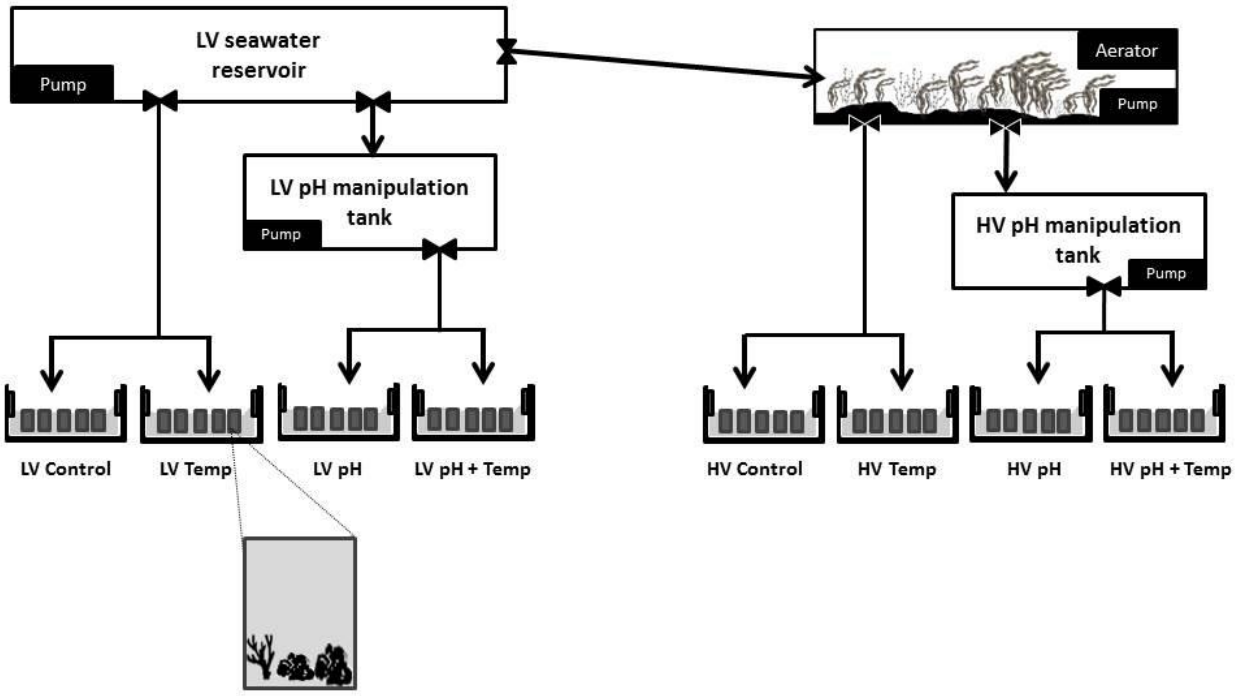


Figure S1| Schematic of the experimental design. Each treatment, which included a control and the effect of reduced pH and/or elevated temperature, was performed relative to the background variance of each habitat (Low variance (LV) outer-reef and high variance (HV) seagrass). *Acropora palmata* sampled from the LV habitat (*n*= 40), and *Porites astreoides* from both the HV (*n*= 40) and LV (*n*= 40) habitats) were simultaneously subjected to each of the eight treatments. Each vessel held one fragment of *A. palmata* (LV), *P. astreoides* (LV) and *P. astreoides* (HV) as shown in the close-up image of the vessel.

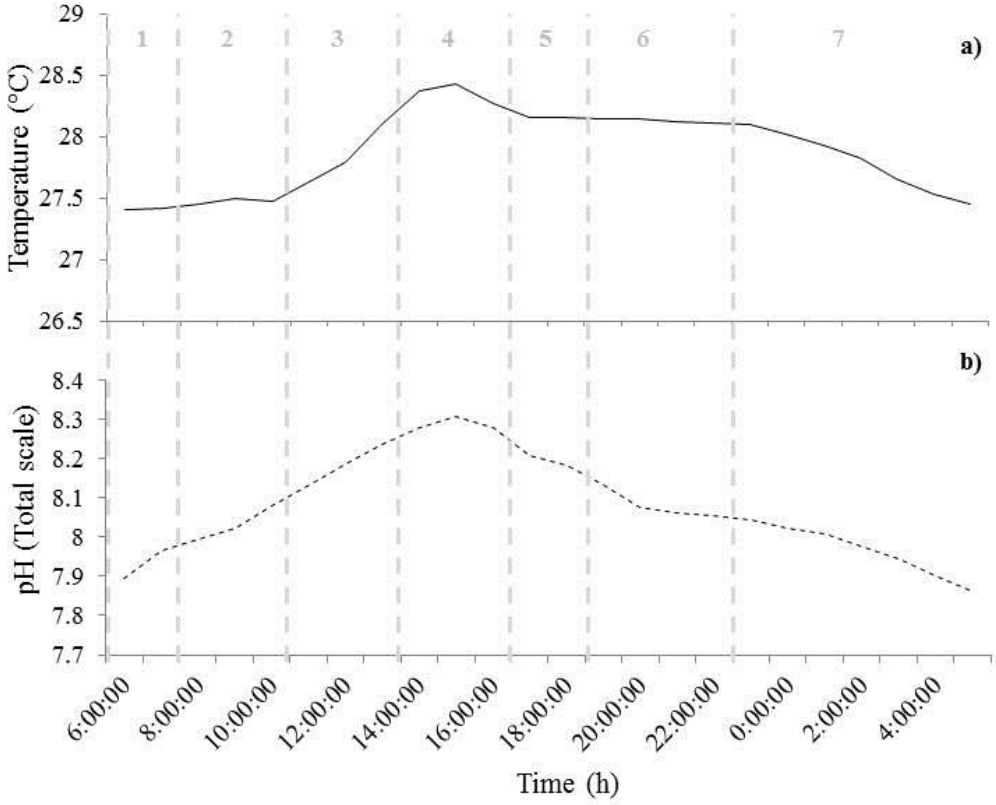


Figure S2| The natural diurnal oscillations in: a) temperature and b) pH for the high-variance seagrass habitat on Little Cayman, Cayman Islands, BWI. From the natural diurnal cycles, seven time periods were selected to manipulate the temperature and pH to conditions predicted in 2100 under the IPCC A1B scenario. The seven time periods were selected to try and best-represent the natural diurnal conditions.

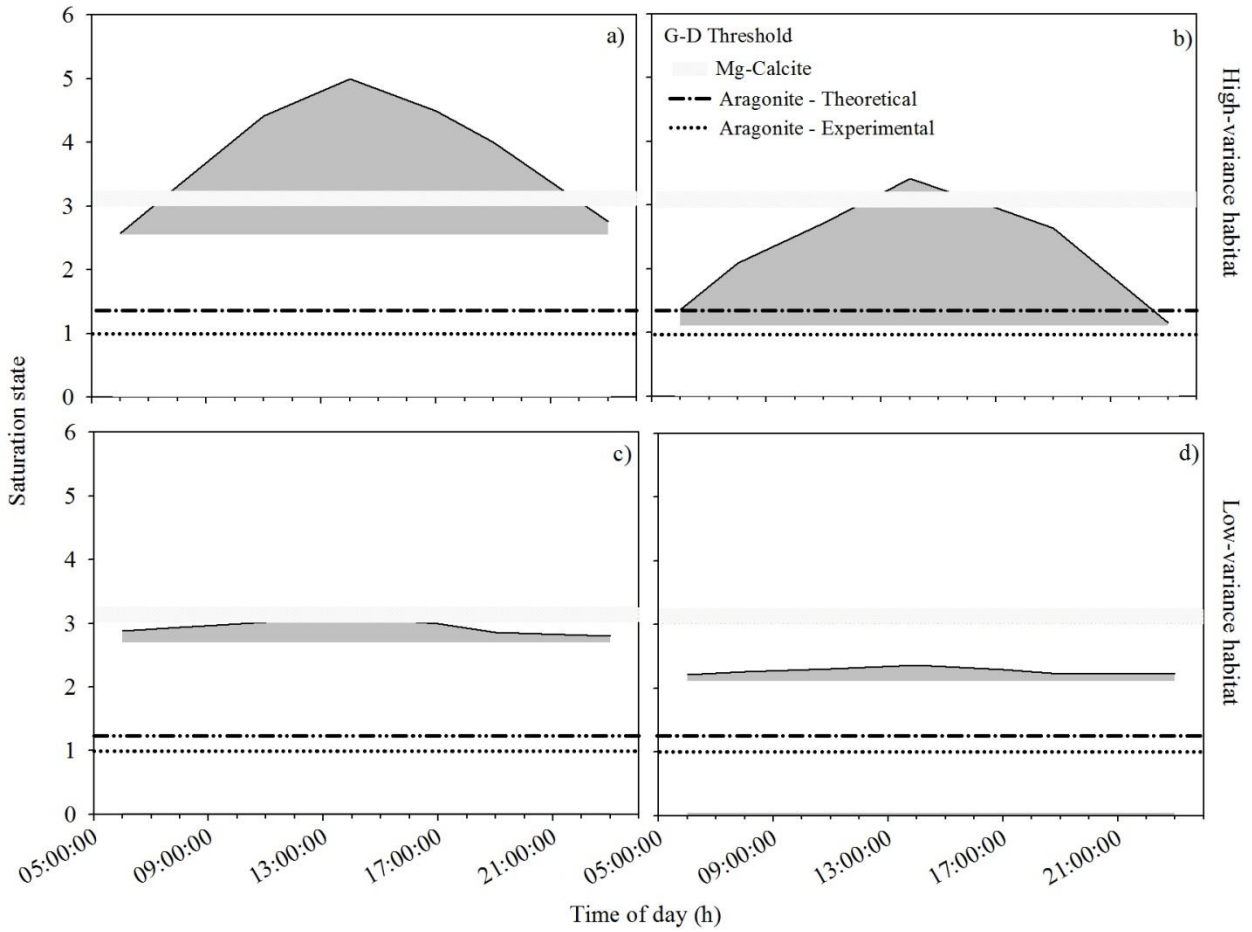


Figure S3| The time each habitat (outer-reef, low-variance and seagrass, high-variance) was exposed to a given saturation state. Data is averaged for each level of variability (high or low). a & c show current ambient seawater conditions, b & d show the effect a change of – 0.3 pH units and a 2.0 °C temperature increase has on the saturation states of each habitat as predicted under IPCC scenario A1B. Calcification-to-dissolution thresholds (G-D) are shown for Mg-calcite, aragonite theoretical (e.g. the calculated level of one) and experimental aragonite (levels experiments have measured the aragonite threshold to occur at).

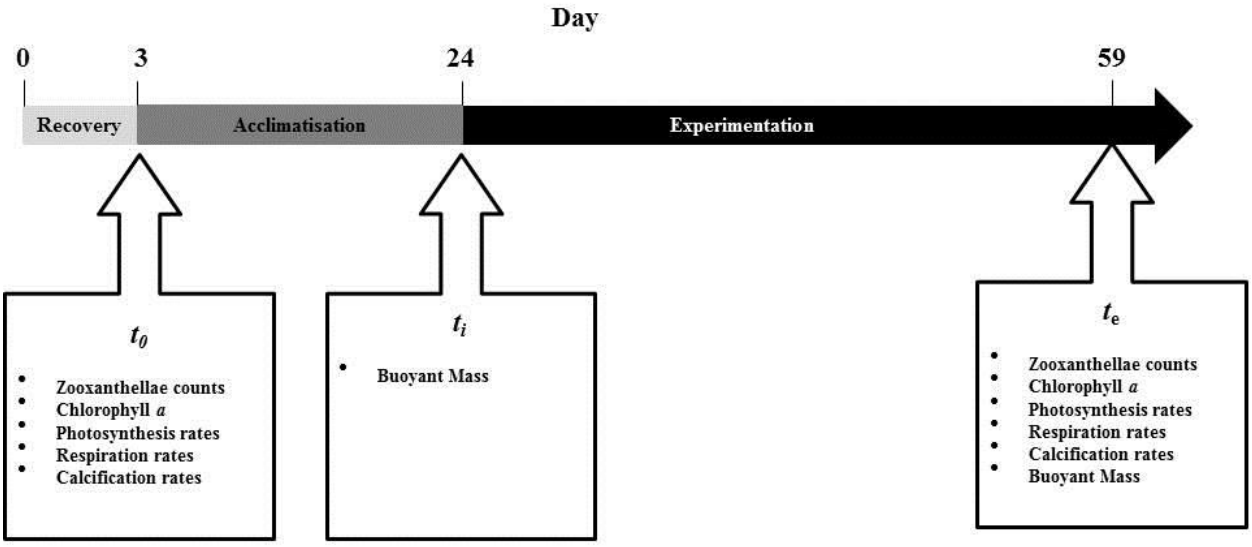


Figure S4| Sampling timeline demonstrating the experimental design and times of physiological measurements. Corals were removed from their native environment at day 0 and allowed to recover in the laboratory within tanks set to their ambient conditions for three days (Recovery period). At the end of the recovery period ($t_0$) a series of metabolic measurements were taken. Corals were then given a 21-day acclimatisation period to the *ex situ* treatment conditions. At the end of the acclimatisation period ($t_i$) buoyant mass was measured for each colony. The experimentation conditions were then run for 35-days. At the end of the experimentation period ($t_e$) the metabolic parameters measured at $t_0$ along with buoyant mass were re-measured.

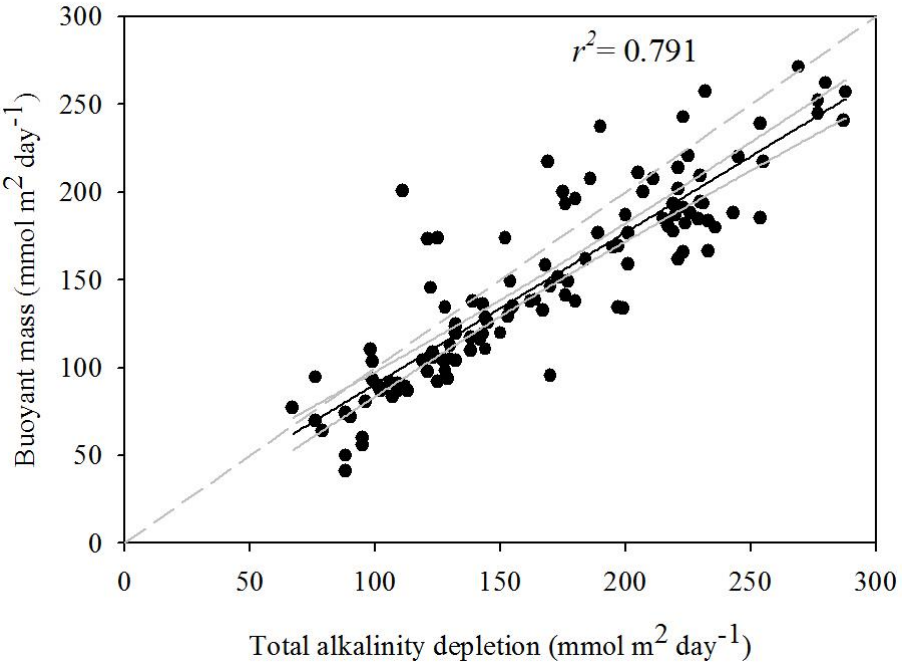


Figure S5| The relationship between growth rates based on the total alkalinity depletion and buoyant mass methods. Each point represents measurements from both methods on an individual coral fragment. Data is shown for the high-variance and low-variance treatments. The grey-dotted line illustrates a 1:1 ratio, the solid black line represents the best fit line (Buoyant Mass (mmol $m^{-2}$ $day^{-1}$) = 4.32 + 0.864 * Alkalinity depletion (mmol $m^{-2}$ $day^{-1}$), $r^2$= 0.791, $n$= 120, $p$< 0.001) and the grey-solid lines represent the 95% confidence internals. Rates were obtained from 8 x 3h incubations conducted over a 24h period at $t_0$ and $t_e$.

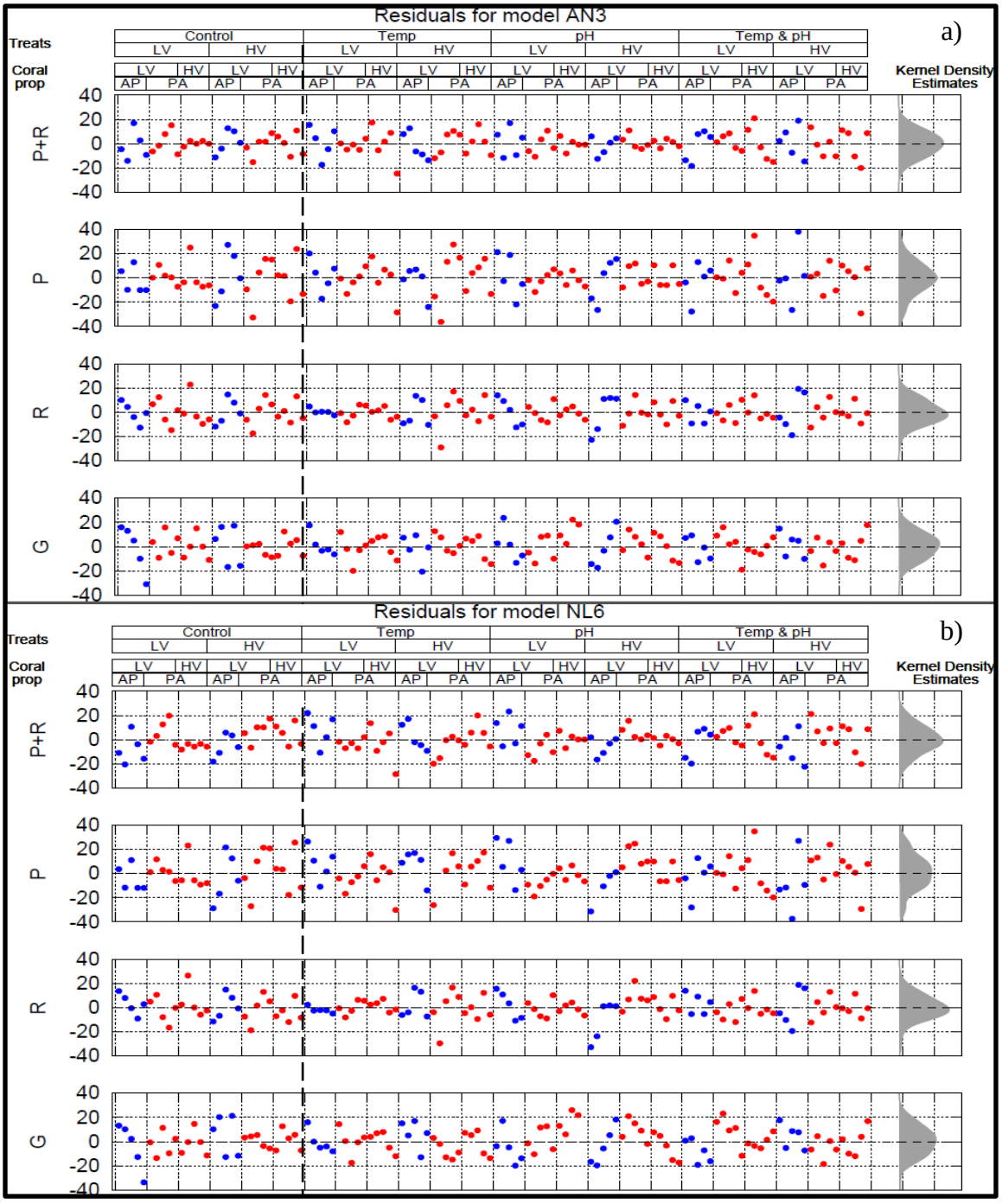


Figure S6| Residuals of models: a) AN3 and b) NL6, showing those for controls (left of the dashed line) and treatments (right of the dashed line.) The issue is whether residuals from the controls (left of the dashed line) are differently distributed from the treatments (right of dashed line). This was quantified by the Kolmogorov-Smirnoff test (table S6).

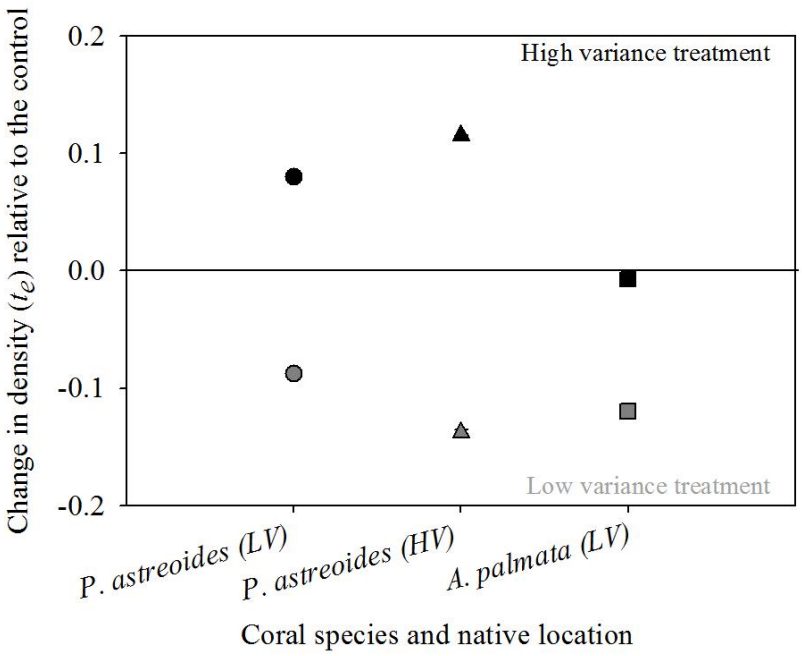


Figure S7| The changes in coral density over the experimental period. The average (± standard error) changes in density for each coral species, from each habitat (outer-reef, low-variance (LV), seagrass, high-variance (HV)) for both the HV and LV treatments, relative to the controls at the end of the experiment ($t_e$). Density was determined on a sub-sample of corals from each experimental treatment, ($n$= 3 per treatment, total $n$= 24) using a 3D scanning process following the protocol of [27].

**Electronic Supplementary Material- Statistical Analysis**

**Summary of models:**

**Saturating model: SAT**

This is a somewhat crude model that gives each experiment treatment a mean and assumes a common error. It corresponds to maximum number of variables that can be used to describe the results. It serves as an upper bound on model complexity.

**Linear models / ANOVA: AN1-3**

These models were validations against the R package. As the experiment was not fully factorial it was necessary to eliminate species-habitat interaction terms from the ANOVA. In R these were written as:

AN1: $v \sim 1 + s + h + v + T + pH$

AN2: $v \sim 1 + (s + h + v + T + pH)^2 - s:h$

AN3: $v \sim 1 + (s + h + v + T + pH)^3 - s:h:(1 + v + T + pH)$

**Non-linear models : NL1-6**

A set of nested non-linear models were fitted to the data (table S2). The form for each model was chosen from initial exploratory analyses that suggested the major effects were pH, temperature and species. The general form these non-linear models were:

$$V = V_0 \times \overbrace{\left[1 + a_s s + a_h h\right]}^{\text{Baseline}} \times \overbrace{\left[\begin{array}{l} 1 + T \left(b_T + b_{T,v} v + b_{T,h} h\right) \\ + pH \left(c_{pH} + c_{pH,v} v + c_{T,h} h\right) \\ + T \cdot pH \left(d_{T,pH} + d_{T,pH,v} v + d_{T,pH,h} h\right) \end{array}\right]}^{\text{Treatment effecs}} .$$

The general form of the model (NL6) was then simplified and alternative non-linear models derived by setting various coefficients to zero. The nested models NL1-6 are listed in table S2. The values of the coefficients were found by likelihood maximisation, which the case of normally distributed errors is equivalent to least squares fitting. 95% confidence intervals were calculated by the log-profile method. The linear models (ANOVA) and non-linear models were compared using their corrected Akaike Information Criteria (AICc).

**Motivation for model choice:**
There were concerns with interpretation of ANOVA since:

- The data structure was non-factorial, which might make results of the ANOVA unreliable.
- It was difficult to rationalise the behaviour of the terms in the linear model / ANOVA. For example, take the ANOVA series of models for photosynthesis in table S3.

In table S3 the following can be seen:

• In the 1st order ANOVA the habitat variable is significant and has a positive effect.

• At 2nd order the habitat is not significant and has changed sign. However, there is a significant habitat:temperature term and an almost significant habitat:pH term.

• The significant 2nd-order terms containing habitat become less significant at 3rd order.

• Some terms, especially the variability:pH term, change dramatically between 2nd-order and 3rd-order, suggesting that they may not have converged.

This makes it difficult to assess:

• Whether there is confounding or aliasing of the main effects with higher interactions;

• If there are artefacts arising from not having fully factorial data.

For these reasons a set of non-linear models were constructed. Usually non-linear models are used to build more complicated functional dependence in main effect. In this case we have built non-linearity into the interactions by assuming a multiplicative structure in the terms of the model. This allows sparseness to be enforced through model specification. The nonlinear models have significantly fewer terms (23 for 3rd order ANOVA vs 13 for NL6), yet comparable performance in terms of AICc scores – NL6 has a lower relative AIC for 4 out of the 5 observations (table S4). NL6 was used as it allows the role of habitat to be decomposed into multiple contributions; the differences in the 'baseline' condition, and whether habitat affects the response to temperature stress, pH stress and the combined stress of temperature and pH.

The nested models NL1-6 also allow the effect of each additional degree of flexibility to be introduced incrementally. It is reassuring to see the stability of parameters and that, for example, the baseline habitat parameter changes only when addition flexibility related to habitat is added. While perhaps not important in this case, in general there are multiple solutions for nonlinear models so it is prudent to use the optimised parameters from a simpler models as initial parameters for more complex models (table S5).

**Comparison of AN3 and NL6 models**

The parameters in the ANOVA/linear model can be compared to a non-linear model by performing a power series expansion (ie. expanding out the non-linear model and collecting the terms order-by-order). This is shown for AN3 and NL6 in table S6. The arrows highlight how the second order habitat terms come from multiple sources in NL6.

From table S6 it is can be seen that:

- The models are in general agreement, of particular interest are the habitat:temperature and habitat:pH terms.
- In the expansion of the NL6 model the habitat:temperature and habitat:pH terms primarily come from differences between the stress response due to habitat. This suggests that confounding/aliasing of main effects of habitat and pH/temp are unlikely to be a problem in ANOVA / linear models.

**In conclusion:**

The linear and non-linear models are broadly in agreement, with the non-linear models allowing some of the subtler points to be tested. Consistently across all the observations (P,R,G) habitat gave a small positive effect (<+4%) which in only a single case (photosynthesis) rose above the threshold for statistical significance. The small benefit of exposure to higher variability conditions is unable to offset the larger negative effects of temperature, pH and temperature:pH (ranging from -20 to -40%). Overall the influence of native habitat was therefore negligible.

**Testing for heteroskedasticy**

Concerns were raised about the heteroskedasticy of errors in the dependent variables as the variance in the independent variables was slightly higher in the future temperature and pH manipulations. We tested the analysis of residuals for model NL6 and AN3. Residuals were plotted and grouped into control and treatment. Kolmogorov–Smirnov tests were performed to verify that residuals for the control and treatment appear to come from the same distribution (table S7). The Bruesch-Pagan test was used on the ANOVA/linear models with no significant effects (except for respiration whose *p*-value 0.047). The non-linear model NL6 was extended to have two error terms (one error term for control, one temperature, and pH manipulations). Based on AIC difference, the increased complexity of an additional error term was not justified by better fitting the data (table S8). We therefore concluded there was no evidence of heteroskedasticy in this data set.

## Supplementary Tables

Table S1| Physio-chemical tank and *in situ* conditions.

| Physio-chemical variable | *In situ* | | High-variance (HV) | | | | Low-variance (LV) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HV | LV | Control | Temp. | pH | Temp. & pH | Control | Temp. | pH | Temp. & pH |
| pH (total scale) | 8.154 ± 0.1 | 8.121 ± 0.1 | 8.148 ± 0.2 | 8.145 ± 0.2 | 7.809 ± 0.2 | 7.817 ± 0.3 | 8.115 ± 0.1 | 8.119 ± 0.1 | 7.827 ± 0.2 | 7.841 ± 0.3 |
| Temperature (°C) | 28.0 ± 0.3 | 27.4 ± 0.1 | 27.7 ± 0.2 | 30.1 ± 0.2 | 27.9 ± 0.3 | 30.3 ± 0.3 | 27.6 ± 0.3 | 29.6 ± 0.2 | 27.8 ± 0.4 | 29.5 ± 0.3 |
| Aragonite saturation state | 4.0 ± 0.1 | 3.0 ± 0.1 | 3.8 ± 0.1 | 3.9 ± 0.1 | 2.2 ± 0.1 | 2.4 ± 0.2 | 2.9 ± 0.1 | 2.8 ± 0.2 | 2.2 ± 0.2 | 2.1 ± 0.2 |
| $pCO_2$ (µatm) | 280 ± 8.9 | 310 ± 12.1 | 290 ± 9.6 | 297 ± 13.2 | 700 ± 18.9 | 719 ± 14.1 | 311 ± 6.5 | 303 ± 8.0 | 740 ± 23.1 | 722 ± 16.6 |
| Total Alkalinity (µmol Kg/SW) | 2280.7 ± 0.2 | 2250.9 ± 0.1 | 2255.3 ± 0.4 | 2295.3 ± 0.2 | 2265.6 ± 0.3 | 2245.4 ± 0.3 | 2228.9 ± 0.2 | 2226.0 ± 0.1 | 2243.7 ± 0.3 | 2209.0 ± 0.4 |
| Salinity (ppm) | 35.5 ± 0.2 | 35.1 ± 0.1 | 35.2 ± 0.3 | 35.3 ± 0.2 | 35.2 ± 0.1 | 35.1 ± 0.1 | 35.0 ± 0.2 | 35.1 ± 0.2 | 35.2 ± 0.1 | 35.0 ± 0.1 |
| Light (µmol photons $m^{-2}$ $s^{-1}$) | 406.5 ± 46.9 | 458.8 ± 28.7 | 435.2 ± 30.1 | 440.7 ± 25.9 | 450.3 ± 15.0 | 463.2 ± 35.0 | 445.1 ± 18.1 | 463.9 ± 15.2 | 470.1 ± 30.8 | 450.8 ± 26.1 |
| Nitrates (µM) | 0.85 ± 0.1 | 1.10 ± 0.1 | 0.95 ± 0.1 | 0.90 ± 0.1 | 0.92 ± 0.1 | 0.90 ± 0.1 | 1.04 ± 0.1 | 0.99 ± 0.1 | 1.05 ± 0.1 | 1.01 ± 0.1 |

*In situ* discrete water samples were taken weekly over the study duration ($n$= 8) to obtain all of the physio-chemical conditions. Temperature, salinity, pH, and total alkalinity experimental conditions were determined from discrete water samples collected at the start of every water exchange ($n$= 531). Total alkalinity and pH were used with temperature and salinity to calculate $pCO_2$ and aragonite saturation state ($n$= 531). Light and nitrates were measured daily within each experimental treatment ($n$= 59).

Table S2| The parameters included in the non-linear models (NL1-NL6)

| | NL1 | NL2 | NL3 | NL4 | NL5 | NL6 |
|---|---|---|---|---|---|---|
| $V_0$ | • | • | • | • | • | • |
| $a_s$ | • | • | • | • | • | • |
| $a_h$ | • | • | • | • | • | • |
| $b_T$ | • | • | • | • | • | • |
| $b_{T,v}$ | | | • | • | • | • |
| $b_{T,h}$ | | | | | • | • |
| $c_{pH}$ | • | • | • | • | • | • |
| $c_{pH,v}$ | | | • | • | • | • |
| $c_{pH,h}$ | | | | | • | • |
| $d_{pH,T}$ | | • | • | • | • | • |
| $d_{pH,T,v}$ | | | | • | • | • |
| $d_{pH,T,h}$ | | | | | | • |

Model parameters for the first six non-linear models. The parameters included were: species (s), habitat (h), experimental treatment variability (v), temperature (t) and pH (pH).

Table S3| Point estimates for the parameters in the ANOVA, linear models.

| | AN1 | | AN2 | | AN3 | |
|---|---|---|---|---|---|---|
| (Intercept) | 322.6 | *** | 298.3 | *** | 297.1 | *** |
| Species | 17.9 | *** | 21.0 | *** | 23.1 | *** |
| Habitat | 6.7 | * | -1.7 | | -2.8 | |
| Variance | -1.5 | | -4.1 | | -0.1 | |
| Temperature | -16.3 | ** | 28.9 | *** | 31.0 | *** |
| pH | -97.4 | *** | -52.8 | *** | -50.7 | *** |
| species:variance | | | 3.7 | * | 2.1 | |
| species:temp | | | -5.7 | | -9.8 | * |
| species:pH | | | -0.6 | | -4.7 | |
| habitat:varince | | | -1.3 | | -0.2 | |
| habitat:temp | | | 6.6 | . | 8.9 | . |
| habitat:pH | | | 10.2 | ** | 12.5 | * |
| variance:temp | | | 15.9 | *** | 12.0 | ** |
| variance:pH | | | -14.2 | *** | -24.6 | *** |
| temp:pH | | | -82.1 | *** | -86.4 | *** |
| species:variance:temp | | | | | -4.2 | |
| spcecies:variance:pH | | | | | 7.4 | * |
| spcecies:temp:pH | | | | | 8.3 | |
| habitat:variance:temp | | | | | 2.9 | |
| habitat:variance:pH | | | | | -5.0 | |
| habitat:temp:pH | | | | | -4.2 | |
| variance:temp:pH | | | | | 12.6 | * |
| Studentized Bruesch-Pagan *p*-value | 0.3 | | 0.3 | | 0.2 | |

Terms relating to the habitat variable are highlighted in bold. (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$)

Table S4| Comparison of the corrected Akaike Information Criteria (AICc) for all models.

| | | Photosynthesis (G) | | Respiration | | Photosynthesis (N) | | Calcification | |
|---|---|---|---|---|---|---|---|---|---|
| Model | K | AICc | AICc rel | AICc | AICc rel | AICc | AICc rel | AICc | AICc rel |
| NL1 | 6 | 1144.6 | 209.9 | 915.5 | 0.7 | 1160.0 | 136.1 | 994.6 | 29.1 |
| NL2 | 7 | 1026.0 | 91.3 | 916.5 | 1.7 | 1079.0 | 55.1 | 994.8 | 29.3 |
| AN1 | 7 | 1141.1 | 206.4 | 914.8 | 0.0 | 1156.6 | 132.7 | 1009.4 | 43.9 |
| NL3 | 9 | 987.1 | 52.5 | 918.1 | 3.4 | 1046.4 | 22.5 | 986.7 | 21.2 |
| NL4 | 10 | 988.4 | 53.7 | 915.9 | 1.2 | 1044.5 | 20.6 | 984.4 | 18.9 |
| NL5 | 12 | 939.8 | 5.1 | 917.6 | 2.9 | 1023.9 | 0.0 | 965.5 | 0.0 |
| NL6 | 13 | 939.0 | 4.3 | 916.4 | 1.6 | 1026.4 | 2.5 | 968.0 | 2.5 |
| AN2 | 16 | 946.3 | 11.6 | 924.1 | 9.3 | 1023.9 | 0.0 | 973.0 | 7.5 |
| AN3 | 23 | 934.7 | 0.0 | 930.2 | 15.5 | 1029.3 | 5.4 | 979.6 | 14.1 |
| SAT | 25 | 938.9 | 4.2 | 936.3 | 21.5 | 1034.0 | 10.1 | 983.1 | 17.6 |

Non-linear (NL) models 1-6 and Analysis of Variance (ANOVA) 2-3 were compared using their AICc with decreasing number of interaction terms (k) for the parameters: Respiration, Photosynthesis (Net and Gross) and Calcification. AICc rel. is the difference in AICc relative to best performing model (lowest AICc score). NL6 was used as it allows the role of habitat to be decomposed into multiple contributions; the differences in the 'baseline' condition, and whether habitat affects the response to temperature stress, pH stress and the combined stress of temperature and pH.

Table S5| Point estimates for the variables in the non-linear models.

| | | NL1 | NL2 | NL3 | NL4 | NL5 | NL6 |
|---|---|---|---|---|---|---|---|
| Baseline | Intercept | 321.1 | 301.2 | 301.4 | 301.4 | 299 | 299.1 |
| | Species | 0.066 | 0.065 | 0.064 | 0.064 | 0.066 | 0.065 |
| | Habitat | 0.021 | 0.021 | 0.021 | 0.021 | -0.005 | -0.004 |
| Temp | Temperature | -0.050 | 0.080 | 0.080 | 0.080 | 0.084 | 0.083 |
| | Temperature:Variance | | | 0.047 | 0.034 | 0.034 | 0.034 |
| | Temperature:Habitat | | | | | 0.014 | 0.012 |
| pH | pH | -0.296 | -0.183 | -0.183 | -0.183 | -0.172 | -0.173 |
| | pH: Variance | | | -0.050 | -0.063 | -0.063 | -0.063 |
| | pH:Habitat | | | | | 0.040 | 0.038 |
| Temp & pH | Temperature& pH | | -0.266 | -0.266 | -0.266 | -0.266 | -0.265 |
| | Temperature& pH:Variance | | | | 0.037 | 0.037 | 0.037 |
| | Temperature& pH:Habitat | | | | | | 0.005 |

Table S6| Comparison between the parameters of the AN3 model and NL6 model by power expansion of NL6.

| | AN3 | | | NL6 expanded |
|---|---|---|---|---|
| | Linear Variable | Est | *sig* | Est |
| 1st order | (Intercept) | 297.2 | *** | 299.1 |
| | Species (spe) | 23.1 | *** | 19.4 |
| | Habitat (hab) | -2.9 | | -1.2 |
| | Variance (var) | -0.1 | | NA |
| | Temp | 31.0 | *** | 24.8 |
| | pH | -50.7 | *** | -51.7 |
| 2nd order | spe:var | 2.1 | | |
| | spe:temp | -9.8 | * | 1.6 |
| | spe:pH | -4.7 | | -3.4 |
| | hab:var | -0.2 | | NA |
| | hab:temp | 8.9 | . | 10.1 |
| | Hab:pH | 12.5 | * | 11.6 |
| | var:temp | 12.0 | ** | 10.2 |
| | var:pH | -24.6 | *** | -18.8 |
| | temp:pH | -86.4 | *** | -83.6 |
| 3rd order | spe:var:temp | -4.2 | | 0.7 |
| | spe:var:pH | 7.4 | * | -1.2 |
| | spe:temp:pH | 8.3 | | -5.4 |
| | hab:var:temp | 2.9 | | -0.1 |
| | hab:var:pH | -5.0 | | 0.1 |
| | hab:temp:pH | -4.2 | | 1.8 |
| | var:temp:pH | 12.6 | * | 11.1 |

| NL6 Non-linear model | | | | |
|---|---|---|---|---|
| *sig* | | Variable | | |
| 299.1 | *** | | V0 | baseline |
| 6.5 | *** | Spe | a | |
| -0.4 | | Hab | | |
| 8.3 | *** | Temp | b | Temp effect |
| 3.4 | *** | Temp:var | | |
| 1.2 | | Temp:hab | | |
| -17.3 | *** | pH | c | pH effect |
| -6.3 | *** | pH:var | | |
| 3.8 | ** | pH:hab | | |
| -26.5 | *** | Temp:pH | d | Temp & pH |
| 3. 7 | * | T:pH:var | | |
| 0.5 | | Temp:pH:hab | | |

The parameters in the ANOVA/linear model can be compared to a non-linear model by performing a power series expansion (ie. expanding out the non-linear model and collecting the terms order-by-order). This is shown for AN3 and NL6 in table S5. The arrows highlight how the second order habitat terms come from multiple sources in NL6

Table S7| Kolmogorov-Smirnov tests of whether the residuals in the control and treatments appear to come from different distributions.

| | Kolmogorov-Smirnov | | Bruesh-Pagan |
|---|---|---|---|
| | *p*-values (two sided) | | *p*-value |
| | NL6 | AN3 | AN3 |
| Photosynthesis (P) | 0.74 | 0.74 | 0.22 |
| Respiration (R) | 0.65 | 0.82 | 0.05 |
| P&R | 0.27 | 0.82 | 0.06 |
| Calcification | 0.94 | 0.89 | 0.14 |

Table S8| Comparison between the NL6 model with a single error term and NL6 with two error terms (one for control, one for treatment).

| | | AICc | sigma | |
|---|---|---|---|---|
| | | | control | treatment |
| Photosynthesis | one error | 299.09 | | 15.41 |
| | two error | 298.96 | 14.26 | 15.78 |
| Respiration | one error | 150.97 | | 9.74 |
| | two error | 150.96 | 9.99 | 9.66 |
| PR | one error | 148.79 | | 10.71 |
| | two error | 148.64 | 10.24 | 10.86 |
| Calcification | one error | 248.58 | | 12.08 |
| | two error | 248.59 | 11.70 | 12.21 |

Table S9| Physio-chemical tank and *in situ* conditions.

| Physio-chemical variable | *In situ* | | High-variance (HV) | | | | Low-variance (LV) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HV | LV | Control | Temp. | pH | Temp. & pH | Control | Temp. | pH | Temp. & pH |
| pH (total scale) | 8.154 ± 0.1 | 8.121 ± 0.1 | 8.148 ± 0.2 | 8.145 ± 0.2 | 7.809 ± 0.2 | 7.817 ± 0.3 | 8.115 ± 0.1 | 8.119 ± 0.1 | 7.827 ± 0.2 | 7.841 ± 0.3 |
| Temperature (°C) | 28.0 ± 0.3 | 27.4 ± 0.1 | 27.7 ± 0.2 | 30.1 ± 0.2 | 27.9 ± 0.3 | 30.3 ± 0.3 | 27.6 ± 0.3 | 29.6 ± 0.2 | 27.8 ± 0.4 | 29.5 ± 0.3 |
| Aragonite saturation state | 4.0 ± 0.1 | 3.0 ± 0.1 | 3.8 ± 0.1 | 3.9 ± 0.1 | 2.2 ± 0.1 | 2.4 ± 0.2 | 2.9 ± 0.1 | 2.8 ± 0.2 | 2.2 ± 0.2 | 2.1 ± 0.2 |
| $pCO_2$ (µatm) | 280 ± 8.9 | 310 ± 12.1 | 290 ± 9.6 | 297 ± 13.2 | 700 ± 18.9 | 719 ± 14.1 | 311 ± 6.5 | 303 ± 8.0 | 740 ± 23.1 | 722 ± 16.6 |
| Total Alkalinity (µmol Kg/SW) | 2280.7 ± 0.2 | 2250.9 ± 0.1 | 2255.3 ± 0.4 | 2295.3 ± 0.2 | 2265.6 ± 0.3 | 2245.4 ± 0.3 | 2228.9 ± 0.2 | 2226.0 ± 0.1 | 2243.7 ± 0.3 | 2209.0 ± 0.4 |
| Salinity (ppm) | 35.5 ± 0.2 | 35.1 ± 0.1 | 35.2 ± 0.3 | 35.3 ± 0.2 | 35.2 ± 0.1 | 35.1 ± 0.1 | 35.0 ± 0.2 | 35.1 ± 0.2 | 35.2 ± 0.1 | 35.0 ± 0.1 |
| Light (µmol photons $m^{-2}$ $s^{-1}$) | 406.5 ± 46.9 | 458.8 ± 28.7 | 435.2 ± 30.1 | 440.7 ± 25.9 | 450.3 ± 15.0 | 463.2 ± 35.0 | 445.1 ± 18.1 | 463.9 ± 15.2 | 470.1 ± 30.8 | 450.8 ± 26.1 |
| Nitrates (µM) | 0.85 ± 0.1 | 1.10 ± 0.1 | 0.95 ± 0.1 | 0.90 ± 0.1 | 0.92 ± 0.1 | 0.90 ± 0.1 | 1.04 ± 0.1 | 0.99 ± 0.1 | 1.05 ± 0.1 | 1.01 ± 0.1 |

*In situ* discrete water samples were taken weekly over the study duration ($n$= 8) to obtain all of the physio-chemical conditions. Temperature, salinity, pH, and total alkalinity experimental conditions were determined from discrete water samples collected at the start of every water exchange ($n$= 531). Total alkalinity and pH were used with temperature and salinity to calculate $pCO_2$ and aragonite saturation state ($n$= 531). Light and nitrates were measured daily within each experimental treatment ($n$= 59).

Table S9| Raw data measurements before experimental manipulation ($t_0$) and at the end ($t_e$) of the experimental period for the corals *Acropora palmata* and *Porites astreodies* from a high-variance (HV) seagrass habitat and a low-variance (LV) outer-reef location on Little Cayman, Cayman Islands, BWI. Measurements include: daily net photosynthesis ($P_N$), daily respiration (R), daily calcification (G), and growth rates. Note: buoyant mass rates were calculated from the end of the acclimatization period ($t_i$) to $t_e$.

| Variability | Treatment | Species | $P_N$ (mmol $m^{-2}$ $d^{-1}$) | | R (mmol $m^{-2}$ $d^{-1}$) | | G (mmol $m^{-2}$ $d^{-1}$) | | Zooxanthellae density (cells/$cm^{-2}$) | | Chlorophyll a (μg $cm^{-2}$) | | Buoyant Mass (mg $d^{-1}$ $g^{-1}$coral) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | Rate ($t_i$ to $t_e$) |
| High | Control | *A.palmata LV* | 132.0 ± 1.7 | 138.3 ± 0.3 | 142.1 ± 2.1 | 139.5 ± 3.3 | 274.1 ± 1.3 | 272.2 ± 2.1 | $1.1 \times 10^6 \pm 3.1 \times 10^4$ | $1.2 \times 10^6 \pm 3.4 \times 10^4$ | 14.2 ± 2.1 | 15.0 ± 3.2 | 6.08 ± 1.2 |
| | | *P.astreoides HV* | 157.2 ± 0.6 | 161.2 ± 1.7 | 165.2 ± 1.9 | 159.1 ± 1.7 | 226.1 ± 1.6 | 231.6 ± 2.6 | $2.0 \times 10^6 \pm 7.5 \times 10^4$ | $2.2 \times 10^6 \pm 6.3 \times 10^4$ | 12.4 ± 1.8 | 12.0 ± 1.5 | 3.93 ± 2.1 |
| | | *P.astreoides LV* | 162.1 ± 2.2 | 157.8 ± 2.8 | 169.9 ± 3.1 | 163.8 ± 2.5 | 230.1 ± 1.0 | 221.4 ± 7.7 | $1.3 \times 10^6 \pm 3.8 \times 10^4$ | $1.2 \times 10^6 \pm 1.9 \times 10^4$ | 13.1 ± 2.0 | 13.6 ± 4.0 | 3.60 ± 2.1 |
| | Temperature | *A.palmata LV* | 129.9 ± 3.2 | 173.7 ± 1.2 | 140.7 ± 3.2 | 138.1 ± 5.1 | 280.1 ± 0.7 | 227.3 ± 0.9 | $1.9 \times 10^6 \pm 7.5 \times 10^5$ | $5.1 \times 10^5 \pm 5.0 \times 10^4$ | 13.9 ± 2.2 | 7.5 ± 0.9 | 4.71 ± 0.8 |
| | | *P.astreoides HV* | 142.1 ± 2.2 | 193.8 ± 2.8 | 150.1 ± 0.8 | 159.1 ± 3.7 | 231.9 ± 0.6 | 189.3 ± 1.1 | $1.9 \times 10^6 \pm 2.9 \times 10^4$ | $2.0 \times 10^6 \pm 3.2 \times 10^4$ | 12.8 ± 1.4 | 11.4 ± 2.0 | 2.71 ± 2.3 |
| | | *P.astreoides LV* | 160.4 ± 2.1 | 179.3 ± 4.9 | 152.1 ± 5.9 | 160.9 ± 7.9 | 223.1 ± 0.2 | 169.5 ± 1.3 | $1.1 \times 10^6 \pm 3.8 \times 10^4$ | $9.9 \times 10^5 \pm 2.1 \times 10^4$ | 12.9 ± 2.7 | 13.0 ± 1.6 | 2.22 ± 3.2 |
| | pH | *A.palmata LV* | 127.8 ± 1.9 | 72.1 ± 2.2 | 137.2 ± 2.6 | 130.9 ± 3.6 | 277.3 ± 1.7 | 185.4 ± 2.7 | $1.9 \times 10^6 \pm 9.8 \times 10^4$ | $7.7 \times 10^5 \pm 4.9 \times 10^4$ | 15.2 ± 3.1 | 12.8 ± 1.9 | 3.58 ± 1.1 |
| | | *P.astreoides HV* | 155.1 ± 3.8 | 100.1 ± 1.7 | 155.6 ± 0.7 | 160.6 ± 3.7 | 233.1 ± 0.2 | 140.6 ± 2.7 | $2.1 \times 10^6 \pm 3.5 \times 10^4$ | $2.2 \times 10^6 \pm 6.0 \times 10^4$ | 12.2 ± 2.9 | 11.0 1.6 | 2.38 1.7 |
| | | *P.astreoides LV* | 162.9 ± 0.5 | 188.5 ± 2.3 | 151.1 ± 0.3 | 162.7 ± 4.1 | 228.1 ± 4.3 | 138.2 ± 3.1 | $1.1 \times 10^6 \pm 5.6 \times 10^5$ | $9.9 \times 10^5 \pm 2.3 \times 10^4$ | 13.1 ± 1.4 | 12.7 ± 1.1 | 1.85 ± 09 |
| | Temperature & pH | *A.palmata LV* | 139.2 ± 2.4 | 28.1 ± 2.8 | 139.1 ± 0.9 | 138.5 ± 4.4 | 265.9 ± 6.4 | 118.6 ± 2.0 | $2.0 \times 10^6 \pm 1.0\ 10^5$ | $3.7 \times 10^5 \pm 4.8\ 10^4$ | 14.0 ± 2.3 | 5.3 ± 1.9 | 2.56 ± 2.0 |
| | | *P.astreoides HV* | 141.2 ± 6.4 | 68.8 ± 4.1 | 151.6 ± 1.1 | 158.6 ± 3.3 | 225.5 ± 0.2 | 122.2 ± 0.2 | $1.0 \pm \times 10^6 \pm 4.6 \times 10^5$ | $1.1 \times 10^6 \pm 5.3 \times 10^4$ | 13.8 ± 2.8 | 11.3 ± 2.6 | 1.78 ± 1.1 |
| | | *P.astreoides LV* | 146.2 ± 1.9 | 42.1 ± 3.1 | 158.3 ± 5.5 | 164.9 ± 4.2 | 225.1 ± 2.4 | 115.3 ± 6.9 | $1.1 \times 10^6 \pm 6.8 \times 10^4$ | $9.9 \times 10^5 \pm 3.6 \times 10^4$ | 12.7 ± 0.9 | 12.1 ± 3.1 | 1.76 ± 0.6 |

| Variability | Treatment | Species | $P_N$ (mmol $m^{-2}$ $d^{-1}$) | | R (mmol $m^{-2}$ $d^{-1}$) | | G (mmol $m^{-2}$ $d^{-1}$) | | Zooxanthellae density (cells/$cm^{-2}$) | | Chlorophyll a (µg $cm^{-2}$) | | Buoyant Mass (mg $d^{-1}$ $g^{-1}$coral) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | $t_0$ | $t_e$ | Rate ($t_i$ to $t_e$) |
| Low | Control | *A.palmata LV* | 129.2 ± 1.1 | 134.8 ± 1.9 | 135.1 ± 0.6 | 141.7 ± 1.9 | 272.0 ± 0.9 | 269.6 ± 1.7 | $2.0 \times 10^6 \pm 7.7 \times 10^5$ | $1.9 \times 10^6 \pm 7.3 \times 10^4$ | 14.6 ± 2.7 | 12.2 ± 1.2 | 6.21 ± 1.1 |
| | | *P.astreoides HV* | 143.9 ± 2.1 | 149.3 ± 2.7 | 170.3 ± 1.3 | 167.3 ± 4.7 | 231.0 ± 3.6 | 229.0 ± 5.9 | $1.1 \times 10^6 \pm 5.6 \times 10^5$ | $1.1 \times 10^6 \pm 6.2 \times 10^4$ | 12.1 ± 2.1 | 10.2 ± 1.2 | 3.74 ± 2.1 |
| | | *P.astreoides LV* | 160.1 ± 2.4 | 158.8 ± 4.9 | 160.1 ± 0.3 | 163.2 ± 1.8 | 221.1 ± 6.1 | 218.6 ± 0.9 | $1.2 \times 10^6 \pm 3.5 \times 10^5$ | $1.2 \times 10^6 \pm 2.6 \times 10^4$ | 11.8 ± 2.0 | 14.5 ± 1.8 | 3.46 ± 2.1 |
| | Temperature | *A.palmata LV* | 133.8 ± 2.1 | 164.5 ± 4.5 | 134.2 ± 0.9 | 135.0 ± 1.7 | 225.1 ± 0.4 | 203.8 ± 1.3 | $1.8 \times 10^6 \pm 9.0 \times 10^4$ | $9.1 \times 10^5 \pm 4.9 \times 10^4$ | 14.4 ± 1.6 | 7.9 ± 1.1 | 4.88 ± 1.1 |
| | | *P.astreoides HV* | 149.3 ± 2.4 | 170.6 ± 6.2 | 167.7 ± 7.8 | 163.5 ± 2.0 | 272.0 ± 0.9 | 183.0 ± 1.4 | $1.1 \times 10^6 \pm 1.9 \times 10^4$ | $1.0 \times 10^6 \pm 3.3 \times 10^4$ | 11.3 ± 2.1 | 9.8 ± 2.6 | 2.64 ± 1.2 |
| | | *P.astreoides LV* | 140.1 ± 0.1 | 163.9 ± 2.2 | 171.9 ± 1.6 | 163 ± 2.7 | 231.0 ± 0.6 | 168.8 ± 1.1 | $1.3 \times 10^6 \pm 8.7 \times 10^4$ | $1.0 \times 10^6 \pm 3.0 \times 10^5$ | 11.9 ± 2.9 | 13.0 ± 2.1 | 2.07 2.2 |
| | pH | *A.palmata LV* | 163.9 ± 1.5 | 111.8 ± 3.4 | 144.3 ± 2.9 | 137.8 ± 5.2 | 221.0 ± 1.6 | 152.9 ± 8.7 | $1.5 \times 10^6 \pm 1.0 \times 10^5$ | $1.3 \times 10^6 \pm 3.7 \times 10^4$ | 15.0 ± 2.1 | 9.4 ± 3.4 | 3.53 ± 1.3 |
| | | *P.astreoides HV* | 147.3 ± 3.1 | 125.3 ± 1.1 | 168.1 ± 4.1 | 168.8 ± 3.9 | 270.0 ± 1.2 | 159.0 ± 1.7 | $1.0 \times 10^6 \pm 2.1 \times 10^5$ | $1.2 \times 10^6 \pm 3.4 \times 10^4$ | 11.9 ± 2.8 | 10.1 ± 1.6 | 2.5 ± 1.2 |
| | | *P.astreoides LV* | 139.9 ± 3.4 | 103.2 ± 5.5 | 152.3 ± 7.5 | 139.5 ± 3.5 | 235.0 ± 6.1 | 133.1 ± 3.9 | $1.5 \times 10^6 \pm 6.7 \times 10^5$ | $1.3 \times 10^6 \pm 1.6 \times 10^5$ | 13.2 ± 1.2 | 14.4 ± 3.2 | 2.06 ± 1.1 |
| | Temperature & pH | *A.palmata LV* | 137.9 ± 3.4 | 21.6 ± 2.2 | 144.7 ± 2.6 | 139.5 ± 3.8 | 229.6 ± 6.3 | 87.4 ± 7.9 | $2.3 \times 10^6 \pm 9.0 \times 10^4$ | $6.8 \times 10^5 \pm 4.6 \times 10^4$ | 14.2 ± 1.4 | 6.0 ± 1.5 | 2.4 ± 0.9 |
| | | *P.astreoides HV* | 153.1 ± 2.8 | 63.4 ± 2.1 | 162.1 ± 6.7 | 164.8 ± 3.5 | 275.0 ± 3.1 | 76.4 ± 2.9 | $1.4 \times 10^6 \pm 9.9 \times 10^4$ | $1.5 \times 10^6 \pm 2.6 \times 10^5$ | 10.1 ± 1.0 | 9.7 ± 2.3 | 2.09 ± 1.3 |
| | | *P.astreoides LV* | 146.2 ± 2.1 | 28.8 ± 2.9 | 150.3 ± 1.9 | 158.9 ± 3.7 | 230.0 ± 2.1 | 87.9 ± 1.6 | $1.1 \times 10^6 \pm 6.0 \times 10^5$ | $1.0 \times 10^6 \pm 1.2 \times 10^4$ | 13.3 ± 1.6 | 12.7 ± 0.7 | 1.61 ± 1.6 |