Supporting Information. Andrew A. Shantz, Mark C. Ladd, and Deron E. Burkepile. 2020.

Overfishing and the ecological impacts of extirpating large parrotfish from Caribbean coral reefs.

Ecological Monographs.

Appendix S1: Supplemental Figures and Tables

Supplemental Methods

AGRRA Data compilation

Fish surveys were conducted by AGRRA trained divers who swam 30 x 2 m belt transect to record the species and size of every fish encountered in the survey area. Benthic surveys were conducted using a point-intercept method, recording the taxonomic identity or substrate type encountered by divers every 10 cm along 10 m transects. Detailed survey descriptions are available from AGRRA (http://www.agrra.org). We restricted our data to forereef sites deeper than 3 m that had been surveyed between 2012-2017. For sites that had been surveyed multiple times during that time span, we only used the most recent survey data. Furthermore, we excluded 3 sites from Guatemala (AGRRA site codes GT002, GT003, GT004) which were ambiguously reported as patch reefs in 2012 but forereef sites in 2013 and an additional site in the Bahamas (AGRRA site code JC007) which reported over 229,000 g of parrotfish in a 60 m^2 area.

Experimental Manipulations

To assess whether caging material influenced herbivore feeding on the benthos we tested for differences in grazing between Control exclosures and 1m^2 external plots with no caging material present. Mann Whitney U-tests, which revealed no differences between the two (bite rate: W = 10540, p = 0.394; biomass-corrected bite rate: W = 10452, p = 0.334). Additionally, our mixed-effects models detected no differences in the bite rates (parrotfish: $\chi^2(1) = 0.012$, p = 0.912; surgeon fishes ($\chi^2(1) = 0.027$, p = 0.868) or biomass-corrected bites rates (parrotfish: $\chi^2(1) = 2.011$, p = 0.156; surgeonfish: ($\chi^2(1) = 0.713$, p = 0.399) between External and Control plots (Fig. S2).

Table S1: Results from Mann Whitney One-sided tests corrected for multiple comparisons to determine whether the parrotfish population size structure is significantly smaller than the size distribution observed in the Florida Keys.

Country	Mann Whitney U Score
2. Bahamas	W = 2523100, p < 0.001
3. Turks & Caicos	W = 141690, p = 0.999
4. Haiti	W = 1899000, p < 0.001
5. Navassa	W = 1144600, p < 0.001
6. St. Vincent	W = 1675600, p < 0.001
7. Grenada	W = 1425900, p < 0.001
8. Jamaica	W = 2899000, p < 0.001
9. Colombia	W = 1243900, p < 0.001
10. Honduras	W = 5363900, p < 0.001
11. Guatemala	W = 329920, p < 0.001
12. Belize	W = 1056800, p < 0.001
13. Mexico	W = 1396000, p = 0.021

Table S2: P-values from Tukey's HSD post hoc results comparing differences in parrotfish biomass across Caribbean countries and territories. Significant differences are in **Bold** font. Country abbreviations are: **FL** – Florida Keys, USA; **BS** – Bahamas; **T&C** – Turks and Caicos; **HT** – Haiti; **NS** – Navassa; **SV** – St. Vincent; **GD** – Grenada; **JM** – Jamaica; **CO** – Colombia; **HN** – Honduras; **GT** – Guatemala; **BZ** – Belize; **MX** - Mexico

	Fl	BS	T&C	HT	NS	SV	GD	JM	CO	HN	GT	BZ	MX
FL	-												
BS	1	-											
T&C	1	0.948	-										
HT	1	0.24	1	-									
NS	0.981	**0.001**	1	0.997	-								
SV	0.97	**0.004**	1	0.993	1	-							
GD	1	0.42	1	1	0.983	0.971	-						
JM	1	0.133	1	1	0.82	0.806	1	-					
CO	1	0.992	0.998	0.961	0.212	0.239	0.992	0.991	-				
HN	0.999	**<0.001**	1	1	0.994	0.989	1	0.996	0.437	-			
GT	0.998	0.986	0.704	0.222	**0.016**	**0.018**	0.32	0.277	0.825	**0.047**	-		
BZ	1	1	0.992	0.848	0.095	0.118	0.944	0.92	1	0.192	0.937	-	
MX	1	0.895	1	0.997	0.489	0.494	1	1	1	0.845	0.662	1	-

Table S3: Results from Mann-Whitney U tests assessing differences in the size-distribution of parrotfishes and surgeon fish between each of our three experimental treatments.

Treatment comparison	Parrotfish	Surgeonfish
Control vs Partial exclosure	W = 69404; p < 0.001	W = 15773; p < 0.001
Control vs. Full exclosure	W = 51547; p < 0.001	W = 6522.5; p < 0.001
Partial vs. Full exclosure	W = 36526; p < 0.001	W = 2598; p = 0.002

Table S4: ANOSIM test statistic and associated p-value for comparisons of the benthic community structure in each treatment based on Bray-Curtis distances at each sampling time point.

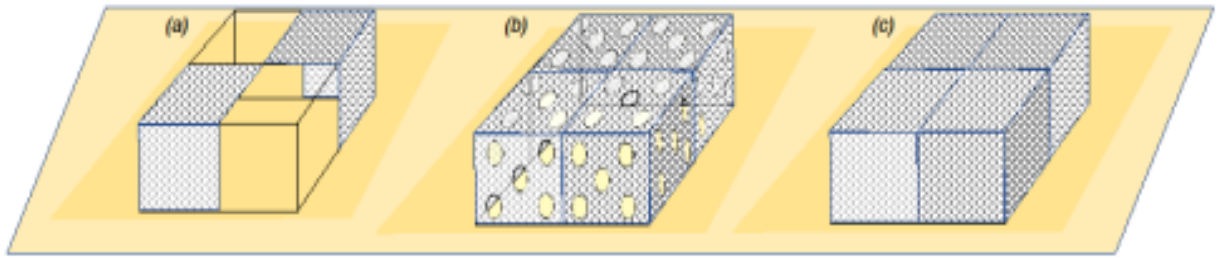| Date	ANOSIM test statistic
July, 2013	R = -0.078; p = 0.846
September, 2013	R = 0.294; p = 0.002
November, 2013	R = 0.441; p = 0.002
February, 2014	R = 0.529; p = 0.001
May, 2014	R = 0.619, p < 0.001
July, 2014	R = 0.762, p < 0.001
September 2014	R = 0.714, p < 0.001

Supplemental Figures

Figure S1: Schematic of the exclosures used to limit the access of different sized fishes in our manipulative field experiment.
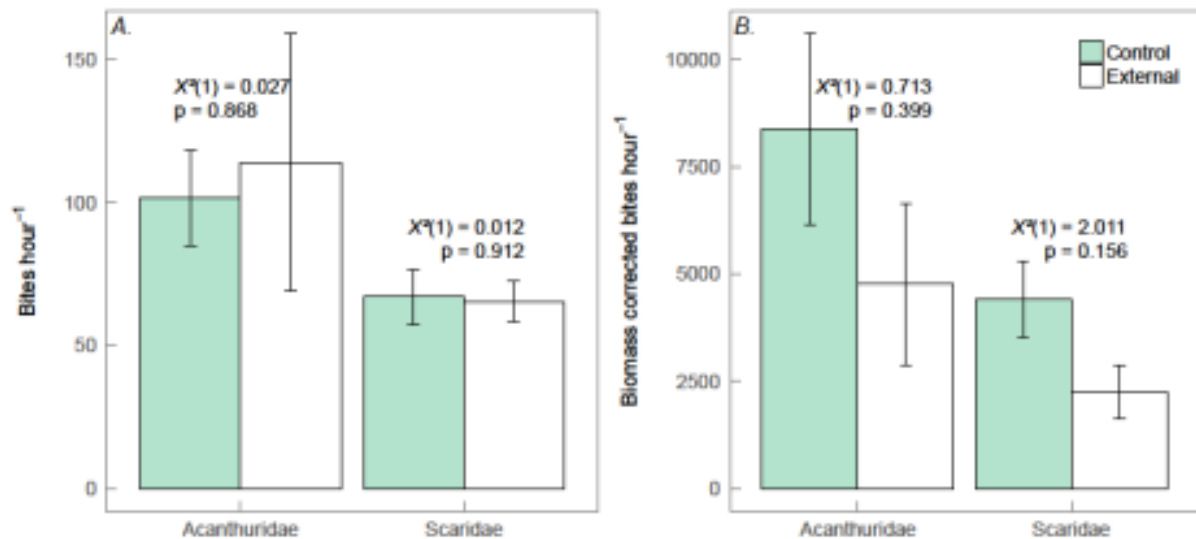

Figure S2: The number of bites per hour **(A)** and biomass-corrected bites per hour **(B)** taken by surgeonfishes and parrotfishes feeding in our Control exclosures or external 1 m² plots established in open sections of the reef. P-values are from mixed effects models that include treatment (Control vs External) as fixed effects and random effects to account for the plot number and date filmed. Error bars are ± 1 SE.
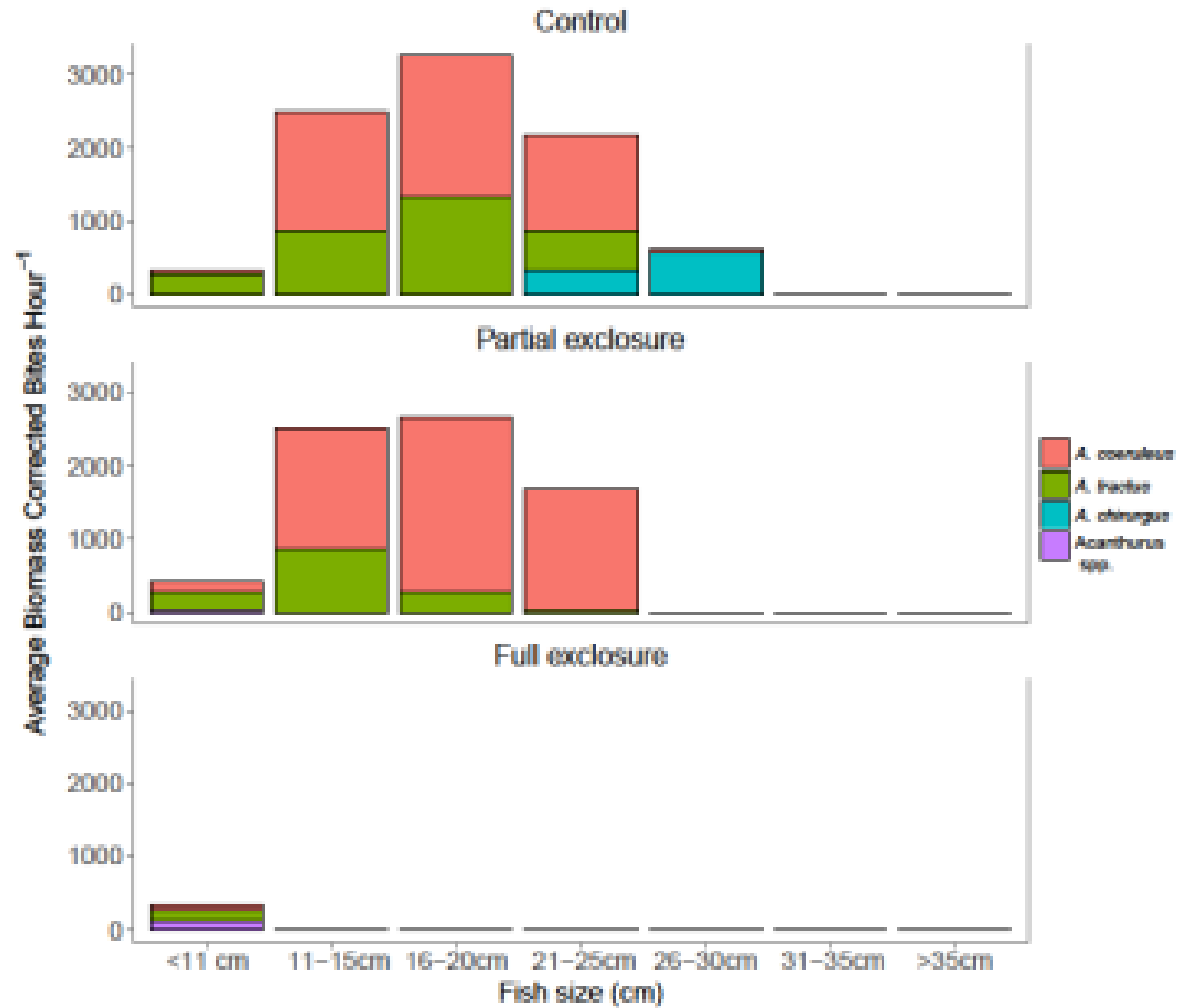
Figure S3: The average biomass-corrected bites per hour measured for different sized parrotfishes recorded on video feeding within our different exclusion treatments. Biomass-corrected bite rates were calculated by multiplying the number of bites that a fish took within a given treatment by the fish's weight. Error bars are ± 1 SE.