.4±0.1	17.3±1.6	3000±70

September

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.14±0.01	32.0±0.1	17.8±3.0	250±40
Ambient/Unfiltered	8.13±0.02	31.5±0.0	16.4±3.8	320±50
CO ₂ /Filtered	7.11±0.10	31.5±0.5	15.0±0.8	2890±160
CO ₂ /Unfiltered	7.19±0.03	31.5±0.1	15.5±0.1	3000±190

October

Treatment	pH	Salinity	Temperature	pCO ₂
Ambient/Filtered	8.05±0.05	30.0±0.1	14.2±0.7	330±20
Ambient/Unfiltered	8.09±0.01	29.9±0.2	15.0±0.9	370±10
CO ₂ /Filtered	7.31±0.02	30.1±0.1	14.4±1.6	1850±290
CO ₂ /Unfiltered	7.39±0.05	29.9±0.2	14.3±2.2	1820±110

Supplementary Tables S2

Statistical analyses of variance for laboratory and *in situ* experiments (July through October 2015) for *Gracilaria* and *Ulva*.

Three-way analysis of variance for *Gracilaria* growth for July through October experiments

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00731	0.00731	7.001	0.009
Filtered	1	0.000136	0.000136	0.13	0.719
Competition	1	0.000249	0.000249	0.239	0.626
CO ₂ x Filtered	1	0.000117	0.000117	0.112	0.739
CO ₂ x Competition	1	0.000126	0.000126	0.12	0.729
Filtered x Competition	1	0.000368	0.000368	0.352	0.554
CO ₂ x Filtered x Competition	1	0.000181	0.000181	0.173	0.678
Residual	128	0.134	0.00104		
Total	135	0.142	0.00105		

Three-way analysis of variance for *Ulva* growth for July through October experiments

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.0832	0.0832	17.696	<0.001
Filtered	1	0.00881	0.00881	1.876	0.173
Competition	1	0.0413	0.0413	8.793	0.004
CO ₂ x Filtered	1	0.00218	0.00218	0.464	0.497
CO ₂ x Competition	1	0.00619	0.00619	1.316	0.253
Filtered x Competition	1	0.0112	0.0112	2.393	0.124
CO ₂ x Filtered x Competition	1	0.000885	0.000885	0.188	0.665
Residual	124	0.583	0.0047		
Total	131	0.739	0.00564		

One-way analysis of variance for *Gracilaria* growth under control and *in situ* conditions

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.000459	0.000115	0.0526	0.995
Residual	79	0.172	0.00218		
Total	83	0.173			

One-way analysis of variance for *Ulva* growth under control and *in situ* conditions

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.0362	0.00905	1.979	0.106
Residual	78	0.357	0.00457		
Total	82	0.393			

Three-way analysis of variance for *Ulva* growth for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.0106	0.0106	9.157	0.009
Filtered	1	0.0105	0.0105	9.069	0.009
Competition	1	0.0109	0.0109	9.43	0.008
CO ₂ x Filtered	1	0.0000119	0.0000119	0.0103	0.92
CO ₂ x Competition	1	0.00304	0.00304	2.622	0.126
Filtered x Competition	1	0.00868	0.00868	7.494	0.015
CO ₂ x Filtered x Competition	1	0.00134	0.00134	1.16	0.298
Residual	15	0.0174	0.00116		
Total	22	0.065	0.00296		

Three-way analysis of variance for *Ulva* growth for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.0933	0.0933	11.504	0.004
Filtered	1	0.122	0.122	15.017	0.001
Competition	1	0.00184	0.00184	0.227	0.64
CO ₂ x Filtered	1	0.0172	0.0172	2.12	0.165
CO ₂ x Competition	1	0.00137	0.00137	0.169	0.687
Filtered x Competition	1	0.00985	0.00985	1.215	0.287
CO ₂ x Filtered x Competition	1	0.00781	0.00781	0.963	0.341
Residual	16	0.13	0.00811		
Total	23	0.383	0.0166		

Three-way analysis of variance for *Ulva* growth for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.0115	0.0115	5.908	0.027
Filtered	1	0.00238	0.00238	1.226	0.285
Competition	1	0.0089	0.0089	4.576	0.048
CO ₂ x Filtered	1	0.000283	0.000283	0.145	0.708
CO ₂ x Competition	1	0.0000132	0.0000132	0.00679	0.935
Filtered x Competition	1	1.21E-06	1.21E-06	0.000625	0.98
CO ₂ x Filtered x Competition	1	0.00357	0.00357	1.834	0.194
Residual	16	0.0311	0.00195		
Total	23	0.0578	0.00251		

Three-way analysis of variance for *Ulva* growth for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.0582	0.0582	12.559	0.002
Filtered	1	0.00245	0.00245	0.528	0.475
Competition	1	0.0114	0.0114	2.456	0.131
CO ₂ x Filtered	1	0.0256	0.0256	5.518	0.028
CO ₂ x Competition	1	0.00139	0.00139	0.3	0.589
Filtered x Competition	1	0.00411	0.00411	0.886	0.356
CO ₂ x Filtered x Competition	1	0.00834	0.00834	1.8	0.193
Residual	23	0.107	0.00464		
Total	30	0.223	0.00742		

Three-way analysis of variance for *Ulva* growth for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00109	0.00109	0.461	0.503
Filtered	1	0.00423	0.00423	1.786	0.194
Competition	1	0.00348	0.00348	1.469	0.237
CO ₂ x Filtered	1	0.000394	0.000394	0.167	0.687
CO ₂ x Competition	1	0.0000488	0.0000488	0.0206	0.887
Filtered x Competition	1	0.000529	0.000529	0.224	0.641
CO ₂ x Filtered x Competition	1	0.000128	0.000128	0.0539	0.818
Residual	24	0.0568	0.00237		
Total	31	0.0667	0.00215		

Three-way analysis of variance for *Gracilaria* growth for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000941	0.000941	1.304	0.27
Filtered	1	0.00555	0.00555	7.697	0.014
Competition	1	0.000154	0.000154	0.213	0.651
CO ₂ x Filtered	1	0.00149	0.00149	2.065	0.17
CO ₂ x Competition	1	0.0000196	0.0000196	0.0272	0.871
Filtered x Competition	1	0.0000531	0.0000531	0.0736	0.79
CO ₂ x Filtered x Competition	1	0.00128	0.00128	1.77	0.202
Residual	16	0.0115	0.000722		
Total	23	0.021	0.000915		

Three-way analysis of variance for *Gracilaria* growth for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00206	0.00206	5.088	0.039
Filtered	1	9.42E-06	9.42E-06	0.0233	0.881
Competition	1	0.000556	0.000556	1.373	0.26
CO ₂ x Filtered	1	0.000666	0.000666	1.643	0.219
CO ₂ x Competition	1	0.000525	0.000525	1.295	0.273
Filtered x Competition	1	0.0000027	0.0000027	0.00667	0.936
CO ₂ x Filtered x Competition	1	0.0000374	0.0000374	0.0924	0.765
Residual	15	0.00608	0.000405		
Total	22	0.00989	0.000449		

Three-way analysis of variance for *Gracilaria* growth for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000999	0.000999	5.763	0.031
Filtered	1	0.0000351	0.0000351	0.203	0.659
Competition	1	0.000141	0.000141	0.811	0.383
CO ₂ x Filtered	1	0.000114	0.000114	0.658	0.431
CO ₂ x Competition	1	0.000234	0.000234	1.351	0.265
Filtered x Competition	1	0.00131	0.00131	7.563	0.016
CO ₂ x Filtered x Competition	1	0.0000623	0.0000623	0.359	0.558
Residual	14	0.00243	0.000173		
Total	21	0.00524	0.00025		

Three-way analysis of variance for *Gracilaria* growth for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00132	0.00132	2.466	0.129
Filtered	1	0.000429	0.000429	0.798	0.381
Competition	1	0.000297	0.000297	0.553	0.464
CO ₂ x Filtered	1	0.0000624	0.0000624	0.116	0.736
CO ₂ x Competition	1	8.93E-06	8.93E-06	0.0166	0.899
Filtered x Competition	1	0.000307	0.000307	0.571	0.457
CO ₂ x Filtered x Competition	1	0.0000483	0.0000483	0.0898	0.767
Residual	24	0.0129	0.000537		
Total	31	0.0154	0.000496		

Three-way analysis of variance for *Gracilaria* growth for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00257	0.00257	6.01	0.022
Filtered	1	0.000228	0.000228	0.532	0.473
Competition	1	0.00129	0.00129	3.007	0.096
CO ₂ x Filtered	1	0.000257	0.000257	0.599	0.447
CO ₂ x Competition	1	4.51E-07	4.51E-07	0.00105	0.974
Filtered x Competition	1	1.01E-07	1.01E-07	0.000236	0.988
CO ₂ x Filtered x Competition	1	2.31E-06	2.31E-06	0.0054	0.942
Residual	24	0.0103	0.000428		
Total	31	0.0146	0.000472		

Three-way analysis of variance for diatom growth for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00127	0.00127	0.139	0.712
<i>Ulva</i>	1	0.047	0.047	5.17	0.032
<i>Gracilaria</i>	1	0.00542	0.00542	0.596	0.448
CO ₂ x <i>Ulva</i>	1	0.00513	0.00513	0.565	0.46
CO ₂ x <i>Gracilaria</i>	1	0.0196	0.0196	2.159	0.155
<i>Ulva</i> x <i>Gracilaria</i>	1	0.000237	0.000237	0.0261	0.873
CO ₂ x <i>Ulva</i> x <i>Gracilaria</i>	1	0.0075	0.0075	0.825	0.373
Residual	24	0.218	0.00909		
Total	31	0.304	0.00982		

Three-way analysis of variance for dinoflagellate growth for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00347	0.00347	2.203	0.151
<i>Ulva</i>	1	0.00354	0.00354	2.246	0.147
<i>Gracilaria</i>	1	0.0403	0.0403	25.611	<0.001
CO ₂ x <i>Ulva</i>	1	0.00154	0.00154	0.975	0.333
CO ₂ x <i>Gracilaria</i>	1	0.00316	0.00316	2.005	0.17
<i>Ulva</i> x <i>Gracilaria</i>	1	0.00291	0.00291	1.849	0.187
CO ₂ x <i>Ulva</i> x <i>Gracilaria</i>	1	0.0000306	0.0000306	0.0194	0.89
Residual	24	0.0378	0.00158		
Total	31	0.0928	0.00299		

One-way analysis of variance for changes in diatom abundance in elevated CO₂ treatments during the September experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	20930450	20930450	44.91	<0.001
Residual	6	2796350	466058.33		
Total	7	23726800			

One-way analysis of variance for changes in dinoflagellate abundance in elevated CO₂ treatments during the September experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	2420000	2420000	10.204	0.019
Residual	6	1423000	237166.67		
Total	7	3843000			

One-way analysis of variance for changes in diatom abundance in ambient treatments during the September experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	7761800	7761800	12.669	0.012
Residual	6	3675950	612658.33		
Total	7	11437750			

One-way analysis of variance for changes in dinoflagellate abundance in ambient treatments during the September experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	11685344	11685344	17.003	0.009
Residual	5	3436341.7	687268.33		
Total	6	15121686			

One-way analysis of variance for changes in diatom abundance in elevated CO₂ treatments during the October experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	30186450	30186450	20.589	0.004
Residual	6	8796700	1466116.7		
Total	7	38983150			

One-way analysis of variance for changes in dinoflagellate abundance in elevated CO₂ treatments during the October experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	13912813	13912813	73.452	<0.001
Residual	6	1136475	189412.5		
Total	7	15049288			

One-way analysis of variance for changes in diatom abundance in ambient treatments during the October experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	35490313	35490313	61.082	<0.001
Residual	6	3486175	581029.17		
Total	7	38976488			

One-way analysis of variance for changes in dinoflagellate abundance in ambient treatments during the October experiment

Source of Variation	DF	SS	MS	F	P
Between Groups	1	48856613	48856613	38.12	<0.001
Residual	6	7689875	1281645.8		
Total	7	56546488			

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Ulva* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	3287.232	3287.232	217.325	<0.001
<i>Gracilaria</i>	1	70.658	70.658	4.671	0.046
Filtered	1	0.06	0.06	0.00397	0.951
CO ₂ x <i>Gracilaria</i>	1	2.968	2.968	0.196	0.664
CO ₂ x Filtered	1	0.443	0.443	0.0293	0.866
<i>Gracilaria</i> x Filtered	1	121.5	121.5	8.033	0.012
CO ₂ x <i>Gracilaria</i> x Filtered	1	87.937	87.937	5.814	0.028
Residual	16	242.014	15.126		
Total	23	3812.812	165.774		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Ulva* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	4319.63	4319.63	359.192	<0.001
<i>Gracilaria</i>	1	1.197	1.197	0.0995	0.756
Filtered	1	11.399	11.399	0.948	0.345
CO ₂ x <i>Gracilaria</i>	1	1.197	1.197	0.0995	0.756
CO ₂ x Filtered	1	52.747	52.747	4.386	0.053
<i>Gracilaria</i> x Filtered	1	1.52	1.52	0.126	0.727
CO ₂ x <i>Gracilaria</i> x Filtered	1	13.321	13.321	1.108	0.308
Residual	16	192.415	12.026		
Total	23	4593.426	199.714		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Ulva* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2026.395	2026.395	273.867	<0.001
<i>Gracilaria</i>	1	2.142	2.142	0.289	0.598
Filtered	1	75.935	75.935	10.263	0.006
CO ₂ x <i>Gracilaria</i>	1	1.832	1.832	0.248	0.626
CO ₂ x Filtered	1	1.744	1.744	0.236	0.634
<i>Gracilaria</i> x Filtered	1	4.208	4.208	0.569	0.462
CO ₂ x <i>Gracilaria</i> x Filtered	1	5.273	5.273	0.713	0.411
Residual	16	118.387	7.399		
Total	23	2235.917	97.214		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Ulva* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2195.378	2195.378	667.221	<0.001
<i>Gracilaria</i>	1	9.573	9.573	2.909	0.102
Filtered	1	27.114	27.114	8.241	0.009
CO ₂ x <i>Gracilaria</i>	1	0.667	0.667	0.203	0.657
CO ₂ x Filtered	1	10.879	10.879	3.306	0.082
<i>Gracilaria</i> x Filtered	1	0.781	0.781	0.237	0.631
CO ₂ x <i>Gracilaria</i> x Filtered	1	2.813	2.813	0.855	0.365
Residual	23	75.678	3.29		
Total	30	2378.782	79.293		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Ulva* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	3886.313	3886.313	265.278	<0.001
<i>Gracilaria</i>	1	5.977	5.977	0.408	0.529
Filtered	1	1.562	1.562	0.107	0.747
CO ₂ x <i>Gracilaria</i>	1	11.198	11.198	0.764	0.391
CO ₂ x Filtered	1	10.615	10.615	0.725	0.403
<i>Gracilaria</i> x Filtered	1	23.822	23.822	1.626	0.214
CO ₂ x <i>Gracilaria</i> x Filtered	1	30.988	30.988	2.115	0.159
Residual	24	351.599	14.65		
Total	31	4322.075	139.422		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Gracilaria* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2005.865	2005.865	456.536	<0.001
<i>Ulva</i>	1	1.799	1.799	0.409	0.531
Filtered	1	13.039	13.039	2.968	0.104
CO ₂ x <i>Ulva</i>	1	11.551	11.551	2.629	0.124
CO ₂ x Filtered	1	0.746	0.746	0.17	0.686
<i>Ulva</i> x Filtered	1	25.523	25.523	5.809	0.028
CO ₂ x <i>Ulva</i> x Filtered	1	20.963	20.963	4.771	0.044
Residual	16	70.299	4.394		
Total	23	2149.783	93.469		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Gracilaria* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	807.244	807.244	62.43	<0.001
<i>Ulva</i>	1	16.187	16.187	1.252	0.28
Filtered	1	33.868	33.868	2.619	0.125
CO ₂ x <i>Ulva</i>	1	14.837	14.837	1.147	0.3
CO ₂ x Filtered	1	1.515	1.515	0.117	0.737
<i>Ulva</i> x Filtered	1	5.772	5.772	0.446	0.514
CO ₂ x <i>Ulva</i> x Filtered	1	4.412	4.412	0.341	0.567
Residual	16	206.885	12.93		
Total	23	1090.719	47.423		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Gracilaria* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	307.459	307.459	266.635	<0.001
<i>Ulva</i>	1	2.262	2.262	1.962	0.182
Filtered	1	2.256	2.256	1.957	0.182
CO ₂ x <i>Ulva</i>	1	0.00217	0.00217	0.00188	0.966
CO ₂ x Filtered	1	7.398	7.398	6.416	0.023
<i>Ulva</i> x Filtered	1	0.487	0.487	0.423	0.525
CO ₂ x <i>Ulva</i> x Filtered	1	9.983	9.983	8.657	0.01
Residual	15	17.297	1.153		
Total	22	360.766	16.398		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Gracilaria* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	260.833	260.833	266.558	<0.001
<i>Ulva</i>	1	0.0242	0.0242	0.0247	0.876
Filtered	1	0.324	0.324	0.331	0.57
CO ₂ x <i>Ulva</i>	1	0.461	0.461	0.471	0.499
CO ₂ x Filtered	1	0.019	0.019	0.0194	0.89
<i>Ulva</i> x Filtered	1	0.183	0.183	0.187	0.669
CO ₂ x <i>Ulva</i> x Filtered	1	0.316	0.316	0.323	0.575
Residual	24	23.485	0.979		
Total	31	285.644	9.214		

Three-way analysis of variance of the tissue $\delta^{13}\text{C}$ for *Gracilaria* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	885.354	885.354	399.976	<0.001
<i>Ulva</i>	1	0.329	0.329	0.148	0.704
Filtered	1	2.032	2.032	0.918	0.348
CO ₂ x <i>Ulva</i>	1	2.864	2.864	1.294	0.267
CO ₂ x Filtered	1	0.833	0.833	0.376	0.546
<i>Ulva</i> x Filtered	1	9.388	9.388	4.241	0.051
CO ₂ x <i>Ulva</i> x Filtered	1	6.562	6.562	2.965	0.099
Residual	23	50.911	2.214		
Total	30	973.57	32.452		

One-way analysis of variance of the $\delta^{13}\text{C}$ content of *Gracilaria* exposed to elevated CO_2 concentrations compared with the $\delta^{13}\text{C}$ content expected from the exclusive use of CO_2 or the exclusive use of HCO_3^- (Fig. 4). Tukey tests were used to determine which groups were significantly different from one another.

Source of Variation	DF	SS	MS	F	P
Between Groups	2	1583.667	791.834	24.706	<0.001
Residual	47	1506.357	32.05		
Total	49	3090.024			

One-way analysis of variance of the $\delta^{13}\text{C}$ content of *Ulva* exposed to elevated CO_2 concentrations compared with the $\delta^{13}\text{C}$ content expected from the exclusive use of CO_2 or the exclusive use of HCO_3^- (Fig. 4). Tukey tests were used to determine which groups were significantly different from one another.

Source of Variation	DF	SS	MS	F	P
Between Groups	2	8621.591	4310.796	195.973	<0.001
Residual	48	1055.849	21.997		
Total	50	9677.44			

Three-way analysis of variance of the tissue carbon for *Gracilaria* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO_2	1	4.78E-05	4.78E-05	0.102	0.753
<i>Ulva</i>	1	9.93E-05	9.93E-05	0.213	0.651
Filtered	1	9.98E-05	9.98E-05	0.214	0.65
$\text{CO}_2 \times \text{Ulva}$	1	8.59E-05	8.59E-05	0.184	0.674
$\text{CO}_2 \times \text{Filtered}$	1	0.000302	0.000302	0.647	0.433
<i>Ulva</i> x Filtered	1	0.00264	0.00264	5.648	0.03
$\text{CO}_2 \times \text{Ulva} \times \text{Filtered}$	1	0.000032	0.000032	0.0685	0.797
Residual	16	0.00747	0.000467		
Total	23	0.0108	0.000468		

Three-way analysis of variance of the tissue carbon for *Gracilaria* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00144	0.00144	5.247	0.036
<i>Ulva</i>	1	1.33E-05	1.33E-05	0.0486	0.828
Filtered	1	0.0026	0.0026	9.506	0.007
CO ₂ x <i>Ulva</i>	1	0.00129	0.00129	4.722	0.045
CO ₂ x Filtered	1	0.000171	0.000171	0.625	0.441
<i>Ulva</i> x Filtered	1	0.0019	0.0019	6.943	0.018
CO ₂ x <i>Ulva</i> x Filtered	1	1.53E-05	1.53E-05	0.0559	0.816
Residual	16	0.00438	0.000274		
Total	23	0.0118	0.000513		

Three-way analysis of variance of the tissue carbon for *Gracilaria* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00139	0.00139	2.438	0.138
<i>Ulva</i>	1	0.000205	0.000205	0.36	0.557
Filtered	1	0.000139	0.000139	0.244	0.628
CO ₂ x <i>Ulva</i>	1	9.57E-06	9.57E-06	0.0167	0.899
CO ₂ x Filtered	1	0.000235	0.000235	0.41	0.531
<i>Ulva</i> x Filtered	1	0.00102	0.00102	1.788	0.2
CO ₂ x <i>Ulva</i> x Filtered	1	3.93E-08	3.93E-08	6.89E-05	0.993
Residual	16	0.00914	0.000571		
Total	23	0.0121	0.000528		

Three-way analysis of variance of the tissue carbon for *Gracilaria* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00279	0.00279	3.026	0.095
<i>Ulva</i>	1	1.33E-05	1.33E-05	0.0144	0.905
Filtered	1	8.49E-06	8.49E-06	0.00921	0.924
CO ₂ x <i>Ulva</i>	1	0.000177	0.000177	0.193	0.665
CO ₂ x Filtered	1	9.27E-05	9.27E-05	0.101	0.754
<i>Ulva</i> x Filtered	1	1.39E-09	1.39E-09	1.51E-06	0.999
CO ₂ x <i>Ulva</i> x Filtered	1	0.000142	0.000142	0.154	0.698
Residual	24	0.0221	0.000921		
Total	31	0.0253	0.000817		

Three-way analysis of variance of the tissue carbon for *Gracilaria* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000717	0.000717	1.115	0.302
<i>Ulva</i>	1	3.35E-05	3.35E-05	0.0521	0.821
Filtered	1	0.00121	0.00121	1.878	0.184
CO ₂ x <i>Ulva</i>	1	3.29E-06	3.29E-06	0.00511	0.944
CO ₂ x Filtered	1	0.000663	0.000663	1.031	0.32
<i>Ulva</i> x Filtered	1	5.55E-05	5.55E-05	0.0863	0.772
CO ₂ x <i>Ulva</i> x Filtered	1	0.00232	0.00232	3.603	0.07
Residual	23	0.0148	0.000643		
Total	30	0.0198	0.000661		

Three-way analysis of variance of the tissue nitrogen for *Gracilaria* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2.22E-05	2.22E-05	1.469	0.243
<i>Ulva</i>	1	6.4E-07	6.4E-07	0.0424	0.839
Filtered	1	0.000215	0.000215	14.231	0.002
CO ₂ x <i>Ulva</i>	1	2.07E-05	2.07E-05	1.372	0.259
CO ₂ x Filtered	1	4.88E-05	4.88E-05	3.236	0.091
<i>Ulva</i> x Filtered	1	0.000136	0.000136	9.014	0.008
CO ₂ x <i>Ulva</i> x Filtered	1	2.57E-05	2.57E-05	1.705	0.21
Residual	16	0.000241	1.51E-05		
Total	23	0.00071	3.09E-05		

Three-way analysis of variance of the tissue nitrogen for *Gracilaria* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	1.82E-05	1.82E-05	3.86	0.067
<i>Ulva</i>	1	1.51E-05	1.51E-05	3.197	0.093
Filtered	1	0.000191	0.000191	40.666	<0.001
CO ₂ x <i>Ulva</i>	1	6.45E-05	6.45E-05	13.706	0.002
CO ₂ x Filtered	1	1.53E-06	1.53E-06	0.324	0.577
<i>Ulva</i> x Filtered	1	2.17E-09	2.17E-09	0.000462	0.983
CO ₂ x <i>Ulva</i> x Filtered	1	9.2E-06	9.2E-06	1.953	0.181
Residual	16	7.53E-05	4.71E-06		
Total	23	0.000375	1.63E-05		

Three-way analysis of variance of the tissue nitrogen for *Gracilaria* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2.43E-08	2.43E-08	0.00305	0.957
<i>Ulva</i>	1	4.39E-05	0.0000439	5.512	0.032
Filtered	1	2.11E-05	0.0000211	2.648	0.123
CO ₂ x <i>Ulva</i>	1	3.68E-06	3.68E-06	0.461	0.507
CO ₂ x Filtered	1	4.6E-06	0.0000046	0.577	0.459
<i>Ulva</i> x Filtered	1	4.29E-09	4.29E-09	0.000538	0.982
CO ₂ x <i>Ulva</i> x Filtered	1	7.11E-06	7.11E-06	0.892	0.359
Residual	16	0.000128	7.97E-06		
Total	23	0.000208	9.05E-06		

Three-way analysis of variance of the tissue nitrogen for *Gracilaria* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000022	0.000022	6.983	0.014
<i>Ulva</i>	1	3.59E-05	3.59E-05	11.416	0.002
Filtered	1	0.000101	0.000101	31.959	<0.001
CO ₂ x <i>Ulva</i>	1	8.3E-06	8.3E-06	2.635	0.118
CO ₂ x Filtered	1	0.000018	0.000018	5.714	0.025
<i>Ulva</i> x Filtered	1	1.08E-07	1.08E-07	0.0344	0.854
CO ₂ x <i>Ulva</i> x Filtered	1	7.43E-08	7.43E-08	0.0236	0.879
Residual	24	7.56E-05	3.15E-06		
Total	31	0.000261	8.41E-06		

Three-way analysis of variance of the tissue nitrogen for *Gracilaria* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	1.17E-05	0.0000117	1.283	0.269
<i>Ulva</i>	1	0.000131	0.000131	14.353	<0.001
Filtered	1	0.000091	0.000091	9.985	0.004
CO ₂ x <i>Ulva</i>	1	1.87E-05	0.0000187	2.046	0.166
CO ₂ x Filtered	1	2.13E-06	2.13E-06	0.233	0.634
<i>Ulva</i> x Filtered	1	2.17E-05	0.0000217	2.38	0.137
CO ₂ x <i>Ulva</i> x Filtered	1	7.12E-06	7.12E-06	0.781	0.386
Residual	23	0.00021	9.11E-06		
Total	30	0.000479	0.000016		

Three-way analysis of variance of the tissue C:N for *Gracilaria* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	57.836	57.836	3.625	0.075
<i>Ulva</i>	1	17.293	17.293	1.084	0.313
Filtered	1	533.096	533.096	33.41	<0.001
CO ₂ x <i>Ulva</i>	1	17.141	17.141	1.074	0.315
CO ₂ x Filtered	1	68.366	68.366	4.285	0.055
<i>Ulva</i> x Filtered	1	97.61	97.61	6.117	0.025
CO ₂ x <i>Ulva</i> x Filtered	1	47.512	47.512	2.978	0.104
Residual	16	255.296	15.956		
Total	23	1094.15	47.572		

Three-way analysis of variance of the tissue C:N for *Gracilaria* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	22.778	22.778	2.254	0.153
<i>Ulva</i>	1	32.128	32.128	3.179	0.094
Filtered	1	441.833	441.833	43.718	<0.001
CO ₂ x <i>Ulva</i>	1	68.615	68.615	6.789	0.019
CO ₂ x Filtered	1	18.677	18.677	1.848	0.193
<i>Ulva</i> x Filtered	1	0.0995	0.0995	0.00985	0.922
CO ₂ x <i>Ulva</i> x Filtered	1	0.019	0.019	0.00188	0.966
Residual	16	161.705	10.107		
Total	23	745.855	32.428		

Three-way analysis of variance of the tissue C:N for *Gracilaria* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	3.495	3.495	0.356	0.559
<i>Ulva</i>	1	52.291	52.291	5.334	0.035
Filtered	1	6.656	6.656	0.679	0.422
CO ₂ x <i>Ulva</i>	1	6.612	6.612	0.674	0.424
CO ₂ x Filtered	1	3.627	3.627	0.37	0.552
<i>Ulva</i> x Filtered	1	1.194	1.194	0.122	0.732
CO ₂ x <i>Ulva</i> x Filtered	1	13.916	13.916	1.42	0.251
Residual	16	156.855	9.803		
Total	23	244.644	10.637		

Three-way analysis of variance of the tissue C:N for *Gracilaria* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	66.139	66.139	12.563	0.002
<i>Ulva</i>	1	28.729	28.729	5.457	0.029
Filtered	1	74.106	74.106	14.077	0.001
CO ₂ x <i>Ulva</i>	1	0.578	0.578	0.11	0.743
CO ₂ x Filtered	1	11.299	11.299	2.146	0.156
<i>Ulva</i> x Filtered	1	0.126	0.126	0.0239	0.878
CO ₂ x <i>Ulva</i> x Filtered	1	3.086	3.086	0.586	0.452
Residual	23	121.084	5.265		
Total	30	312.539	10.418		

Three-way analysis of variance of the tissue C:N for *Gracilaria* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	31.069	31.069	5.109	0.034
<i>Ulva</i>	1	104.004	104.004	17.104	<0.001
Filtered	1	28.785	28.785	4.734	0.04
CO ₂ x <i>Ulva</i>	1	24.465	24.465	4.023	0.057
CO ₂ x Filtered	1	0.0994	0.0994	0.0163	0.899
<i>Ulva</i> x Filtered	1	7.524	7.524	1.237	0.277
CO ₂ x <i>Ulva</i> x Filtered	1	0.677	0.677	0.111	0.742
Residual	23	139.857	6.081		
Total	30	334.766	11.159		

Three-way analysis of variance of the tissue carbon for *Ulva* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000155	0.000155	0.903	0.356
<i>Gracilaria</i>	1	2.99E-05	2.99E-05	0.174	0.682
Filtered	1	0.000084	0.000084	0.49	0.494
CO ₂ x <i>Gracilaria</i>	1	0.000683	0.000683	3.984	0.063
CO ₂ x Filtered	1	0.000011	0.000011	0.0639	0.804
<i>Gracilaria</i> x Filtered	1	0.00131	0.00131	7.617	0.014
CO ₂ x <i>Gracilaria</i> x Filtered	1	0.00053	0.00053	3.088	0.098
Residual	16	0.00274	0.000172		
Total	23	0.00554	0.000241		

Three-way analysis of variance of the tissue carbon for *Ulva* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000687	0.000687	0.584	0.456
<i>Gracilaria</i>	1	8.2E-08	8.2E-08	6.97E-05	0.993
Filtered	1	0.00111	0.00111	0.942	0.346
CO ₂ x <i>Gracilaria</i>	1	0.000543	0.000543	0.462	0.506
CO ₂ x Filtered	1	0.00162	0.00162	1.377	0.258
<i>Gracilaria</i> x Filtered	1	0.0023	0.0023	1.955	0.181
CO ₂ x <i>Gracilaria</i> x Filtered	1	0.000757	0.000757	0.644	0.434
Residual	16	0.0188	0.00118		
Total	23	0.0258	0.00112		

Three-way analysis of variance of the tissue carbon for *Ulva* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000125	0.000125	0.41	0.531
<i>Gracilaria</i>	1	0.000295	0.000295	0.965	0.341
Filtered	1	0.000138	0.000138	0.451	0.512
CO ₂ x <i>Gracilaria</i>	1	9.52E-05	9.52E-05	0.312	0.584
CO ₂ x Filtered	1	0.000059	0.000059	0.193	0.666
<i>Gracilaria</i> x Filtered	1	5.53E-05	5.53E-05	0.181	0.676
CO ₂ x <i>Gracilaria</i> x Filtered	1	6.23E-08	6.23E-08	0.000204	0.989
Residual	16	0.00488	0.000305		
Total	23	0.00565	0.000246		

Three-way analysis of variance of the tissue carbon for *Ulva* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.000678	0.000678	1.555	0.225
<i>Gracilaria</i>	1	0.00049	0.00049	1.124	0.3
Filtered	1	8.16E-05	8.16E-05	0.187	0.669
CO ₂ x <i>Gracilaria</i>	1	0.00114	0.00114	2.614	0.12
CO ₂ x Filtered	1	0.00454	0.00454	10.412	0.004
<i>Gracilaria</i> x Filtered	1	0.000552	0.000552	1.267	0.272
CO ₂ x <i>Gracilaria</i> x Filtered	1	4E-08	4E-08	9.18E-05	0.992
Residual	23	0.01	0.000436		
Total	30	0.0178	0.000594		

Three-way analysis of variance of the tissue carbon for *Ulva* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	0.00176	0.00176	2.109	0.159
<i>Gracilaria</i>	1	1.65E-05	1.65E-05	0.0198	0.889
Filtered	1	4.8E-07	4.8E-07	0.000575	0.981
CO ₂ x <i>Gracilaria</i>	1	0.000157	0.000157	0.188	0.668
CO ₂ x Filtered	1	0.000204	0.000204	0.244	0.626
<i>Gracilaria</i> x Filtered	1	0.000031	0.000031	0.0372	0.849
CO ₂ x <i>Gracilaria</i> x Filtered	1	0.000433	0.000433	0.518	0.479
Residual	24	0.02	0.000835		
Total	31	0.0226	0.00073		

Three-way analysis of variance of the tissue nitrogen for *Ulva* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	3.17E-06	3.17E-06	1.414	0.252
<i>Gracilaria</i>	1	5.26E-06	5.26E-06	2.343	0.145
Filtered	1	0.000191	0.000191	85.053	<0.001
CO ₂ x <i>Gracilaria</i>	1	1.69E-06	1.69E-06	0.751	0.399
CO ₂ x Filtered	1	6.17E-08	6.17E-08	0.0275	0.87
<i>Gracilaria</i> x Filtered	1	1.18E-05	1.18E-05	5.254	0.036
CO ₂ x <i>Gracilaria</i> x Filtered	1	7.32E-07	7.32E-07	0.326	0.576
Residual	16	3.59E-05	2.25E-06		
Total	23	0.00025	1.09E-05		

Three-way analysis of variance of the tissue nitrogen for *Ulva* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2.38E-06	2.38E-06	0.216	0.648
<i>Gracilaria</i>	1	8.07E-07	8.07E-07	0.0733	0.79
Filtered	1	6.64E-05	0.0000664	6.021	0.026
CO ₂ x <i>Gracilaria</i>	1	1.64E-06	1.64E-06	0.148	0.705
CO ₂ x Filtered	1	3.5E-07	3.5E-07	0.0318	0.861
<i>Gracilaria</i> x Filtered	1	4.31E-06	4.31E-06	0.391	0.54
CO ₂ x <i>Gracilaria</i> x Filtered	1	2.33E-06	2.33E-06	0.211	0.652
Residual	16	0.000176	0.000011		
Total	23	0.000254	0.0000111		

Three-way analysis of variance of the tissue nitrogen for *Ulva* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	5.27E-06	5.27E-06	0.658	0.429
<i>Gracilaria</i>	1	1.67E-05	0.0000167	2.091	0.167
Filtered	1	8.51E-05	0.0000851	10.634	0.005
CO ₂ x <i>Gracilaria</i>	1	2.8E-06	0.0000028	0.349	0.563
CO ₂ x Filtered	1	2.79E-06	2.79E-06	0.349	0.563
<i>Gracilaria</i> x Filtered	1	5.27E-05	0.0000527	6.585	0.021
CO ₂ x <i>Gracilaria</i> x Filtered	1	3.42E-06	3.42E-06	0.427	0.523
Residual	16	0.000128	8.01E-06		
Total	23	0.000297	0.0000129		

Three-way analysis of variance of the tissue nitrogen for *Ulva* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	2.9E-06	0.0000029	1.488	0.235
<i>Gracilaria</i>	1	1.88E-06	1.88E-06	0.963	0.337
Filtered	1	2.13E-05	0.0000213	10.912	0.003
CO ₂ x <i>Gracilaria</i>	1	1.93E-06	1.93E-06	0.991	0.33
CO ₂ x Filtered	1	5.78E-09	5.78E-09	0.00296	0.957
<i>Gracilaria</i> x Filtered	1	1.18E-05	0.0000118	6.049	0.022
CO ₂ x <i>Gracilaria</i> x Filtered	1	2.61E-06	2.61E-06	1.341	0.259
Residual	23	4.48E-05	1.95E-06		
Total	30	0.000089	2.97E-06		

Three-way analysis of variance of the tissue nitrogen for *Ulva* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	3.18E-09	3.18E-09	0.001	0.975
<i>Gracilaria</i>	1	5.93E-06	5.93E-06	1.867	0.184
Filtered	1	3.06E-06	3.06E-06	0.964	0.336
CO ₂ x <i>Gracilaria</i>	1	7.32E-07	7.32E-07	0.231	0.635
CO ₂ x Filtered	1	8.15E-08	8.15E-08	0.0257	0.874
<i>Gracilaria</i> x Filtered	1	0.0000015	0.0000015	0.474	0.498
CO ₂ x <i>Gracilaria</i> x Filtered	1	2.06E-07	2.06E-07	0.065	0.801
Residual	24	0.0000762	3.17E-06		
Total	31	0.0000877	2.83E-06		

Three-way analysis of variance of the tissue C:N for *Ulva* for the early July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	60.304	60.304	3.115	0.097
<i>Gracilaria</i>	1	5.327	5.327	0.275	0.607
Filtered	1	2024.355	2024.355	104.559	<0.001
CO ₂ x <i>Gracilaria</i>	1	3.167	3.167	0.164	0.691
CO ₂ x Filtered	1	22.906	22.906	1.183	0.293
<i>Gracilaria</i> x Filtered	1	28.628	28.628	1.479	0.242
CO ₂ x <i>Gracilaria</i> x Filtered	1	6.405	6.405	0.331	0.573
Residual	16	309.776	19.361		
Total	23	2460.867	106.994		

Three-way analysis of variance of the tissue C:N for *Ulva* for the late July experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	6.605	6.605	0.192	0.667
<i>Gracilaria</i>	1	14.493	14.493	0.422	0.525
Filtered	1	661.367	661.367	19.261	<0.001
CO ₂ x <i>Gracilaria</i>	1	27.963	27.963	0.814	0.38
CO ₂ x Filtered	1	11.549	11.549	0.336	0.57
<i>Gracilaria</i> x Filtered	1	0.00146	0.00146	4.24E-05	0.995
CO ₂ x <i>Gracilaria</i> x Filtered	1	6.484	6.484	0.189	0.67
Residual	16	549.389	34.337		
Total	23	1277.85	55.559		

Three-way analysis of variance of the tissue C:N for *Ulva* for the August experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	21.361	21.361	1.211	0.287
<i>Gracilaria</i>	1	8.219	8.219	0.466	0.505
Filtered	1	305.054	305.054	17.289	<0.001
CO ₂ x <i>Gracilaria</i>	1	18.795	18.795	1.065	0.317
CO ₂ x Filtered	1	15.42	15.42	0.874	0.364
<i>Gracilaria</i> x Filtered	1	146.02	146.02	8.276	0.011
CO ₂ x <i>Gracilaria</i> x Filtered	1	23.864	23.864	1.352	0.262
Residual	16	282.314	17.645		
Total	23	821.046	35.698		

Three-way analysis of variance of the tissue C:N for *Ulva* for the September experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	55.191	55.191	3.585	0.071
<i>Gracilaria</i>	1	0.675	0.675	0.0439	0.836
Filtered	1	272.751	272.751	17.717	<0.001
CO ₂ x <i>Gracilaria</i>	1	1.711	1.711	0.111	0.742
CO ₂ x Filtered	1	27.663	27.663	1.797	0.193
<i>Gracilaria</i> x Filtered	1	61.005	61.005	3.963	0.059
CO ₂ x <i>Gracilaria</i> x Filtered	1	17.035	17.035	1.107	0.304
Residual	23	354.08	15.395		
Total	30	808.275	26.943		

Three-way analysis of variance of the tissue C:N for *Ulva* for the October experiment

Source of Variation	DF	SS	MS	F	P
CO ₂	1	26.543	26.543	1.646	0.212
<i>Gracilaria</i>	1	73.064	73.064	4.531	0.044
Filtered	1	34.41	34.41	2.134	0.157
CO ₂ x <i>Gracilaria</i>	1	22.149	22.149	1.373	0.253
CO ₂ x Filtered	1	0.101	0.101	0.00626	0.938
<i>Gracilaria</i> x Filtered	1	13.702	13.702	0.85	0.366
CO ₂ x <i>Gracilaria</i> x Filtered	1	0.45	0.45	0.0279	0.869
Residual	24	387.028	16.126		
Total	31	557.447	17.982		

Supplementary Tables S3

Tissue $\delta^{13}\text{C}$ content (‰) of dry tissue samples of *Gracilaria* and *Ulva* for July through October experiments. Values represent means $\pm$ standard deviation.

Gracilaria

	Treatment	Early July	Late July	August	September	October
Filtered	Control	-12.76 $\pm$ 1.67	-12.46 $\pm$ 0.77	-12.51 $\pm$ 0.90	-12.90 $\pm$ 0.48	-12.05 $\pm$ 0.30
	Ulva	-13.41 $\pm$ 0.22	-12.65 $\pm$ 0.81	-15.19 $\pm$ 2.14	-13.15 $\pm$ 1.47	-12.63 $\pm$ 1.21
	CO ₂	-34.66 $\pm$ 2.99	-21.12 $\pm$ 1.70	-19.34 $\pm$ 1.28	-18.60 $\pm$ 0.24	-22.80 $\pm$ 0.92
	CO ₂ /Ulva	-28.79 $\pm$ 0.85	-26.18 $\pm$ 2.02	-18.33 $\pm$ 1.15	-18.77 $\pm$ 1.29	-24.01 $\pm$ 0.92
Unfiltered	Control	-14.40 $\pm$ 1.41	-14.45 $\pm$ 1.13	-12.28 $\pm$ 0.42	-13.00 $\pm$ 1.38	-13.07 $\pm$ 1.78
	Ulva	-15.43 $\pm$ 0.63	-14.40 $\pm$ 2.24	-11.90 $\pm$ 0.62	-13.35 $\pm$ 0.95	-13.30 $\pm$ 0.56
	CO ₂	-31.85 $\pm$ 3.77	-25.84 $\pm$ 2.99	-19.49 $\pm$ 1.31	-19.20 $\pm$ 0.79	-25.02 $\pm$ 1.77
	CO ₂ /Ulva	-33.84 $\pm$ 2.47	-27.22 $\pm$ 8.94	-21.73 $\pm$ 1.63	-18.67 $\pm$ 0.55	-22.17 $\pm$ 2.72

Ulva

	Treatment	Early July	Late July	August	September	October
Filtered	Control	-11.88 $\pm$ 2.35	-8.58 $\pm$ 2.46	-8.10 $\pm$ 0.64	-12.61 $\pm$ 3.30	-12.90 $\pm$ 4.50
	Gracilaria	-8.48 $\pm$ 1.12	-9.57 $\pm$ 2.43	-9.92 $\pm$ 4.35	-12.51 $\pm$ 0.90	-15.19 $\pm$ 2.14
	CO ₂	-40.09 $\pm$ 0.73	-39.42 $\pm$ 2.82	-26.32 $\pm$ 1.73	-29.81 $\pm$ 0.95	-36.94 $\pm$ 1.44
	CO ₂ /Gracilaria	-27.63 $\pm$ 5.59	-38.32 $\pm$ 4.60	-27.37 $\pm$ 3.95	-31.51 $\pm$ 0.86	-32.92 $\pm$ 5.28
Unfiltered	Control	-11.38 $\pm$ 1.31	-13.91 $\pm$ 2.73	-12.89 $\pm$ 1.77	-14.76 $\pm$ 2.70	-12.43 $\pm$ 5.41
	Gracilaria	-9.33 $\pm$ 2.71	-12.92 $\pm$ 1.25	-11.16 $\pm$ 2.45	-16.50 $\pm$ 0.91	-14.23 $\pm$ 3.87
	CO ₂	-31.39 $\pm$ 7.33	-35.84 $\pm$ 4.75	-30.32 $\pm$ 2.49	-30.79 $\pm$ 0.88	-34.84 $\pm$ 4.08
	CO ₂ /Gracilaria	-35.59 $\pm$ 4.44	-38.73 $\pm$ 4.85	-31.57 $\pm$ 2.43	-31.91 $\pm$ 1.81	-38.21 $\pm$ 1.26

Supplementary Tables S4

Tissue nitrogen content (g N per g dry tissue), tissue carbon content (g N per g dry tissue), and tissue C:N of dry tissue samples of *Gracilaria* and *Ulva* for July through October experiments. Values represent means $\pm$ standard deviation.

Gracilaria

Tissue C content

	Treatment	Early July	Late July	August	September	October
Filtered	Control	0.292 $\pm$ 0.030	0.294 $\pm$ 0.026	0.278 $\pm$ 0.016	0.295 $\pm$ 0.026	0.309 $\pm$ 0.015
	Ulva	0.274 $\pm$ 0.017	0.329 $\pm$ 0.030	0.298 $\pm$ 0.012	0.287 $\pm$ 0.032	0.330 $\pm$ 0.008
	CO ₂	0.309 $\pm$ 0.018	0.289 $\pm$ 0.012	0.300 $\pm$ 0.026	0.308 $\pm$ 0.028	0.326 $\pm$ 0.012
	CO ₂ /Ulva	0.277 $\pm$ 0.021	0.292 $\pm$ 0.011	0.318 $\pm$ 0.041	0.318 $\pm$ 0.036	0.314 $\pm$ 0.008
Unfiltered	Control	0.277 $\pm$ 0.015	0.328 $\pm$ 0.010	0.292 $\pm$ 0.032	0.295 $\pm$ 0.029	0.307 $\pm$ 0.004
	Ulva	0.295 $\pm$ 0.022	0.325 $\pm$ 0.010	0.286 $\pm$ 0.018	0.296 $\pm$ 0.025	0.288 $\pm$ 0.065
	CO ₂	0.274 $\pm$ 0.024	0.331 $\pm$ 0.011	0.302 $\pm$ 0.016	0.310 $\pm$ 0.042	0.308 $\pm$ 0.008
	CO ₂ /Ulva	0.289 $\pm$ 0.021	0.302 $\pm$ 0.001	0.294 $\pm$ 0.013	0.312 $\pm$ 0.021	0.325 $\pm$ 0.013

Tissue N content

	Treatment	Early July	Late July	August	September	October
Filtered	Control	0.021 $\pm$ 0.004	0.019 $\pm$ 0.001	0.022 $\pm$ 0.004	0.024 $\pm$ 0.001	0.025 $\pm$ 0.004
	Ulva	0.016 $\pm$ 0.004	0.022 $\pm$ 0.002	0.017 $\pm$ 0.004	0.021 $\pm$ 0.001	0.022 $\pm$ 0.002
	CO ₂	0.022 $\pm$ 0.005	0.023 $\pm$ 0.002	0.021 $\pm$ 0.005	0.023 $\pm$ 0.002	0.026 $\pm$ 0.005
	CO ₂ /Ulva	0.018 $\pm$ 0.002	0.017 $\pm$ 0.002	0.020 $\pm$ 0.001	0.022 $\pm$ 0.001	0.017 $\pm$ 0.002
Unfiltered	Control	0.011 $\pm$ 0.001	0.015 $\pm$ 0.002	0.019 $\pm$ 0.003	0.022 $\pm$ 0.002	0.020 $\pm$ 0.002
	Ulva	0.020 $\pm$ 0.008	0.016 $\pm$ 0.001	0.017 $\pm$ 0.001	0.019 $\pm$ 0.003	0.018 $\pm$ 0.004
	CO ₂	0.010 $\pm$ 0.001	0.015 $\pm$ 0.004	0.019 $\pm$ 0.001	0.018 $\pm$ 0.002	0.020 $\pm$ 0.001
	CO ₂ /Ulva	0.011 $\pm$ 0.002	0.012 $\pm$ 0.001	0.016 $\pm$ 0.002	0.017 $\pm$ 0.001	0.017 $\pm$ 0.003

Tissue C:N

		Early July	Late July	August	September	October
Filtered	Control	16.4 $\pm$ 2.1	18.1 $\pm$ 3.1	15.3 $\pm$ 2.4	14.3 $\pm$ 1.3	14.7 $\pm$ 2.2
	Ulva	19.9 $\pm$ 2.9	17.2 $\pm$ 0.4	21.3 $\pm$ 5.7	16.0 $\pm$ 1.4	17.9 $\pm$ 1.6
	CO ₂	17.3 $\pm$ 4.6	15.0 $\pm$ 1.4	17.9 $\pm$ 5.8	15.6 $\pm$ 1.1	15.1 $\pm$ 2.5
	CO ₂ /Ulva	18.5 $\pm$ 0.5	20.7 $\pm$ 2.0	18.7 $\pm$ 1.5	17.1 $\pm$ 2.0	21.3 $\pm$ 2.5
Unfiltered	Control	29.3 $\pm$ 3.3	25.1 $\pm$ 3.2	17.6 $\pm$ 0.9	15.6 $\pm$ 1.6	17.8 $\pm$ 1.9
	Ulva	19.1 $\pm$ 7.7	23.9 $\pm$ 0.8	19.6 $\pm$ 0.1	18.4 $\pm$ 1.7	18.4 $\pm$ 3.2
	CO ₂	31.3 $\pm$ 1.8	25.4 $\pm$ 0.4	18.6 $\pm$ 1.4	20.7 $\pm$ 4.9	17.8 $\pm$ 0.9
	CO ₂ /Ulva	30.1 $\pm$ 4.6	31.0 $\pm$ 7.4	21.6 $\pm$ 1.3	21.6 $\pm$ 2.4	22.6 $\pm$ 3.8

Ulva

Tissue C content

	Treatment	Early July	Late July	August	September	October
Filtered	Control	0.302±0.004	0.259±0.073	0.296±0.008	0.280±0.015	0.315±0.036
	Gracilaria	0.315±0.008	0.300±0.044	0.288±0.022	0.251±0.023	0.307±0.019
	CO ₂	0.307±0.008	0.307±0.003	0.285±0.014	0.301±0.014	0.294±0.018
	CO ₂ /Gracilaria	0.318±0.019	0.306±0.014	0.285±0.028	0.297±0.018	0.309±0.023
Unfiltered	Control	0.302±0.015	0.320±0.033	0.292±0.005	0.299±0.033	0.315±0.046
	Gracilaria	0.305±0.009	0.299±0.008	0.278±0.016	0.287±0.017	0.318±0.022
	CO ₂	0.328±0.006	0.313±0.027	0.286±0.014	0.272±0.019	0.298±0.037
	CO ₂ /Gracilaria	0.291±0.024	0.295±0.013	0.280±0.022	0.285±0.020	0.295±0.014

Tissue N content

	Treatment	Early July	Late July	August	September	October
Filtered	Control	0.013±0.001	0.013±0.006	0.017±0.004	0.012±0.003	0.011±0.003
	Gracilaria	0.015±0.003	0.014±0.005	0.012±0.001	0.009±0.001	0.010±0.002
	CO ₂	0.012±0.001	0.012±0.001	0.017±0.006	0.010±0.001	0.011±0.001
	CO ₂ /Gracilaria	0.014±0.001	0.013±0.001	0.012±0.001	0.010±0.001	0.010±0.001
Unfiltered	Control	0.008±0.001	0.011±0.004	0.010±0.001	0.009±0.001	0.010±0.003
	Gracilaria	0.009±0.002	0.009±0.001	0.013±0.003	0.009±0.001	0.009±0.001
	CO ₂	0.008±0.001	0.009±0.001	0.010±0.001	0.008±0.001	0.011±0.002
	CO ₂ /Gracilaria	0.007±0.001	0.010±0.001	0.010±0.001	0.009±0.001	0.009±0.001

Tissue C:N

		Early July	Late July	August	September	October
Filtered	Control	27.7±0.6	26.7±8.8	21.0±4.8	28.3±6.8	35.6±5.1
	Gracilaria	24.9±4.9	26.3±5.2	27.3±1.3	31.8±4.9	35.5±4.7
	CO ₂	29.2±1.7	30.3±2.9	21.5±7.2	33.8±2.8	32.0±4.1
	CO ₂ /Gracilaria	25.8±1.3	27.6±3.2	27.4±0.9	35.4±1.2	35.6±4.7
Unfiltered	Control	42.9±3.5	37.6±9.3	33.5±3.2	40.4±2.2	36.3±3.7
	Gracilaria	42.4±9.5	39.2±4.0	25.9±6.9	35.3±2.2	39.2±2.1
	CO ₂	46.3±1.0	40.4±5.1	33.2±0.7	39.2±3.7	32.9±4.5
	CO ₂ /Gracilaria	49.3±4.7	35.7±4.6	33.2±2.4	38.1±4.0	38.7±1.9