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Benthic Habitat Characterization for the South Florida Ocean Measurement Facility (SFOMF)

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Protected Stony Coral Species Assessment

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SUMMARY

This report summarizes the distribution and relative abundance of two stony coral species (*Acropora cervicornis* and *Acropora palmata*) currently listed as threatened under the US Endangered Species Act (ESA) (Federal Register/Vol. 71, No. 129/Thursday, July 6, 2006 / Rules and Regulations, http://www.gpo.gov/fdsys/pkg/FR-2006-07-06/pdf/06-6017.pdf) and seven additional stony coral species which have been petitioned for listing as endangered or threatened under the ESA (*Agaricia lamarcki, Dendrogyra cylindrus*, *Dichocoenia stokesii, Montastraea annularis, Montastraea faveolata, Montastraea franksi*, and *Mycetophyllia ferox*) (Federal Register/Vol. 75, No. 27/Wednesday, February 10, 2010/Proposed Rules, http://www.nmfs.noaa.gov/pr/pdfs/fr/fr75-6616.pdf). This report also summarizes the abundance and distribution of small recreational vessel anchors observed within the study area for this survey effort.

This effort was guided by the NOAA Fisheries Service's recommended survey protocol (http://sero.nmfs.noaa.gov/pr/pdf/RecommendedSurveyProtocolforAcropora.pdf). This protocol was designed for surveying the distribution and abundance of *Acropora* spp. utilizing a 2-tiered survey approach. The protocol recommends data collection at 1 sampling site per every 10,000 m^2 within the project area. The first tier is a rapid assessment of the site to locate any occurrences of *Acropora* spp. The second tier is a more comprehensive effort designed to provide greater detail on colony abundance, size, and condition. If five or more *Acropora* colonies are identified during the tier 1 effort, a tier 2 effort is conducted. The seven candidate species were also included in the tier 1 sampling effort. No tier 2 effort was conducted for the seven candidate species. The number of small recreational vessel anchors seen during the tier 1 effort was also included.

The project area included eight coral reef habitats found in depths less than 30m (Walker et al. 2008). These habitats included, from nearshore to offshore: colonized pavement-shallow, ridge-shallow, inner linear reef, middle linear reef, colonized pavement-deep, outer linear reef, spur and groove, and aggregated patch reefs. Within these habitats in the project area, 376 sites were sampled (tier 1 sites).

No *Acropora palmata* colonies were identified during this effort. *Acropora cervicornis* was identified within 45 of the 376 tier 1 sites. A majority of these sites were within the nearshore habitats (colonized pavement-shallow, ridge-shallow, and inner linear reef) in depths less than 10m. Of these 45 sites, 29 had more than five colonies identified and were included in the tier 2 effort.

All seven candidate species were identified at the tier 1 sites within the project area during the effort: *Dichocoenia stokesii* (344 sites), *Montastraea faveolata* (291 sites), *Agaricia lamarcki* (155 sites), *Montastraea annularis* (85 sites); *Montastraea franksi* (74 sites), *Mycetophyllia ferox* (24 sites), and *Dendrogyra cylindrus (4 sites). D. stokesii* was abundant in all habitats with more than five colonies identified in 228 sites. The middle reef supported the highest abundance of *M. faveolata*. More than five colonies of *M. faveolata* were identified in 188 sites, and 11 sites had

more than 50 colonies identified. *A. lamarki* colonies were identified at nearly all of the colonized pavement-deep, outer reef, spur and groove, and aggregated patch reef; no colonies were identified in the nearshore colonized pavement-shallow and ridge-shallow habitats. Fifty sites had more than five colonies identified, and 29 sites had more than 10 colonies identified.

Fourteen sites supported more than five colonies of *M. annularis*, and four sites in the middle linear reef habitat had more than 10 colonies identified. *M. franksi* colonies were identified in all habitats except the ridge shallow habitat; more than five colonies of *M. franksi* were identified in 15 sites, and the middle linear reef supported the highest abundance of colonies. More than five colonies of *D. cylindricus* and *M. ferox* were not identified in any of the 376 tier one sites during the survey.

Anchors were counted at 149 of the 376 tier 1 sites. Anchors were observed in all eight habitats. The maximum number of anchors seen at one site was eight, and 65 sites had two or more anchors.

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I. SCOPE OF WORK AND PROJECT AREA

The purpose of this effort was to characterize the relative abundance and distribution of protected stony coral species within the shallow-water (<30 m deep) cable conduit area of the South Florida Ocean Measurement Facility (SFOMF) Restricted OPAREA. Two stony coral species (*Acropora cervicornis* and *Acropora palmata*) currently listed as threatened under the U.S. Endangered Species Act (ESA; Federal Register/Vol. 71, No. 129/Thursday, July 6, 2006 / Rules and Regulations, http://www.gpo.gov/fdsys/pkg/FR-2006-07-06/pdf/06-6017.pdf) and seven additional stony coral species (candidate species) which have been petitioned for listing as endangered or threatened under the ESA (*Dendrogyra cylindrus*, *Dichocoenia stokesii*, *Montastraea annularis*, *Montastraea faveolata*, *Montastraea franksi*, *Mycetophyllia ferox*, and *Agaricia lamarcki*; Federal Register/Vol. 75, No. 27/Wednesday, February 10, 2010/Proposed Rules, http://www.nmfs.noaa.gov/pr/pdfs/fr/fr75-6616.pdf) were included in this effort. In addition to its potential federal listing, *D. cylindrus* is currently a Florida state designated threatened species (http://myfwc.com/media/1515251/Threatened_Endangered_Species.pdf). All nine coral species are found within the southeast Florida coral reef habitats (Gilliam et al. 2011a, 2011b). Because these habitats also occur within the shallow-water cable conduit area, where the majority of cables have been deployed and will be deployed in the future, an assessment of the relative abundance and distribution of these species was requested by the Navy.

The project area for this effort was entirely within the SFOMF Restricted OPAREA located just south of the Port Everglades entrance channel in Broward County, Florida. The reef benthic habitats in water depths less than 30 m within the project area are estimated to be approximately 3.2 square kilometers. Figure 1 depicts the area (yellow outline) and the benthic habitats included in the project. Table 1 lists the benthic habitats and the estimated area of each habitat type within the project area.

II. METHODS

The field work was designed to characterize the relative abundance and distribution of the two protected and seven candidate stony coral species within the project area. Prior to data collection, sample site locations were determined. The NOAA survey protocol recommends for projects that include an area greater than 0.25 acre, data should be collected at a sample density of 1 sampling site per 10,000 m² within the project area. This sampling protocol is only required on coral reef or hardbottom habitats which are appropriate for stony coral growth. The large sand habitats which exist between the linear reefs (outer, middle and inner) and within areas of the inner reef were excluded. GIS tools were used to assign a grid of sample locations with 100-m spacing in the project area. A total of 376 sample sites were assigned within the coral reef habitats in the project area (Table 1, Figure 2, and Appendix 1).

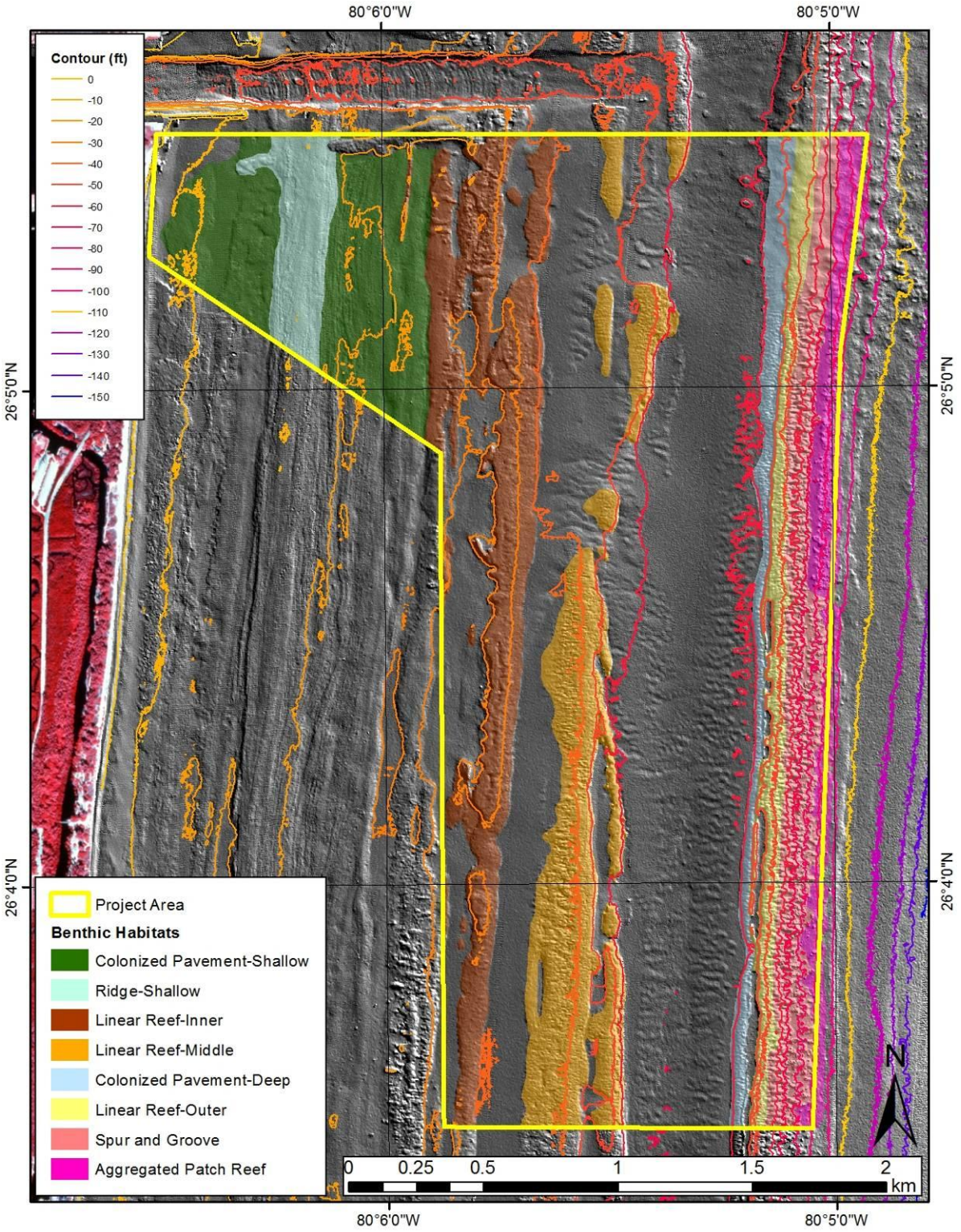

Figure 1. Map of the project area (inside the yellow line) within the shallow-water (<30m deep) cable conduit area of the SFOMF Restricted OPAREA. The map displays the benthic habitats from Walker et al. 2008 over a hillshaded image of the 2008 Broward lidar survey.

Table 1. The area (m² and acres) of each benthic habitat surveyed within the project area and the number of sample sites within each habitat.

Habitat	Square meters	Acres	No. Sample Sites
Colonized Pavement-Shallow (CPS)	565,791	140	62
Ridge-Shallow (RS)	173,880	43	18
Inner Linear Reef (IR)	716,962	177	102
Middle Linear Reef (MR)	640,020	158	83
Colonized Pavement-Deep (CPD)	202,260	50	31
Outer Linear Reef (OR)	252,368	62	24
Spur and Groove (SG)	422,374	104	45
Aggregated Patch Reef (APR)	274,466	68	11
Total	3,248,121	735	376

During surveys, divers noted the presence and abundance of each *Acropora* and candidate species at each site. The following data was also recorded for *Acropora* spp:

1. Species,
2. Single largest linear dimension of the colony or length, height, and width,
3. Estimate of percentage of live tissue.

At each sampling site, a two-tiered survey was conducted. During tier 1, divers conducted a structured 20-min timed swim from a referenced center point, noting the abundance of each *Acropora* and candidate species. Colony counts for each site were later summarized into six relative abundance categories (0 colonies, 1-5, 6-10, 11-49, 50-99, and >100). If five or less *Acropora* colonies were encountered, the required data was collected for those colonies and sampling was concluded at that site. If more than five *Acropora* colonies were encountered, the site was later revisited for a tier 2 survey. During the second tier, three belt transects were conducted from a referenced center point at three random bearings. Each belt transect measured 4 m x 50 m, for a total of 600 m^2 sampled within each site. Required data was recorded for all *Acropora* colonies encountered along each transect.

Only abundance data was recorded for candidate species during tier 1 surveys. Because the seven candidate species were included in the tier 1 effort, we standardized the area surveyed during a 20-minute dive. At each of the 376 sample sites, two research divers extended 30-m fiberglass measure tapes from the center point of the sample site. These two tapes defined a 60-m linear distance. In most cases, these tapes were extended east and west from the center point. Each diver surveyed one side of this 60-m distance out to a distance 30-m perpendicular to the measuring tapes for 20 minutes. The resulting estimated total survey area was 3,600m² (60 m x 60 m) at each tier 1 site.

Figure 2. Project area habitat map with the locations of the 376 sample sites.

The project area within the South Florida Ocean Measurement Facility (SFOMF) Restricted OPAREA is immediately south of the Port Everglades entrance channel. This close proximity to the channel leads to many recreational (boating, fishing, and diving) activities within the project area. Although anchoring is prohibited in the OPAREA, previous observations by the Navy and its contractors have noted the presence of abandoned small recreational vessel anchors on reef and on cable within the project area. Anchor snags on cable are likely one factor contributing to potential cable movement. In order to capture information on the presence of anchors, the number of small recreational vessel anchors observed during the tier 1 effort was recorded.

III. RESULTS

Listed Species

Acropora palmata

No *Acropora palmata* colonies were observed at any of the 376 survey sites.

Acropora cervicornis

Acropora cervicornis colonies were identified at 45 of the 376 sites during tier 1 surveys. Table 2 summarizes and Figure 3 illustrates the relative abundance of *A. cervicornis* identified within the project area sites. Thirty-eight of these 45 sites were in the nearshore colonized pavement-shallow, ridge-shallow, and inner reef habitats. *Acropora cervicornis* was identified in all habitats surveyed except for the aggregated patch reef which was generally in depths greater than 20 m. Twenty-nine sites had more than five *A. cervicornis* colonies identified, and tier 2 efforts were conducted at those sites.

Table 2. Tier 1 site summary data for *Acropora cervicornis*. The tier 2 sites were those with >5 colonies identified.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	19	15	43	4	2	9	3	1	573
RS	18	13	12	5	1	1	3	4	4	1196
IR	102	6	1	96	5	1	0	0	0	21
MR	83	2	0	81	2	0	0	0	0	3
CPD	31	1	0	30	1	0	0	0	0	1
OR	24	1	1	23	0	1	0	0	0	9
SG	45	3	0	42	3	0	0	0	0	5
APR	11	0	0	11	0	0	0	0	0	0
Total	376	45	29	331	16	5	12	7	5	1808

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

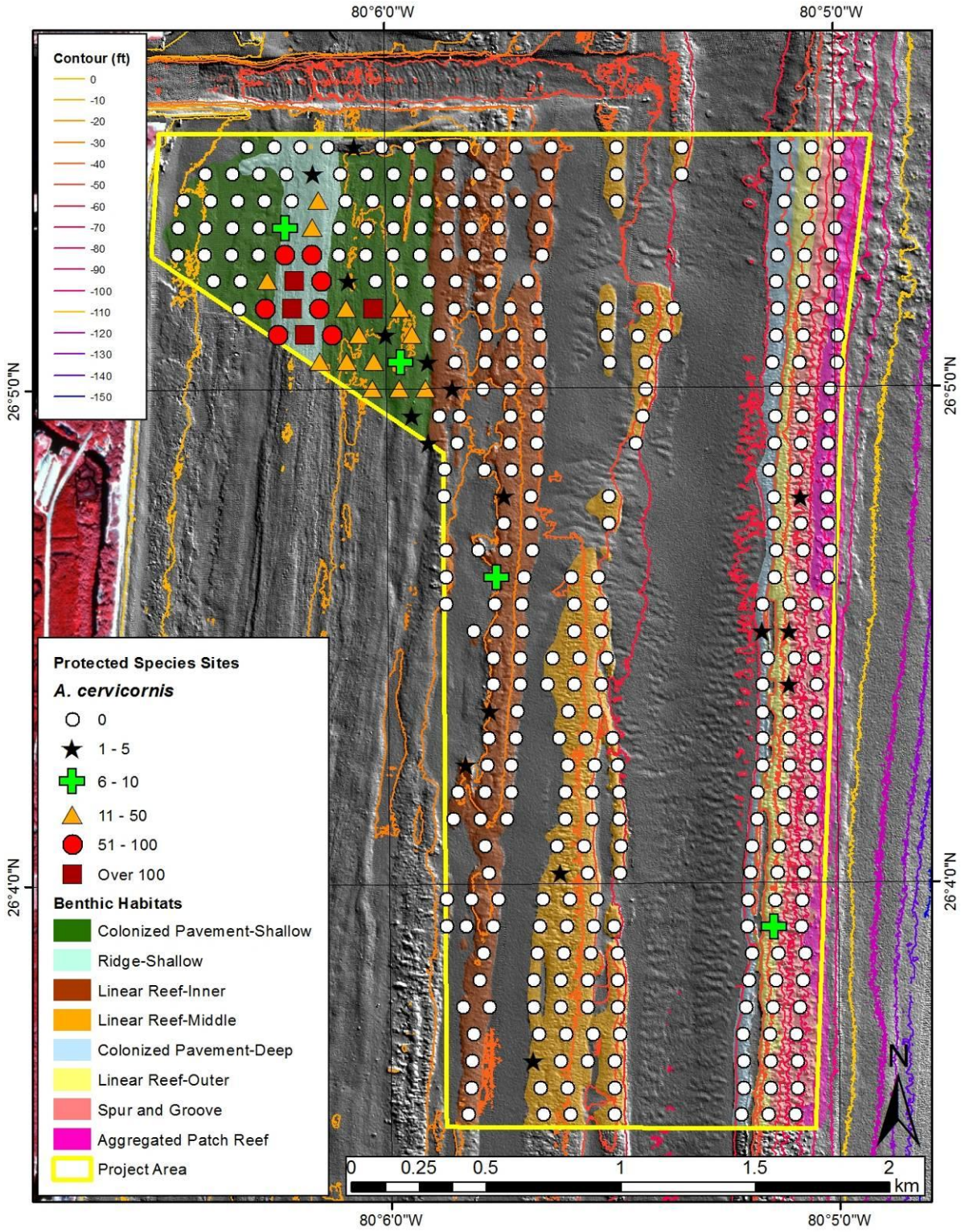

Figure 3. Project area map with the locations and abundance categories (number of colonies) of the 45 sample sites where *Acropora cervicornis* was observed. The 29 tier 2 sites are those in the 6-10, 11-49, 50-99, and >100 abundance categories.

Table 3 summarizes the data recorded at the 29 tier 2 sites. *Acropora cervicornis* colonies were observed within the three randomly-placed belt transects at 26 of the 29 sites. No colonies were observed within the belt transects at sites 60, 208, and 320 (refer to Figure 2 for site locations). This was not surprising considering the patchy distribution of *A. cervicornis* and the fact that the belt transects encompassed only 600 m^2 of each 3,600 m^2 tier 1 survey area. The number of colonies identified within belt transects at the remaining 26 sites ranged from two (0.01 colonies/m^2; sites 59 and 152) to 137 (0.23 colonies/m^2; site 123). The overall mean density (±1 standard deviation [SD]) for the 29 tier 2 sites was 0.05 (±0.07) colonies/m^2. Colony length ranged from 1 cm to 90 cm with an overall mean length of 30.41 cm (±15.50 cm). The mean colony length at 17 of the 26 sites was greater than 30 cm and two sites (sites 153 and 154) had mean colony lengths greater than 40 cm. Percent live colony tissue ranged from 63% to 96% with an overall mean of 79% (±23%). Mean percent live colony tissue was at least 75% at 21 of the 26 sites, and was greater than 90% at five sites.

Cable impacts to the *A. cervicornis* colonies identified within the belt transects during tier 2 surveys were recorded. These impacts included colony shading (which occurred when a cable was not in direct contact with a colony but was suspended over a portion of the colony), colony growth over a cable, and colony contact with no growth over the cable. Cable impacts were identified at nine tier 2 sites (Table 4). In total, 10 colonies were shaded by cable, 17 colonies were growing over cable, and six colonies were in contact with the cable with no growth over the cable. This total (33 colonies) represented 4% of the total 823 colonies (Table 3) identified at the 29 tier 2 sites. Table 5 presents a comparison of average percent live tissue for *A. cervicornis* colonies impacted and not impacted by cables at the nine tier 2 sites where cable impacts were observed. With the small sample size of colonies within each impacted type, especially compared to the number of not impacted colonies, it is difficult to complete a meaningful comparison of colony condition (percent live tissue) among colony types. The summary data does indicate that the condition of the colonies is similar within each of the colony types (Table 5).

Candidate Species

Agaricia lamarcki

Agaricia lamarcki colonies were identified at 155 of the 376 sites during the tier 1 surveys. Table 6 summarizes and Figure 4 illustrates the relative abundance of *A. lamarcki* observed within the project area sites. No colonies were observed in the nearshore colonized pavement-shallow and ridge-shallow habitats, but nearly all of the colonized pavement-deep, outer linear reef, spur and groove, and aggregated patch reef sites had *A. lamarcki* colonies present. Fifty sites had more than five colonies identified and 29 sites had more than 10 colonies identified.

Table 3. Tier 2 site summary data for *Acropora cervicornis*. The mean values for number of colonies identified, colony length (cm), colony percent live tissue, and colony density (colonies/m^2) for each site are based on the three sampled transects. The bottom row is summary data for the entire project area (all 29 sites pooled).

		Total	No. of Colonies		Colony Length		%Live Tissue		Density	
Site #	Habitat	Colonies	Mean	SD	Mean	SD	Mean	SD	Mean	SD
41	RS	9	3.00	2.65	24.33	10.01	75.00	27.16	0.02	0.01
59	RS	2	0.67	0.58	26.50	17.68	92.50	10.61	0.01	0.00
60	RS	0	---	---	---	---	---	---	0.00	---
76	RS	8	2.67	3.79	27.25	11.21	91.25	6.41	0.01	0.02
77	RS	18	6.00	8.72	23.50	7.31	90.83	10.74	0.03	0.04
91	CPS	55	18.33	17.04	32.04	14.48	82.27	20.97	0.09	0.09
92	RS	127	42.33	19.66	30.07	15.55	78.57	24.78	0.21	0.10
93	RS	37	12.33	16.29	32.16	14.09	86.27	21.92	0.06	0.08
105	RS	9	3.00	4.36	35.00	16.30	81.67	19.53	0.02	0.02
106	RS	106	35.33	13.58	26.27	12.44	79.35	23.88	0.18	0.07
107	CPS	80	26.67	20.82	27.23	11.98	83.01	19.77	0.13	0.10
108	CPS	7	2.33	2.08	35.00	11.90	63.57	23.93	0.01	0.01
109	CPS	42	14.00	7.81	30.83	15.90	89.81	16.19	0.07	0.04
110	CPS	10	3.33	5.77	25.50	13.63	75.00	13.54	0.02	0.03
122	RS	7	2.33	1.15	34.29	8.38	81.43	20.56	0.01	0.01
123	RS	137	45.67	12.22	29.22	16.58	69.56	24.64	0.23	0.06
124	CPS	36	12.00	4.58	36.53	22.29	76.67	19.57	0.06	0.02
125	CPS	19	6.33	2.52	37.05	19.82	80.26	16.87	0.03	0.01
127	CPS	7	2.33	2.08	39.29	22.28	85.71	29.36	0.01	0.01
138	RS	32	10.67	10.02	31.28	16.64	72.81	28.37	0.05	0.05
139	CPS	5	1.67	2.89	37.00	8.37	96.00	5.48	0.01	0.01
140	CPS	32	10.67	3.79	33.97	15.02	78.59	22.55	0.05	0.02
141	CPS	11	3.67	6.35	30.91	14.69	68.18	16.62	0.02	0.03
152	CPS	2	0.67	1.15	35.00	14.14	65.00	21.21	0.01	0.01
153	CPS	15	5.00	4.36	46.87	20.55	75.67	17.20	0.03	0.02
154	CPS	6	2.00	1.73	40.00	5.48	83.33	18.62	0.01	0.01
163	CPS	4	1.33	2.31	26.25	7.50	95.00	5.77	0.01	0.01
208	IR	0	---	---	---	---	---	---	0.00	---
320	OR	0	---	---	---	---	---	---	0.00	---
29 sites		823	28.38	37.92	30.41	15.50	78.83	22.83	0.05	0.07

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, and OR = Outer Linear Reef.

Table 4. Tier 2 cable impact (shaded by cable, growth over cable, and contact with cable) site summary data for *Acropora cervicornis*. Only sites where cable impacts to *A. cervicornis* colonies were observed are listed.

Site	Habitat	Total No. Colonies	Shaded	Growth	Contact
91	Ridge-Shallow	55	2	0	0
92	Ridge-Shallow	127	2	2	5
107	Colonized Pavement-Shallow	80	2	10	0
110	Colonized Pavement-Shallow	10	2	0	0
122	Colonized Pavement-Shallow	7	0	1	0
124	Colonized Pavement-Shallow	36	0	1	0
125	Colonized Pavement-Shallow	19	2	0	1
140	Colonized Pavement-Shallow	32	0	1	0
153	Colonized Pavement-Shallow	15	0	2	0
9		381	10	17	6

Table 5. Tier 2 cable impact site summary data for *Acropora cervicornis* percent live tissue. Only sites where cable impacts to *A. cervicornis* colonies were observed are included.

Colony Type	No. of Colonies	%Live Tissue Mean	SD
Not Impacted	348	79.8	21.7
Shaded	10	89.5	8.6
Growth over cable	17	75.5	24.3
Contact with cable	6	75.0	20.5
All colonies	381	79.8	21.6

Table 6. Tier 1 site summary data for *Agaricia lamarcki*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories 0	1-5	6-10	11-49	50-99	>100	Estimated Total No. Colonies
CPS	62	0	0	62	0	0	0	0	0	0
RS	18	0	0	18	0	0	0	0	0	0
IR	102	5	0	97	5	0	0	0	0	5
MR	83	50	3	33	47	3	0	0	0	107
CPD	31	26	2	5	24	2	0	0	0	74
OR	24	20	4	4	16	4	0	0	0	66
SG	45	43	30	2	13	11	19	0	0	459
APR	11	11	11	0	0	1	10	0	0	201
Total	376	155	50	221	105	21	29	0	0	912

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

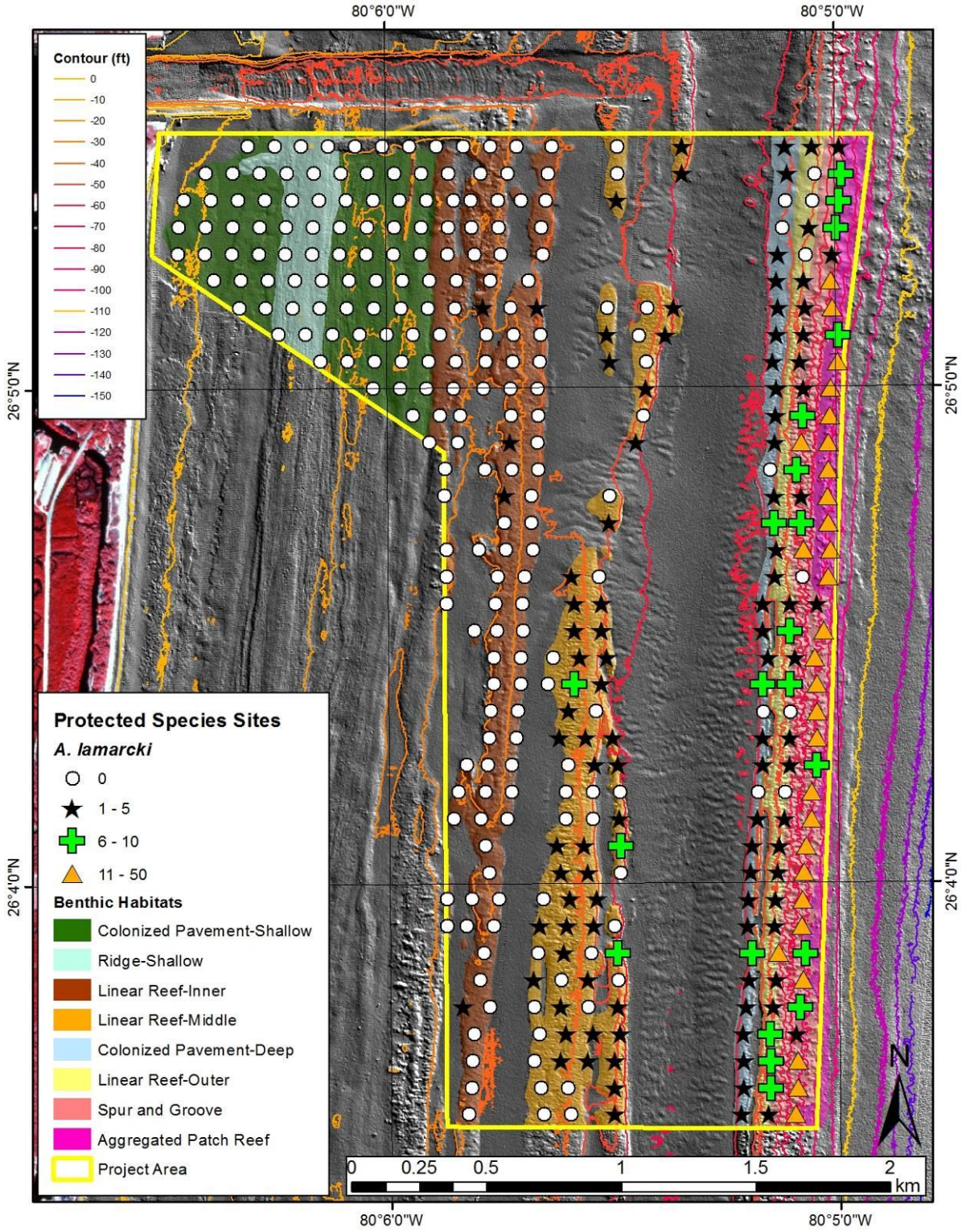

Figure 4. Project area map with the locations and abundance categories (numbers of colonies) of the 155 sample sites where *Agaricia lamarcki* was observed.

Dendrogyra cylindrus

Dendrogyra cylindrus was observed at only four of the 376 tier 1 sites, making it the least common and abundant of the targeted species. Table 7 summarizes and Figure 5 illustrates the relative abundance of *D. cylindrus* observed within the project area sites. All four colonies were observed on the inner linear reef at four separate sites. No sites had more than five colonies identified.

Table 7. Tier 1 site summary data for *Dendrogyra cylindrus*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	0	0	62	0	0	0	0	0	0
RS	18	0	0	18	0	0	0	0	0	0
IR	102	4	0	98	4	0	0	0	0	4
MR	83	0	0	83	0	0	0	0	0	0
CPD	31	0	0	31	0	0	0	0	0	0
OR	24	0	0	24	0	0	0	0	0	0
SG	45	0	0	45	0	0	0	0	0	0
APR	11	0	0	11	0	0	0	0	0	0
Total	376	4	0	372	4	0	0	0	0	4

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

Dichocoenia stokesii

Dichocoenia stokesii was observed at 344 (91%) of the 376 tier 1 sites, making it the most common and abundant of the targeted species. Table 8 summarizes and Figure 6 illustrates the relative abundance of *D. stokesii* observed within the project area sites. Colonies were relatively abundant in all habitats and more than five colonies were observed at 228 sites.

Table 8. Tier 1 site summary data for *Dichocoenia stokesii*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	55	50	7	5	4	40	6	0	1490
RS	18	18	18	0	0	0	8	9	1	1051
IR	102	102	91	0	11	24	61	6	0	2004
MR	83	76	41	7	35	27	14	0	0	559
CPD	31	26	9	5	17	7	2	0	0	127
OR	24	24	15	0	9	11	4	0	0	162
SG	45	34	2	11	32	1	1	0	0	94
APR	11	9	2	2	7	2	0	0	0	27
Total	376	344	228	32	116	76	130	21	1	5514

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

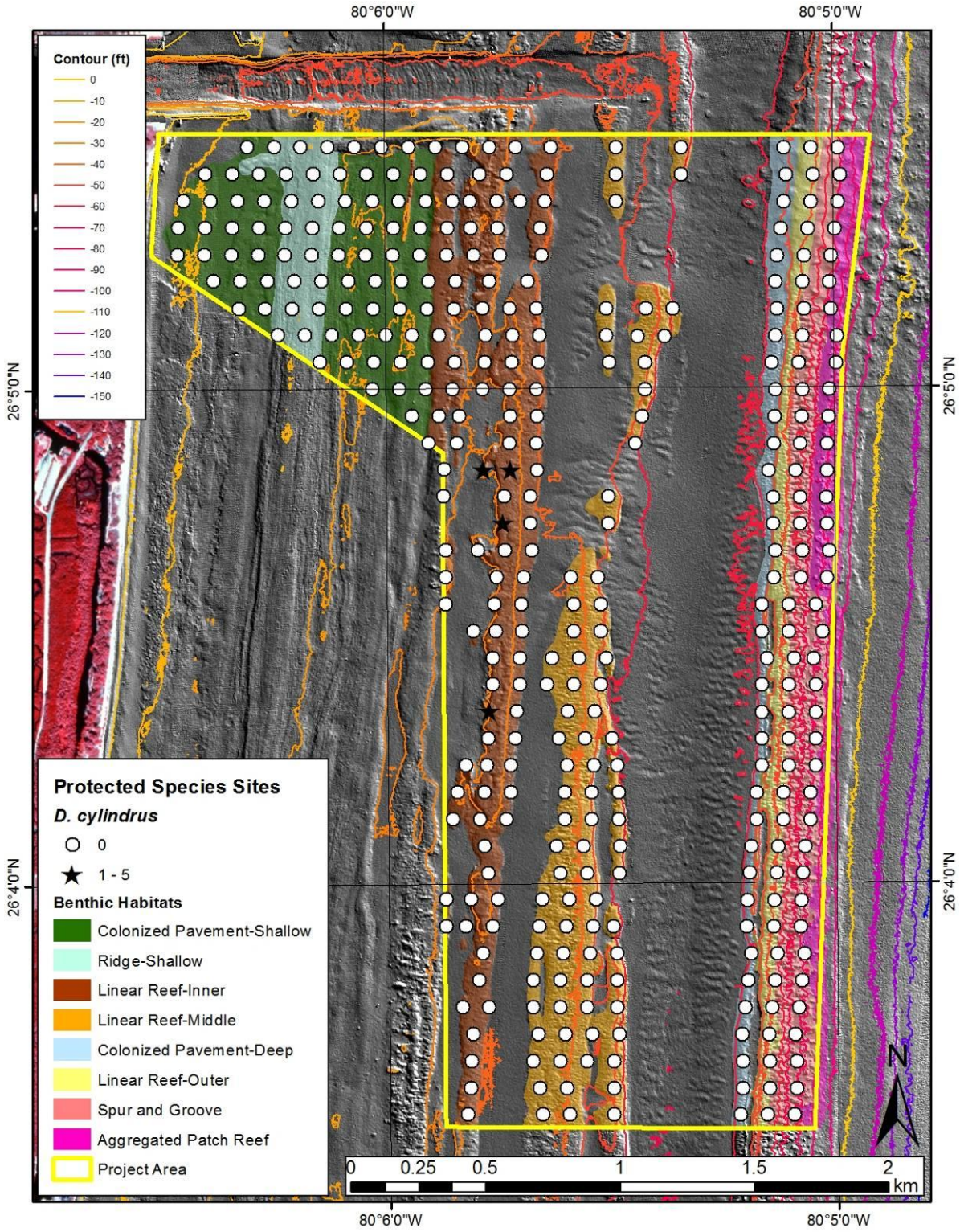

Figure 5. Project area map with the locations and abundance categories (numbers of colonies) of the 4 sample sites where *Dendrogyra cylindrus* was observed.

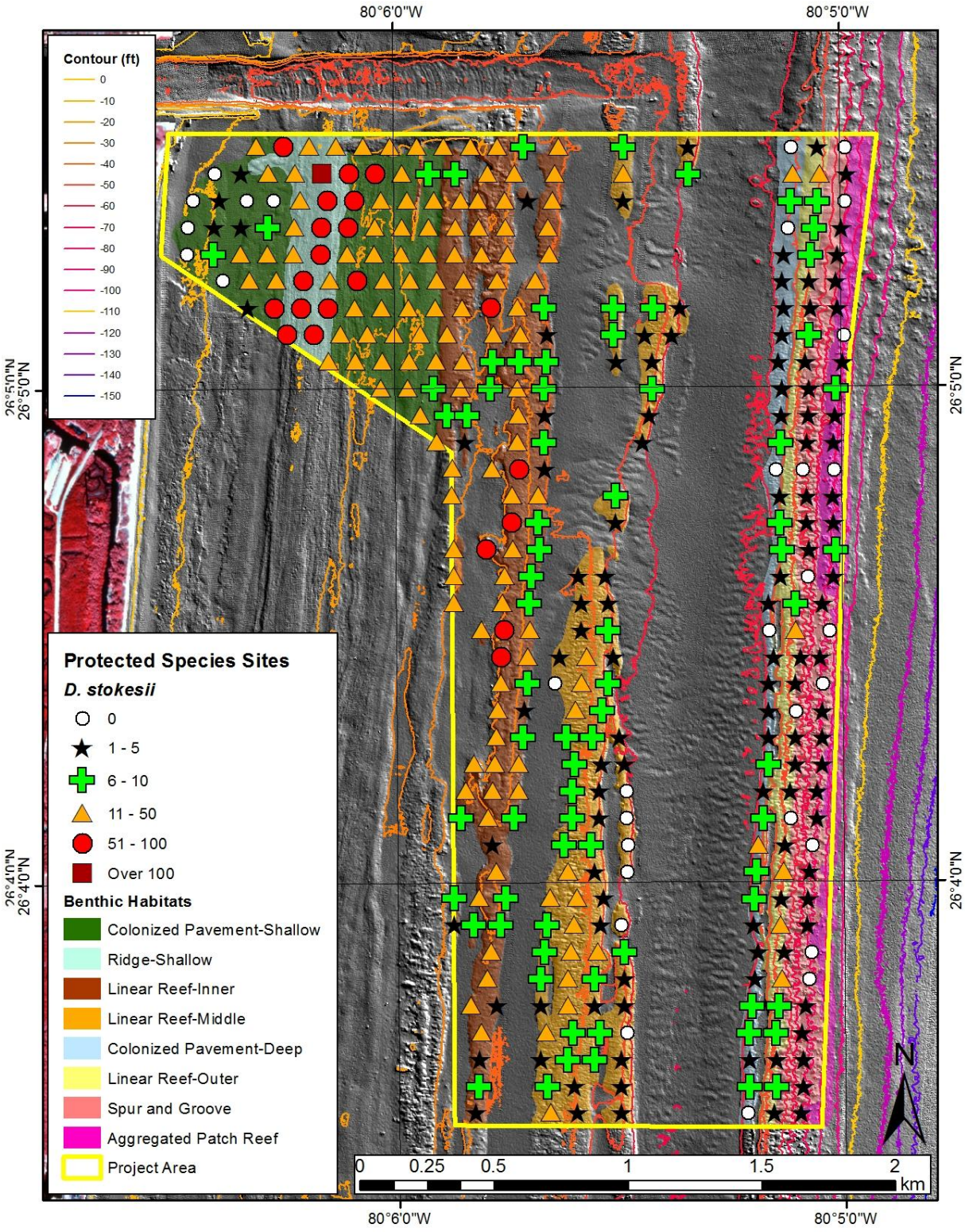

Figure 6. Project area map with the locations and abundance categories (numbers of colonies) of the 344 sample sites where *Dichocoenia stokesii* was observed.

Montastraea annularis

Montastraea annularis colonies were identified at 85 of the 376 tier 1 sites. Table 9 summarizes and Figure 7 illustrates the relative abundance of *M. annularis* identified at the project area sites. *Montastraea annularis* was identified in all habitats except for ridge-shallow. More than five colonies were observed at 14 sites and more than 10 colonies were observed at three sites all on the middle linear reef.

Table 9. Tier 1 site summary data for *Montastraea annularis*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	4	0	58	4	0	0	0	0	6
RS	18	0	0	18	0	0	0	0	0	0
IR	102	23	2	79	21	2	0	0	0	44
MR	83	36	9	47	27	6	3	0	0	143
CPD	31	5	1	26	4	1	0	0	0	20
OR	24	7	1	17	6	1	0	0	0	20
SG	45	7	1	38	6	1	0	0	0	22
APR	11	3	0	8	3	0	0	0	0	7
Total	376	85	14	291	71	11	3	0	0	262

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

Montastraea faveolata

Montastraea faveolata was observed at 291 of the 376 tier 1 sites, making it the second most common and abundant of the targeted species. Table 10 summarizes and Figure 8 illustrates the relative abundance of *M. faveolata* identified within the project area sites. *Montastraea faveolata* colonies were observed in all benthic habitats except for the ridge-shallow. More than five colonies were observed at 180 sites, and 50 or more colonies were observed at 11 sites, ten of which were on the middle linear reef.

Table 10. Tier 1 site summary data for *Montastraea faveolata*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	29	4	33	25	3	1	0	0	84
RS	18	4	0	14	4	0	0	0	0	6
IR	102	85	43	17	42	21	22	0	0	621
MR	83	76	57	7	19	9	38	9	1	1776
CPD	31	23	20	1	6	8	12	0	0	284
OR	24	26	17	5	6	0	17	0	0	313
SG	45	38	33	7	5	5	27	1	0	862
APR	11	10	6	1	4	3	3	0	0	84
Total	376	291	180	85	111	49	120	10	1	4030

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

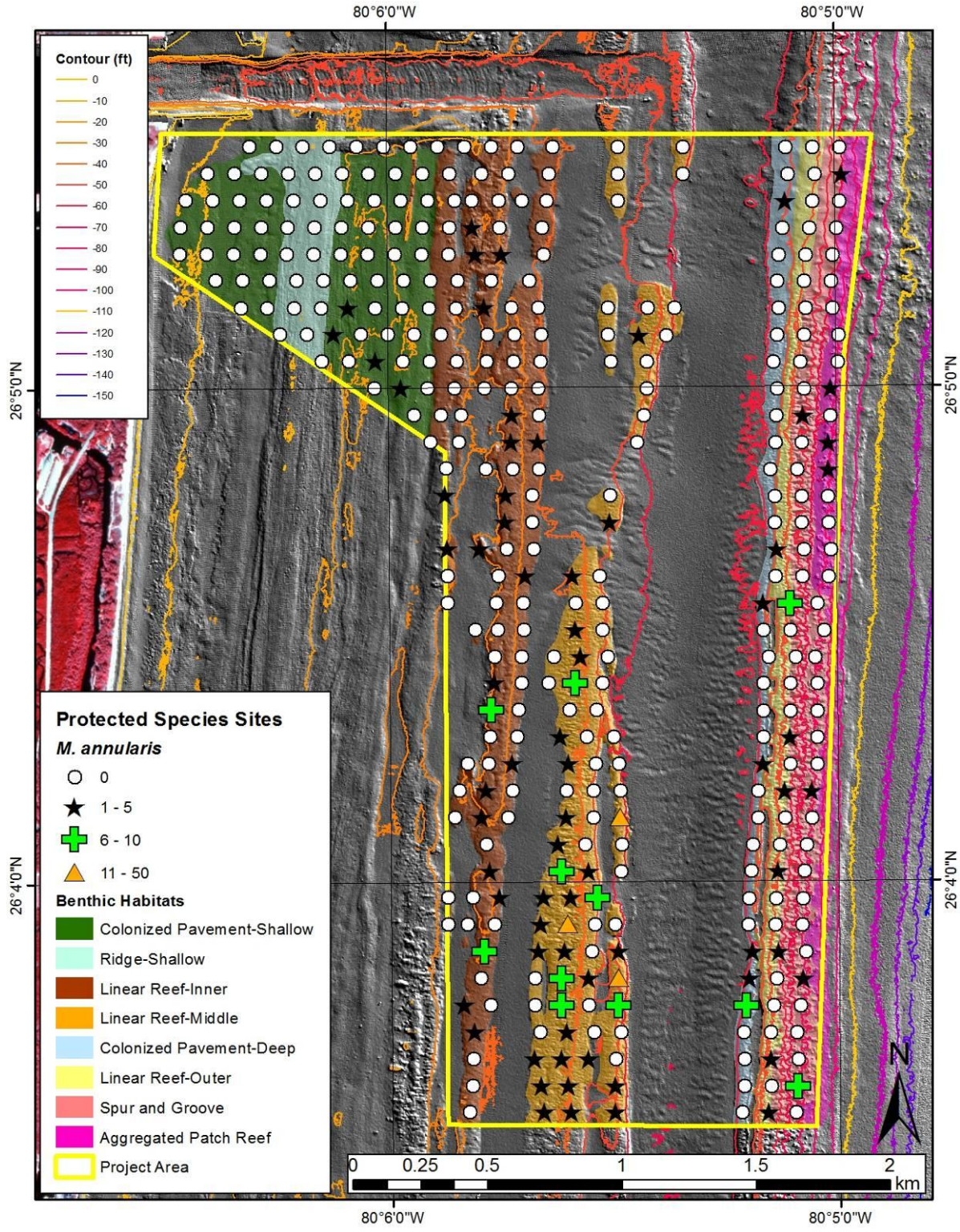

Figure 7. Project area map with the locations and abundance categories (numbers of colonies) of the 85 sample sites where *Montastraea annularis* was observed.

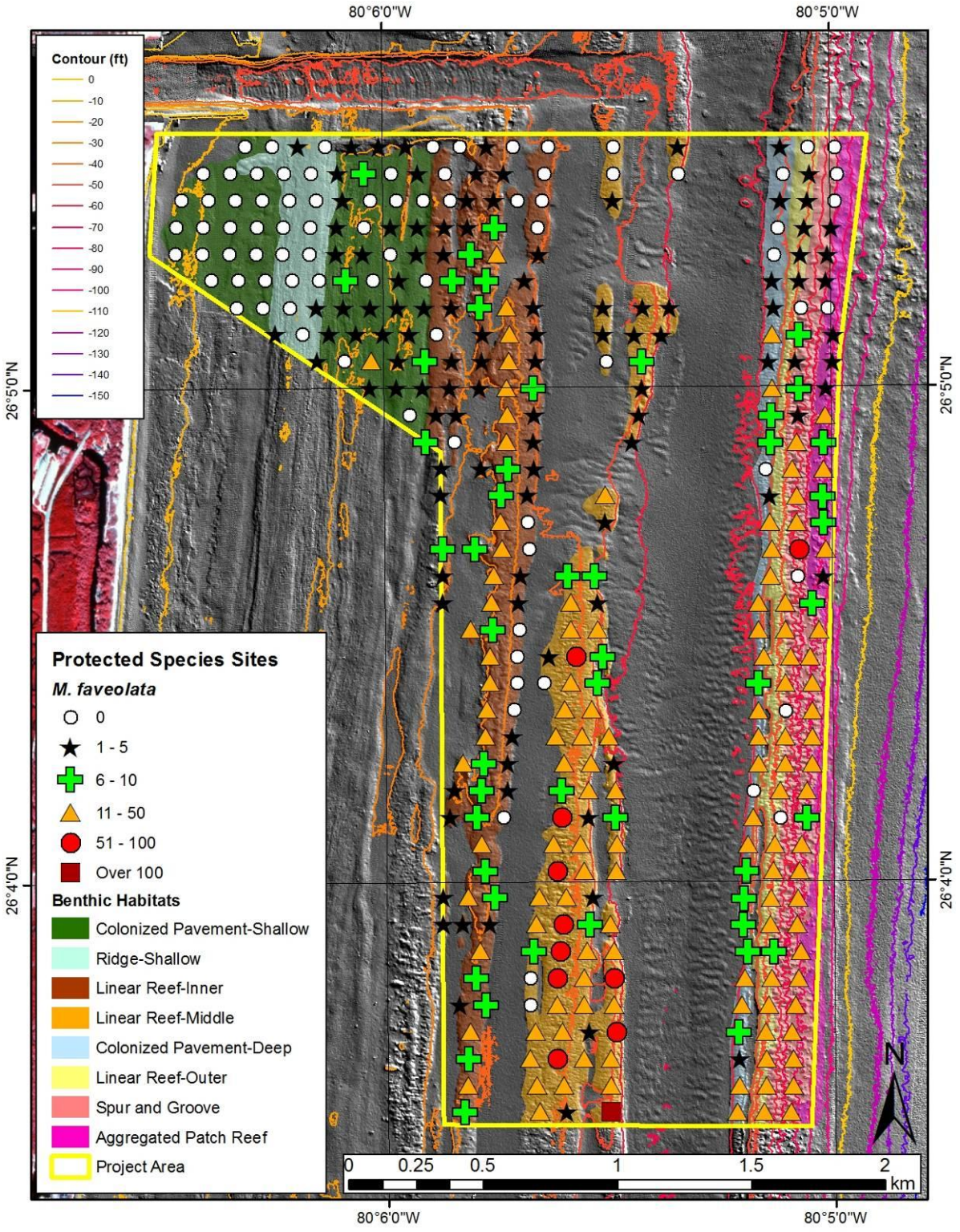

Figure 8. Project area map with the locations and abundance categories (numbers of colonies) of the 291 sample sites where *Montastraea faveolata* was observed.

Montastraea franksi

Montastraea franksi colonies were observed at 74 of the 376 tier 1 sites. Table 11 summarizes and Figure 9 illustrates the relative abundance of *M. franksi* identified within the project area sites. *Montastraea franksi* colonies were observed in all habitats except the ridge-shallow, and were observed at only one site each on the colonized pavement-shallow and aggregated patch reef. More than five colonies were observed at 15 sites, all deeper than the inner linear reef.

Table 11. Tier 1 site summary data for *Montastraea franksi*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	1	0	61	1	0	0	0	0	2
RS	18	0	0	18	0	0	0	0	0	0
IR	102	19	0	83	19	0	0	0	0	25
MR	83	22	9	61	13	5	4	0	0	151
CPD	31	9	1	22	8	1	0	0	0	28
OR	24	8	4	16	4	2	2	0	0	55
SG	45	14	1	31	13	1	0	0	0	36
APR	11	1	0	10	1	0	0	0	0	1
Total	376	74	15	302	59	9	6	0	0	298

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

Mycetophyllia ferox

Mycetophyllia ferox was observed at 24 of the 376 tier 1 sites, making it the second-least common and abundant of the targeted species. Table 12 summarizes and Figure 10 illustrates the relative abundance of *M. ferox* observed within the project area sites. *Mycetophyllia ferox* colonies were not observed in the nearshore colonized pavement-shallow and ridge-shallow habitats. No more than five colonies were observed at any site.

Table 12. Tier 1 site summary data for *Mycetophyllia ferox*.

Habitat	Total Sample Sites	No. Sites Species Present	No. Sites >5 Colonies	Abundance Categories						Estimated Total No. Colonies
				0	1-5	6-10	11-49	50-99	>100	
CPS	62	0	0	62	0	0	0	0	0	0
RS	18	0	0	18	0	0	0	0	0	0
IR	102	4	0	98	4	0	0	0	0	4
MR	83	8	0	75	8	0	0	0	0	9
CPD	31	1	0	30	1	0	0	0	0	1
OR	24	5	0	19	5	0	0	0	0	6
SG	45	5	0	40	5	0	0	0	0	5
APR	11	1	0	10	1	0	0	0	0	1
Total	376	24	0	352	24	0	0	0	0	26

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

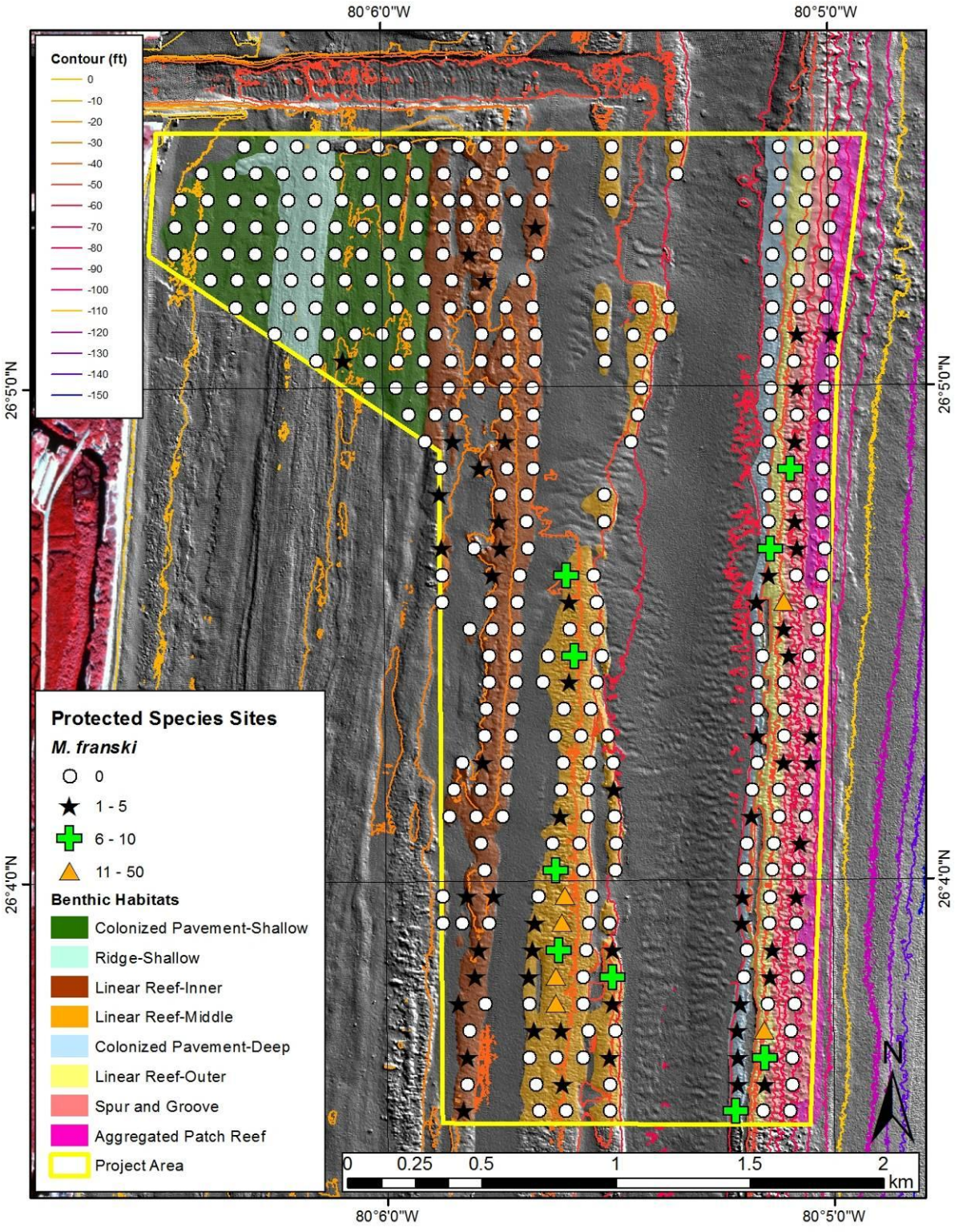

Figure 9. Project area map with the locations and abundance categories (numbers of colonies) of the 74 sample sites where *Montastraea franksi* was observed.

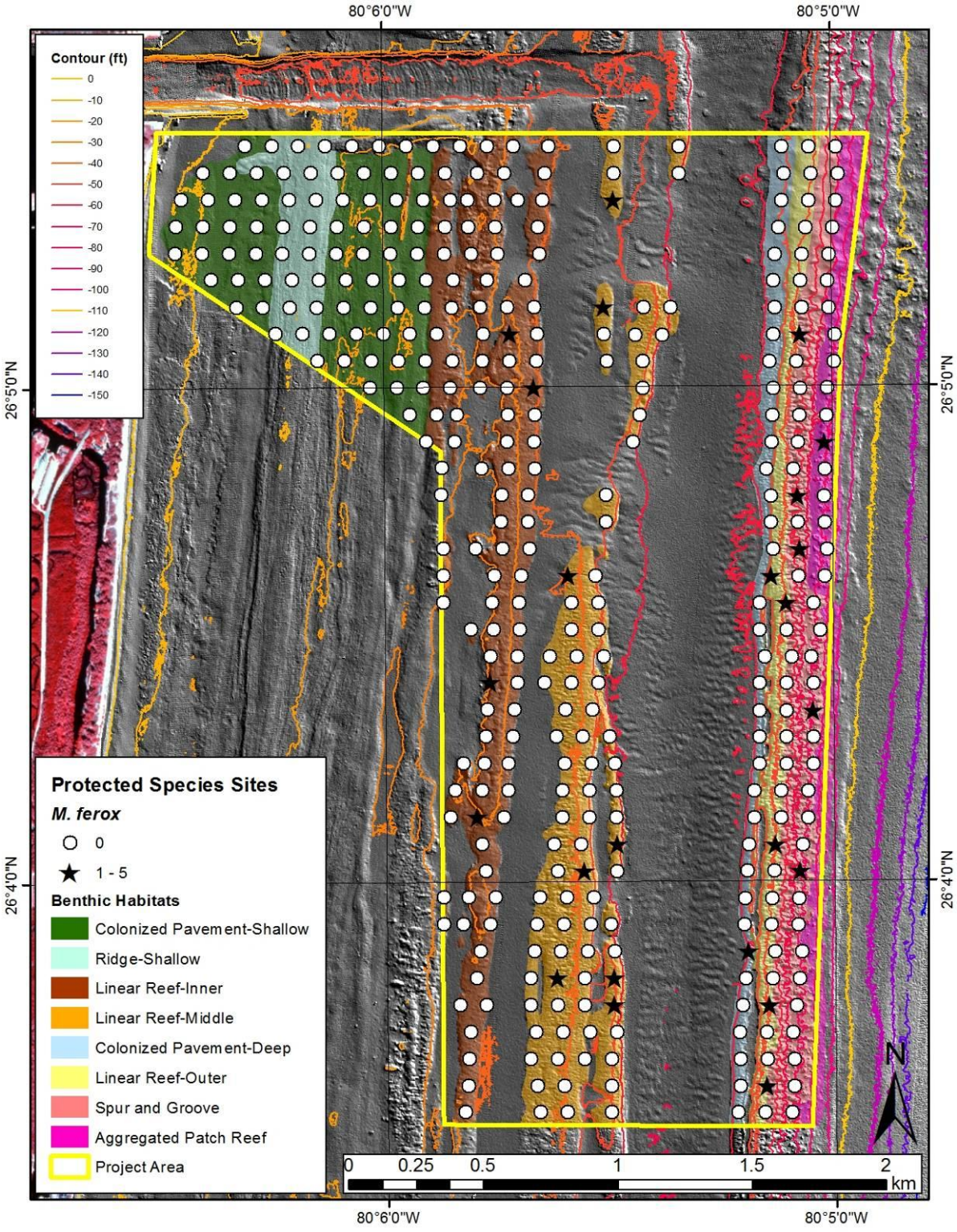

Figure 10. Project area map with the locations and abundance categories (numbers of colonies) of the 24 sample sites where *Mycetophyllia ferox* was observed.

Small Vessel Anchors

Anchors were observed and counted at 149 (40%) of the 376 tier 1 sites. Although not quantified, many cables were observed to be snagged by anchors. Table 13 summarizes and Figure 11 illustrates the abundance of anchors counted within the project area sites. Anchors were observed in all eight habitats. The maximum number of anchors seen at one site was eight, and 65 sites had two or more anchors.

Table 13. Tier 1 site summary data for small vessel anchors.

Habitat	Total Sample Sites	No. Sites with Anchors	No. of Anchors									Estimated Total No. Anchors
			0	1	2	3	4	5	6	7	8	
CPS	62	24	38	18	2	3	1	0	0	0	0	35
RS	18	5	13	5	0	0	0	0	0	0	0	5
IR	102	39	63	16	13	7	1	0	0	1	1	82
MR	83	42	41	24	10	4	3	1	0	0	0	73
CPD	31	8	23	4	4	0	0	0	0	0	0	12
OR	24	14	10	8	5	0	1	0	0	0	0	22
SG	45	13	32	6	4	1	2	0	0	0	0	25
APR	11	4	7	3	1	0	0	0	0	0	0	5
Total	376	149	227	84	39	15	8	1	0	1	1	259

Habitat legend: CPS = Colonized Pavement-Shallow, RS = Ridge-shallow, IR = Inner Linear Reef, MR = Middle Linear Reef, CPD = Colonized Pavement-Deep, OR = Outer Linear Reef, SG = Spur and Groove, and APR = Aggregated Patch Reef.

IV. DISCUSSION

Two U.S. ESA-listed coral species, *Acropora palmata* and *Acropora cervicornis*, and seven candidate coral species (*Agaricia lamarcki*, *Dendrogyra cylindrus*, *Dichocoenia stokesii*, *Montastraea annularis*, *Montastraea faveolata*, *Montastraea franksi*, and *Mycetophyllia ferox*) were included in this survey. The project area included 376 sites distributed across eight habitats in water <30 m deep. All nine species were surveyed following the NOAA Fisheries Service's recommended *Acropora* spp. sampling protocol.

Table 14 summarizes the survey effort and presence data by habitat and Table 15 summarizes the number of sites for which more than five colonies of a given species were present.

No *A. palmata* colonies were observed.

Acropora cervicornis was observed at 45 sites, 38 (84%) of which were in the three shallowest habitats. More than five colonies were observed at 29 sites, 27 (93%) of which were in the two shallowest habitats. Past cable lays have shaded and directly contacted 4% of the *A. cervicornis* colonies observed during tier 2 surveys in the project area, and all of these occurrences were observed in the two shallowest habitats: colonized pavement-shallow and ridge-shallow.

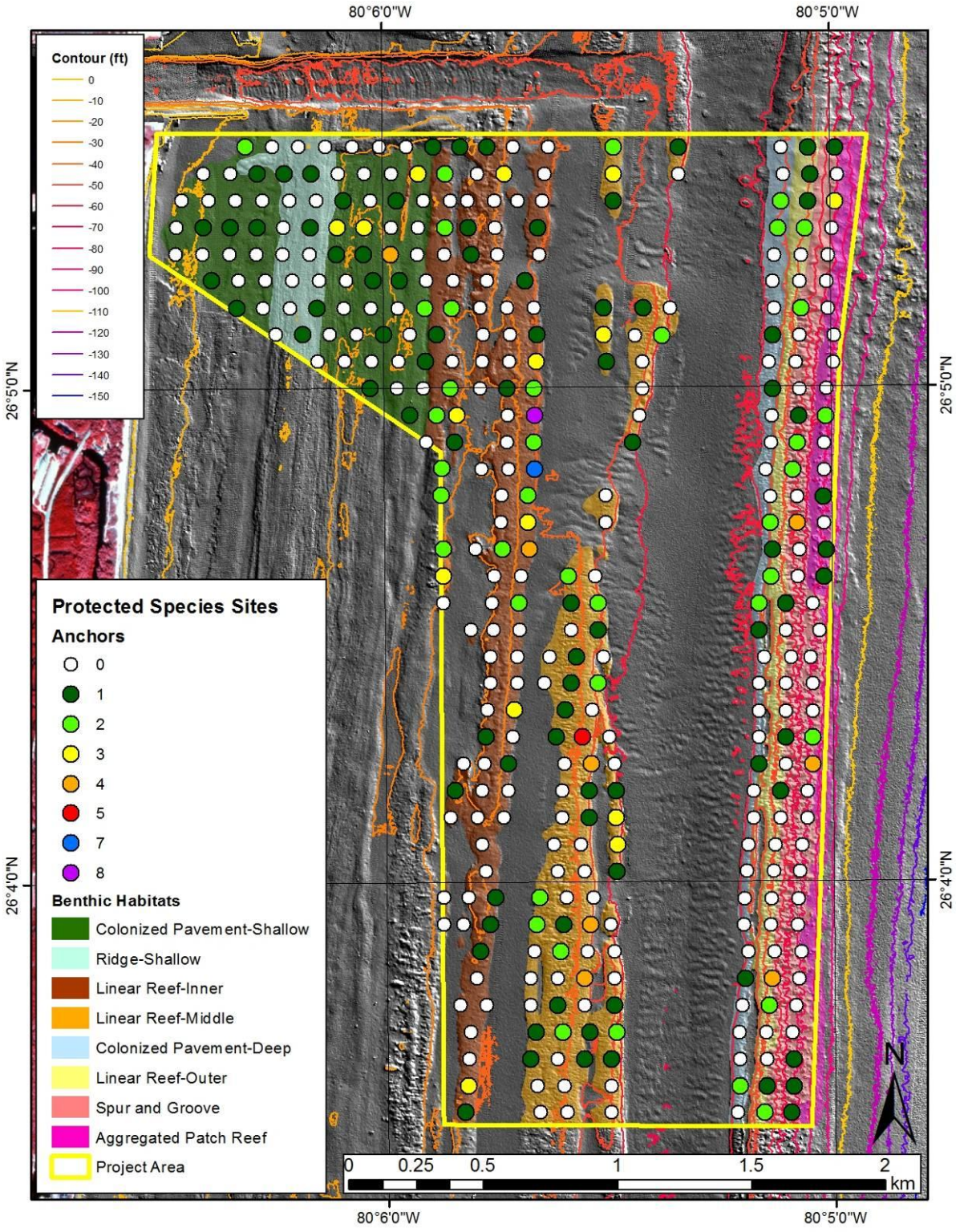

Figure 11. Project area map with the locations and abundances of small vessel anchors.

Table 14. Number of sites within each habitat for in which coral colonies were observed for a given species. The values are the number of sites.

Habitat	Total Sample Sites	Species								
		Apal	Acer	Alam	Dcyl	Dsto	Mann	Mfav	Mfra	Mfer
Colonized Pavement-Shallow	62	0	19	0	0	55	4	29	1	0
Ridge-Shallow	18	0	13	0	0	18	0	4	0	0
Inner Linear Reef	102	0	6	5	4	102	23	85	19	4
Middle Linear Reef	83	0	2	50	0	76	36	76	22	8
Colonized Pavement-Deep	31	0	1	26	0	26	5	23	9	1
Outer Linear Reef	24	0	1	20	0	24	7	26	8	5
Spur and Groove	45	0	3	43	0	34	7	38	14	5
Aggregated Patch Reef	11	0	0	11	0	9	3	10	1	1
Total sites	376	0	45	155	4	344	85	291	74	24

Species legend: Apal = *Acropora palmata*, Acer = *Acropora cervicornis*, Alam =*Agaricia lamarcki*, Dcyl = *Dendrogyra cylindrus*, Dsto = *Dichocoenia stokesii*, Mann = *Montastraea annularis*, Mfav = *Montastraea faveolata*, Mfra = *Montastraea franksi*, Mfer = *Mycetophyllia ferox*.

Table 15. Number of sites within each habitat in which more than five colonies were observed for a given species. The values are the number of sites.

Habitat	Total Sample Sites	Species								
		Apal	Acer	Alam	Dcyl	Dsto	Mann	Mfav	Mfra	Mfer
Colonized Pavement-Shallow	62	0	15	0	0	50	0	4	0	0
Ridge-Shallow	18	0	12	0	0	18	0	0	0	0
Inner Linear Reef	102	0	1	0	0	91	2	43	0	0
Middle Linear Reef	83	0	0	3	0	41	9	57	9	0
Colonized Pavement-Deep	31	0	0	2	0	9	1	20	1	0
Outer Linear Reef	24	0	1	4	0	15	1	17	4	0
Spur and Groove	45	0	0	30	0	2	1	33	1	0
Aggregated Patch Reef	11	0	0	11	0	2	0	6	0	0
Total sites	376	0	29	50	0	228	14	180	15	0

Species legend: Apal = *Acropora palmata*, Acer = *Acropora cervicornis*, Alam = *Agaricia lamarcki*, Dcyl = *Dendrogyra cylindrus*, Dsto = *Dichocoenia stokesii*, Mann = *Montastraea annularis*, Mfav = *Montastraea faveolata*, Mfra = *Montastraea franksi*, Mfer = *Mycetophyllia ferox*.

Agaricia lamarcki and *Mycetophyllia ferox* are not common species at other Broward County annual monitoring sites (Gilliam et al., 2011). *Mycetophyllia ferox* also has not been recorded at any of the 17 Southeast Coral Reef Evaluation and Monitoring Project (SECREMP) sites; while

A. lamarcki was present at only 3 SECREMP sites in 2010 (1 site in Broward County) (Gilliam, 2011). In contrast, *Agaricia lamarcki* was observed at 155 (41%) of the 376 tier 1 sites in the present survey, and was present at nearly all of the colonized pavement-deep, outer reef, spur and groove, and aggregated patch reef sites. *Mycetophyllia ferox* was far less abundant, observed at only 24 sites, and no more than 5 colonies were observed at any site. Throughout the Caribbean, *Agaricia lamarcki* and *M. ferox* are more abundant in deeper water ranging from 10 to 25 m (Aronson et al., 2008c, 2008d). As expected, due to their preference for deeper habitats, *A. lamarcki* and *M. ferox* were not recorded on the colonized pavement-shallow and ridge-shallow habitats.

Dendrogyra cylindrus, a species listed as threatened by the State of Florida, was the least common species observed and was observed at only four of the 376 tier 1 sites. All four colonies were identified on the inner linear reef. *Dendrogyra cylindricus* is uncommon on southeast Florida reefs and is typically found at low abundances throughout its range; however, it can be abundant locally in shallower well-circulated areas due to propagation by fragmentation (Aronson et al., 2008b). *D. cylindrus* is gonochoric (i.e. separation of sexes in different individuals); and therefore characterized by low juvenile survivorship. *Dendrogyra cylindrus* has only been previously reported at a few locations in Broward County. It has not been recorded at any of 25 permanent annual monitoring sites in Broward County (Gilliam et al., 2011) nor the 17 SECREMP sites in southeast Florida (Gilliam, 2011).

The most frequently-observed species was *Dichocoenia stokesii*, recorded at 344 (91%) of 376 sites across all 8 habitats, but most abundant on the inner linear reef. *Dichocoenia stokesii* is widespread on southeast Florida reefs and in the Caribbean and is common throughout its range (Aronson et al, 2008a). The abundance of *D. stokesii* in the study area is consistent with annual monitoring data from the SECREMP and the Broward County annual reef monitoring programs. In 2010, *D. stokesii* was recorded at 12 of the 17 SECREMP monitoring sites in Palm Beach, Broward, Miami-Dade and Martin counties (Gilliam, 2011), and *D. stokesii* is also one of the most common stony corals at the 25 permanent annual monitoring sites in Broward County (Gilliam et al., 2011).

Montastraea annularis (Weil and Knowlton, 1994) has recently been split into three species: *M. annularis, M. faveolata* and *M. franksi*. The majority of studies prior to 1994 did not distinguish between the three species, and current monitoring programs commonly report species cover data as *Montastraea annularis* complex. *Montastraea* spp. are often the numerically dominant coral at shallow and intermediate depths, comprising a substantial portion of total live coral cover in many locations in the Caribbean (Bruckner and Bruckner, 2006). All three *Montastraea* species targeted in this study were also abundant, but only *M. faveolata* was found with any regularity over the two shallowest habitats. In fact, *M. annularis* and *M. franksi* were not observed on the ridge-shallow habitat at all. *Montastraea faveolata* was the second-most common and abundant species in this study, observed in 291 (77%) of the 376 tier 1 sites. These observations were consistent with Broward County's annual reef monitoring program, which has recorded *M. faveolata* at nine out of 25 permanent sites, two of which are located offshore of John U. Lloyd State Park, adjacent to the project area. *Montastraea annularis*, which occurs in water depths ranging between 0.5 and 82 m (Reed, 1985), and is frequently a dominant species of upper reef slopes (Aronson et al., 2008f), was observed at 85 sites in the present study and *Montastraea franksi* was observed at 74 sites.

Small vessel anchors were observed in 149 (40%) of the 376 tier 1 sites. A total of 259 were counted across all habitat types. The maximum number of anchors seen at one site was eight, and 65 sites had two or more anchors. Including small vessel anchors in the tier 1 survey provided data on anchor abundance within the project area. The age of the anchors found in this study is unknown. Restrictions on anchoring at the South Florida Ocean Measurement Facility (SFOMF) Restricted OPAREA have been in place since 1986 for larger vessels. In 2005, the restrictions were amended to exclude all anchoring, trawling, and dredging within the boundaries. The abundance and distribution of anchors found throughout the project area, in addition to anchors and anchor chain seen snagged on cable suggests that anchor snags is a potential source of cable movement.

V. LITERATURE CITED

Aronson, R., Bruckner, A., Moore, J., Precht, B. and Weil E. 2008a *Dichocoenia stokesii*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Aronson, R., Bruckner, A., Moore, J., Precht, B. & and Weil E. 2008b. *Dendrogyra cylindrus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Aronson, R., Bruckner, A., Moore, J., Precht, B. & and Weil E. 2008c. *Mycetophyllia ferox.* In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Aronson, R., Bruckner, A., Moore, J., Precht, B. and Weil E. 2008d. *Agaricia lamarcki*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Aronson, R., Bruckner, A., Moore, J., Precht, B. and Weil E. 2008e. *Montastraea faveolata.* In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Aronson, R., Bruckner, A., Moore, J., Precht, B. and Weil E. 2008f. *Montastraea annularis.* In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 18 September 2011.

Bruckner, A.W. and Bruckner R.J. 2006. The recent decline of *Montastraea annularis* (complex) coral populations in western Curacao: a cause for concern? Rev. Biol Trop. Int. J. Trop. Biol. 54 (Suppl.3): 45-58.

Gilliam D.S., Dodge R.E., Spieler R.E., Walton C, and Kilfoyle K. 2011. Marine Biological Monitoring in Broward County, Florida: Technical Report 11. Prepared for: Broward County Board of County Commissioners Department of Planning and Environmental, Protection Biological Resource Division. Report prepared by: Nova Southeastern University Oceanographic Center.

Gilliam D.S. 2011. Southeast Florida Coral Reef Evaluation and Monitoring Project 2010 Year 8 Final Report. Prepared for: Florida Fish and Wildlife Conservation Commission, Fish & Wildlife Research Institute, Florida Department of Environmental Protection. Report prepared by: Nova Southeastern University Oceanographic Center.

Reed, J.K. 1985. Deepest distribution of Atlantic hermatypic corals discovered in the Bahamas. Fifth International Coral Reef Congress 6: 249-254. Tahiti

Walker, B. K., Riegl, B., and Dodge, R. E. 2008. Mapping coral reef habitats in southeast Florida using a combined technique approach. Journal of Coastal Research 24**:** 1138-1150.

Weil, E. and Knowlton N. 1994. A multi-character analysis of the Caribbean coral *Montastraea annularis* (Ellis and Solander 1786) and its two sibling species, *M. faveolata* (Ellis and Solander 1786) and *M. franksi* (Gregory 1895). Bulletin of Marine Science 55:

V. APPENDICES

Appendix 1. Location, habitat and depth (m) of all 376 sample sites.

Site	Latitude	Longitude	Habitat	Depth (m)
1	26.09149177	-80.10513321	Colonized Pavement-Shallow	5
2	26.09148556	-80.10413367	Ridge-Shallow	5
3	26.09147935	-80.10313414	Ridge-Shallow	5
4	26.09147313	-80.10213460	Ridge-Shallow	5
5	26.09146691	-80.10113507	Artificial	6
6	26.09146068	-80.10013553	Artificial	6
7	26.09145444	-80.09913600	Colonized Pavement-Shallow	7
8	26.09144819	-80.09813647	Artificial	8
9	26.09144194	-80.09713693	Artificial	9
10	26.09143568	-80.09613740	Linear Reef-Inner	7
11	26.09142942	-80.09513787	Linear Reef-Inner	11
12	26.09142175	-80.09385000	Linear Reef-Inner	12
13	26.09140226	-80.09140506	Linear Reef-Middle	13
14	26.09139069	-80.08898458	Linear Reef-Middle	17
15	26.09136699	-80.08517277	Colonized Pavement-Deep	16
16	26.09136065	-80.08417324	Linear Reef-Outer	15
17	26.09135430	-80.08317372	Spur and Groove	21
18	26.09060876	-80.10668524	Colonized Pavement-Shallow	4
19	26.09060257	-80.10568571	Colonized Pavement-Shallow	5
20	26.09059637	-80.10468618	Colonized Pavement-Shallow	5
21	26.09059016	-80.10368665	Ridge-Shallow	5
22	26.09058395	-80.10268712	Ridge-Shallow	4
23	26.09057773	-80.10168760	Colonized Pavement-Shallow	6
24	26.09057150	-80.10068807	Colonized Pavement-Shallow	7
25	26.09056527	-80.09968854	Colonized Pavement-Shallow	7
26	26.09055902	-80.09868902	Colonized Pavement-Shallow	8
27	26.09055278	-80.09768949	Linear Reef-Inner	7
28	26.09053412	-80.09648927	Linear Reef-Inner	7
29	26.09052786	-80.09548974	Linear Reef-Inner	11
30	26.09052003	-80.09398894	Linear Reef-Inner	12
31	26.09050013	-80.09141179	Linear Reef-Middle	13
32	26.09048856	-80.08899132	Linear Reef-Middle	19
33	26.09046391	-80.08509675	Colonized Pavement-Deep	16
34	26.09045757	-80.08409722	Linear Reef-Outer	15
35	26.09045122	-80.08309770	Spur and Groove	22

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
36	26.08970162	-80.10749484	Colonized Pavement-Shallow	3
37	26.08969543	-80.10649532	Colonized Pavement-Shallow	4
38	26.08968924	-80.10549580	Colonized Pavement-Shallow	5
39	26.08968304	-80.10449628	Colonized Pavement-Shallow	6
40	26.08967683	-80.10349676	Ridge-Shallow	6
41	26.08967062	-80.10249724	Ridge-Shallow	4
42	26.08966439	-80.10149772	Colonized Pavement-Shallow	6
43	26.08965817	-80.10049820	Colonized Pavement-Shallow	7
44	26.08965193	-80.09949868	Colonized Pavement-Shallow	7
45	26.08964569	-80.09849917	Colonized Pavement-Shallow	8
46	26.08963944	-80.09749965	Linear Reef-Inner	7
47	26.08963546	-80.09686436	Linear Reef-Inner	8
48	26.08962920	-80.09586484	Linear Reef-Inner	9
49	26.08962375	-80.09499541	Linear Reef-Inner	11
50	26.08961802	-80.09408184	Linear Reef-Inner	12
51	26.08959758	-80.09141876	Linear Reef-Middle	14
52	26.08955254	-80.08518664	Colonized Pavement-Deep	16
53	26.08954620	-80.08418713	Linear Reef-Outer	16
54	26.08953985	-80.08318762	Spur and Groove	22
55	26.08880035	-80.10770982	Colonized Pavement-Shallow	3
56	26.08879417	-80.10671031	Colonized Pavement-Shallow	4
57	26.08878797	-80.10571079	Colonized Pavement-Shallow	5
58	26.08878177	-80.10471128	Colonized Pavement-Shallow	6
59	26.08877557	-80.10371177	Ridge-Shallow	6
60	26.08876936	-80.10271226	Ridge-Shallow	4
61	26.08876314	-80.10171275	Colonized Pavement-Shallow	6
62	26.08875691	-80.10071323	Colonized Pavement-Shallow	6
63	26.08875068	-80.09971372	Colonized Pavement-Shallow	7
64	26.08874443	-80.09871421	Colonized Pavement-Shallow	8
65	26.08873819	-80.09771470	Linear Reef-Inner	8
66	26.08873275	-80.09684527	Linear Reef-Inner	8
67	26.08872649	-80.09584576	Linear Reef-Inner	10
68	26.08871646	-80.09424746	Linear Reef-Inner	12
69	26.08866009	-80.08531262	Colonized Pavement-Deep	17
70	26.08865375	-80.08431312	Linear Reef-Outer	16

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
71	26.08864740	-80.08331361	Spur and Groove	22
72	26.08789796	-80.10774268	Colonized Pavement-Shallow	3
73	26.08789177	-80.10674318	Colonized Pavement-Shallow	4
74	26.08788558	-80.10574367	Colonized Pavement-Shallow	6
75	26.08787938	-80.10474417	Colonized Pavement-Shallow	5
76	26.08787317	-80.10374466	Ridge-Shallow	5
77	26.08786696	-80.10274516	Ridge-Shallow	5
78	26.08786074	-80.10174565	Colonized Pavement-Shallow	6
79	26.08785452	-80.10074615	Colonized Pavement-Shallow	6
80	26.08784828	-80.09974665	Colonized Pavement-Shallow	7
81	26.08784204	-80.09874714	Colonized Pavement-Shallow	8
82	26.08783580	-80.09774764	Linear Reef-Inner	8
83	26.08782954	-80.09674814	Linear Reef-Inner	9
84	26.08782328	-80.09574864	Linear Reef-Inner	10
85	26.08781349	-80.09418830	Linear Reef-Inner	12
86	26.08775835	-80.08544677	Colonized Pavement-Deep	17
87	26.08775201	-80.08444727	Linear Reef-Outer	16
88	26.08774566	-80.08344777	Spur and Groove	21
89	26.08698548	-80.10640374	Colonized Pavement-Shallow	6
90	26.08697929	-80.10540424	Colonized Pavement-Shallow	5
91	26.08697309	-80.10440475	Colonized Pavement-Shallow	6
92	26.08696688	-80.10340525	Ridge-Shallow	4
93	26.08696066	-80.10240575	Ridge-Shallow	5
94	26.08695444	-80.10140626	Colonized Pavement-Shallow	6
95	26.08694821	-80.10040676	Colonized Pavement-Shallow	6
96	26.08694198	-80.09940726	Colonized Pavement-Shallow	7
97	26.08693574	-80.09840777	Colonized Pavement-Shallow	8
98	26.08692949	-80.09740827	Linear Reef-Inner	8
99	26.08692324	-80.09615670	Linear Reef-Inner	8
100	26.08691271	-80.09473074	Linear Reef-Inner	12
101	26.08685622	-80.08552106	Colonized Pavement-Deep	17
102	26.08684988	-80.08452157	Linear Reef-Outer	16
103	26.08684354	-80.08352208	Spur and Groove	21
104	26.08606970	-80.10548247	Colonized Pavement-Shallow	5
105	26.08606350	-80.10448298	Colonized Pavement-Shallow	6

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
106	26.08605729	-80.10348349	Ridge-Shallow	4
107	26.08605108	-80.10248400	Ridge-Shallow	5
108	26.08604485	-80.10148452	Colonized Pavement-Shallow	6
109	26.08603863	-80.10048503	Colonized Pavement-Shallow	6
110	26.08603239	-80.09948554	Colonized Pavement-Shallow	7
111	26.08602615	-80.09848605	Colonized Pavement-Shallow	8
112	26.08601990	-80.09748657	Linear Reef-Inner	10
113	26.08602221	-80.09640612	Linear Reef-Inner	8
114	26.08601594	-80.09540663	Linear Reef-Inner	10
115	26.08600967	-80.09440715	Linear Reef-Inner	12
116	26.08599098	-80.09182542	Linear Reef-Middle	13
117	26.08598249	-80.09033833	Linear Reef-Middle	15
118	26.08597618	-80.08933885	Linear Reef-Middle	19
119	26.08595323	-80.08545854	Colonized Pavement-Deep	17
120	26.08594689	-80.08445906	Spur and Groove	17
121	26.08594054	-80.08345958	Aggregated Patch Reef	23
122	26.08516554	-80.10402696	Ridge-Shallow	5
123	26.08515933	-80.10302748	Ridge-Shallow	4
124	26.08515312	-80.10202800	Colonized Pavement-Shallow	6
125	26.08514689	-80.10102852	Colonized Pavement-Shallow	6
126	26.08514066	-80.10002904	Colonized Pavement-Shallow	7
127	26.08513443	-80.09902956	Colonized Pavement-Shallow	7
128	26.08512818	-80.09803008	Linear Reef-Inner	7
129	26.08511899	-80.09630727	Linear Reef-Inner	9
130	26.08511273	-80.09530779	Linear Reef-Inner	9
131	26.08510646	-80.09430831	Linear Reef-Inner	13
132	26.08508842	-80.09183239	Linear Reef-Middle	14
133	26.08505998	-80.09065935	Linear Reef-Middle	15
134	26.08505368	-80.08965987	Linear Reef-Middle	18
135	26.08505112	-80.08553509	Colonized Pavement-Deep	17
136	26.08504478	-80.08453562	Spur and Groove	17
137	26.08503491	-80.08323111	Aggregated Patch Reef	25
138	26.08425484	-80.10246657	Ridge-Shallow	6
139	26.08424862	-80.10146710	Colonized Pavement-Shallow	7
140	26.08424239	-80.10046763	Colonized Pavement-Shallow	7

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
141	26.08423615	-80.09946815	Colonized Pavement-Shallow	7
142	26.08422991	-80.09846868	Colonized Pavement-Shallow	9
143	26.08422366	-80.09746921	Linear Reef-Inner	8
144	26.08421660	-80.09634065	Linear Reef-Inner	8
145	26.08421034	-80.09534118	Linear Reef-Inner	9
146	26.08420407	-80.09434171	Linear Reef-Inner	12
147	26.08418761	-80.09172307	Linear Reef-Middle	14
148	26.08417146	-80.09038027	Linear Reef-Middle	15
149	26.08414934	-80.08566406	Colonized Pavement-Deep	17
150	26.08414300	-80.08466459	Spur and Groove	16
151	26.08413269	-80.08328965	Aggregated Patch Reef	25
152	26.08333867	-80.10054257	Colonized Pavement-Shallow	7
153	26.08333244	-80.09954311	Colonized Pavement-Shallow	7
154	26.08332619	-80.09854365	Colonized Pavement-Shallow	8
155	26.08331995	-80.09754418	Linear Reef-Inner	8
156	26.08331463	-80.09644013	Linear Reef-Inner	10
157	26.08330836	-80.09544067	Linear Reef-Inner	9
158	26.08330209	-80.09444121	Linear Reef-Inner	12
159	26.08326891	-80.09038725	Linear Reef-Middle	16
160	26.08324444	-80.08555064	Colonized Pavement-Deep	17
161	26.08323810	-80.08455118	Spur and Groove	17
162	26.08324921	-80.08353793	Aggregated Patch Reef	23
163	26.08242676	-80.09905029	Colonized Pavement-Shallow	8
164	26.08242052	-80.09805083	Linear Reef-Inner	8
165	26.08241747	-80.09731022	Linear Reef-Inner	9
166	26.08240552	-80.09540133	Linear Reef-Inner	9
167	26.08239925	-80.09440188	Linear Reef-Inner	12
168	26.08237472	-80.09050213	Linear Reef-Middle	17
169	26.08234199	-80.08557474	Colonized Pavement-Deep	17
170	26.08233566	-80.08457529	Spur and Groove	19
171	26.08232931	-80.08357583	Aggregated Patch Reef	24
172	26.08152045	-80.09845668	Linear Reef-Inner	8
173	26.08151548	-80.09740621	Linear Reef-Inner	9
174	26.08150317	-80.09544136	Linear Reef-Inner	8
175	26.08149690	-80.09444191	Linear Reef-Inner	12

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
176	26.08147372	-80.09075531	Linear Reef-Middle	18
177	26.08143972	-80.08562608	Colonized Pavement-Deep	17
178	26.08143339	-80.08462664	Spur and Groove	19
179	26.08142704	-80.08362719	Aggregated Patch Reef	23
180	26.08061587	-80.09788466	Linear Reef-Inner	8
181	26.08060507	-80.09641270	Linear Reef-Inner	7
182	26.08059881	-80.09541326	Linear Reef-Inner	8
183	26.08059254	-80.09441382	Linear Reef-Inner	13
184	26.08053834	-80.08581725	Colonized Pavement-Deep	17
185	26.08053200	-80.08481781	Spur and Groove	18
186	26.08052462	-80.08365422	Aggregated Patch Reef	25
187	26.07971338	-80.09790152	Linear Reef-Inner	8
188	26.07969940	-80.09566794	Linear Reef-Inner	7
189	26.07969313	-80.09466851	Linear Reef-Inner	12
190	26.07967477	-80.09178653	Linear Reef-Middle	14
191	26.07962246	-80.08566398	Linear Reef-Outer	17
192	26.07961613	-80.08466455	Spur and Groove	19
193	26.07960978	-80.08366512	Aggregated Patch Reef	25
194	26.07879688	-80.09568149	Linear Reef-Inner	7
195	26.07879062	-80.09468206	Linear Reef-Inner	11
196	26.07877221	-80.09179349	Linear Reef-Middle	14
197	26.07873216	-80.08566164	Linear Reef-Outer	16
198	26.07872582	-80.08466222	Spur and Groove	18
199	26.07871948	-80.08366279	Aggregated Patch Reef	25
200	26.07790787	-80.09785253	Linear Reef-Inner	10
201	26.07790030	-80.09664156	Linear Reef-Inner	9
202	26.07789404	-80.09564215	Linear Reef-Inner	8
203	26.07788777	-80.09464273	Linear Reef-Inner	12
204	26.07782912	-80.08559207	Linear Reef-Outer	15
205	26.07782279	-80.08459265	Spur and Groove	20
206	26.07781644	-80.08359324	Aggregated Patch Reef	26
207	26.07700532	-80.09785944	Linear Reef-Inner	9
208	26.07699335	-80.09594656	Linear Reef-Inner	8
209	26.07698708	-80.09494715	Linear Reef-Inner	11
210	26.07697615	-80.09320595	Linear Reef-Middle	12

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
211	26.07696987	-80.09220654	Linear Reef-Middle	16
212	26.07692693	-80.08565556	Linear Reef-Outer	15
213	26.07692059	-80.08465616	Spur and Groove	19
214	26.07691425	-80.08365675	Aggregated Patch Reef	26
215	26.07610276	-80.09786636	Linear Reef-Inner	10
216	26.07609134	-80.09604160	Linear Reef-Inner	10
217	26.07608508	-80.09504220	Linear Reef-Inner	11
218	26.07607289	-80.09310072	Linear Reef-Middle	12
219	26.07606661	-80.09210132	Linear Reef-Middle	15
220	26.07602876	-80.08610492	Colonized Pavement-Deep	17
221	26.07602243	-80.08510552	Linear Reef-Outer	16
222	26.07601609	-80.08410613	Spur and Groove	25
223	26.07519204	-80.09682077	Linear Reef-Inner	10
224	26.07518856	-80.09601205	Linear Reef-Inner	7
225	26.07518230	-80.09501265	Linear Reef-Inner	11
226	26.07517034	-80.09310768	Linear Reef-Middle	13
227	26.07516406	-80.09210828	Linear Reef-Middle	15
228	26.07512463	-80.08611345	Colonized Pavement-Deep	17
229	26.07511830	-80.08511405	Spur and Groove	16
230	26.07511033	-80.08385807	Spur and Groove	26
231	26.07428659	-80.09611279	Linear Reef-Inner	7
232	26.07428033	-80.09511340	Linear Reef-Inner	11
233	26.07427279	-80.09391210	Linear Reef-Middle	12
234	26.07426652	-80.09291271	Linear Reef-Middle	13
235	26.07426023	-80.09191333	Linear Reef-Middle	16
236	26.07422077	-80.08591376	Colonized Pavement-Deep	17
237	26.07421444	-80.08491438	Spur and Groove	18
238	26.07421142	-80.08418744	Spur and Groove	24
239	26.07338404	-80.09611972	Linear Reef-Inner	8
240	26.07337778	-80.09512034	Linear Reef-Inner	12
241	26.07337151	-80.09412096	Linear Reef-Middle	12
242	26.07336523	-80.09312158	Linear Reef-Middle	12
243	26.07335895	-80.09212221	Linear Reef-Middle	17
244	26.07332111	-80.08612594	Colonized Pavement-Deep	18
245	26.07331477	-80.08512657	Spur and Groove	17

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
246	26.07330844	-80.08412719	Spur and Groove	24
247	26.07248066	-80.09624963	Linear Reef-Inner	9
248	26.07247440	-80.09525026	Linear Reef-Inner	12
249	26.07246409	-80.09335348	Linear Reef-Middle	12
250	26.07245781	-80.09235411	Linear Reef-Middle	14
251	26.07239850	-80.08613461	Colonized Pavement-Deep	18
252	26.07239217	-80.08513524	Spur and Groove	17
253	26.07238584	-80.08413587	Spur and Groove	25
254	26.07157998	-80.09630142	Linear Reef-Inner	9
255	26.07157372	-80.09530206	Linear Reef-Inner	12
256	26.07156365	-80.09369738	Linear Reef-Middle	12
257	26.07155737	-80.09269801	Linear Reef-Middle	13
258	26.07155109	-80.09169865	Linear Reef-Middle	17
259	26.07151442	-80.08614147	Colonized Pavement-Deep	18
260	26.07150809	-80.08514211	Spur and Groove	17
261	26.07150175	-80.08414275	Spur and Groove	26
262	26.07068263	-80.09713987	Linear Reef-Inner	9
263	26.07067615	-80.09635844	Linear Reef-Inner	8
264	26.07067217	-80.09546948	Linear Reef-Inner	11
265	26.07065905	-80.09337801	Linear Reef-Middle	12
266	26.07065277	-80.09237865	Linear Reef-Middle	16
267	26.07064739	-80.09152445	Linear Reef-Middle	19
268	26.07061187	-80.08614848	Linear Reef-Outer	18
269	26.07060554	-80.08514912	Spur and Groove	17
270	26.07059920	-80.08414977	Spur and Groove	25
271	26.06978209	-80.09746990	Linear Reef-Inner	10
272	26.06977584	-80.09647055	Linear Reef-Inner	8
273	26.06976958	-80.09547121	Linear Reef-Inner	12
274	26.06975710	-80.09348244	Linear Reef-Middle	12
275	26.06975082	-80.09248309	Linear Reef-Middle	17
276	26.06974454	-80.09148375	Linear Reef-Middle	17
277	26.06971204	-80.08633508	Colonized Pavement-Deep	17
278	26.06970571	-80.08533573	Linear Reef-Outer	17
279	26.06969937	-80.08433639	Spur and Groove	25
280	26.06888058	-80.09764359	Linear Reef-Inner	11

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
281	26.06887433	-80.09664425	Linear Reef-Inner	12
282	26.06886807	-80.09564491	Linear Reef-Inner	12
283	26.06885450	-80.09348164	Linear Reef-Middle	12
284	26.06884822	-80.09248230	Linear Reef-Middle	15
285	26.06884193	-80.09148296	Linear Reef-Middle	17
286	26.06880796	-80.08635215	Linear Reef-Outer	18
287	26.06880163	-80.08535281	Spur and Groove	17
288	26.06879530	-80.08435348	Spur and Groove	26
289	26.06796909	-80.09647702	Linear Reef-Inner	10
290	26.06795385	-80.09379145	Linear Reef-Middle	11
291	26.06794757	-80.09279212	Linear Reef-Middle	13
292	26.06793895	-80.09142262	Linear Reef-Middle	17
293	26.06790821	-80.08655089	Colonized Pavement-Deep	17
294	26.06790188	-80.08555156	Linear Reef-Outer	16
295	26.06789555	-80.08455223	Spur and Groove	24
296	26.06706716	-80.09632978	Linear Reef-Inner	10
297	26.06705048	-80.09366991	Linear Reef-Middle	11
298	26.06704421	-80.09267059	Linear Reef-Middle	14
299	26.06703661	-80.09146324	Linear Reef-Middle	17
300	26.06701076	-80.08662578	Colonized Pavement-Deep	17
301	26.06700443	-80.08562646	Linear Reef-Outer	16
302	26.06699810	-80.08462714	Spur and Groove	23
303	26.06617444	-80.09790938	Linear Reef-Inner	11
304	26.06616870	-80.09699243	Linear Reef-Inner	9
305	26.06616245	-80.09599311	Linear Reef-Inner	11
306	26.06615205	-80.09433355	Linear Reef-Middle	11
307	26.06614578	-80.09333423	Linear Reef-Middle	12
308	26.06613950	-80.09233492	Linear Reef-Middle	16
309	26.06609928	-80.08670012	Colonized Pavement-Deep	17
310	26.06609296	-80.08570081	Linear Reef-Outer	17
311	26.06608663	-80.08470149	Spur and Groove	23
312	26.06527188	-80.09791630	Linear Reef-Inner	11
313	26.06526729	-80.09718139	Linear Reef-Inner	11
314	26.06526103	-80.09618208	Linear Reef-Inner	11
315	26.06525020	-80.09445266	Linear Reef-Middle	11

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
316	26.06524392	-80.09345335	Linear Reef-Middle	12
317	26.06523765	-80.09245404	Linear Reef-Middle	15
318	26.06523284	-80.09169028	Linear Reef-Middle	16
319	26.06520165	-80.08674621	Colonized Pavement-Deep	18
320	26.06519533	-80.08574691	Linear Reef-Outer	17
321	26.06518899	-80.08474760	Spur and Groove	24
322	26.06435915	-80.09655036	Linear Reef-Inner	10
323	26.06434827	-80.09456055	Linear Reef-Middle	11
324	26.06434200	-80.09356125	Linear Reef-Middle	12
325	26.06433572	-80.09256195	Linear Reef-Middle	14
326	26.06432944	-80.09156265	Linear Reef-Middle	18
327	26.06429810	-80.08659508	Colonized Pavement-Deep	19
328	26.06429177	-80.08559578	Spur and Groove	17
329	26.06428544	-80.08459648	Spur and Groove	25
330	26.06345747	-80.09669709	Linear Reef-Inner	11
331	26.06344653	-80.09469699	Linear Reef-Middle	12
332	26.06344026	-80.09369769	Linear Reef-Middle	11
333	26.06343398	-80.09269840	Linear Reef-Middle	14
334	26.06342692	-80.09157572	Linear Reef-Middle	16
335	26.06339618	-80.08670264	Colonized Pavement-Deep	18
336	26.06338985	-80.08570335	Linear Reef-Outer	17
337	26.06338352	-80.08470406	Spur and Groove	25
338	26.06256044	-80.09733343	Linear Reef-Inner	10
339	26.06255419	-80.09633415	Linear Reef-Inner	12
340	26.06254397	-80.09470393	Linear Reef-Middle	11
341	26.06253770	-80.09370464	Linear Reef-Middle	12
342	26.06253143	-80.09270535	Linear Reef-Middle	14
343	26.06252430	-80.09157147	Linear Reef-Middle	16
344	26.06249433	-80.08682122	Colonized Pavement-Deep	17
345	26.06248801	-80.08582194	Linear Reef-Outer	17
346	26.06248167	-80.08482265	Spur and Groove	24
347	26.06165533	-80.09693280	Linear Reef-Inner	11
348	26.06164011	-80.09450206	Linear Reef-Middle	11
349	26.06163384	-80.09350278	Linear Reef-Middle	12
350	26.06162756	-80.09250350	Linear Reef-Middle	15

Appendix 1. Continued

Site	Latitude	Longitude	Habitat	Depth (m)
351	26.06162127	-80.09150422	Linear Reef-Middle	18
352	26.06159252	-80.08694647	Colonized Pavement-Deep	17
353	26.06158620	-80.08594719	Linear Reef-Outer	16
354	26.06157987	-80.08494791	Spur and Groove	24
355	26.06075318	-80.09700447	Linear Reef-Inner	11
356	26.06073886	-80.09471780	Linear Reef-Middle	11
357	26.06073259	-80.09371853	Linear Reef-Middle	12
358	26.06072631	-80.09271926	Linear Reef-Middle	15
359	26.06072003	-80.09171999	Linear Reef-Middle	16
360	26.06068974	-80.08691800	Colonized Pavement-Deep	17
361	26.06068342	-80.08591873	Linear Reef-Outer	17
362	26.06067709	-80.08491946	Spur and Groove	24
363	26.05985070	-80.09702461	Linear Reef-Inner	11
364	26.05983308	-80.09446379	Linear Reef-Middle	12
365	26.05982681	-80.09346453	Linear Reef-Middle	13
366	26.05981748	-80.09172695	Linear Reef-Middle	16
367	26.05978716	-80.08691982	Colonized Pavement-Deep	17
368	26.05978083	-80.08592056	Linear Reef-Outer	17
369	26.05977450	-80.08492130	Spur and Groove	24
370	26.05894899	-80.09716576	Linear Reef-Inner	10
371	26.05893151	-80.09437512	Linear Reef-Middle	12
372	26.05892524	-80.09337586	Linear Reef-Middle	13
373	26.05891492	-80.09173392	Linear Reef-Middle	16
374	26.05888509	-80.08700428	Colonized Pavement-Deep	18
375	26.05887877	-80.08600503	Linear Reef-Outer	17
376	26.05887244	-80.08500578	Spur and Groove	25

Appendix 2. *Acropora cervicornis* Tier 1 count data and Tier 2 mean density data (colonies per m^2) for all 376 sample sites. Tier 2 surveys were only completed for those sites which had greater than five colonies counted during Tier 1.

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
1	Colonized Pavement-Shallow	0	0	---
2	Ridge-Shallow	0	0	---
3	Ridge-Shallow	0	0	---
4	Ridge-Shallow	0	0	---
5	Colonized Pavement-Shallow	1	1-5	---
6	Colonized Pavement-Shallow	0	0	---
7	Colonized Pavement-Shallow	0	0	---
8	Colonized Pavement-Shallow	0	0	---
9	Colonized Pavement-Shallow	0	0	---
10	Linear Reef-Inner	0	0	---
11	Linear Reef-Inner	0	0	---
12	Linear Reef-Inner	0	0	---
13	Linear Reef-Middle	0	0	---
14	Linear Reef-Middle	0	0	---
15	Colonized Pavement-Deep	0	0	---
16	Linear Reef-Outer	0	0	---
17	Spur and Groove	0	0	---
18	Colonized Pavement-Shallow	0	0	---
19	Colonized Pavement-Shallow	0	0	---
20	Colonized Pavement-Shallow	0	0	---
21	Ridge-Shallow	0	0	---
22	Ridge-Shallow	2	1-5	---
23	Colonized Pavement-Shallow	0	0	---
24	Colonized Pavement-Shallow	0	0	---
25	Colonized Pavement-Shallow	0	0	---
26	Colonized Pavement-Shallow	0	0	---
27	Linear Reef-Inner	0	0	---
28	Linear Reef-Inner	0	0	---
29	Linear Reef-Inner	0	0	---
30	Linear Reef-Inner	0	0	---
31	Linear Reef-Middle	0	0	---
32	Linear Reef-Middle	0	0	---
33	Colonized Pavement-Deep	0	0	---
34	Linear Reef-Outer	0	0	---
35	Spur and Groove	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
36	Colonized Pavement-Shallow	0	0	---
37	Colonized Pavement-Shallow	0	0	---
38	Colonized Pavement-Shallow	0	0	---
39	Colonized Pavement-Shallow	0	0	---
40	Ridge-Shallow	0	0	---
41	Ridge-Shallow	14	11-49	0.02 ± 0.01
42	Colonized Pavement-Shallow	0	0	---
43	Colonized Pavement-Shallow	0	0	---
44	Colonized Pavement-Shallow	0	0	---
45	Colonized Pavement-Shallow	0	0	---
46	Linear Reef-Inner	0	0	---
47	Linear Reef-Inner	0	0	---
48	Linear Reef-Inner	0	0	---
49	Linear Reef-Inner	0	0	---
50	Linear Reef-Inner	0	0	---
51	Linear Reef-Middle	0	0	---
52	Colonized Pavement-Deep	0	0	---
53	Linear Reef-Outer	0	0	---
54	Spur and Groove	0	0	---
55	Colonized Pavement-Shallow	0	0	---
56	Colonized Pavement-Shallow	0	0	---
57	Colonized Pavement-Shallow	0	0	---
58	Colonized Pavement-Shallow	0	0	---
59	Ridge-Shallow	7	6-10	0.01 ± 0.01
60	Ridge-Shallow	33	11-49	0
61	Colonized Pavement-Shallow	0	0	---
62	Colonized Pavement-Shallow	0	0	---
63	Colonized Pavement-Shallow	0	0	---
64	Colonized Pavement-Shallow	0	0	---
65	Linear Reef-Inner	0	0	---
66	Linear Reef-Inner	0	0	---
67	Linear Reef-Inner	0	0	---
68	Linear Reef-Inner	0	0	---
69	Colonized Pavement-Deep	0	0	---
70	Linear Reef-Outer	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
71	Spur and Groove	0	0	---
72	Colonized Pavement-Shallow	0	0	---
73	Colonized Pavement-Shallow	0	0	---
74	Colonized Pavement-Shallow	0	0	---
75	Colonized Pavement-Shallow	0	0	---
76	Ridge-Shallow	70	50-99	0.01 ± 0.02
77	Ridge-Shallow	94	50-99	0.03 ± 0.04
78	Colonized Pavement-Shallow	0	0	---
79	Colonized Pavement-Shallow	0	0	---
80	Colonized Pavement-Shallow	0	0	---
81	Colonized Pavement-Shallow	0	0	---
82	Linear Reef-Inner	0	0	---
83	Linear Reef-Inner	0	0	---
84	Linear Reef-Inner	0	0	---
85	Linear Reef-Inner	0	0	---
86	Colonized Pavement-Deep	0	0	---
87	Linear Reef-Outer	0	0	---
88	Spur and Groove	0	0	---
89	Colonized Pavement-Shallow	0	0	---
90	Colonized Pavement-Shallow	0	0	---
91	Colonized Pavement-Shallow	50	50-99	0.09 ± 0.09
92	Ridge-Shallow	300	>100	0.21 ± 0.1
93	Ridge-Shallow	55	50-99	0.06 ± 0.08
94	Colonized Pavement-Shallow	2	1-5	---
95	Colonized Pavement-Shallow	0	0	---
96	Colonized Pavement-Shallow	0	0	---
97	Colonized Pavement-Shallow	0	0	---
98	Linear Reef-Inner	0	0	---
99	Linear Reef-Inner	0	0	---
100	Linear Reef-Inner	0	0	---
101	Colonized Pavement-Deep	0	0	---
102	Linear Reef-Outer	0	0	---
103	Spur and Groove	0	0	---
104	Colonized Pavement-Shallow	0	0	---
105	Colonized Pavement-Shallow	65	50-99	0.02 ± 0.02

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
106	Ridge-Shallow	300	>100	0.18 ± 0.07
107	Ridge-Shallow	100	>100	0.13 ± 0.01
108	Colonized Pavement-Shallow	23	11-49	0.01 ± 0.01
109	Colonized Pavement-Shallow	135	>100	0.07 ± 0.04
110	Colonized Pavement-Shallow	17	11-49	0.02 ± 0.03
111	Colonized Pavement-Shallow	0	0	---
112	Linear Reef-Inner	0	0	---
113	Linear Reef-Inner	0	0	---
114	Linear Reef-Inner	0	0	---
115	Linear Reef-Inner	0	0	---
116	Linear Reef-Middle	0	0	---
117	Linear Reef-Middle	0	0	---
118	Linear Reef-Middle	0	0	---
119	Colonized Pavement-Deep	0	0	---
120	Spur and Groove	0	0	---
121	Aggregated Patch Reef	0	0	---
122	Ridge-Shallow	54	50-99	0.01 ± 0.01
123	Ridge-Shallow	150	>100	0.23 ± 0.06
124	Colonized Pavement-Shallow	57	50-99	0.06 ± 0.02
125	Colonized Pavement-Shallow	37	11-49	0.03 ± 0.01
126	Colonized Pavement-Shallow	3	1-5	---
127	Colonized Pavement-Shallow	22	11-49	0.01 ± 0.01
128	Linear Reef-Inner	0	0	---
129	Linear Reef-Inner	0	0	---
130	Linear Reef-Inner	0	0	---
131	Linear Reef-Inner	0	0	---
132	Linear Reef-Middle	0	0	---
133	Linear Reef-Middle	0	0	---
134	Linear Reef-Middle	0	0	---
135	Colonized Pavement-Deep	0	0	---
136	Spur and Groove	0	0	---
137	Aggregated Patch Reef	0	0	---
138	Ridge-Shallow	17	11-49	0.05 ± 0.05
139	Colonized Pavement-Shallow	15	11-49	0.01 ± 0.01
140	Colonized Pavement-Shallow	44	11-49	0.05 ± 0.02

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
141	Colonized Pavement-Shallow	6	6-10	0.02 ± 0.03
142	Colonized Pavement-Shallow	2	1-5	---
143	Linear Reef-Inner	0	0	---
144	Linear Reef-Inner	0	0	---
145	Linear Reef-Inner	0	0	---
146	Linear Reef-Inner	0	0	---
147	Linear Reef-Middle	0	0	---
148	Linear Reef-Middle	0	0	---
149	Colonized Pavement-Deep	0	0	---
150	Spur and Groove	0	0	---
151	Aggregated Patch Reef	0	0	---
152	Colonized Pavement-Shallow	43	11-49	0.01 ± 0.01
153	Colonized Pavement-Shallow	25	11-49	0.03 ± 0.02
154	Colonized Pavement-Shallow	20	11-49	0.01 ± 0.01
155	Linear Reef-Inner	3	1-5	---
156	Linear Reef-Inner	0	0	---
157	Linear Reef-Inner	0	0	---
158	Linear Reef-Inner	0	0	---
159	Linear Reef-Middle	0	0	---
160	Colonized Pavement-Deep	0	0	---
161	Spur and Groove	0	0	---
162	Aggregated Patch Reef	0	0	---
163	Colonized Pavement-Shallow	6	6-10	0.01 ± 0.01
164	Linear Reef-Inner	0	0	---
165	Linear Reef-Inner	0	0	---
166	Linear Reef-Inner	0	0	---
167	Linear Reef-Inner	0	0	---
168	Linear Reef-Middle	0	0	---
169	Colonized Pavement-Deep	0	0	---
170	Spur and Groove	0	0	---
171	Aggregated Patch Reef	0	0	---
172	Linear Reef-Inner	3	1-5	---
173	Linear Reef-Inner	0	0	---
174	Linear Reef-Inner	0	0	---
175	Linear Reef-Inner	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
176	Linear Reef-Middle	0	0	---
177	Colonized Pavement-Deep	0	0	---
178	Spur and Groove	0	0	---
179	Aggregated Patch Reef	0	0	---
180	Linear Reef-Inner	0	0	---
181	Linear Reef-Inner	0	0	---
182	Linear Reef-Inner	0	0	---
183	Linear Reef-Inner	0	0	---
184	Colonized Pavement-Deep	0	0	---
185	Spur and Groove	0	0	---
186	Aggregated Patch Reef	0	0	---
187	Linear Reef-Inner	0	0	---
188	Linear Reef-Inner	1	1-5	---
189	Linear Reef-Inner	0	0	---
190	Linear Reef-Middle	0	0	---
191	Linear Reef-Outer	0	0	---
192	Spur and Groove	1	1-5	---
193	Aggregated Patch Reef	0	0	---
194	Linear Reef-Inner	0	0	---
195	Linear Reef-Inner	0	0	---
196	Linear Reef-Middle	0	0	---
197	Linear Reef-Outer	0	0	---
198	Spur and Groove	0	0	---
199	Aggregated Patch Reef	0	0	---
200	Linear Reef-Inner	0	0	---
201	Linear Reef-Inner	0	0	---
202	Linear Reef-Inner	0	0	---
203	Linear Reef-Inner	0	0	---
204	Linear Reef-Outer	0	0	---
205	Spur and Groove	0	0	---
206	Aggregated Patch Reef	0	0	---
207	Linear Reef-Inner	0	0	---
208	Linear Reef-Inner	9	6-10	0
209	Linear Reef-Inner	0	0	---
210	Linear Reef-Middle	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
211	Linear Reef-Middle	0	0	---
212	Linear Reef-Outer	0	0	---
213	Spur and Groove	0	0	---
214	Aggregated Patch Reef	0	0	---
215	Linear Reef-Inner	0	0	---
216	Linear Reef-Inner	0	0	---
217	Linear Reef-Inner	0	0	---
218	Linear Reef-Middle	0	0	---
219	Linear Reef-Middle	0	0	---
220	Colonized Pavement-Deep	0	0	---
221	Linear Reef-Outer	0	0	---
222	Spur and Groove	0	0	---
223	Linear Reef-Inner	0	0	---
224	Linear Reef-Inner	0	0	---
225	Linear Reef-Inner	0	0	---
226	Linear Reef-Middle	0	0	---
227	Linear Reef-Middle	0	0	---
228	Colonized Pavement-Deep	1	1-5	---
229	Spur and Groove	1	1-5	---
230	Spur and Groove	0	0	---
231	Linear Reef-Inner	0	0	---
232	Linear Reef-Inner	0	0	---
233	Linear Reef-Middle	0	0	---
234	Linear Reef-Middle	0	0	---
235	Linear Reef-Middle	0	0	---
236	Colonized Pavement-Deep	0	0	---
237	Spur and Groove	0	0	---
238	Spur and Groove	0	0	---
239	Linear Reef-Inner	0	0	---
240	Linear Reef-Inner	0	0	---
241	Linear Reef-Middle	0	0	---
242	Linear Reef-Middle	0	0	---
243	Linear Reef-Middle	0	0	---
244	Colonized Pavement-Deep	0	0	---
245	Spur and Groove	3	1-5	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
246	Spur and Groove	0	0	---
247	Linear Reef-Inner	2	1-5	---
248	Linear Reef-Inner	0	0	---
249	Linear Reef-Middle	0	0	---
250	Linear Reef-Middle	0	0	---
251	Colonized Pavement-Deep	0	0	---
252	Spur and Groove	0	0	---
253	Spur and Groove	0	0	---
254	Linear Reef-Inner	0	0	---
255	Linear Reef-Inner	0	0	---
256	Linear Reef-Middle	0	0	---
257	Linear Reef-Middle	0	0	---
258	Linear Reef-Middle	0	0	---
259	Colonized Pavement-Deep	0	0	---
260	Spur and Groove	0	0	---
261	Spur and Groove	0	0	---
262	Linear Reef-Inner	3	1-5	---
263	Linear Reef-Inner	0	0	---
264	Linear Reef-Inner	0	0	---
265	Linear Reef-Middle	0	0	---
266	Linear Reef-Middle	0	0	---
267	Linear Reef-Middle	0	0	---
268	Linear Reef-Outer	0	0	---
269	Spur and Groove	0	0	---
270	Spur and Groove	0	0	---
271	Linear Reef-Inner	0	0	---
272	Linear Reef-Inner	0	0	---
273	Linear Reef-Inner	0	0	---
274	Linear Reef-Middle	0	0	---
275	Linear Reef-Middle	0	0	---
276	Linear Reef-Middle	0	0	---
277	Colonized Pavement-Deep	0	0	---
278	Linear Reef-Outer	0	0	---
279	Spur and Groove	0	0	---
280	Linear Reef-Inner	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
281	Linear Reef-Inner	0	0	---
282	Linear Reef-Inner	0	0	---
283	Linear Reef-Middle	0	0	---
284	Linear Reef-Middle	0	0	---
285	Linear Reef-Middle	0	0	---
286	Linear Reef-Outer	0	0	---
287	Spur and Groove	0	0	---
288	Spur and Groove	0	0	---
289	Linear Reef-Inner	0	0	---
290	Linear Reef-Middle	0	0	---
291	Linear Reef-Middle	0	0	---
292	Linear Reef-Middle	0	0	---
293	Colonized Pavement-Deep	0	0	---
294	Linear Reef-Outer	0	0	---
295	Spur and Groove	0	0	---
296	Linear Reef-Inner	0	0	---
297	Linear Reef-Middle	1	1-5	---
298	Linear Reef-Middle	0	0	---
299	Linear Reef-Middle	0	0	---
300	Colonized Pavement-Deep	0	0	---
301	Linear Reef-Outer	0	0	---
302	Spur and Groove	0	0	---
303	Linear Reef-Inner	0	0	---
304	Linear Reef-Inner	0	0	---
305	Linear Reef-Inner	0	0	---
306	Linear Reef-Middle	0	0	---
307	Linear Reef-Middle	0	0	---
308	Linear Reef-Middle	0	0	---
309	Colonized Pavement-Deep	0	0	---
310	Linear Reef-Outer	0	0	---
311	Spur and Groove	0	0	---
312	Linear Reef-Inner	0	0	---
313	Linear Reef-Inner	0	0	---
314	Linear Reef-Inner	0	0	---
315	Linear Reef-Middle	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
316	Linear Reef-Middle	0	0	---
317	Linear Reef-Middle	0	0	---
318	Linear Reef-Middle	0	0	---
319	Colonized Pavement-Deep	0	0	---
320	Linear Reef-Outer	9	6-10	0
321	Spur and Groove	0	0	---
322	Linear Reef-Inner	0	0	---
323	Linear Reef-Middle	0	0	---
324	Linear Reef-Middle	0	0	---
325	Linear Reef-Middle	0	0	---
326	Linear Reef-Middle	0	0	---
327	Colonized Pavement-Deep	0	0	---
328	Spur and Groove	0	0	---
329	Spur and Groove	0	0	---
330	Linear Reef-Inner	0	0	---
331	Linear Reef-Middle	0	0	---
332	Linear Reef-Middle	0	0	---
333	Linear Reef-Middle	0	0	---
334	Linear Reef-Middle	0	0	---
335	Colonized Pavement-Deep	0	0	---
336	Linear Reef-Outer	0	0	---
337	Spur and Groove	0	0	---
338	Linear Reef-Inner	0	0	---
339	Linear Reef-Inner	0	0	---
340	Linear Reef-Middle	0	0	---
341	Linear Reef-Middle	0	0	---
342	Linear Reef-Middle	0	0	---
343	Linear Reef-Middle	0	0	---
344	Colonized Pavement-Deep	0	0	---
345	Linear Reef-Outer	0	0	---
346	Spur and Groove	0	0	---
347	Linear Reef-Inner	0	0	---
348	Linear Reef-Middle	0	0	---
349	Linear Reef-Middle	0	0	---
350	Linear Reef-Middle	0	0	---

Appendix 2. Continued

Site	Habitat	Tier 1 Count	Tier 1 Abundance Category	Tier 2 Density ± SD
351	Linear Reef-Middle	0	0	---
352	Colonized Pavement-Deep	0	0	---
353	Linear Reef-Outer	0	0	---
354	Spur and Groove	0	0	---
355	Linear Reef-Inner	0	0	---
356	Linear Reef-Middle	2	1-5	---
357	Linear Reef-Middle	0	0	---
358	Linear Reef-Middle	0	0	---
359	Linear Reef-Middle	0	0	---
360	Colonized Pavement-Deep	0	0	---
361	Linear Reef-Outer	0	0	---
362	Spur and Groove	0	0	---
363	Linear Reef-Inner	0	0	---
364	Linear Reef-Middle	0	0	---
365	Linear Reef-Middle	0	0	---
366	Linear Reef-Middle	0	0	---
367	Colonized Pavement-Deep	0	0	---
368	Linear Reef-Outer	0	0	---
369	Spur and Groove	0	0	---
370	Linear Reef-Inner	0	0	---
371	Linear Reef-Middle	0	0	---
372	Linear Reef-Middle	0	0	---
373	Linear Reef-Middle	0	0	---
374	Colonized Pavement-Deep	0	0	---
375	Linear Reef-Outer	0	0	---
376	Spur and Groove	0	0	---