

Supplementary material S1. *Light intensity experiment lighting*
Supplementary material S2. *Press vs Pulse experiment lighting*
Supplementary material S3. *Detailed PERMANOVA results*
Supplementary material S4. *Photosynthetic pigments*

Supplementary material S1

Light intensity experiment lighting

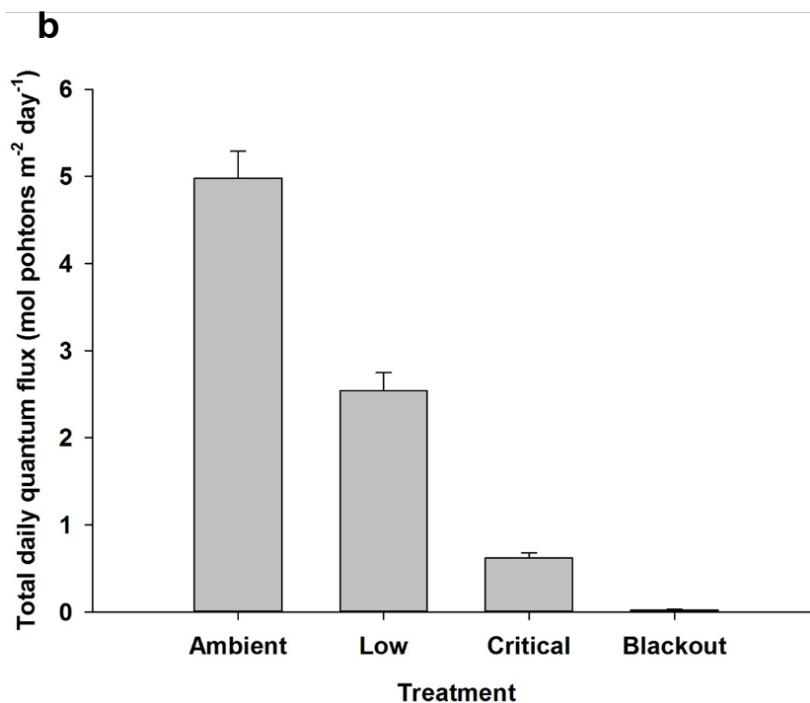


Figure S1. Experimental tanks (a) and mean (\pm SE) total daily photon flux density (mol photons m⁻² day⁻¹) in ambient, low, critical, and blackout treatments of the light intensity experiment (b; n = 30 for each bar).

Supplementary material S2

Press vs Pulse experiment lighting

Total daily PFD ranged from 0.8 to 9.2 mol photons $\text{m}^{-2} \text{day}^{-1}$ in ambient tanks and 0.4 to 3.5 mol photons $\text{m}^{-2} \text{day}^{-1}$ in press (chronic low-light) tanks. For the first two days of the seven day light cycles, pulse tanks were close to complete darkness (0.02 to 0.65 mol photons $\text{m}^{-2} \text{day}^{-1}$). Light slowly increased over days three to five and were comparable to ambient tanks for days six and seven (1.1 – 7.2 mol photons $\text{m}^{-2} \text{day}^{-1}$) (Fig. S2a). Total weekly PFD was significantly higher (*c.* 2 times greater) in ambient tanks than press and pulse tanks (Factor = Treatment, $F_{2,45} = 139.34$, $p < 0.0001$) but was similar between press and pulse tanks (LS means, $p = 0.19$) (Fig. S2b). Total weekly PFD in ambient tanks was *c.* 9.7 % of surface irradiance, while press and pulse were only *c.* 4.0 and 4.1 % of surface irradiance, respectively.

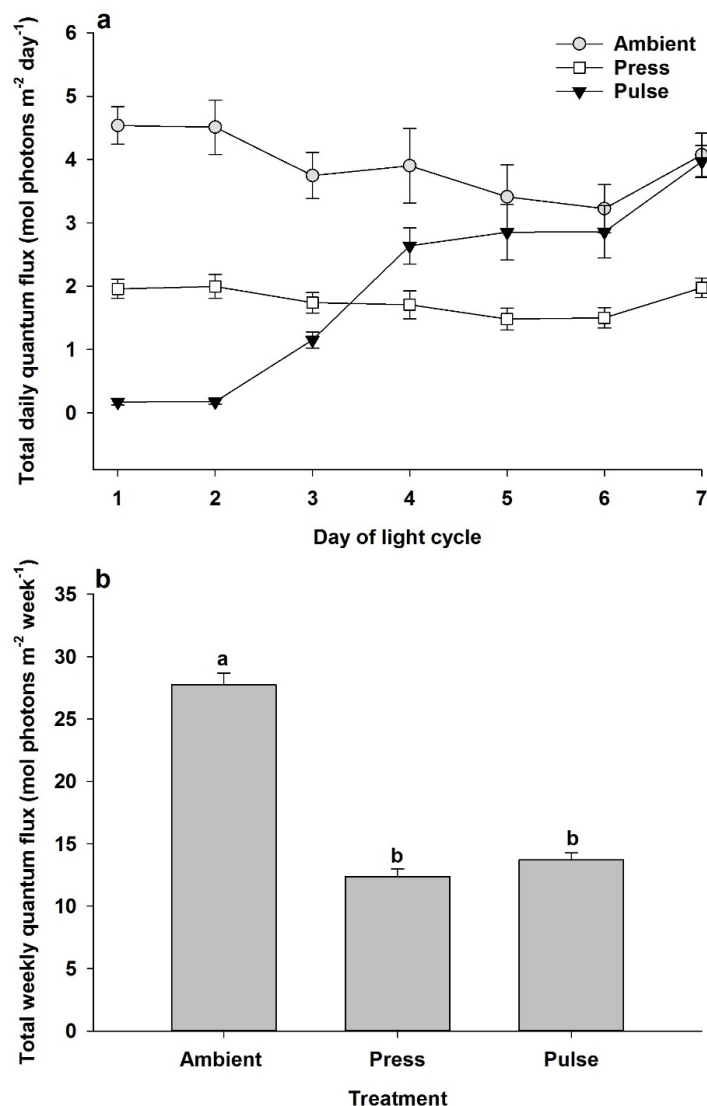


Figure S2. Mean (\pm SE) total daily photon flux density (mol photons $\text{m}^{-2} \text{day}^{-1}$) (a) and total weekly photon flux density (mol photons $\text{m}^{-2} \text{week}^{-1}$) (b) in ambient, press, and pulse treatments of the press vs pulse experiment. Each point in (a) represents the average of four days for each of four tanks in each treatment ($n = 16$). Each bar in (b) represents the average PFD of the four light cycles (one week) for each treatment ($n = 4$). Bars not sharing the same letter are different (LS means tests, $p < 0.05$).

Supplementary material S3*Detailed PERMANOVA results***Initial parameters:**

Table S3.1. Summary of ANOVAs (applied to normalized data using Type III SSs and 9999 permutations) examining differences of initial lamina biomass and photosynthetic parameters between species (fixed effect: *E. radiata* and *C. flexuosum*) and among light treatments (fixed effect: ambient, low, critical, blackout [light intensity experiment] or ambient, press, pulse [press vs pulse experiment]) at the start of the experiments. Tank (random effect: nested in Treatment) was included in the model as a random effect. **Bold** values denote significance.

Source of variation	<i>df</i>	MS	Pseudo-F	<i>p</i>
Experiment 1: light intensity				
Lamina biomass				
Species	1	39.67	84.24	0.0001
Treatment	3	0.53	0.41	0.7229
Tank [Treatment]	4	1.29	2.73	0.0356
Species × Treatment	3	0.19	0.40	0.7574
Residual	68	0.47		
Total	79			
P_{\max}				
Species	1	16.48	25.89	0.0001
Treatment	3	0.87	0.98	0.4482
Tank [Treatment]	4	0.89	1.40	0.2615
Species × Treatment	3	0.48	0.75	0.5274
Residual	36	0.64		
Total	47			
R_d				
Species	1	0.70	0.64	0.4271
Treatment	3	0.58	1.00	0.4648
Tank [Treatment]	4	0.59	0.53	0.7114
Species × Treatment	3	0.89	0.81	0.5029
Residual	36	1.10		
Total	47			
α				
Species	1	0.75	0.67	0.4121
Treatment	3	0.12	0.29	0.8248
Tank [Treatment]	4	0.41	0.37	0.8279
Species × Treatment	3	1.44	1.29	0.2834
Residual	36	1.11		
Total	47			
E_k				
Species	1	2.84	3.11	0.0843
Treatment	3	0.58	0.39	0.7852
Tank [Treatment]	4	1.49	1.63	0.1900
Species × Treatment	3	0.18	1.29	0.2949
Residual	36	0.91		
Total	47			
E_c				
Species	1	0.63	0.60	0.4455

Treatment	3	0.53	1.09	0.3898
Tank [Treatment]	4	0.48	0.46	0.7657
Species × Treatment	3	1.81	1.74	0.1787
Residual	36	1.04		
Total	47			

Experiment 2: press vs pulse**Lamina biomass**

Species	1	20.20	30.00	0.0001
Treatment	2	0.49	1.38	0.3109
Tank [Treatment]	9	0.35	0.52	0.8596
Species × Treatment	2	0.21	0.31	0.7423
Residual	33	0.67		
Total	47			

 P_{\max}

Species	1	10.48	9.56	0.0137
Treatment	2	0.03	0.15	0.8617
Tank [Treatment]	9	0.22	0.20	0.9876
Species × Treatment	2	0.31	0.28	0.7511
Residual	9	1.10		
Total	23			

 R_d

Species	1	5.12	3.91	0.0778
Treatment	2	0.01	0.01	0.9911
Tank [Treatment]	9	0.65	0.49	0.8783
Species × Treatment	2	0.10	0.08	0.9235
Residual	9	1.31		
Total	23			

 α

Species	1	3.80	3.66	0.0822
Treatment	2	0.37	0.37	0.7455
Tank [Treatment]	9	0.98	0.95	0.5307
Species × Treatment	2	0.14	0.14	0.8682
Residual	9	1.04		
Total	23			

 E_k

Species	1	5.10	5.20	0.0432
Treatment	2	0.13	0.17	0.8339
Tank [Treatment]	9	0.73	0.74	0.6764
Species × Treatment	2	1.14	1.16	0.3517
Residual	9	0.98		
Total	23			

 E_c

Species	1	2.26	1.57	0.2435
Treatment	2	0.18	0.22	0.8101
Tank [Treatment]	9	0.80	0.56	0.8279
Species × Treatment	2	0.11	0.08	0.9321
Residual	9	1.44		
Total	23			

Final parameters:

Table S3.2 Summary of ANOVAs (applied to normalized data using Type III SS and 999 permutations) examining differences in changes in lamina biomass (proportion of initial biomass), photosynthetic parameters, and pigment content between species (fixed effect: *Ecklonia radiata* and *Carpophyllum flexuosum*) and among light treatments (fixed effect: Ambient, Low, Critical, Blackout) in the light intensity experiment. Tank (random effect: nested in Treatment) was included in the model as a random effect. **Bold** values indicate significance.

Source of variation	<i>df</i>	MS	Pseudo-F	<i>p</i>
Experiment 1: light intensity				
Change in lamina biomass				
Species	1	9.04	33.67	0.0001
Treatment	3	12.50	439.27	0.0078
Tank [Treatment]	4	0.028	0.11	0.9821
Species × Treatment	3	4.70	17.49	0.0001
Residual	68	0.27		
Total	79			
P_{\max}				
Species	1	2.14	3.99	0.0527
Treatment	3	6.35	10.93	0.0105
Tank [Treatment]	4	0.58	1.08	0.3700
Species × Treatment	3	1.39	2.59	0.0723
Residual	36	0.54		
Total	47			
R_d				
Species	1	6.20	9.22	0.0045
Treatment	3	2.24	4.05	0.1331
Tank [Treatment]	4	0.55	0.82	0.5061
Species × Treatment	3	2.55	3.80	0.0178
Residual	36	0.67		
Total	47			
α				
Species	1	2.98	1.91	0.1412
Treatment	3	0.11	0.06	0.9892
Tank [Treatment]	4	1.64	1.84	0.1416
Species × Treatment	3	1.70	3.35	0.0730
Residual	36	0.89		
Total	47			
E_k				
Species	1	0.16	0.20	0.6646
Treatment	3	1.74	0.99	0.5071
Tank [Treatment]	4	1.75	2.17	0.0916
Species × Treatment	3	1.90	2.36	0.0943
Residual	36	0.80		
Total	47			
E_c				
Species	1	0.96	1.10	0.2994
Treatment	3	2.34	1.31	0.3477
Tank [Treatment]	4	1.78	2.04	0.1091
Species × Treatment	3	0.17	0.20	0.9007

Residual	36	0.87		
Total	47			
Chl <i>a</i>				
Species	1	15.33	23.72	0.0001
Treatment	3	3.57	2.64	0.1958
Tank [Treatment]	4	1.35	2.09	0.0889
Species × Treatment	3	1.21	1.87	0.1441
Residual	68	0.65		
Total	79			
Chl <i>c</i>				
Species	1	52.61	242.36	0.0001
Treatment	3	1.84	4.07	0.1070
Tank [Treatment]	4	0.45	2.09	0.0986
Species × Treatment	3	1.43	6.58	0.0004
Residual	68	0.22		
Total	79			
Fucoxanthin				
Species	1	27.86	60.53	0.0001
Treatment	3	3.42	3.02	0.1987
Tank [Treatment]	4	1.13	2.46	0.0545
Species × Treatment	3	1.68	3.66	0.0153
Residual	68	0.46		
Total	79			
Experiment 2: press vs pulse				
Change in lamina biomass				
Species	1	6.66	18.52	0.0002
Treatment	2	6.78	11.06	0.0108
Tank [Treatment]	9	0.61	1.70	0.1234
Species × Treatment	2	4.71	13.07	0.0001
Residual	33	0.36		
Total	47			
<i>P</i>_{max}				
Species	1	13.50	41.60	0.0002
Treatment	2	1.00	5.09	0.0274
Tank [Treatment]	9	0.20	0.60	0.7599
Species × Treatment	2	1.41	4.33	0.0491
Residual	9	0.32		
Total	23			
<i>R</i>_d				
Species	1	0.52	3.08	0.1142
Treatment	2	0.28	0.88	0.4549
Tank [Treatment]	9	0.32	1.89	0.1816
Species × Treatment	2	0.85	51.41	0.0001
Residual	9	0.17		
Total	23			
<i>α</i>				
Species	1	4.98	8.34	0.0191
Treatment	2	0.31	0.24	0.7540
Tank [Treatment]	9	1.31	2.20	0.1310

Species × Treatment	2	1.10	0.16	0.8454
Residual	9	0.60		
Total	23			
<i>E_k</i>				
Species	1	0.01	0.02	0.9069
Treatment	2	0.02	0.01	0.9837
Tank [Treatment]	9	1.65	1.89	0.1807
Species × Treatment	2	0.10	0.11	0.8910
Residual	9	0.87		
Total	23			
<i>E_c</i>				
Species	1	2.91	5.76	0.0397
Treatment	2	0.95	0.79	0.4747
Tank [Treatment]	9	1.20	2.37	0.1116
Species × Treatment	2	1.44	2.84	0.1149
Residual	9	0.50		
Total	23			
Chl <i>a</i>				
Species	1	14.95	43.40	0.0001
Treatment	2	8.87	31.52	0.0002
Tank [Treatment]	9	0.28	0.82	0.6065
Species × Treatment	2	0.21	0.62	0.5449
Residual	33	0.34		
Total	47			
Chl <i>c</i>				
Species	1	36.82	522.51	0.0001
Treatment	2	2.23	48.38	0.0006
Tank [Treatment]	9	0.05	0.65	0.7501
Species × Treatment	2	1.49	21.19	0.0001
Residual	33	0.07		
Total	47			
Fucoxanthin				
Species	1	27.17	77.46	0.0001
Treatment	2	1.92	7.11	0.0191
Tank [Treatment]	9	0.27	0.77	0.6424
Species × Treatment	2	0.98	2.80	0.0717
Residual	33	0.35		
Total	47			

Supplementary material S4

Photosynthetic pigments

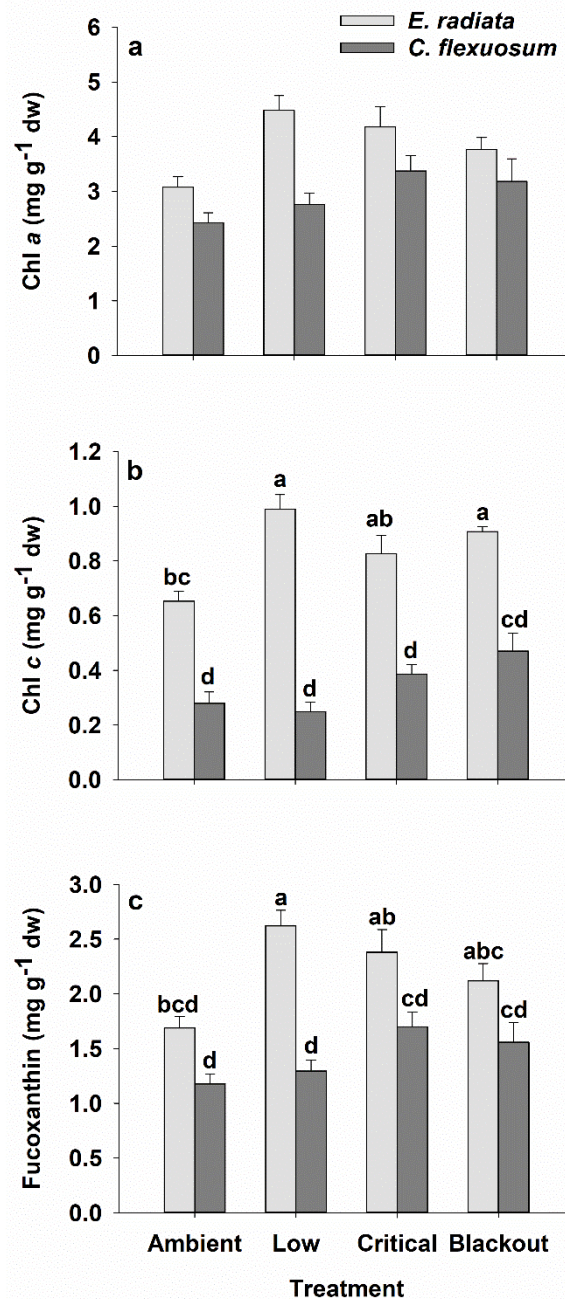


Figure S4.1. Mean (\pm SE) chlorophyll *a* (a), chlorophyll *c* (b), and fucoxanthin (c) levels of *Ecklonia radiata* and *Carpophyllum flexuosum* after 30 days in each light treatment (ambient, low, critical, blackout) of the light intensity experiment. Bars not sharing the same letter are significantly different (pair-wise tests, $p < 0.05$; $n = 10$ for each bar).

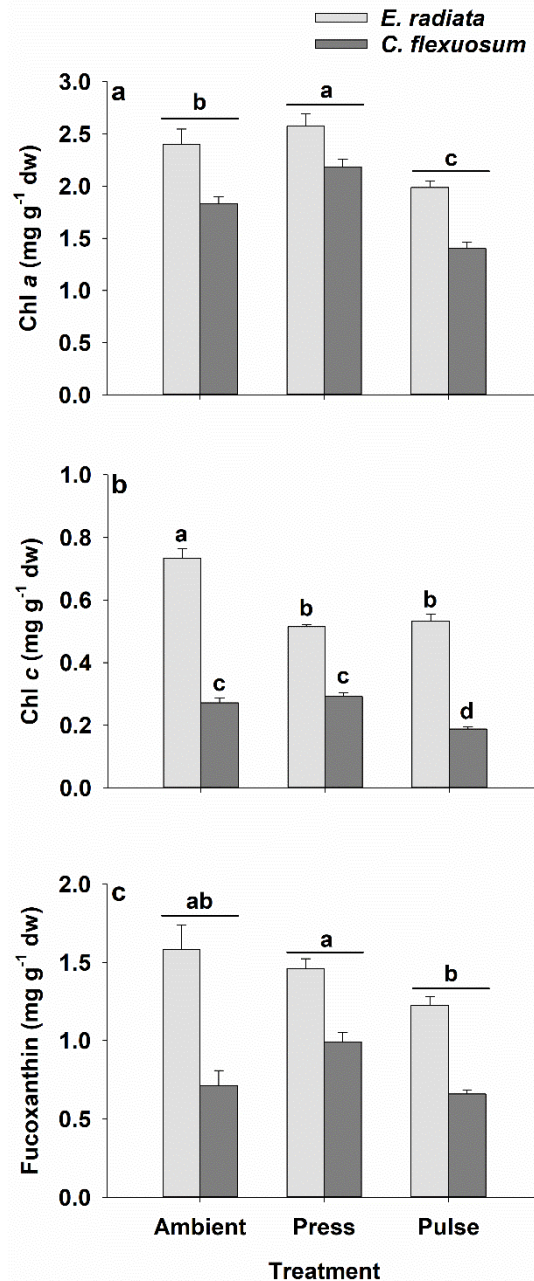


Figure S4.2. Mean (\pm SE) chlorophyll *a* (a), chlorophyll *c* (b), and fucoxanthin (c) levels of *Ecklonia radiata* and *Carpophyllum flexuosum* after 30 days in each treatment (ambient, press, and pulse) of the press vs pulse experiment. Bars not sharing the same letter or light treatments not bracketed by the same horizontal line are significantly different (pair-wise tests, $p < 0.05$; $n = 8$ for each bar).