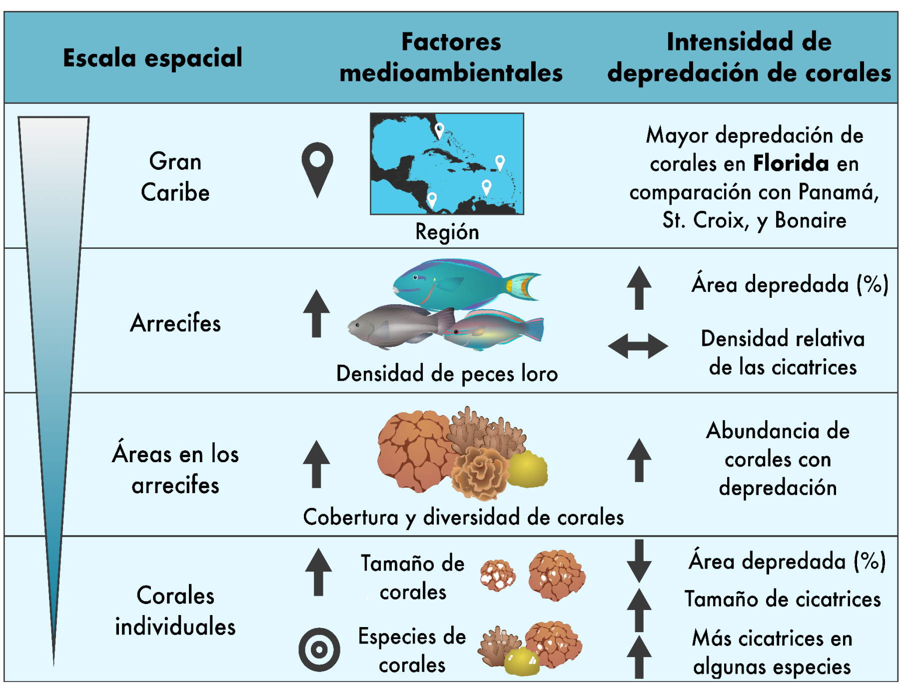
Supplements–Ecological drivers of parrotfish coral predation across spatial scales

Hannah S. Rempel, Kelly N. Bodwin, Deron E. Burkepile, Thomas C. Adam, Andrew H. Altieri, Emma M. Barton, Roxanne-Liana Francisca, Maurice C. Goodman, Rachael J. Lamore, Marilla Lippert, Marietta Marroquín, Tara C. O'Rourke, Peter D. VanderBloomer, Benjamin I. Ruttenberg

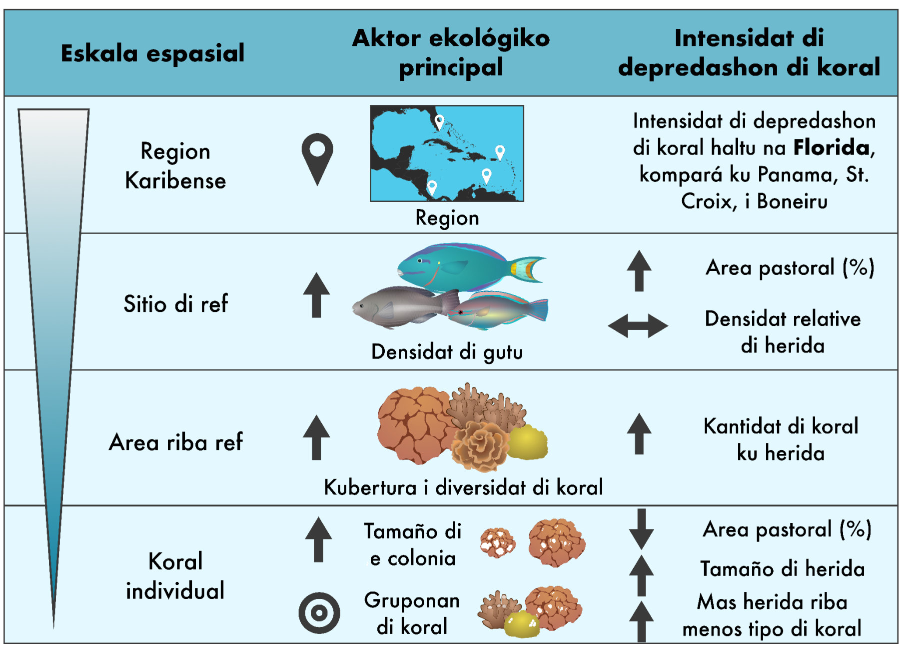
Abstract – Español

Los peces loro (Labridae: Scarini) son ampliamente reconocidos por la importancia de su rol funcional de consumir algas que ayuda en la reducción de la competencia entre corales y estas, sin embargo, algunas especies también son depredadores de coral. Para comprender mejor los impulsores ecológicos de la intensidad de depredación de corales por peces loro, comparamos patrones de tamaño y abundancia relativa de cicatrices de depredación a través de escalas espaciales desde colonias de corales (<1 a varios metros), arrecifes (1 a 10s de km), hasta cuatro regiones del Gran Caribe (de 100 a 1000 de km), incluidas Panamá, Florida, St. Croix y Bonaire. En arrecifes, hubo una correlación positiva entre la densidad de peces loro y el área relativa de cicatrices en los corales, pero no en la abundancia relativa de cicatrices, lo que sugiere que puede haber cicatrices más grandes en áreas con densidades más altas de peces loro. Si bien no hubo un efecto aparente de la cobertura de coral a nivel del sitio sobre la intensidad de depredación de coral, encontramos que la intensidad de depredación se correlacionó positivamente tanto con la cobertura de coral como con la diversidad dentro de áreas de 30 m^2 en arrecifes. A escala de colonias de coral, si bien numerosos taxones de coral son mordidos, la coralivoría se concentra solo en unas pocas especies como *Orbicella* spp., *Porites* spp., y *Stephanocoenia intersepta*. Estos patrones sugieren que si bien, el aumento de las densidades de los peces loro puede resultar en un aumento del área de coral depredada en los arrecifes, intensidad de la coralivoría dentro de los arrecifes puede disminuir en respuesta a la disminución de la cobertura de taxones de coral frecuentemente atacados y de la diversidad coralina.



Abstract – Papiamentu

Gutu (Labridae: Scarini) ta ampliamente rekonosé pa nan kontribushon den redukshon di kompetensia entre lima i koral por medio di nan dieta ku ta konsistí predominantemente di lima. Sinembargo, pa sierto sortonan, koral tambe ta forma parti di nan dieta (koralivoro) kual por tin konsekuensia negativo pa e koralnan. Pa yega na un miho komprenshon di e faktornan ekológiko ku ta influensiá e intensidat ku kual e gutu ta depredá koral, a kompará e tamaño i abundansia di leshon riba koral kausa pa gutu na varios eskala espasial for di kolonia individual (<1 te algun meter), pa refnan rondo di sierto isla (1 te mas ku 10 km), te 4 diferente region den Karibe (100 pa miles di km) inkluiendo Panamá, Florida, St. Croix, i Boneiru. Komparando diferente ref por mira un korelashon positivo entre densidat di gutu i area depreda, pero no e kantidat di leshon relativo. Esaki ta sugerí ku den area ku densidat di gutu mas haltu lo tin leshon mas grandi. Aunke ku den e estudio aki no a detektá un efekto di kubertura di koral di e ref en general riba e intensidat di depredashon, si por a mira ku e intensidat di depredashon ta korela positivamente ku kubertura i diversidat di koral na eskala di areanan di 30 m^2 riba ref. Na e eskala di kolonia individual, e intensidat di depredashon tabata mas haltu ribe e espesienan *Orbicella* spp., *Porites* spp., i *Stephanocoenia intersepta,* kual ta sugerí ku aunke tin diferente espesie di koral ku ta depredá, e fenómeno di depredashon di koral pa gutu, ta konsentrá riba solamente sierto espesie. Resultadonan di e studio ta sugerí ku aunke ku densidat mas haltu di gutu por resultá den depredashon di koral mas haltu riba ref, e intensidat di depredashon di koral por baha na momentu ku e kubertura di koralnan di enfoké baha i tambe ora ku e diversidat di koral riba ref baha.



Supplemental Methods

Text S1: *Estimating mean corallivory rates from prior studies*

We calculated the mean percentage of bites on live coral by Caribbean parrotfishes from several published datasets from research in Barbados, the Florida Keys, and St. Croix, respectively (Cardoso et al. 2009; Adam et al. 2015, 2016). For the two studies where raw data were available (Adam et al. 2015, 2016), authors recorded data as bites on a given substrate type per one-minute interval over the course of a ~20-minute observation. For further details on the methods used to collect these data, see Roycroft 2018 (for St. Croix data archived in Adam et al. 2016) and Burkepile et al. 2019 (for Florida data archived in Adam et al. 2015). When summarizing the raw data from these two studies, we excluded data from minutes in which a fish was not observed or instances where the food type a fish was consuming was not identified. For data from the study by Cardoso and colleagues, we extracted the mean percent of bites on coral by parrotfishes and the number of individuals observed per species from figures using WebPlotDigitizer (Rohatgi 2020). We estimated the mean percentage of bites on live coral from the pooled data from all studies, where we weighted mean estimates for each species by the number of fish observed in each study. These data suggested that *Scarus taeniopterus, Sc. vetula* and *Sparisoma viride* were the only Caribbean parrotfish species that take >1% of their mean bites on live coral (Table S2). Therefore, for the purposes of this study, we defined these three species as major corallivorous parrotfishes and focused our analysis of the relationship between corallivory intensity and parrotfish density or biomass for these major corallivores.

Text S2: *Variation in corallivory intensity in response to parrotfish biomass*

During parrotfish surveys, we recorded the species and fork length (cm) of individuals within 5 cm bins in Panamá and to the nearest cm in all other regions. To estimate parrotfish biomass from binned Panamá data, we estimated fork length as the size bin midpoint (e.g., 17.5 cm for individuals ≥15 to <20 cm). As this may introduce greater uncertainty in biomass estimates for data from Panamá compared to other regions, we focused on parrotfish density as our primary metric of interest but included these supplementary analyses as a comparison. We estimated fish biomass (g 100 m^{-2}) using published length-weight conversions (Bohnsack and Harper 1988; Froese et al. 2014). For *Sp. viride* and *Sc. taeniopterus,* there were multiple length-weight conversion values from different sampling locations (Bohnsack and Harper 1988), so we selected the values with an R^2 >0.85 from the region with highest sample size. For *Sc. vetula*, we used FishBase Bayesian length-weight relationship estimates from species with a similar body plan (Froese et al. 2014).

To assess how relative scar density (n m^{-2} target coral) and target coral area preyed upon (%) varied in response to corallivorous parrotfish biomass (g 100 m^{-2}), target coral cover (%), and the interaction of these variables, we used two GLMMs with random-intercepts by region. For both models, we used a natural-log transformation of the response variable and square root transformation of parrotfish biomass to address quantile deviations from normality. We used a t-distribution for the model of scar density because residual plots indicated it was a better fit than Gaussian, and a Gaussian distribution for the model of coral area preyed upon. We evaluated model fit according to methods described in the manuscript 'Assessing GLMM fit' section.

Supplemental Figures

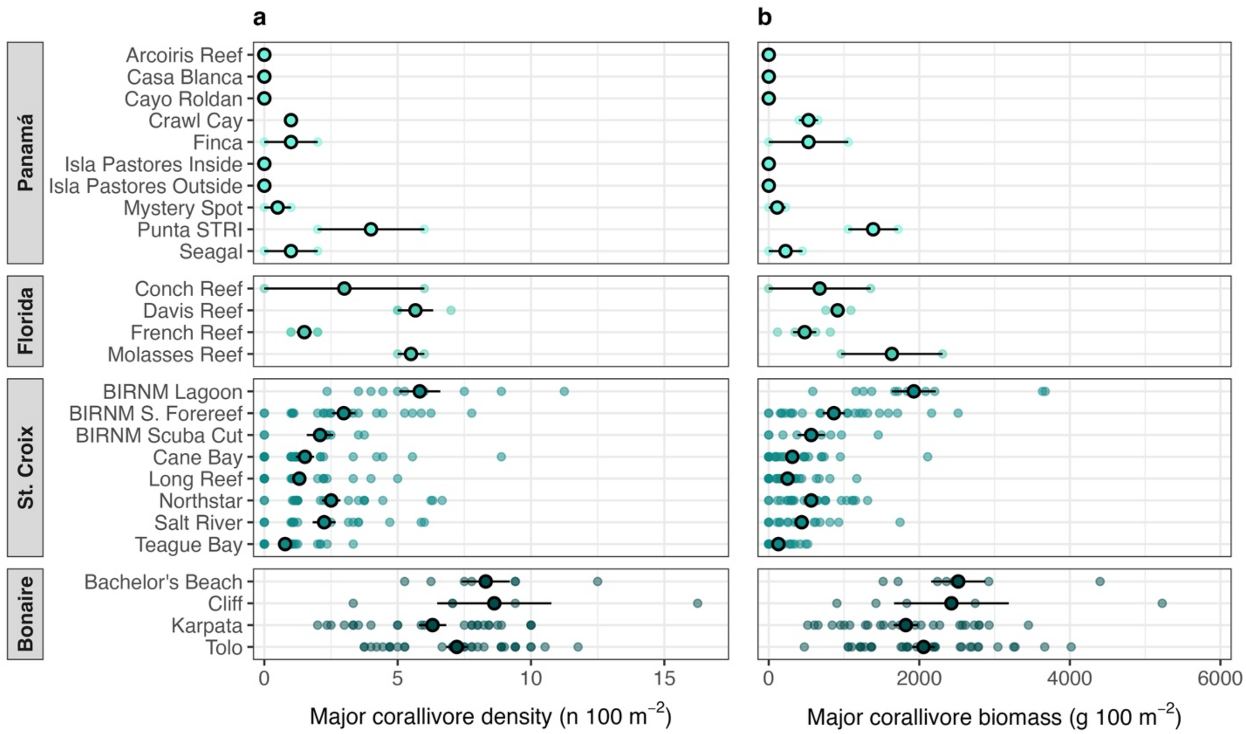


Fig. S1. Site-level means ± S.E. of the (a) density and (b) biomass of major corallivorous parrotfishes (*Scarus taeniopterus, Sc. vetula,* and *Sparisoma viride*) for individuals ≥15 cm. Raw data points are shown transparently in the background. See Table S1 for a summary of the number of surveys per site.

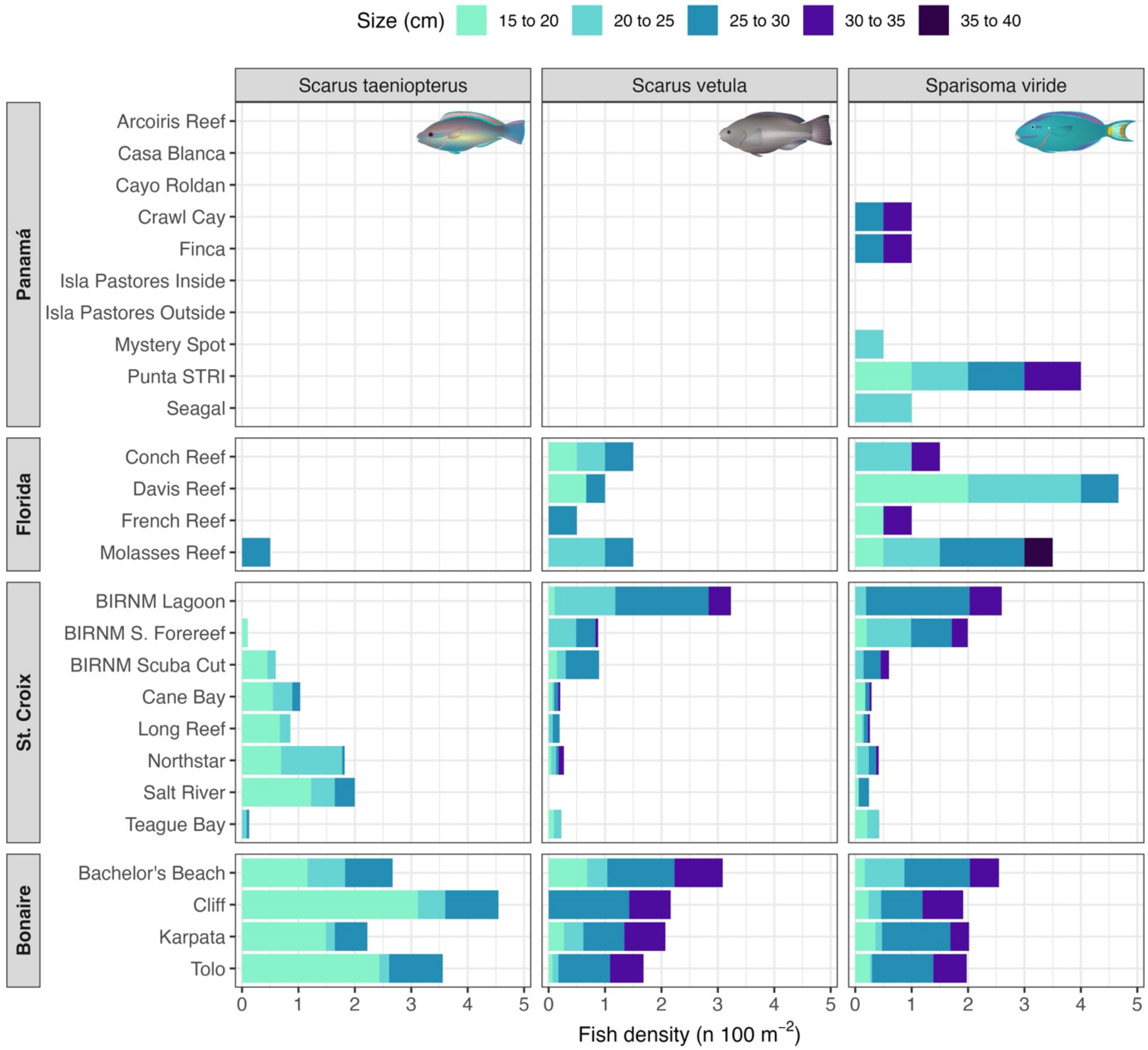


Fig. S2. Site-level mean density of major corallivorous parrotfish species by fork length in 5 cm bins for individuals ≥15 cm. We conducted 2 to 32 fish surveys per site stratified across depths ranging from 1.5 to 17.7 m (Table S1).

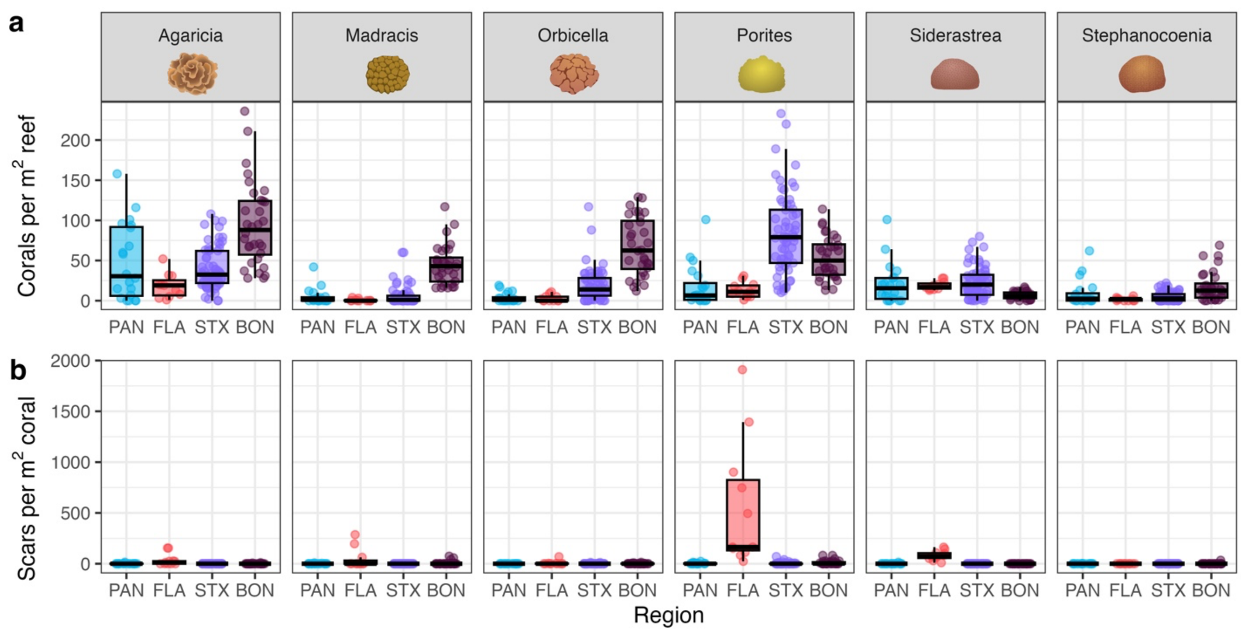


Fig. S3. (a) Coral density and (b) scar density on corals for targeted coral genera across regions (PAN–Panamá, FLA–Florida, STX–St. Croix, BON–Bonaire). Transect-level values are shown transparently in the background (n=20 transects in Panamá, 11 in Florida, 64 in St. Croix, and 32 in Bonaire). The boxplot displays the median as a central line, the box shows the 25th to 75th percentile range, with 1.5 times the interquartile range shown as whiskers.

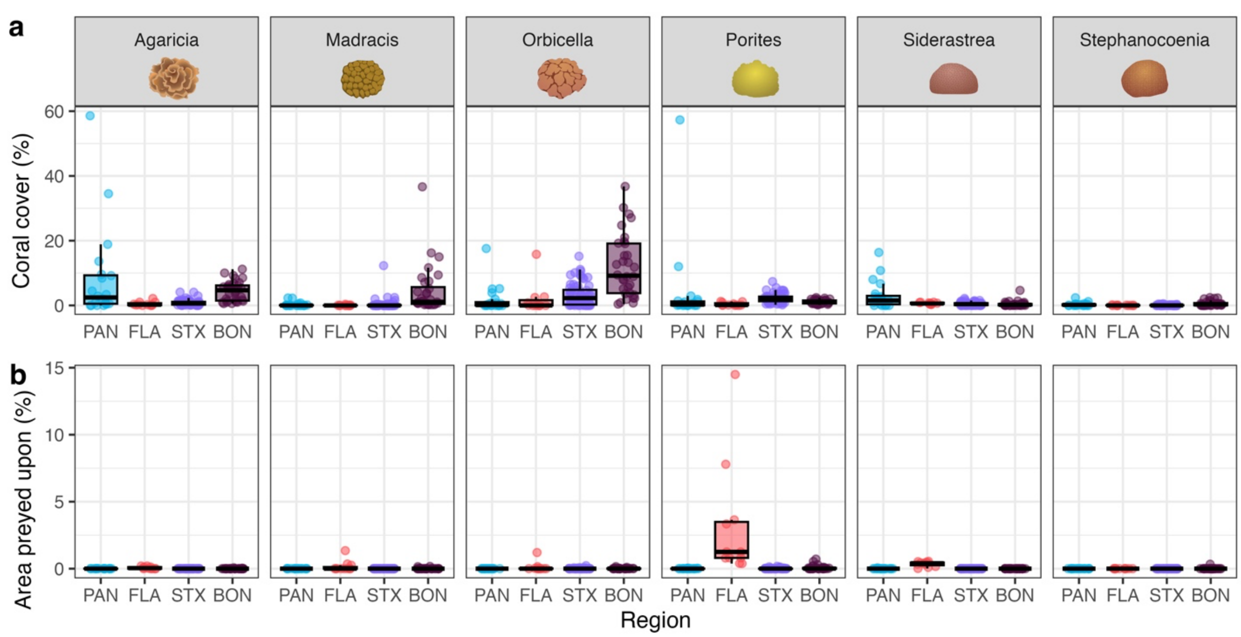


Fig. S4. (a) Coral cover and (b) coral area preyed upon for targeted coral genera across regions (PAN–Panamá, FLA–Florida, STX–St. Croix, BON–Bonaire). Transect-level values are shown transparently in the background (n=20 transects in Panamá, 11 in Florida, 64 in St. Croix, and 32 in Bonaire). The boxplot displays the median as a central line, the box shows the 25th to 75th percentile range, with 1.5 times the interquartile range shown as whiskers.

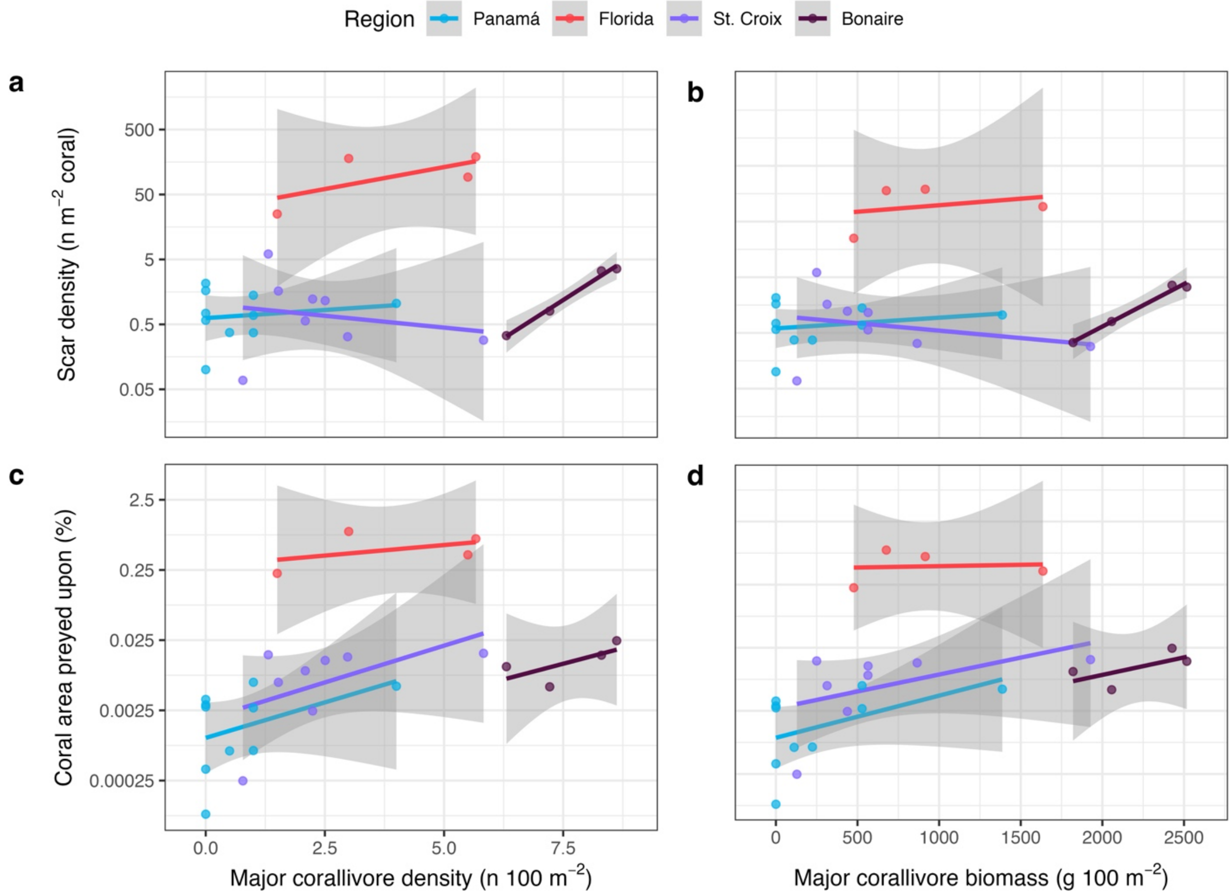


Fig. S5. (a & b) Site-level mean predation scar density and (c & d) mean percent coral area preyed upon in response to the (a & c) density and (b & d) biomass of major corallivorous parrotfishes for all individuals ≥15 cm, with the line of best fit ± 95% C.I. by region. Predation scar density and coral area preyed upon are shown on a natural log-transformed scale. We surveyed 10 sites in Panamá, 4 in Florida, 8 in St. Croix, and 4 in Bonaire.

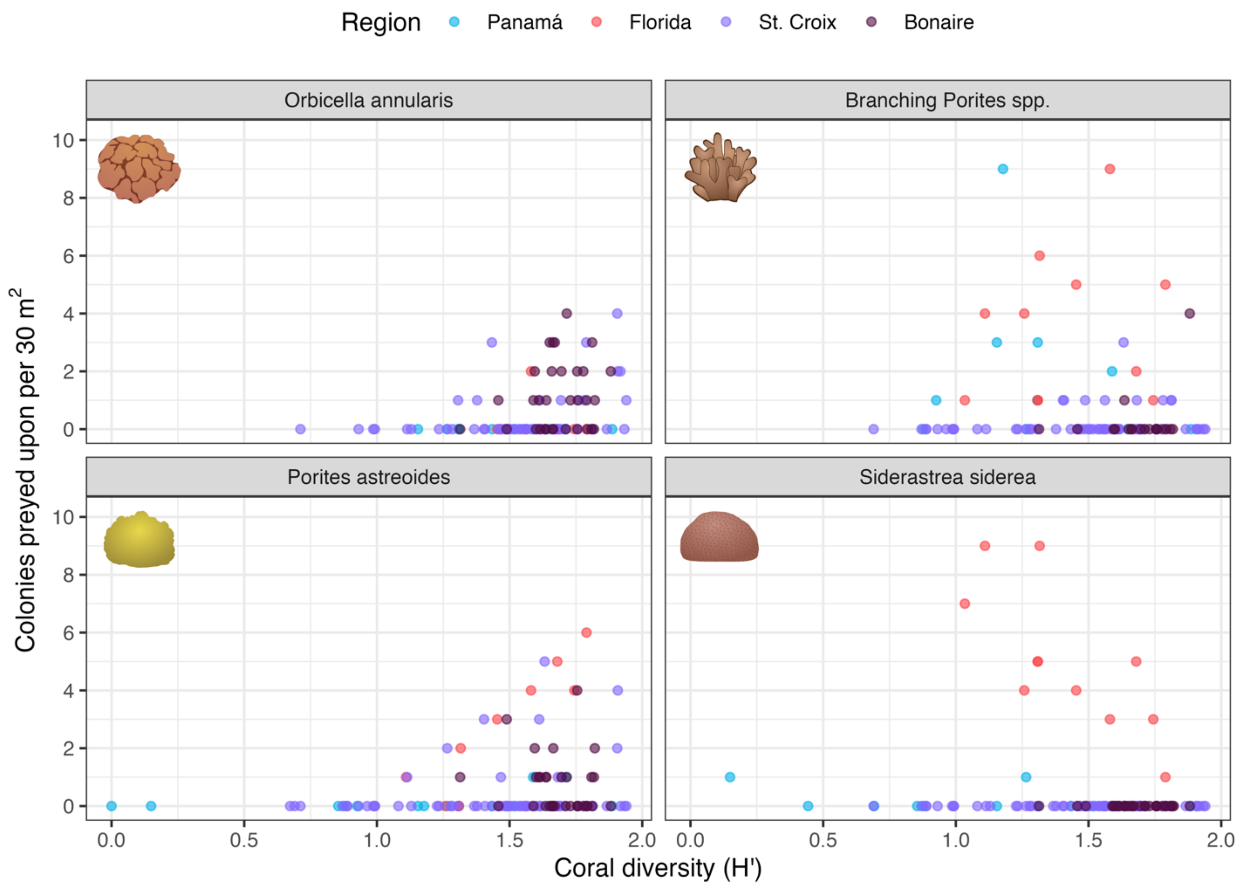


Fig. S6. Number of *Orbicella annularis*, branching *Porites* spp., *Porites astreoides*, and *Siderastrea siderea* coral colonies preyed upon per 30 m^2 reef in response to the diversity of target coral taxa within the area (n=441 total colonies of these four species present within transects, see Table S1 for the number of transects per region). These four coral taxa accounted for >80% of observed colonies with recent predation scars.

Supplemental Tables

Table S1. Coordinates of study sites in decimal degrees, as well a summary of the number of parrotfish density surveys and paired coral and scar surveys per site.

Region	Site	Latitude (DD)	Longitude (DD)	Parrotfish surveys			Coral & scar surveys		
				n	Min depth (m)	Max depth (m)	n	Min depth (m)	Max depth (m)
Panamá	Arcoiris Reef	9.26844	-82.24192	2	5.0	10.0	2	5.0	10.0
Panamá	Casa Blanca	9.35944	-82.27667	2	5.0	10.0	2	5.0	10.0
Panamá	Cayo Roldan	9.21478	-82.32456	2	5.0	10.0	2	5.0	10.0
Panamá	Crawl Cay	9.24383	-82.14514	2	5.0	10.0	2	5.0	10.0
Panamá	Finca	9.28831	-82.25678	2	5.0	10.0	2	5.0	10.0
Panamá	Isla Pastores Inside	9.23469	-82.34553	2	5.0	10.0	2	5.0	10.0
Panamá	Isla Pastores Outside	9.24000	-82.33750	2	5.0	10.0	2	5.0	10.0
Panamá	Mystery Spot	9.27125	-82.29806	2	5.0	10.0	2	5.0	10.0
Panamá	Punta STRI	9.34881	-82.26286	2	5.0	10.0	2	5.0	10.0
Panamá	Seagal	9.28919	-82.29569	2	5.0	10.0	2	5.0	10.0
Florida	Conch Reef	24.96119	-80.45665	2	5.5	5.8	2	5.5	5.8
Florida	Davis Reef	24.92706	-80.50551	3	6.1	6.7	3	6.1	6.7
Florida	French Reef	25.03482	-80.34778	4	7.0	9.8	4	7.0	9.8
Florida	Molasses Reef	25.00847	-80.37627	2	6.1	6.1	2	6.1	6.1
St. Croix	BIRNM Lagoon	17.78787	-64.60996	11	1.5	3.0	8	2.1	3.4
St. Croix	BIRNM S. Forereef	17.78671	-64.60880	23	4.6	9.8	11	3.0	10.4
St. Croix	BIRNM Scuba Cut	17.78939	-64.61028	8	6.1	8.5	8	5.5	10.1
St. Croix	Cane Bay	17.77308	-64.81282	32	5.2	16.2	11	5.5	10.7
St. Croix	Long Reef	17.76148	-64.72001	30	7.0	13.7	6	7.0	11.0
St. Croix	Northstar	17.76844	-64.82313	27	8.2	16.2	8	7.6	10.1
St. Croix	Salt River	17.77988	-64.76039	19	6.1	17.7	7	6.4	9.1
St. Croix	Teague Bay	17.76112	-64.60743	25	4.6	11.0	5	7.0	9.8
Bonaire	Bachelor's Beach	12.12573	-68.28823	7	9.1	12.2	8	7.6	15.2
Bonaire	Cliff	12.17428	-68.29073	5	9.1	17.1	8	6.4	15.5
Bonaire	Karpata	12.21912	-68.35268	26	4.9	15.8	8	5.8	15.8
Bonaire	Tolo	12.21496	-68.33796	32	5.8	15.5	8	5.8	15.5

Table S2. Summary of the number of colonies with recent parrotfish predation scars present and the percentage of observed colonies with recent scars relative to total number of predated colonies across taxa (n=327 total colonies with recent scars). Observations from species with fewer than 3 total predated colonies were excluded from analyses (i.e. *Orbicella franksi, Dichocoenia stokesii,* and *Helioseris cucullata*).

Coral taxa	Colonies with recent scars (n)	Proportion of total observed predation (%)
Branching *Porites* spp.	74	22.6
Porites astreoides	73	22.3
Orbicella annularis	59	18.0
Siderastrea siderea	57	17.4
Agaricia agaricites	12	3.7
Agaricia tenuifolia	11	3.4
Madracis decactis	9	2.8
Orbicella faveolata	9	2.8
Agaricia humilis	8	2.4
Madracis auretenra	5	1.5
Agaricia spp.	3	0.9
Stephanocoenia intersepta	3	0.9
Orbicella franksi	2	0.6
Dichocoenia stokesii	1	0.3
Helioseris cucullata	1	0.3

Table S3. Summary of the mean percentage of bites on live coral relative to total bites from published datasets of parrotfish behavioral observations from Barbados, Florida, and St. Croix, respectively (Cardoso et al. 2009; Adam et al. 2015, 2016). Species with 1% or more of mean bites on live coral were defined as major corallivores for the purposes of this study.

Parrotfish species	Bites on live coral (%)	Individuals observed (n)
Sparisoma viride	2.38	63
Scarus taeniopterus	1.85	74
Scarus vetula	1.02	66
Scarus guacamaia	0.92	16
Sparisoma aurofrenatum	0.37	71
Sparisoma rubripinne	0.26	48
Scarus coelestinus	0.02	18
Scarus coeruleus	0.00	19
Scarus iseri	0.00	28
Sparisoma chrysopterum	0.00	45

Table S4. Results of GLMMs of the site-level means of the natural log of scar density (n scars m^{-2} coral) and natural log of coral area preyed upon (%) in response to the square root of major corallivore density (n 100 m^{-2}, models 1-2) or major corallivore biomass (g 100 m^{-2}, models 3-4), target coral cover (%), and the interaction thereof with a random intercept by region (n=26 total sites observed across 4 regions). Models of scar density had a t-distribution, where model 1 had a regional variance of 2.454 and model 3 had a regional variance of 2.885 (residual df=19 for both models). Models of coral area preyed upon had a Gaussian distribution, where model 2 had a regional variance of 2.141 and residual variance of 1.164, while model 4 had a regional variance of 2.628 and residual variance of 1.076 (residual df=20 for both models).

Model	Corallivory metric	Term	Wald Z	p-value	β	95% CI
1	ln (Scar density)	Intercept	0.432	0.666	0.461	[-1.631, 2.554]
1	ln (Scar density)	√(Corallivore density)	1.384	0.166	0.805	[-0.335, 1.946]
1	ln (Scar density)	Coral cover (%)	-0.681	0.496	-0.044	[-0.169, 0.082]
1	ln (Scar density)	√(Corallivore density) x (coral cover)	-0.340	0.734	-0.010	[-0.071, 0.050]
2	ln (Area preyed upon)	Intercept	-5.550	<0.001	-5.883	[-7.961, -3.806]
2	ln (Area preyed upon)	√(Corallivore density)	2.509	0.012	1.344	[0.294, 2.394]
2	ln (Area preyed upon)	Coral cover (%)	-0.917	0.359	-0.055	[-0.172, 0.062]
2	ln (Area preyed upon)	√(Corallivore density) x (coral cover)	0.109	0.913	0.004	[-0.069, 0.077]
3	ln (Scar density)	Intercept	0.817	0.414	0.927	[-1.296, 3.149]
3	ln (Scar density)	√(Corallivore biomass)	0.762	0.446	0.024	[-0.038, 0.085]
3	ln (Scar density)	Coral cover (%)	-0.787	0.431	-0.052	[-0.180, 0.077]
3	ln (Scar density)	√(Corallivore biomass) x (coral cover)	0.096	0.923	0.000	[-0.004, 0.004]
4	ln (Area preyed upon)	Intercept	-5.090	<0.001	-5.451	[-7.549, -3.352]
4	ln (Area preyed upon)	√(Corallivore biomass)	2.207	0.027	0.064	[0.007, 0.122]
4	ln (Area preyed upon)	Coral cover (%)	-1.346	0.178	-0.078	[-0.191, 0.035]
4	ln (Area preyed upon)	√(Corallivore biomass) x (coral cover)	0.549	0.583	0.001	[-0.003, 0.005]

Table S5. Results a negative binomial GLMM of the relative abundance of colonies with recent predation scars in response to the diversity of all target corals (Shannon Index, H'), coral taxa (*Orbicella annularis,* branching *Porites* spp., *P. astreoides* or *Siderastrea siderea*), transect depth (m), region, and the natural log transformed ratio of the cover of one of the four coral taxa of interest relative to total target coral cover within 30 m^2 transects on reefs. The model included a random intercept by transect nested within region. The model had a transect-level variance of 0.046 and a site-level variance of 0.324. The model included 441 observations of coral colonies of these four taxa across 126 transects and 26 sites (residual df=426). Effect sizes (β) are shown without back transformations; values reported in the paper were back transformed by exponentiating β, where for every one unit increase in the independent variable of interest, mean scar size increased by a factor of e^{β} with one exception. Since the ratio of the cover of the four coral taxa of interest relative to total target coral cover was natural log transformed, we reported back transformed values in the paper as follows: for every 1% increase in the relative cover of a taxa, the abundance of colonies with predation scars changed by a factor of by e^{β}.

Corallivory metric	Term	Wald Z	p-value	β	95% CI
Colonies preyed upon	Intercept	-0.992	0.321	-0.767	[-2.281, 0.748]
Colonies preyed upon	Coral diversity (H')	2.950	0.003	1.468	[0.493, 2.443]
Colonies preyed upon	*Orbicella annularis*	-1.303	0.193	-0.733	[-1.837, 0.370]
Colonies preyed upon	*Porites astreoides*	-2.149	0.032	-1.180	[-2.256, -0.104]
Colonies preyed upon	*Siderastrea siderea*	-2.893	0.004	-1.433	[-2.405, -0.462]
Colonies preyed upon	*Transect depth (m)*	0.475	0.635	0.021	[-0.066, 0.108]
Colonies preyed upon	*Florida*	5.493	<0.001	2.222	[1.429, 3.015]
Colonies preyed upon	*St. Croix*	-2.771	0.006	-1.070	[-1.827, -0.313]
Colonies preyed upon	*Bonaire*	0.887	0.375	0.386	[-0.468, 1.241]
Colonies preyed upon	ln (branching *Porities* spp. cover)	5.717	<0.001	0.748	[0.491, 1.004]
Colonies preyed upon	ln (*O. annularis* cover)	4.853	<0.001	1.493	[0.890, 2.096]
Colonies preyed upon	ln (*P. astreoides* cover)	3.747	<0.001	0.582	[0.277, 0.886]
Colonies preyed upon	ln (*S. siderea* cover)	5.472	<0.001	0.940	[0.603, 1.277]

Table S6. Results of a negative binomial GLMM of parrotfish predation scar abundance on colonies in response to colony surface area (cm^2), taxa, transect depth (m), and region with a random intercept by transect nested within site. The model had a transect-level variance of 1.257 and a site-level variance of 0.555. The model included a total of 23,074 coral colony observations across 127 transects in 26 sites (residual df=23,054). Effect sizes (β) are shown without back transformations in the table, while effect sizes reported in the paper were back transformed by exponentiating β, where for every one unit increase in the independent variable of interest, scar abundance increased by a factor of e^{β}.

Corallivory metric	Term	Wald Z	p-value	β	95% CI
Scar abundance	Intercept	-6.547	<0.001	-6.063	[-7.878, -4.248]
Scar abundance	Colony area (cm^2)	6.608	<0.001	0.001	[0.000, 0.001]
Scar abundance	*Agaricia humilis*	0.730	0.466	0.841	[-1.418, 3.099]
Scar abundance	*Agaricia spp.*	1.518	0.129	1.236	[-0.360, 2.831]
Scar abundance	*Agaricia tenuifolia*	1.588	0.112	1.416	[-0.332, 3.164]
Scar abundance	*Branching Porites spp.*	5.710	<0.001	4.522	[2.970, 6.074]
Scar abundance	*Madracis auretenra*	1.529	0.126	1.396	[-0.394, 3.185]
Scar abundance	*Madracis decactis*	3.373	0.001	2.790	[1.169, 4.411]
Scar abundance	*Orbicella annularis*	5.355	<0.001	4.227	[2.680, 5.774]
Scar abundance	*Orbicella faveolata*	0.751	0.453	0.699	[-1.126, 2.525]
Scar abundance	*Porites astreoides*	5.420	<0.001	4.174	[2.665, 5.684]
Scar abundance	*Siderastrea siderea*	1.470	0.141	1.020	[-0.340, 2.380]
Scar abundance	*Stephanocoenia intersepta*	0.672	0.501	0.663	[-1.270, 2.595]
Scar abundance	Transect depth (m)	-0.175	0.861	-0.010	[-0.123, 0.103]
Scar abundance	Florida	5.424	<0.001	4.465	[2.852, 6.078]
Scar abundance	St. Croix	-4.950	<0.001	-3.159	[-4.411, -1.908]
Scar abundance	Bonaire	-1.659	0.097	-1.168	[-2.548, 0.212]

Table S7. Results of a GLMM with a t-distribution of the natural log of mean scar size for colonies with predation scars present in response to colony surface area (cm^2), taxa, transect depth (m), and region with a random intercept by transect nested within site. The model had a transect-level variance of 1.372×10^{-9} and a site-level variance of 1.188×10^{-2}. The model included a total of 323 coral colonies with predation scars across 81 transects in 26 sites (residual df=302). Effect sizes (β) are shown without back transformations; values reported in the paper were back transformed by exponentiating β, where for every one unit increase in the independent variable of interest, mean scar size increased by a factor of e^{β} with one exception. When interpreting the effect of colony area, since both the independent and dependent variables were natural log transformed, we reported values as follows: for every 1% increase in coral colony surface area, mean scar size increased by β%.

Corallivory metric	Term	Wald Z	p-value	β	95% CI
ln (Mean scar size)	Intercept	-7.034	<0.001	-2.893	[-3.700, -2.087]
ln (Mean scar size)	ln (Colony area, cm^2)	2.167	0.030	0.082	[0.008, 0.157]
ln (Mean scar size)	*Agaricia humilis*	-0.836	0.403	-0.318	[-1.064, 0.428]
ln (Mean scar size)	*Agaricia tenuifolia*	3.064	0.002	1.320	[0.476, 2.164]
ln (Mean scar size)	*Agaricia spp.*	1.705	0.088	0.933	[-0.140, 2.005]
ln (Mean scar size)	*Madracis auretenra*	0.281	0.779	0.130	[-0.776, 1.036]
ln (Mean scar size)	*Madracis decactis*	-1.065	0.287	-0.405	[-1.151, 0.341]
ln (Mean scar size)	*Orbicella annularis*	1.733	0.083	0.605	[-0.079, 1.288]
ln (Mean scar size)	*Orbicella faveolata*	1.495	0.135	0.772	[-0.240, 1.785]
ln (Mean scar size)	*Branching Porites spp.*	2.899	0.004	0.804	[0.260, 1.348]
ln (Mean scar size)	*Porites astreoides*	1.502	0.133	0.451	[-0.138, 1.040]
ln (Mean scar size)	*Siderastrea siderea*	0.728	0.466	0.201	[-0.340, 0.742]
ln (Mean scar size)	*Stephanocoenia intersepta*	2.259	0.024	1.270	[0.168, 2.371]
ln (Mean scar size)	Transect depth (m)	0.382	0.703	0.011	[-0.043, 0.065]
ln (Mean scar size)	Florida	4.821	<0.001	1.063	[0.631, 1.496]
ln (Mean scar size)	St. Croix	3.180	0.001	0.841	[0.323, 1.359]
ln (Mean scar size)	Bonaire	3.946	<0.001	1.076	[0.541, 1.610]

Table S8. Results of a GLMM with a t-distribution of the natural log of relative coral colony area preyed upon (%) for colonies with predation scars present in response to colony surface area (cm^2), taxa, transect depth (m), and region with a random intercept by transect nested within site. The model had a transect-level variance of 1.630×10^{-9} and a site-level variance of 3.129×10^{-10}. The model included a total of 323 coral colonies with predation scars across 81 transects in 26 sites (residual df=302). Effect sizes (β) are shown without back transformations; values reported in the paper were back transformed by exponentiating β, where for every one unit increase in the independent variable of interest, the relative coral area preyed upon increased by a factor of e^{β} with one exception. When interpreting the effect of colony area, since both the independent and dependent variables were natural log transformed, we reported values as follows: for every 1% increase in coral colony surface area, the relative coral area preyed upon increased by β%.

Corallivory metric	**Term**	**Wald Z**	**p-value**	**β**	**95% CI**
ln (% Area preyed upon)	Intercept	2.356	0.018	1.149	[0.193, 2.104]
ln (% Area preyed upon)	ln (Colony area, cm^2)	-15.984	<0.001	-0.739	[-0.830, -0.649]
ln (% Area preyed upon)	*Agaricia humilis*	-0.822	0.411	-0.380	[-1.285, 0.525]
ln (% Area preyed upon)	*Agaricia tenuifolia*	3.258	0.001	1.605	[0.640, 2.571]
ln (% Area preyed upon)	*Agaricia* spp.	3.055	0.002	2.040	[0.731, 3.349]
ln (% Area preyed upon)	*Madracis auretenra*	0.603	0.546	0.367	[-0.826, 1.561]
ln (% Area preyed upon)	*Madracis decactis*	0.341	0.733	0.167	[-0.795, 1.129]
ln (% Area preyed upon)	*Orbicella annularis*	2.051	0.040	0.794	[0.035, 1.553]
ln (% Area preyed upon)	*Orbicella faveolata*	1.034	0.301	0.557	[-0.499, 1.612]
ln (% Area preyed upon)	*Branching Porites spp.*	3.448	0.001	1.137	[0.491, 1.783]
ln (% Area preyed upon)	*Porites astreoides*	2.293	0.022	0.802	[0.116, 1.487]
ln (% Area preyed upon)	*Siderastrea siderea*	0.863	0.388	0.288	[-0.366, 0.942]
ln (% Area preyed upon)	*Stephanocoenia intersepta*	1.693	0.091	1.160	[-0.183, 2.503]
ln (% Area preyed upon)	Transect depth (m)	-0.180	0.857	-0.006	[-0.069, 0.057]
ln (% Area preyed upon)	Florida	6.494	<0.001	1.691	[1.180, 2.201]
ln (% Area preyed upon)	St. Croix	4.294	<0.001	1.298	[0.705, 1.890]
ln (% Area preyed upon)	Bonaire	5.714	<0.001	1.789	[1.175, 2.402]

Supplemental References

Adam TC, Kelley M, Ruttenberg BI, Burkepile DE (2015) Abundance and behavior of parrotfishes (Labridae, Scarinae) in the upper Florida Keys from 2013-06-19 to 2013-07-30 (NCEI Accession 0127525).

Adam TC, Ruttenberg BI, Roycroft MV (2016) Behavior of parrotfishes (Labridae, Scarinae) in St. Croix from 2015-07-06 to 2015-07-26 (NCEI Accession 0157087).

Bohnsack J, Harper D (1988) Length-weight relationships of selected marine reef fishes from the southeastern United States and the Caribbean. NOAA Tech Memo NMFS- SEFC-215

Burkepile DE, Adam TC, Roycroft M, Ladd MC, Munsterman KS, Ruttenberg BI (2019) Species-specific patterns in corallivory and spongivory among Caribbean parrotfishes. Coral Reefs 38:417–423

Cardoso SC, Soares MC, Oxenford HA, Côté IM (2009) Interspecific differences in foraging behaviour and functional role of Caribbean parrotfish. Mar Biodivers Rec 2:e148

Froese R, Thorson JT, Reyes RB (2014) A Bayesian approach for estimating length-weight relationships in fishes. J Appl Ichthyol 30:78–85

Matuschek H, Kliegl R, Vasishth S, Baayen H, Bates D (2017) Balancing Type I error and power in linear mixed models. J Mem Lang 94:305–315

Rohatgi A (2020) WebPlotDigitizer. Software version 4.4. https://automeris.io/WebPlotDigitizer.

Roycroft MV (2018) Foraging ecology of parrotfishes in the Greater Caribbean: Impacts of specialization and dietary preferences on marine benthic communities. Master of Science, California Polytechnic State University