Supplement 1

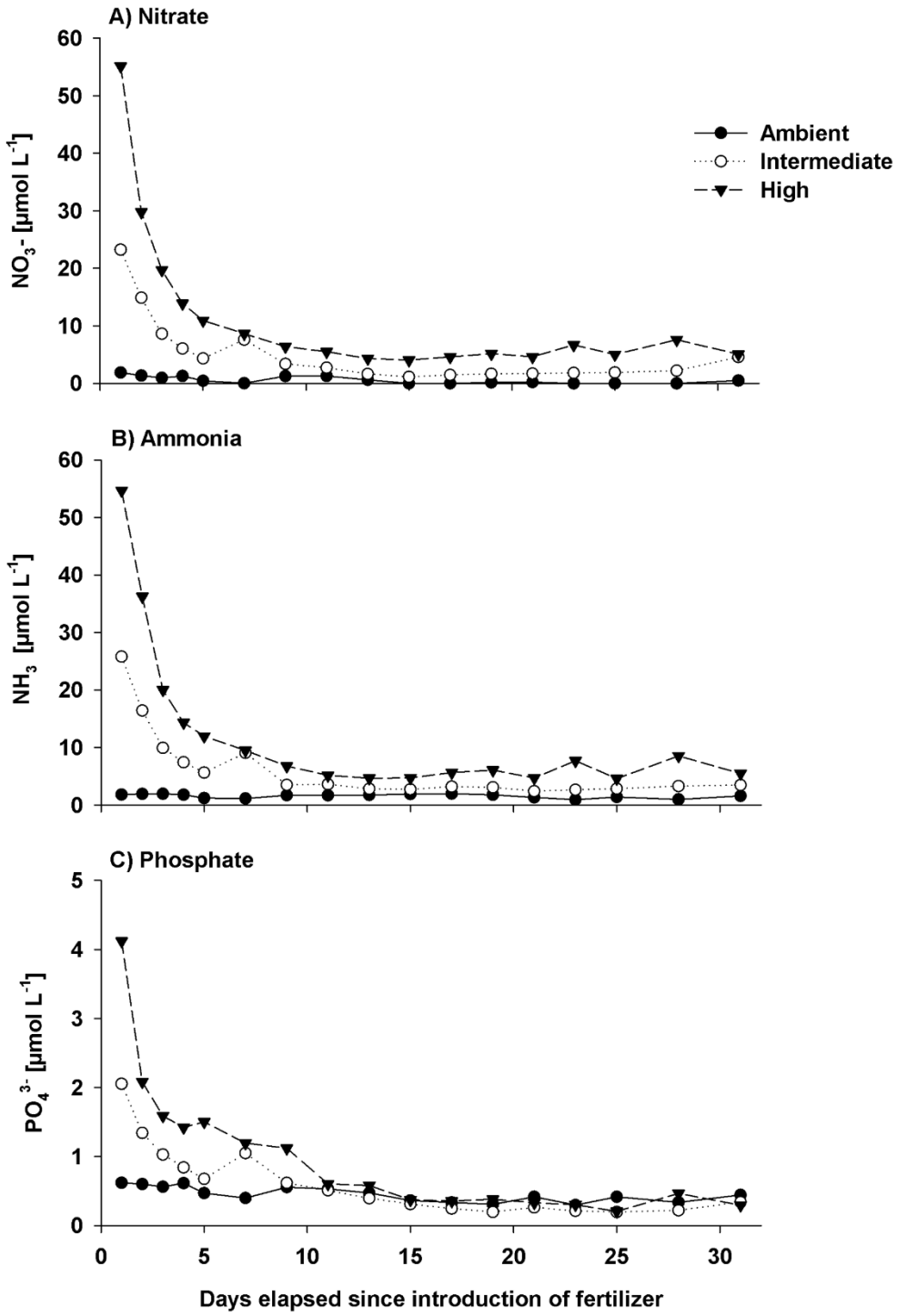
Methods S1. Pre-experimental trials – nutrient release

We carried out pre-experimental trials to characterize patterns of nutrient release and underwater lifetime of the Osmocote® fertilizer prills used in the present study. Several quantities of Osmocote® were tested along with the custom-built nutrient dispensers (Fig. S1) to create a consistently repeatable pattern of nutrient release with detectable levels of nitrate, ammonia, and phosphorus. The present appendix reports on the methods and results for the pattern of release chosen to carry out the laboratory mesocosm and field experiments.

Trials were carried out in three, 180-L flow-through (1 L min^{-1}) glass mesocosms (those used in the laboratory experiment); one for each of the three targeted nutrient concentrations: ambient, intermediate, or high. All mesocosms replicated the same general conditions as in the laboratory experiment (see "Mesocosm enrichment experiment" for details on mesocosm setup), except they contained no rhodoliths. Trials lasted 31 d and began on 1 June, 2015, with the introduction of two, 25-cm-long nutrient dispensers to each mesocosm. Each dispenser in the ambient, intermediate, and high nutrient concentration mesocosms contained 0, 62.5, and 125 g of fertilizer, respectively, for a total of 0, 125, or 250 g of fertilizer in the mesocosms. Water samples were collected from each mesocosm every 24 h from days 1 to 5, every 48 h from days 6 to 25, and every 72 h from days 26 to 31, for a total of 17 samples per mesocosm, and analyzed with the same protocols as in the laboratory mesocosm experiment (see "Water sampling and nutrient analysis"). Water temperature was recorded every 5 min with one temperature logger (HOBO Pendant; Onset Computer Corporation) on the bottom of each mesocosm.

Patterns of nitrate (NO_3^-), ammonia (NH_3), and phosphate (PO_4^{3-}) release were similar for the intermediate and high nutrient concentration treatments, with a quick release to peak concentrations within the first 24 h, followed by a quasi exponential decline over the following 8 to10 d to relatively low and stable concentrations (Fig. S1). The diminishing phase was more abrupt for nitrate and ammonia, which both decreased by an order of magnitude, than for phosphate, which decreased by 75% and 85% in the intermediate and high enrichment treatments, respectively. As expected, concentrations of nitrate, ammonia, and phosphate in the ambient treatment were quite stable throughout the trials (Fig. S1). Nitrate and ammonia were continuously lower in the ambient than intermediate and high concentration treatments, whereas phosphate exhibited no clear differences among the three treatments beyond 10 d (Fig. S1). Daily mean water temperature during the pre-experimental trials generally increased from ~4°C on 1 June, 2015, to ~10°C on 1 July, 2015, averaging 7.8±2.1 (SD) °C during this period. These results helped us anticipate nutrient depletion, while guiding the number and size of nutrient dispensers and frequency at which we changed them in the laboratory (see "Mesocosm enrichment experiment") and field (see "Field nutrient enrichment") experiments.

Fig. S1. Concentration of (A) nitrate [NO_3^-], (B) ammonia [NH_3], and (C) phosphate [PO_4^{3-}] for each nutrient concentration treatment (ambient [0 g of fertilizer], intermediate [125 g] and high [250 g]) for each of the 17 water collections during the 31-d pre-experiment trials. Concentration was measured every 24 h from days 1 to 5, every 48 h from days 6 to25, and every 72 h from days 25 to 31, from a single water sample per collection event (n=17 for each concentration treatment).



Supplement 2

Methods S2. Determination of lux to PAR conversion factors

The following procedures were applied to calculate numerical factors for conversion of illuminance values (in lx) of artificial actinic light and sunlight measured in the lab and field, to irradiance (PAR) values (in µmol photons m^{-2} s^{-1}).

S2.1. Artificial actinic light

Illuminance and irradiance at the bottom of one mesocosm (see "Mesocosm enrichment experiment" for details on mesocosm setup) were recorded simultaneously for 15 min for each of two actinic fluorescent tubes. Tubes were chosen randomly from the pool of tubes used in the laboratory experiment. Both trials were performed in the dark to measure the sole contribution of each tube to light environment. Illuminance was recorded once every minute with the same model of temperature and light logger (HOBO Pendant; Onset Computer Corporation) used in the mesocsom experiment. Irradiance was recorded 240 times min^{-1} with a quantum sensor (LI-192; LI-COR). One conversion factor was calculated for each tube. This was done by averaging illuminance and irradiance data for each of the 15 min that each trial lasted, and then by dividing each mean illuminance by corresponding mean irradiance. Means of the resulting 15 conversion factors (one per minute for each tube) were similar for both tubes, and hence averaged, yielding one overall conversion factor (Table S1).

Table S1. Mean (±SD) illuminance to PAR conversion factors (in) for each of the two actinic fluorescent tubes chosen randomly among the six tubes used in the laboratory experiment (n=15 for each tube and 30 for the overall factor pooled across tubes).

Actinic tube	Conversion factor
1	21.6 (0.7)
2	22.6 (0.6)
Tubes pooled	22.1 (0.8)*

*Overall factor used to convert individual actinic illuminance values to PAR values in the laboratory mesocosm experiment.

S2.2. Sunlight

Illuminance and irradiance above the rhodolith bed were recorded simultaneously for 15 min at a depth of ~16 m, on a partly cloudy day with low winds in both April and August, when phytoplankton abundance was respectively high (during spring bloom) and low (after spring bloom) (Parrish et al. 2005). Illuminance was recorded once every second with the same model of temperature and light logger (HOBO Pendant; Onset Computer Corporation) used in the laboratory mesocosm experiment. Irradiance was recorded 240 times min^{-1} with a quantum

sensor (LI-192; LI-COR). Both instruments were attached next to one another on a metal frame deposited on the surface of the rhodolith bed and pointed towards the sea surface. One conversion factor was calculated on each sampling day. This was done by averaging illuminance and irradiance data for each of the 15 min that each trial lasted, and then by dividing each mean illuminance by corresponding mean irradiance. Means of the resulting 15 conversion factors (one per minute for each day) were similar between days, and hence averaged, yielding one overall conversion factor (Table S2).

Table S2. Mean (±SD) illuminance to PAR conversion factors (in) measured in the field experiment at a depth of ~15 m, on a partly cloudy day with low winds in April and August, when phytoplankton abundance was respectively high and low (n=15 for each factor per day, and 30 for the overall factor pooled across days).

Sampling day	Conversion factor
1 (April)	25.0 (0.1)
2 (August)	21.9 (0.5)
Days pooled	23.5 (1.6)*

*Overall factor used to convert sunlight illuminance values to PAR values in the field experiment.

LIETERATURE CITED

Parrish C, Thompson R, Deibel D (2005) Lipid classes and fatty acids in plankton and settling matter during the spring bloom in a cold ocean coastal environment. Mar Ecol Prog Ser 286:57–68

Supplement 3. Additional tables

Table S3. Mean (±SD) concentration of nitrate (NO_3^-), ammonia (NH_3), and phosphate (PO_4^{3-}) for each nutrient concentration treatment (ambient [0 g of fertilizer], intermediate [125 g] and high [250 g]) in the 183-d laboratory mesocosm experiment, and for each nutrient concentration treatment (ambient [0 g of fertilizer] and elevated [250 g of fertilizer]) in the 193-d field experiment. Concentrations in the laboratory experiment were averaged over the 26 water collections and two mesocosms per concentration treatment (n=52). Concentrations in the field experiment were averaged over the 12 water collections and six rhodolith cages per concentration treatment (n=72).

		Nutrient concentration (µmol l^{-1})		
Experiment	Treatment	NO_3^-	NH_3	PO_4^{3-}
Laboratory	Ambient	3.2 (1.8)	3.5 (3.2)	0.6 (0.4)
	Intermediate	10.2 (6.7)	14.4 (11.5)	1.3 (0.7)
	High	29.5 (52.2)	33.9 (42.7)	2.9 (5.0)
Field	Ambient	1.0 (1.3)	3.3 (2.0)	0.4 (0.1)
	Elevated	3.3 (1.0)	5.1 (1.7)	1.2 (0.3)

Table S4. Summary of split-plot ANCOVA (applied to raw data) examining the effects of between-plot factor nutrient Concentration (C; three levels: ambient, intermediate, and high), within-plot factor Biofouling (B; two levels: cleaned and uncleaned rhodoliths), and covariate Time (T; number of days elapsed since the onset of the experiment on each rhodolith sampling event [29, 61, 91, 122, 152, and 183 d]), while correcting for the random factor Mesocosm (each of the six experimental mesocosms) nested within Concentration (two mesocosms per level of Concentration), on relative dry weight of biofoulers on rhodoliths in the laboratory mesocosm experiment (see "Mesocosm enrichment experiment" for a description of the experiment). Random-factor effects are not relevant to the present study, and hence not shown for simplicity.

Source of variation	**numDF**	**denDF**	**F-ratio**	***p***
Intercept	1	345	200.05	<0.001
C	2	3	0.01	0.986
B	1	345	83.54	<0.001
T	1	345	0.03	0.871
C x B	2	345	0.30	0.738
C x T	2	345	0.03	0.972
B x T	1	345	3.04	0.082
C x B x T	2	342	0.73	0.481

numDF = F-ratio numerator; denDF = F-ratio denominator; *p* = p-value.

Table S5. Summary of split-plot ANCOVA (applied to raw data) examining the effects of between-plot factor nutrient Concentration (C; three levels: ambient, intermediate, and high), within-plot factor Biofouling (B; two levels: cleaned and uncleaned rhodoliths), and covariate Time (T; number of days elapsed since the onset of the experiment on each rhodolith sampling event [29, 61, 91, 122, 152, and 183 d]), while correcting for the random factor Mesocosm (each of the six experimental mesocosms) nested within Concentration (two mesocosms per level of Concentration), on rhodolith branch elongation in the laboratory mesocosm experiment (see "Mesocosm enrichment experiment" for a description of the experiment). Random-factor effects are not relevant to the present study, and hence not shown for simplicity.

Source of variation	numDF	denDF	F-ratio	*p*
Intercept	1	345	13793.56	<0.001
C	2	3	16.55	0.024
B	1	345	1.72	0.191
T	1	345	979.12	<0.001
C x B	2	345	0.70	0.498
C x T	2	345	43.57	<0.001
B x T	1	345	12.63	<0.001
C x B x T	2	342	0.66	0.515

numDF = F-ratio numerator; denDF = F-ratio denominator; *p* = p-value.

Table S6. Summary of nested ANCOVA (applied to raw data) examining the effects of nutrient Concentration (C; two levels: ambient and elevated) and covariate Time (T; number of days elapsed since the onset of the experiment on each rhodolith sampling event [39, 64, 95, 125, 154, and 193 d], while correcting for the random factor Cage (each of the 12 rhodolith cages) nested within Concentration (six cages per level of Concentration), on relative dry weight of biofoulers on rhodoliths in the field experiment (see "Field nutrient enrichment" for a description of the experiment). Random-factor effects are not relevant to the present study, and hence not shown for simplicity.

Source of variation	numDF	denDF	F-ratio	*p*
Intercept	1	346	139.30	<0.001
C	1	10	0.84	0.380
T	1	346	296.35	<0.001
C x T	1	346	0.92	0.339

numDF = F-ratio numerator; denDF = F-ratio denominator; *p* = p-value.

Table S7. Summary of nested ANCOVA (applied to raw data) examining the effects of nutrient Concentration (C; two levels: ambient and elevated) and covariate Time (T; number of days elapsed since the onset of the experiment on each rhodolith sampling event [39, 64, 95, 125, 154, and 193 d], while correcting for the random factor Cage (each of the 12 rhodolith cages) nested within Concentration (six cages per level of Concentration), on rhodolith branch elongation in the field experiment (see "Field nutrient enrichment" for a description of the experiment). Random-factor effects are not relevant to the present study, and hence not shown for simplicity.

Source of variation	numDF	denDF	F-ratio	*p*
Intercept	1	346	5022.20	<0.001
C	1	10	8.12	0.017
T	1	346	460.17	<0.001
C x T	1	346	0.13	0.722

numDF = F-ratio numerator; denDF = F-ratio denominator; *p* = p-value.