Appendix E: MAR model parameter estimates, full sensitivities for cover analysis, and sensitivities of variance of quasi-stationary distribution.

Tables E1 and E2 provide parameter estimates and robust bootstrap standard errors for the MAR parameters of the cover and taxonomic analysis, respectively. Parameter notation follows the detailed presentation in appendix A.

Table E1. Parameter estimates ± robust bootstrap standard errors for the cover analysis.

Parameter	Tektite	Yawzi Point	RS
a_1	0.65 ± 0.16	0.00 ± 0.25	-0.89 ± 0.50†
a_2	-0.52 ± 0.15	-0.85 ± 0.38	-1.42 ± 0.45†
b_{11}	0.25 ± 0.30	0.60 ± 0.19	0.34 ± 0.13
b_{12}	0.21 ± 0.29	0.22 ± 0.31	-0.01 ± 0.12
b_{21}	0.30 ± 0.36	-0.02 ± 0.20	-0.01 ± 0.19
b_{22}	0.43 ± 0.31	0.04 ± 0.30	0.19 ± 0.17
c_{11}	-0.08 ± 0.11	-0.23 ± 0.09	-0.03 ± 0.15
c_{12}	-0.34 ± 0.09	-0.23 ± 0.15	-0.38 ± 0.14
c_{21}	0.08 ± 0.13	0.15 ± 0.10	-0.09 ± 0.17
c_{22}	0.22 ± 0.10	0.01 ± 0.17	0.25 ± 0.16
z_1	-0.050 ± 0.019	-0.024 ± 0.024	-0.011 ± 0.016
z_2	0.035 ± 0.017	-0.020 ± 0.041	0.011 ± 0.015
σ^2_{11}	0.053 ± 0.015	0.037 ± 0.008	0.195 ± 0.043

σ^2_{12}	-0.026 ± 0.008	-0.043 ± 0.012	-0.110 ± 0.032
σ^2_{22}	0.041 ± 0.010	0.103 ± 0.034	0.152 ± 0.034

†average of site-specific values

Table E2. Parameter estimates ± robust bootstrap standard errors for the taxonomic analysis.

Parameter†	Estimate ± rbse
a_1	-1.61 ± 0.29‡
a_2	-2.78 ± 0.33‡
a_3	-2.78 ± 0.32‡
a_4	-0.98 ± 0.16‡
a_5	-0.75 ± 0.11‡
a_6	-0.68 ± 0.10‡
b_{11}	0.19 ± 0.10
b_{22}	-0.08 ± 0.12
b_{33}	-0.09 ± 0.11
b_{44}	-0.09 ± 0.10
b_{55}	-0.15 ± 0.12
b_{66}	-0.06 ± 0.10
c_{11}	-0.45 ± 0.19
c_{12}	-0.93 ± 0.21
c_{21}	0.09 ± 0.18

c_{22}	0.26 ± 0.18
c_{31}	0.07 ± 0.07
c_{32}	0.11 ± 0.11
c_{41}	-0.27 ± 0.22
c_{42}	-0.04 ± 0.25
c_{51}	-0.08 ± 0.21
c_{52}	-0.03 ± 0.21
c_{61}	-0.05 ± 0.08
c_{62}	0.08 ± 0.13
z_1	-0.023 ± 0.019‡
z_2	0.073 ± 0.023‡
z_3	0.016 ± 0.018‡
z_4	0.008 ± 0.018‡
z_5	0.081 ± 0.011‡
z_6	0.003 ± 0.011‡
σ^2_{11}	0.718 ± 0.101
σ^2_{12}	0.053 ± 0.066
σ^2_{13}	0.013 ± 0.068
σ^2_{14}	0.066 ± 0.064
σ^2_{15}	0.112 ± 0.056
σ^2_{16}	0.068 ± 0.080

σ^2_{22}	0.897 ± 0.147
σ^2_{23}	0.175 ± 0.087
σ^2_{24}	0.202 ± 0.104
σ^2_{25}	0.103 ± 0.065
σ^2_{26}	-0.025 ± 0.090
σ^2_{33}	1.153 ± 0.230
σ^2_{34}	-0.032 ± 0.088
σ^2_{35}	0.074 ± 0.051
σ^2_{36}	-0.072 ± 0.053
σ^2_{44}	0.805 ± 0.151
σ^2_{45}	-0.020 ± 0.043
σ^2_{46}	-0.057 ± 0.053
σ^2_{55}	0.489 ± 0.168
σ^2_{56}	0.145 ± 0.123
σ^2_{66}	0.499 ± 0.141

† throughout, coral genera are coded as follows: 1: *Agarcia*, 2: *Diploria*, 3: *Montastrea*, 4: *Orbicella*, 5: *Porites*, 6: *Siderastrea*

‡ average of site-specific values

Sensitivities of long-run average cover with respect to each of the environmental factors are shown in Fig. E1. (Note that the sensitivities and trend shown in Fig. E1 are absolute sensitivities, and not proportional sensitivities as reported in the main text.) The figure shows that changes in each of the environmental factors (either an increase in average hurricane activity or seawater temperature, or the annual trend after accounting for hurricanes and sea temperature) would lead to an increase in macroalgal cover at the expense of both coral and "other" at both Tektite and Yawzi Point (although the effect of hurricanes on cover composition at Tektite appears to be minimal). At the RS, increases in average seawater temperature would decrease both macroalgal and coral cover.

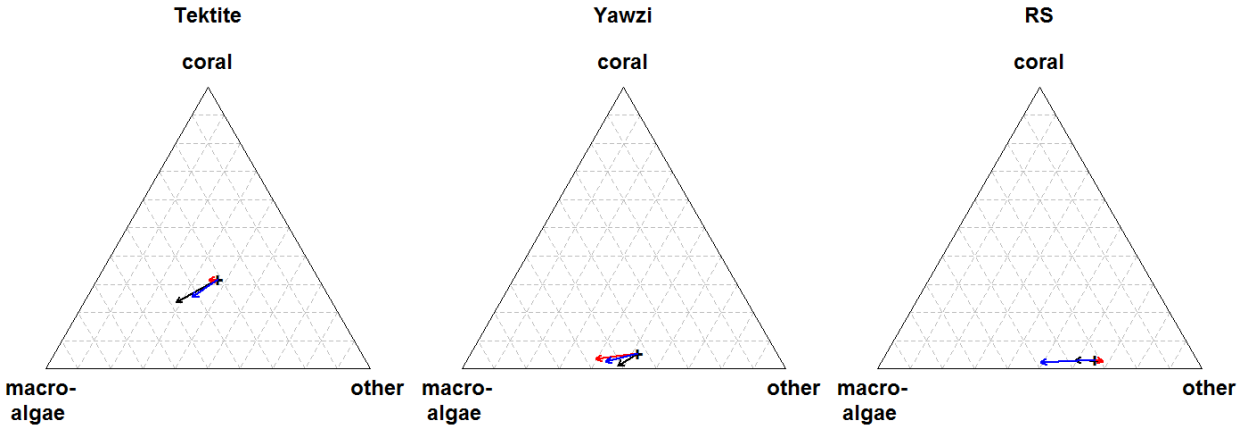

Figure E1. Sensitivity (i.e., $d\boldsymbol{\mu}_p / d\boldsymbol{\mu}_u$) and trend (i.e., $d\boldsymbol{\mu}_p / dt^*$) of the entire cover composition at three habitats. In each panel, the plus sign denotes the metric center of the 2012 quasi-stationary distribution. Red, blue and black arrows show sensitivity of cover composition with respect to hurricane activity, seawater temperature, and the annual trend respectively. To make arrows more visible, the length of each arrow corresponds to the rate of change of

the cover calculated with respect to 1 additional hurricane per year, 1 additional DHM per year, or to 10 additional years.

Sensitivities of the SD of coral cover to the SD of each of the random environmental factors are shown in Figure E2. Sensitivities are calculated assuming that the (product-moment) correlation between hurricane activity and DHMs remains fixed. That is, an increase in the SD of one environmental factor also increases the covariance between the two random environmental factors. Error bars in fig. E2 are ±1 robust bootstrap s.e. However, in most cases the bootstrap sampling distributions are severely right skewed, such that a bootstrap-based confidence interval would not be symmetric around the point estimate. For reference, the SD of hurricane activity for 1992 – 2012 was 0.55, and the SD of DHM was 0.46.

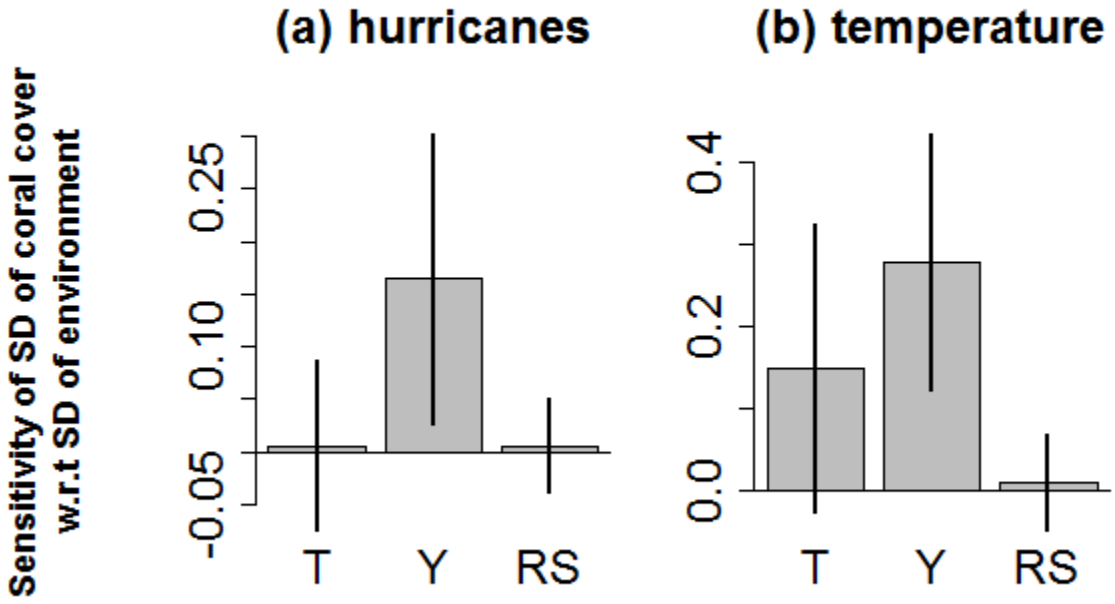

Figure E2. Sensitivity (i.e., $d\sigma_{\mathbf{p}}/d\sigma_{\mathbf{u}}$) of the SD of long-run coral cover with respect to the SD of (a) annual hurricane activity and (b) annual DHM at Tektite (T), Yawzi Point. (Y), and the random sites (RS). Sensitivities are calculated with respect to a 100% increase in the SD of the environmental covariate. Error bars are ±1 robust bootstrap s.e.