Supplementary Material

1 Supplementary Data

Supplementary Figures:

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Figure S6. Principal component analysis of benthic assemblages from each site.

Figure S7. Mantel test of genetic distance vs Bray Curtis distance of benthic species and substrate categorized by functional group.

Supplementary Tables:

Table S1. *Pocillopora* sample and genetic data

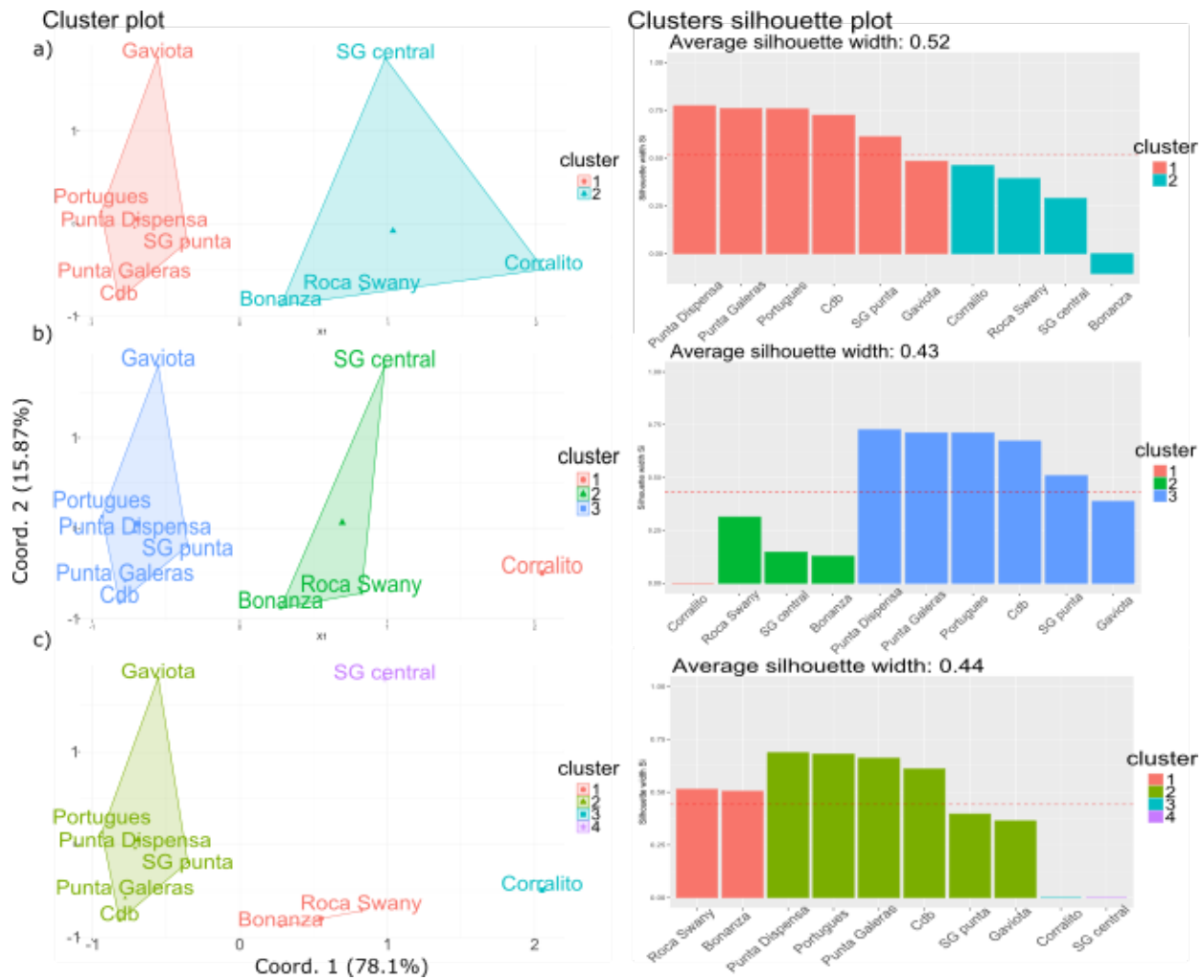Table S2. Area in hectares of the reef area considered.

Table S3. *Pocillopora* Pairwise PhiPT values

Table S4. *Pocillopora* Pairwise PhiPT values by cluster (disturbance group)

Table S5. Pairwise comparison of Rao's Q index values among sites

Table S6. *Pocillopora* AMOVA results

1.1 Supplementary Figures

Figure S1. Cluster and Silhouette plots for *Pocillopora*. **a)** k = 2, cluster 1: size = 6, average silhouette width = 0.69, cluster 2: size = 4, average silhouette width = 0.26. **b)** k = 3, cluster 1: size = 1, average silhouette width = 0.00, cluster 2: size = 3, average silhouette width = 0.20, cluster 3: size = 6, average silhouette width = 0.62 **c)** k = 4, cluster 1: size = 2, average silhouette width = 0.51, cluster 2: size = 6, average silhouette width = 0.57, cluster 3, size = 1, average silhouette width = 0.00, cluster 4: size =1, average silhouette width = 0.00
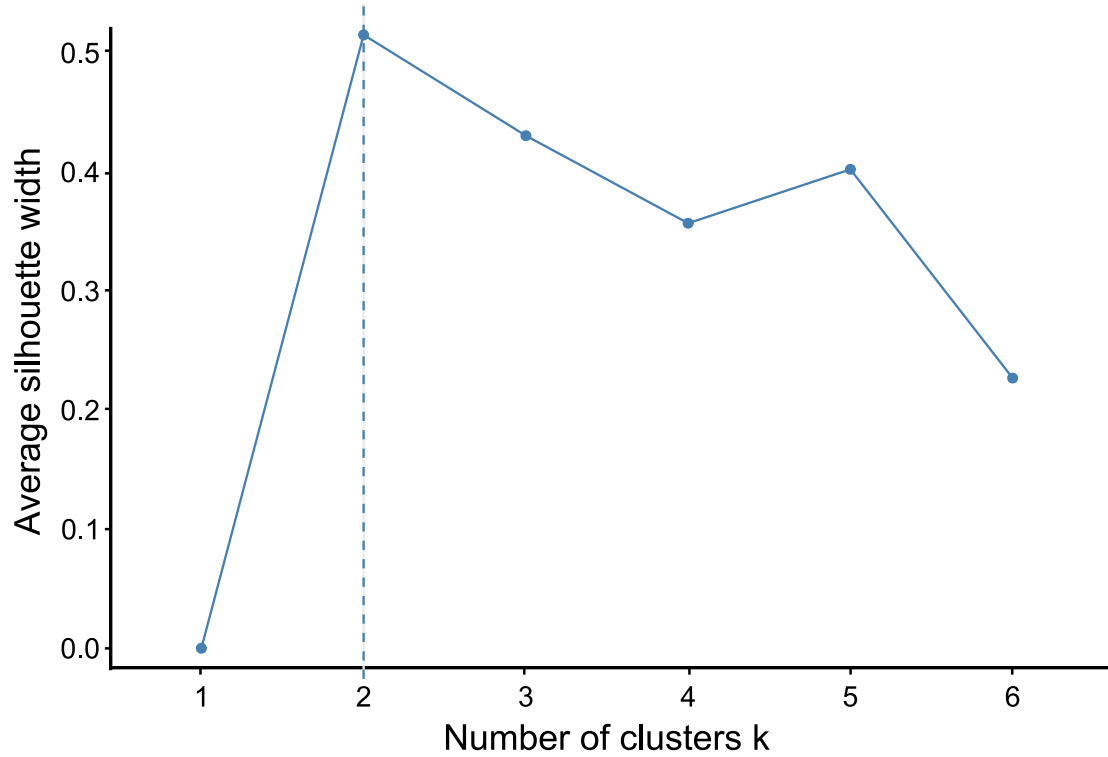
Figure S2. Optimal number of clusters Silhouette method for *Pocillopora* optimal at k = 2
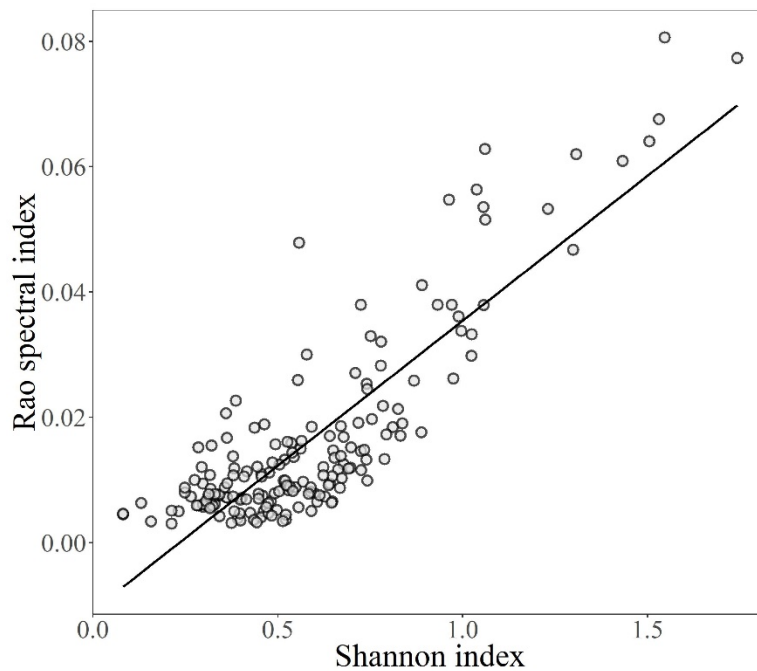

Figure S3. Display of 200 index values of Rao index *versus* Shannon index. Shannon index is the transects mean value for each groundtruthed data point. Rao spectral diversity index is the extracted value over the same points ($R^2 = 0.72$, p < 0.001, N=200).

Sampling data:

Fieldwork was conducted during two distinct periods: October 2016 and December 2016, coinciding with the acquisition dates of the two most recent Landsat satellite images. Over the course of approximately 20 days for each imaging scene, a total of 200 SCUBA dives by a team of four divers were executed to collect in situ data.

At each sampling location, three transects, each measuring 30 meters in length, were randomly deployed to capture the heterogeneity of the benthic environment. This resulted in a total of 300 transects per imaging scene. Data collection employed the Point Intercept Method, wherein the type of benthic substrate was recorded at one-meter intervals along each transect, using the transect itself as a spatial reference.

Subsequent data analysis utilized the Shannon-Wiener Diversity Index, a quantitative metric that accounts for both the richness and evenness of classes present in a sample—be it species, taxa, or substrate types. This index is conventionally employed for estimating species diversity but was adapted in this study to quantify both taxa and substrate diversity within each transect. The final output comprised a data table delineating the Shannon diversity values for each transect, corresponding to each ground-truthed sampling point.
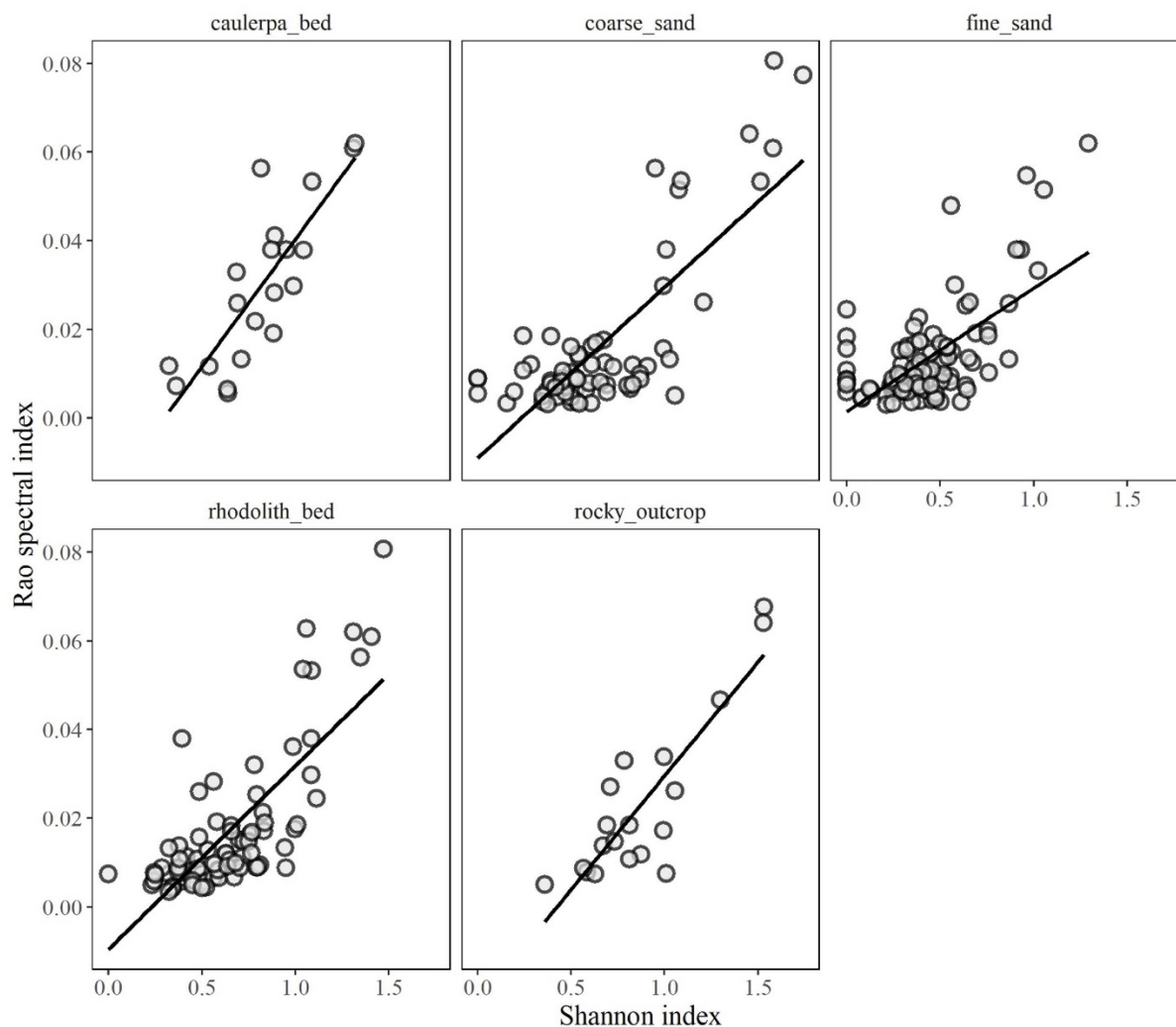
Figure S4. Display of Rao spectral index versus Shannon Index for five substrate types.
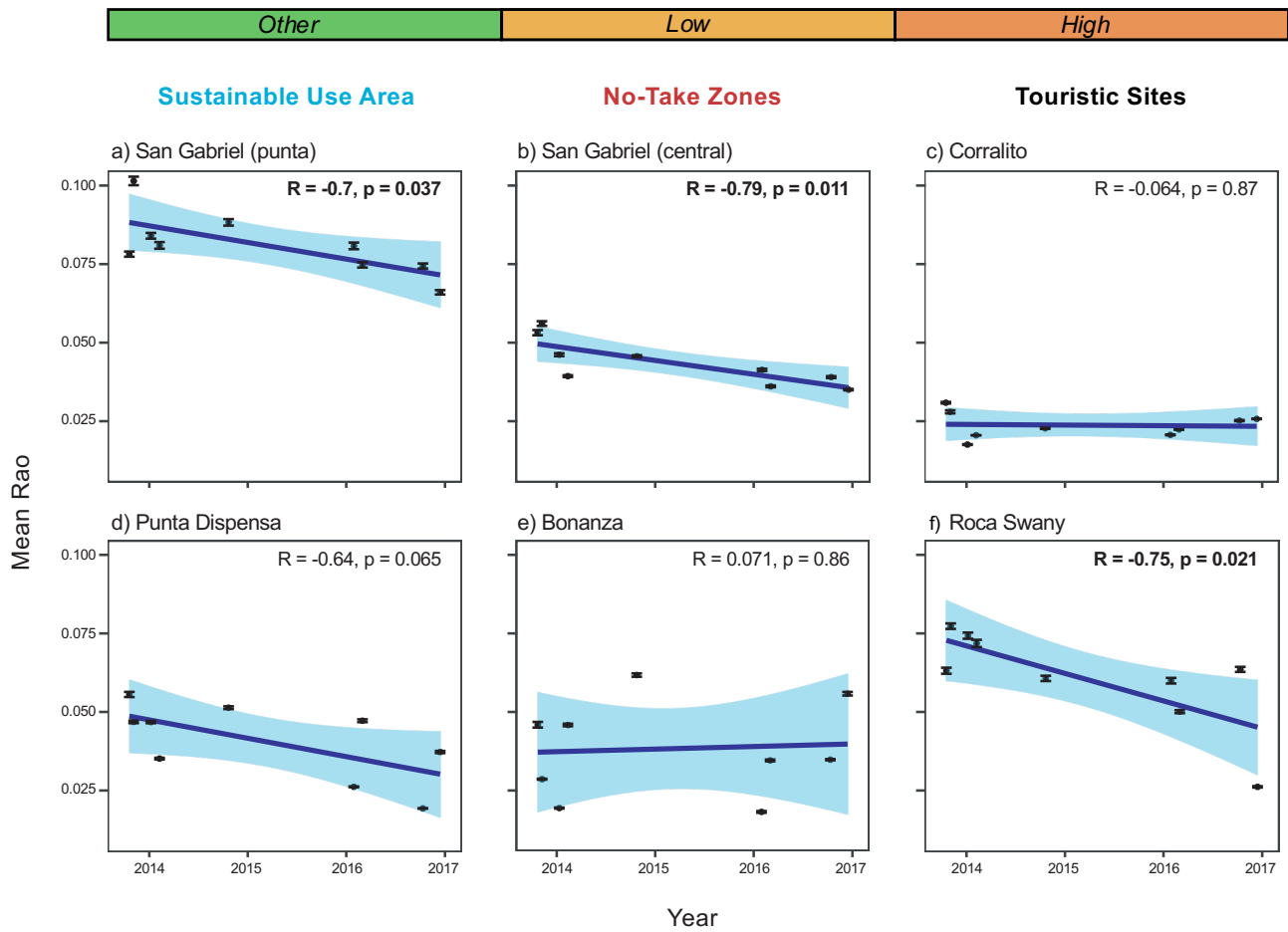
Figure S5. Mean Rao's Q (Environmental Heterogeneity) trend through time (2013-2017) by site. Bolded *p* values are significant.
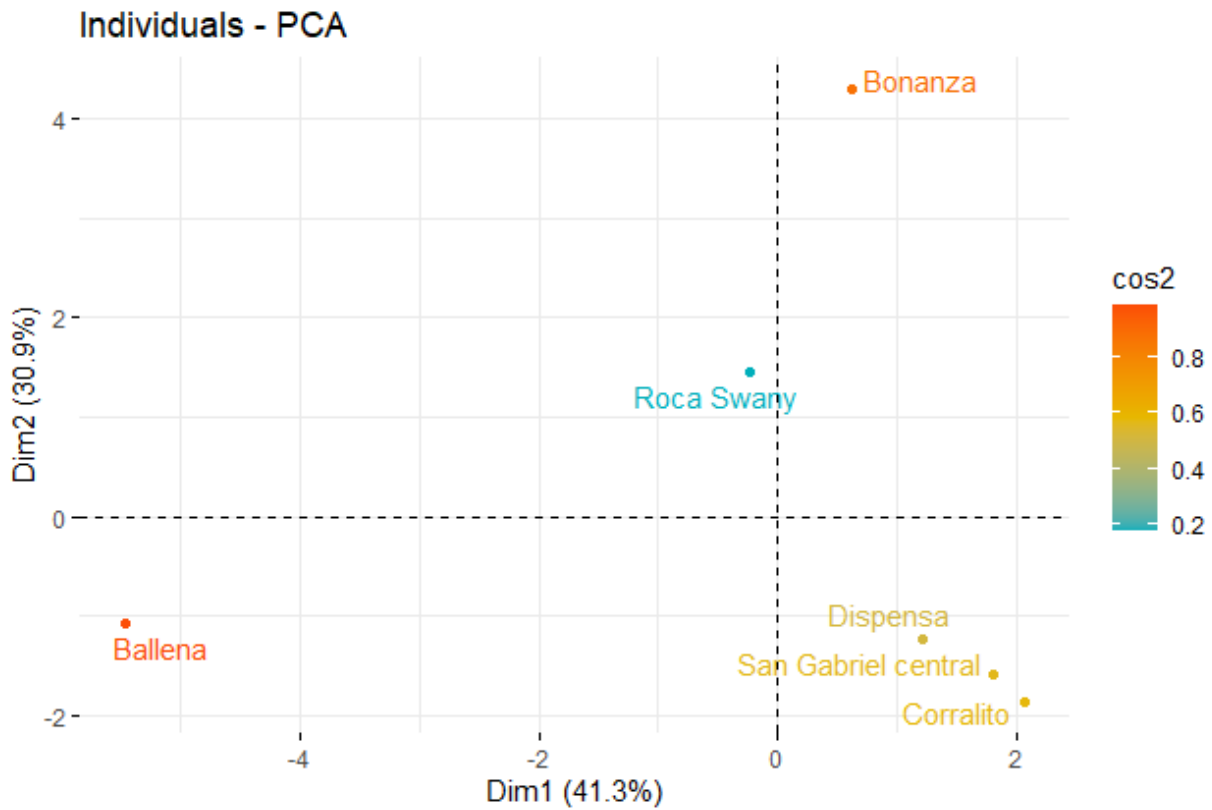
Figure S6. Principal component analysis of benthic assemblages from each site. Cos2 value indicates how well the variable is represented on the principal component. The better the variable is represented by the principal component, the higher the value (the color of the site names are based on the cos2 legend on the right-hand side; red for high values and blue for low values).
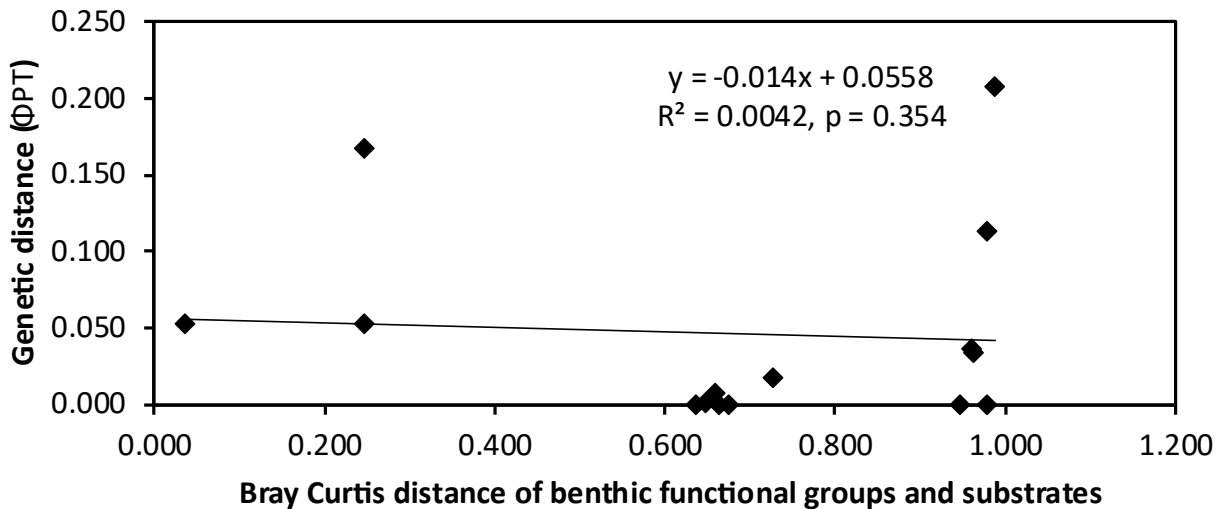
Figure S7. Mantel Test plot to test for IBE. Genetic distance of the pairwise populations values against the Bray Curtis distances for the environmental dissimilarities between sites. The benthic communities and substrates were categorized by their functional groups (Littler et al. 1983)

1.2 Supplementary Tables

Table S1. *P. grandis* sample and genetic data

Site	n	H	S	Hd	±S.D.	π	± S.D.	Cluster (disturbance)	MPA zone	Year collected
Isla Gaviota	36	9	10	0.763	0.048	0.00432	0.00038	1 (Other)	Outside MPA	2015-2019
El Portugues	15	3	3	0.686	0.061	0.0026	0.00024	1 (Other)	Outside MPA	2015-2019
Punta Galeras	13	4	4	0.679	0.089	0.00315	0.00033	1 (Other)	Sustainable Use	2015-2019
Punta Dispensa	21	4	4	0.681	0.059	0.00273	0.0002	1 (Other)	Sustainable Use	2018
San Gabriel(punta)	17	3	3	0.662	0.065	0.00253	0.00028	1 (Other)	Sustainable Use	2018
Cabeza de Ballena	16	4	4	0.65	0.075	0.00288	0.00026	1 (Other)	Sustainable Use	2018
San Gabriel (central)	18	3	3	0.627	0.062	0.00159	0.00039	2 (Low)	No Take	2018
Roca Swany	13	3	4	0.603	0.088	0.00289	0.00039	2 (High)	Traditional Use (Touristic)	2018
Bonanza	18	3	4	0.569	0.071	0.00276	0.00032	2 (Low)	No Take	2018
Corralito	18	4	4	0.529	0.117	0.00221	0.00051	2 (Very high)	Sustainable Use (Touristic)	2018
Cluster 1	118	12	10	0.687	0.027	0.00319	0.00017	Other		
Cluster 2	67	4	4	0.612	0.045	0.00233	0.00020	High/Low		
All	185	12	10	0.666	0.022	0.00292	0.00013			

Notes

Sample size (n, represents the number of sequences), number of haplotypes (H), number of segregating sites (S). Haplortpe diversity (Hd), standard deviation (S.D.), nucleotide diversity (π), standard deviation (S.D.), clusters based on PCoA and k-means cluster analysis (k = 2).

Table S2. Area in hectares of the reef area considered.

Reef	Area (Hectares)
Corallito	18
S_Gab_punt	44
S_Gab_cent	15
Dispensa	37
Roca_swany	22
Bonanza	67

Table S3. *P. grandis* pairwise PhiPT values by site

	Bonanza	San Gabriel central	Roca Swany	Corralito	Punta Dispensa	Cabeza de Ballena	San Gabriel punta	Gaviota	Punta Galeras	Portugues
Bonanza	-	0.254	0.276	0.258	0.341	0.287	0.285	0.226	0.290	0.299
San Gabriel (c)	0.037	-	0.320	0.215	0.195	0.138	0.313	0.101	0.169	0.205
Roca Swany	0.000	0.008	-	0.353	0.364	0.308	0.351	0.200	0.228	0.256
Corralito	0.034	0.053	0.000	-	**0.047**	0.052	0.143	**0.001***	0.079	0.061
Punta Dispensa	0.000	0.053	0.001	0.167	-	0.325	0.285	0.365	0.344	0.318
Cabeza de Ballena	0.000	0.114	0.018	0.208	0.000	-	0.341	0.343	0.354	0.332
San Gabriel (p)	0.000	0.023	0.000	0.110	0.000	0.000	-	0.359	0.337	0.293
Gaviota	0.030	0.075	0.047	0.175	0.004	0.013	0.000	-	0.398	0.360
Punta Galeras	0.000	0.091	0.000	0.179	0.000	0.000	0.000	0.000	-	0.310
Portugues	0.000	0.062	0.031	0.203	0.000	0.000	0.000	0.000	0.000	-

Notes.
Pairwise PhiPT values were estimated using AMOVA in Genalex with 9999 permutations. Below diagonal = PhiPT values, Above diagonal = p values. Bolded with * values still significant after the Bonferroni correction ($p < 0.005$).

Table S4. *P. grandis* Pairwise PhiPT values by cluster (disturbance group)

	High/Low	Intermediate
High/Low	0.000	**0.007***
Intermediate	0.082	0.000

Notes.
Pairwise PhiPT values were estimated using AMOVA in Genalex with 9999 permutations.
Below diagonal = PhiPT values, Above diagonal = p values. Bolded with* values still significant after Bonferroni correction ($p < 0.025$).

Table S5. Pairwise comparison of Rao's Q index values among sites

	Bonanza	Corallito	Dispensa	Roca Swany	San Gabriel (centro)
Corallito	0.147	-	-	-	-
Dispensa	1.000	**0.040**	-	-	-
Roca Swany	**0.0018**	**<0.001**	**0.007**	-	-
San Gabriel (Centro)	1.000	**0.009**	1.000	**0.035**	-
San Gabriel (Punta)	**<0.001**	**<0.001**	**<0.001**	**0.007**	**<0.001**

Table S6. *P. grandis* AMOVA results

Grouping	Df	PhiRT	*p*-value	Sites
MPA inside vs outside	1	0.032	0.075	Inside: Cabeza de ballena, Corralito, San Gabriel punta, San Gabriel central, Punta Dispensa, Roca Swany, Bonanza.
				Outside: Portugues, Isla Gaviota, Punta Galeras
PCoA Clusters (k=2)	1	0.082	0.007	Cluster 1 (Other): Portugues, Punta Galeras, Isla Gaviota, Punta Dispensa, San Gabriel punta, Cabeza de Ballena
				Cluster 2 (Low/High): Roca Swany, Bonanza, San Gabriel central, Corralito
Touristic sites vs. No-take	1	0.005	0.399	Touristic sites: Corralito and Roca Swany
				No-take zones: San Gabriel central and Bonanza
Global AMOVA	9	0.023	0.170	All sites
Multiple Use Areas **f**rom Environmental Heter**o**geneity samples**(**2grps)	1	0.068	0.060	Group 1 (Sustainable Use Area): Punta Dispensa, San Gabriel punta
				Group 2(No-take zones and Touristic sites): San Gabriel central, Bonanza, Corralito, Roca Swany
Multiple Use Areas **f**rom Environmental Heterogeneity samples(3grps)	2	0.059	0.107	Group 1(Sustainable Use area): Punta Dispensa, San Gabriel punta
				Group 2(No-take zones): San Gabriel central, Bonanza
				Group 3(Touristic sites): Corralito, Roca Swany

p values based on 9999 permutations.