The following supplement accompanies the article

Regional spatio–temporal trends in Caribbean coral reef benthic communities

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Text S1: Site differentiation and pooling details

Geographic coordinates were reported for most survey sites (85.0%, 1,667 sites). Reef community structure can vary greatly at relatively small scales (Edmunds & Bruno 1996), so surveys were only considered to be done at the same site if the surveys had identical coordinates. Those sites without coordinates were only considered to be identical if a single author used one reef name for them in multiple studies, or if maps or descriptions in the text allowed us to determine that the surveys were indeed performed at the exact same site. If a site was surveyed at multiple depths or months in a single year, the cover values for that year were averaged (538 surveys, or 14.7%, were pooled from multiple observations).

For a list of references from which cover data were collected, please contact the corresponding author.

Text S2: Depth and zonation effects on coral cover

Survey depth was reported for the majority of surveys (3765 of 3777; see Fig. S1 for an overview of depth profiles for the entire database). There was no trend in study depth over time (linear regression analysis of all data: n = 3765, r^2 adj. = 0.003, p = 0.001); the average yearly survey depth was between 6.5 m and 11.5 m for 30 of the 36 years in the database. There was very little variance in depths pooled by subregion. The average survey depth was 7.0 – 8.8 m for each subregion except for the Gulf of Mexico, in which most surveys were conducted at the Flower Garden Banks and average survey depth was 20.0 m. Survey depth also did not drive cover trends. Coral and macroalgal cover both varied significantly with depth (linear regression analyses; n = 3765 for coral cover and 2235 for macroalgal cover; $p < 0.0001$ for both organisms). However, the amount of variance in cover explained by these trends was extremely low (r^2 adj. = 0.01 for coral cover and 0.03 for macroalgal cover) and so depth was not considered to significantly influence cover patterns.

We also examined whether coral cover varied among reef zones. Reef zones were not designated for most surveys and even when zone assignments were made they were not based on a definition scheme common to all sampling organizations. We used data from Atlantic and Gulf Rapid Reef Assessment (AGRRA), which conducts surveys throughout the Caribbean and classifies them as conducted in the fore reef, reef crest, or patch reef, to determine if cover varied according to reef zone. In some subregions (like the Florida Keys) there is indeed predictable variation among zones in coral cover (e.g. Lirman & Fong 2007), but there were no general, Caribbean–wide patterns (based only on AGRRA data; Fig S3).

Text S3: Temperature data

The temperature data for 2005 are part of the Coral Reef Temperature Anomaly Database (http://www.nodc.noaa.gov/SatelliteData/Cortad; Selig et al. in press). This sea surface temperature (SST) database is produced by the National Oceanic and Atmospheric

Administration’s National Oceanographic Data Center and the University of Miami’s Rosenstiel School of Marine and Atmospheric Science (http://pathfinder.nodc.noaa.gov) and is composed of satellite data processed to a resolution of approximately 4.6 km at the equator. Data were created from a day–night SST average using data with a quality flag of 4 or better (Kilpatrick et al. 2001). We also allowed values back into the analysis if the weekly SST was less than 5°C warmer than the Reynolds Optimum Interpolation Sea Surface Temperature (Reynolds et al. 2002). To fill the remaining gaps, we used a 3 x 3 pixel median spatial fill, where the median of adjacent pixels was used to calculate a value for a mixing pixel. No original temperature data were modified in this approach. Once the data were gap–filled, we used a harmonic analysis procedure that fits annual and semi–annual signals to the time series of weekly SSTs at each grid cell:

$$\mathrm{SST}(t)_{\mathrm{clim}} = A\cos(2\quad t + B) + C\cos(4\quad t + D) + E \qquad (1)$$

where t is time, A and B are coefficients representing the annual phase and amplitude, C and D are the semi–annual phase and amplitude, and E is the long–term temperature mean to calculate climatologies at each pixel. If the temperature exceeded the mean maximum climatological week by more than 1°C (Glynn 1993), a common general threshold for bleaching, we counted that pixel as having a thermal stress anomaly.

Figure S1. Yearly data source composition

Note that all surveys prior to 1996 were gathered from grey or peer–reviewed literature sources.

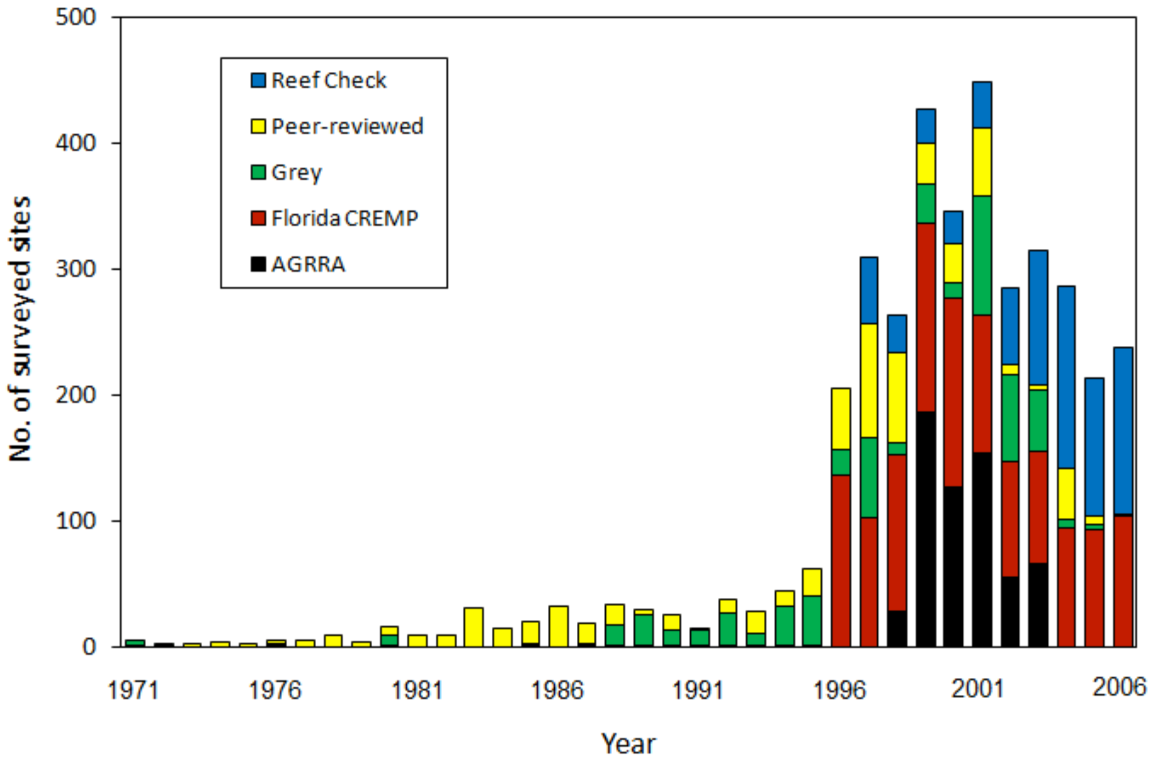

Figure S2. Histogram of survey depths

The box plot shows the range of all data that were not outliers; the median depth was 7 m (shown as a vertical line inside the box) and the average depth was 8.2 m (shown as a diamond inside the box). Survey depths of less than one meter were classified as one meter for our data analyses, and surveys conducted over a range of depths were averaged for this graph.

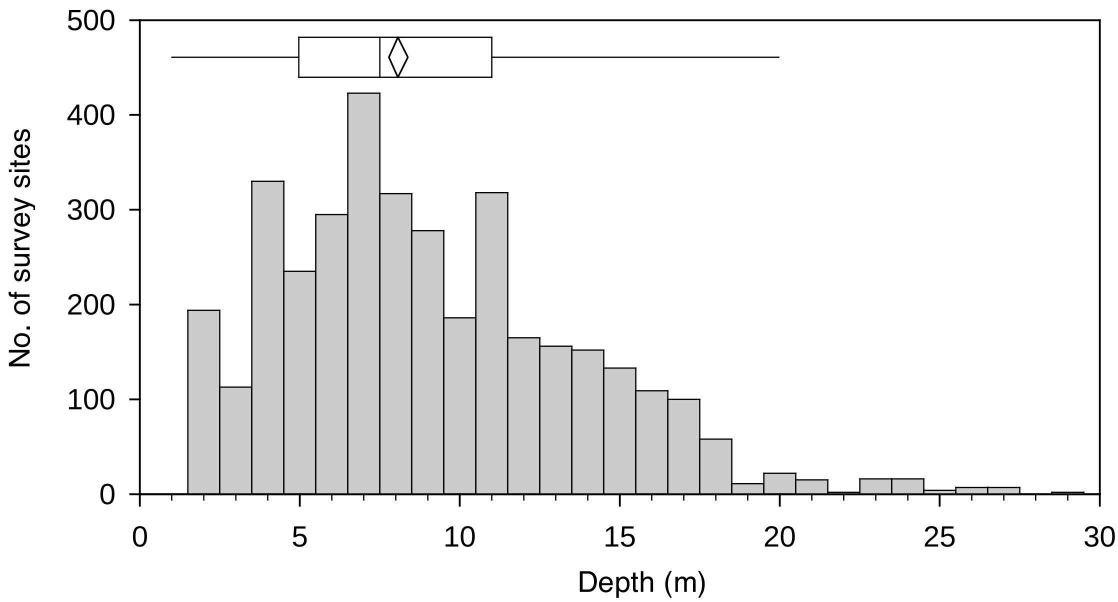

Figure S3. Coral cover zonation

Data is from Atlantic and Gulf Rapid Reef Assessment (AGRRA) only to ensure consistency in zone designation. Surveys were performed from 1998 to 2003. Sample sizes (i.e., the number of sites/reefs surveyed) are shown above the bars, which represent standard error.

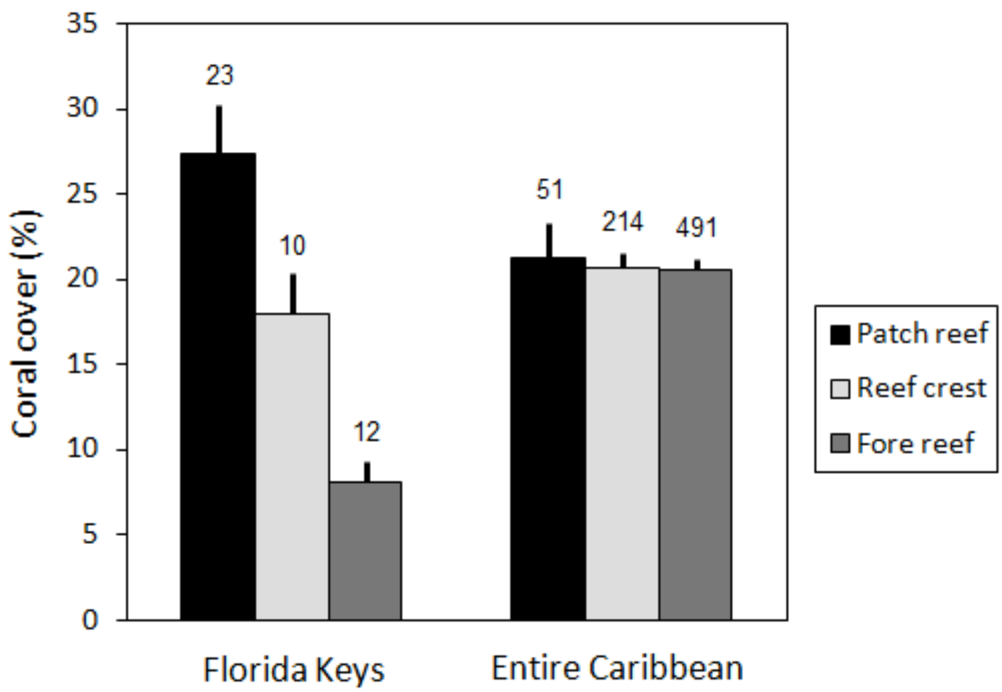

Figure S4. Mean coral cover for each subregion for all years data were available

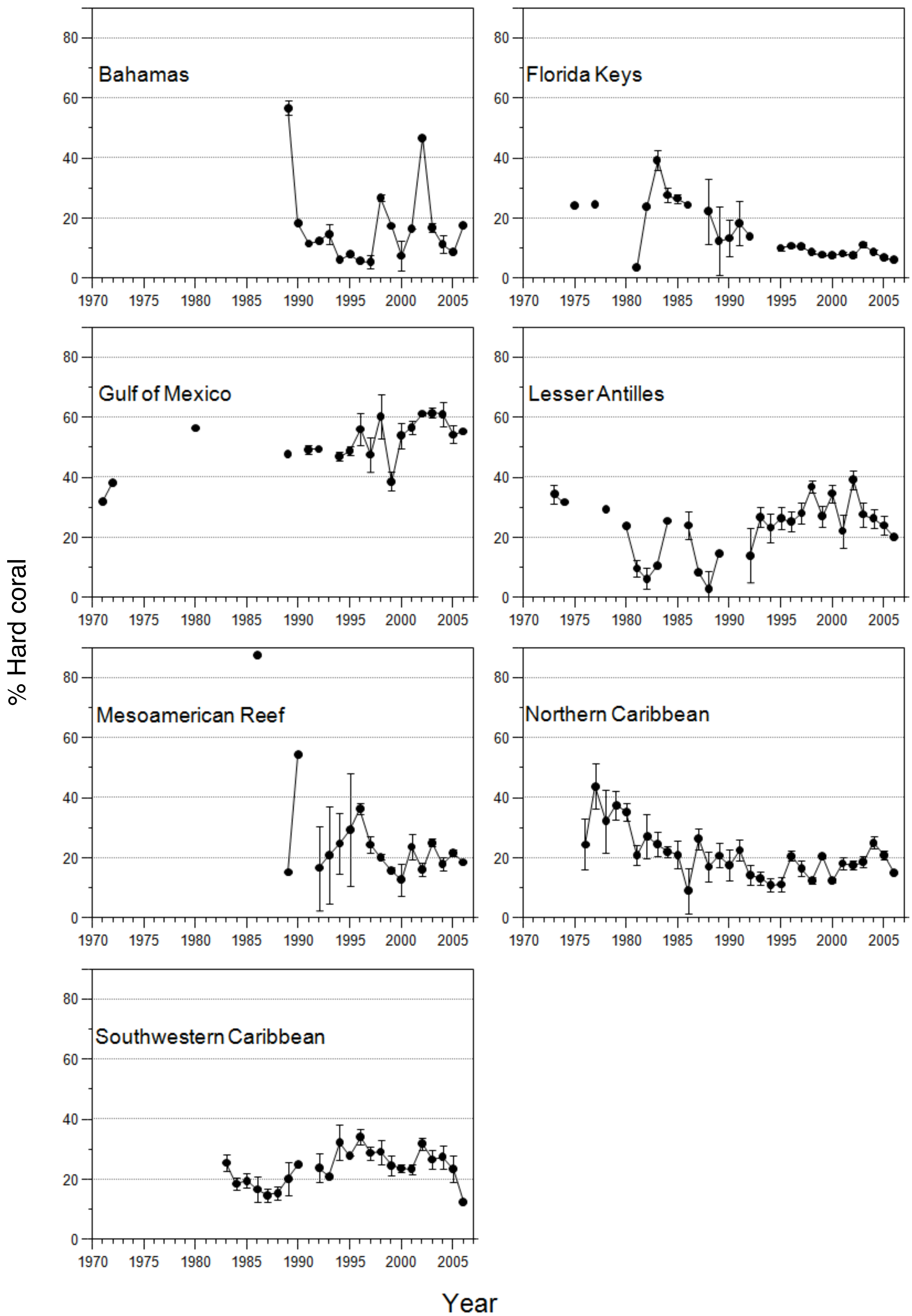

Figure S5: Annual regional cover values calculated using all data available and data from monitored sites only

A) Mean coral cover with 95% confidence intervals for all reefs (n = 1962) and for reefs surveyed in more than 1 yr (monitored; n = 376), and B) mean macroalgal cover with 95% confidence intervals for all reefs from which data were available (n = 875) and from monitored reefs (n = 243).

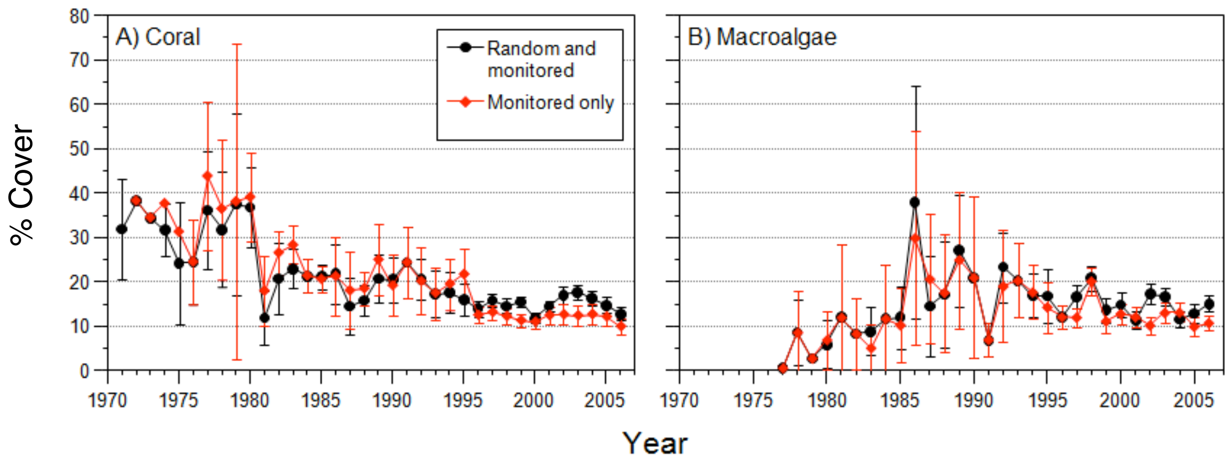

Table S1. Characteristics of the five major coral cover data sources

Note that the number of surveys and reefs in this table is larger than the total number of surveys and reefs analyzed. In some cases, cover at a site was calculated using data averaged from multiple sources. Subregion codes: Florida Keys (FLK), Gulf of Mexico (GOM)

Source	Subregions	Surveys	Reefs	Years
Atlantic and Gulf Rapid Reef Assessment (AGRRA)	All	637	633	1998–2003
Florida Coral Reef Evaluation and Monitoring Project (CREMP)	FLK	1,325	275	1996–2006
Grey literature including conference proceedings and edited books	All	451	297	1971–1972, 1976–1978, 1980, 1982–1985, 1987–2006
Peer reviewed literature	All but GOM	655	410	1973–2005
Reef Check	All but GOM	615	477	1997–2006

Table S2. Geographic distribution of reefs surveyed each year

Year	Bahamas	Florida Keys	Gulf of Mexico	Lesser Antilles	Mesoamerican Reef	Northern Caribbean	Southwestern Caribbean	Total
1971			4					4
1972			1					1
1973				1				1
1974				3				3
1975		2						2
1976						4		4
1977		2				3		5
1978				1		7		8
1979						3		3
1980			3	4		5		12
1981		4		1		4		9
1982		1		2		4		7
1983		1		6		2	22	31
1984		2		1		4	7	14
1985		4				3	12	19
1986		2		13	1	3	12	31
1987				8		4	6	18
1988		1		1		12	21	35
1989	1	2	2	6	6	8	6	31
1990	7	2			1	10	6	26
1991	1	4	2			7		14
1992	1	2	2	1	1	13	18	38
1993	1			3	3	15	6	28
1994	2		2	13	3	22	1	43
1995	1	16	2	8	5	27	2	61
1996	1	154	2	5	4	37	1	204
1997	2	179	2	10	29	44	39	305
1998	32	170	2	12	15	18	14	263
1999	51	165	7	51	80	57	16	427
2000	1	163	2	14	60	91	14	345
2001	6	203	2	14	10	169	45	449
2002	1	166	2	15	4	22	74	284
2003	1	148	2	30	39	67	27	314
2004	26	123	2	23	38	61	14	287
2005	3	107	3	22	27	35	17	214
2006	1	106	2	19	67	40	2	237
Total	139	1729	46	287	393	801	382	3777

Table S3. Characteristics of the 1996–2006 monitored reef subset

The initial and final surveys from each reef were used to calculate net change in coral and macroalgal cover. Reefs in the "> 5%" categories are a subset of those in the "Declined" and "Increased" categories.

Characteristic	No. of reefs	
	Coral cover	Macroalgal cover
Total monitored	331	215
Declined	251	105
Declined > 5%	21	15
Increased	76	103
Increased > 5%	2	16

Table S4. Temporal analysis of pooled Caribbean monitoring data

Results of a repeated measures linear repeated analysis of data from monitored reefs. We tested the hypothesis that coral and macroalgal cover did not change between 1996 and 2006. Separate analyses were performed for coral and macroalgal cover.

Variable	**Reefs**	**Observations**	**Coefficient**	**p-value**	**Lower CI**	**Upper CI**
Coral	331	1901	–0.1049	0.312	–0.3087	0.0989
Macroalgae	215	1427	–0.1825	0.109	–0.4059	–0.0410

Table S5. Temporal analysis of coral monitoring data by subregion

Results of a repeated measures linear regression analysis of data from monitored reefs. We tested the hypothesis that coral cover did not change between 1996 and 2006. Separate analyses were performed for each subregion. Note the small number of reefs sampled for some subregions.

Subregion	Reefs	Observations	Coefficient	p-value	Lower CI	Upper CI
Bahamas	3	9	1.3001	0.081	–0.3944	2.9960
Florida Keys	181	1450	–0.4126	0.000	–0.5471	–0.2781
Gulf of Mexico	3	24	0.3758	0.245	–0.6157	1.3672
Lesser Antilles	39	112	–1.7423	0.003	–2.8711	–0.6133
Mesoamerican Reef	39	97	–0.7520	0.179	–1.864	0.3599
Northern Caribbean	45	138	1.1748	0.007	0.3367	2.0129
Southwestern Caribbean	21	71	–1.3389	0.031	–2.5455	–0.1322

Table S6. Temporal analysis of macroalgae monitoring data by subregion

Results of a repeated measures linear regression analysis of data from monitored reefs. We tested the hypothesis that macroalgal cover did not change between 1996 and 2006. Separate analyses were performed for each subregion. Note the small number of reefs sampled for some subregions.

Subregion	**Reefs**	**Observations**	**Coefficient**	**p-value**	**Lower CI**	**Upper CI**
Bahamas	2	5	–0.6715	0.531	–10.0719	8.7288
Florida Keys	114	1138	–0.2307	0.024	–0.4310	–0.0303
Gulf of Mexico	2	16	0.0429	0.970	–11.4213	11.5051
Lesser Antilles	32	91	0.7826	0.368	–0.9624	2.5275
Mesoamerican Reef	16	37	0.5662	0.505	–1.2074	2.3340
Northern Caribbean	39	116	–1.0467	0.076	–2.2070	0.1137
Southwestern Caribbean	10	24	1.4321	0.215	–0.9990	3.863

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