

Osborne Tire Reef Coral Removal, Relocation, and Monitoring

Final Summary Report Draft

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Task: Colony Collection

This report includes summary information on the 700 colonies collected during the July 2022 – September 2023 award period. Table 1 lists the collection dates, the tire reef locations, and the number of colonies collected. Collected colonies included 16 species (Tables 2 and 3). Five species (*Montastraea cavernosa*, *Porites astreoides*, *Siderastrea siderea*, *Stephanocoenia intersepta*, and *Agaricia agaricites*) represented 88% of the collected colonies (Table 3). We binned collected colonies into 5 cm diameter size classes for colonies up to 20 cm diameter and 10 cm classes for colonies > 21 cm (<5 cm, 5-10 cm, 11-15 cm, 16-20, 21-30, etc.). Nearly 70% of the colonies were in the 5-10 cm and 11-15 cm diameter size classes. Colony diameter ranged from 1 cm to over 50 cm. Thirteen of the 16 species were represented in the < 15 cm diameter size classes while only seven species were represented in the > 30 cm diameter size classes (Table 3). These 700 colonies were collected from two tire reef area target sites (sites 6 and 7) (Tables 1 and 4) (Figure 1).

Task: Colony Relocation

Collected colonies were outplanted (472 colonies), kept in the NSU offshore nursery (95 colonies), or transferred to other institutions (133 colonies) (Table 5). Colonies were outplanted to four locations (Tables 1 and 4). Colonies in the North and South Spawning Hubs and the Clipper Lasco grounding site were monitored 1-month, 3-months, and 6-months post-relocation. These three locations include 274 of the 472 colonies outplanted. The remaining 198 colonies were outplanted to a nearshore habitat offshore Hollywood, Florida (HC1) and monitored once at the end of the project (August 2023).

In August 2023, 67 colonies remain in the NSU offshore nursery (Table 5). These colonies include 35 colonies <5 cm diameter and 32 colonies 6-10 cm diameter. These smaller colonies have been deployed on tree structures and modules. These corals of opportunity will be used to evaluate small colony survival and changes in health condition on each of these nursery structures. We will also compare survival and health of the juvenile colonies to stony coral microfragments and sexual recruits deployed in the nursery. Twenty-six of the colonies stored in the nursery were lost following the passing of Hurricane Nicole on 9 November 2022. The nursery experienced some damage from wave and surge energy associated with the hurricane. Two colonies were removed from the nursery based on observations of possible disease. Colonies still held in the nursery will be outplanted in the future or offered to other institutions. One-hundred and thirty-three colonies were donated to three institutions. Ninety-six were transferred to Dr. Diego Lirman of the University of Miami (<https://marine-biology-ecology.rsmas.miami.edu/research-themes/centers-and-labs/benthic-ecology-coral-restoration-lab/index.html>) (Tables 5 and 6). Dr. Lirman will incorporate these colonies into his restoration program. Twenty-three whole colonies and six fragments were donated to Dr. Lauren E. Fuess at Texas State University (<https://fuesslab.wp.txstate.edu/>) (Tables 5 and 6). Dr. Fuess will assess the symbiont communities and conduct immunity studies with these colonies. Fourteen colonies were donated to Dr. Abigail Renegar at Nova Southeastern University (<https://hcas.nova.edu/research/faculty-labs/scleractian-coral-biology/index.html>) (Tables 5 and 6). Dr. Renegar will incorporate these colonies into growth and predation studies.

Table 1. Summary of activities by task, date, location, and number of colonies involved.

Task	Date	Location	# of Colonies
Collection	8/22/2022	Tire Area 6	57
	8/26/2022	Tire Area 6	48
	9/6/2022	Tire Area 7	77
	9/7/2022	Tire Area 7	92
	9/16/2022	Tire Area 7	48
	10/24/2022	Tire Area 7	84
	10/25/2022	Tire Area 7	37
	11/3/2022	Tire Area 7	71
	12/12/2022	Tire Area 7	37
	1/23/2023	Tire Area 7	48
	2/6/2023	Tire Area 7	101
Outplanting	8/30/2022	North Spawning Hub	14
	8/31/2022	South Spawning Hub	13
	9/9/2022	North Hub (18)/South Hub (20)	38
	9/12/2022	HC1	75
	9/20/2022	South Hub	2
	10/18/2022	North Hub (15)/South Hub (18)	33
	10/19/2022	HC1	56
	10/31/2022	Clipper Lasco	66
	11/1/2022	South Hub	1
	11/30/2022	Clipper Lasco (34)/South Hub (2)	36
	2/2/2023	Clipper Lasco	30
	2/14/2023	Clipper Lasco	41
	2/28/2023	HC1	75
Monitoring	9/20/2022	South Hub	33
	10/12/2022	North Hub	32
	11/23/2022	North Hub (47)/South Hub (54)	101
	11/30/2022	Clipper Lasco	66
	1/5/2023	Clipper Lasco (35)/South Hub (1)	36
	1/17/2023	South Hub	22
	1/20/2023	North Hub	15
	2/22/2023	North Hub (47)/South Hub (55)	102
	2/27/2023	Clipper Lasco	172
	4/14/2023	North Hub	15
	4/17/2023	South Hub	20
	4/21/2023	Clipper Lasco	71
	5/3/2023	Clipper Lasco	101
	7/26/2023	HC1	165
8/9/2023	Clipper Lasco	71	

Table 2. Stony coral species names and 4-letter codes.

Scientific Name	4-Letter code	Scientific Name	4-Letter code
<i>Agaricia agaricites</i>	AAGA	<i>Orbicella faveolata</i>	OFAV
<i>Colpophyllia natans</i>	CNAT	<i>Porites astreoides</i>	PAST
<i>Dichocoenia stokesii</i>	DSTO	<i>Porites porites</i>	PPOR
<i>Eusmilia fastigiata</i>	EFAS	<i>Pseudodiploria strigosa</i>	PSTR
<i>Montastraea cavernosa</i>	MCAV	<i>Solenastrea bournoni</i>	SBOU
<i>Madracis decactis</i>	MDEC	<i>Scolymia cubensis</i>	SCUB
<i>Meandrina meandrites</i>	MMEA	<i>Stephanocoenia intersepta</i>	SINT
<i>Mycetophyllia aliciae</i>	MYAL	<i>Siderastrea siderea</i>	SSID

Table 3. Summary information on the number of colonies of each species collected by size (cm diameter) class (see Table 3 for species codes).

Species	< 5 cm	5-10 cm	11-15 cm	16-20 cm	21-30 cm	31-40 cm	>40 cm	Total
AAGA	4	46	23	3	0	0	0	76
CNAT	0	0	0	0	1	1	0	2
DSTO	0	1	0	0	0	0	0	1
EFAS	0	1	0	0	0	0	0	1
MCAV	9	53	27	11	17	4	1	122
MDEC	0	6	10	0	1	0	0	17
MMEA	4	7	1	0	0	0	0	12
MYAL	0	0	0	0	3	0	0	3
OFAV	0	0	0	0	0	0	1	1
PAST	0	45	63	33	30	7	1	179
PPOR	0	1	2	1	0	0	0	4
PSTR	4	3	1	2	7	1	3	21
SBOU	0	1	0	1	5	1	0	8
SCUB	11	0	0	0	0	0	0	11
SINT	1	41	47	24	3	0	0	116
SSID	8	76	29	10	2	1	0	126
Total	41	281	203	85	69	15	6	700

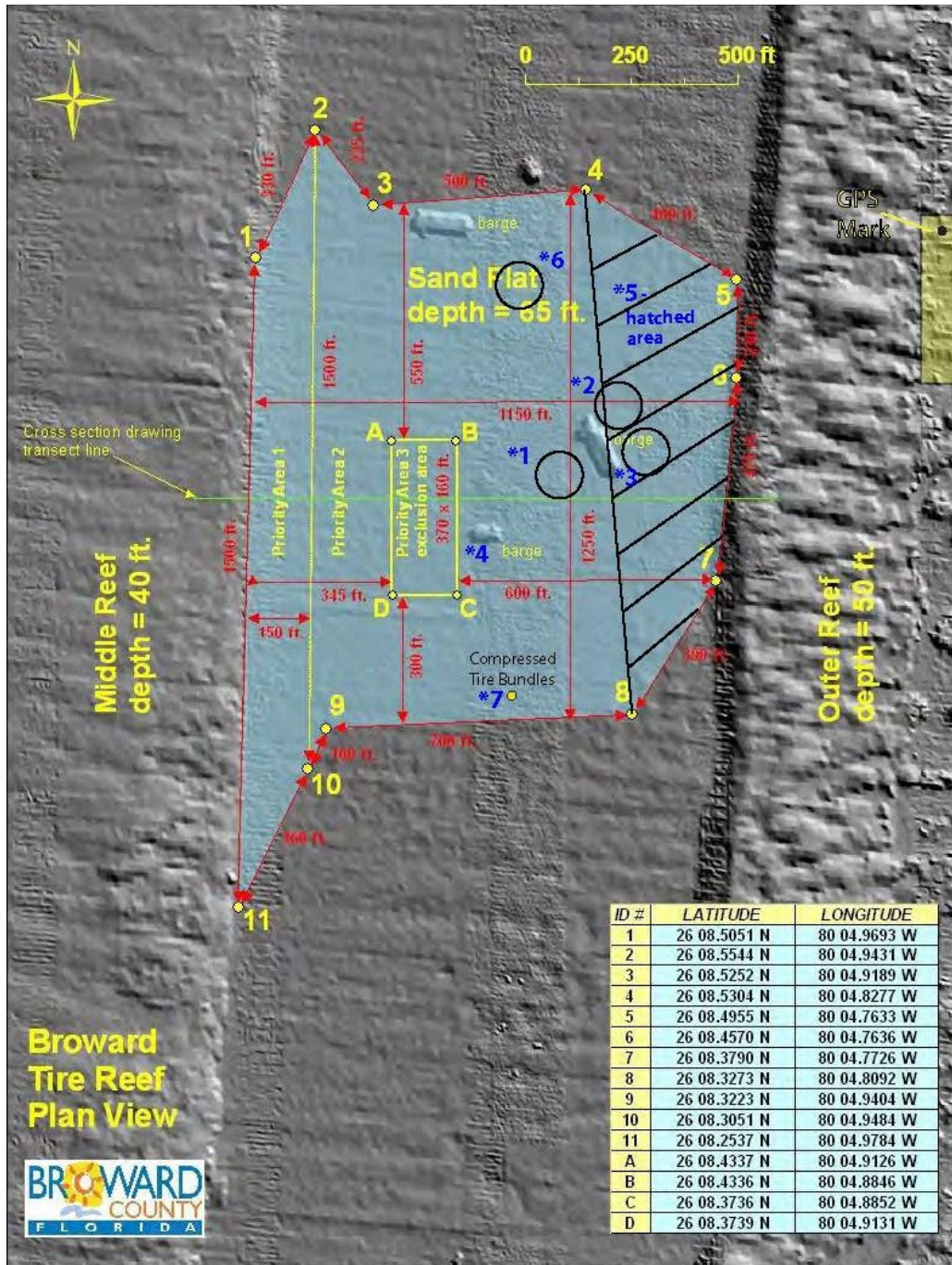


Figure 1. Map showing the Osborne Tire Reef area and the seven target groups (labels *1-*7) for the stony coral assessment (black circles and labels *1-*7). Figure provided by IDC and DEP.

Table 4. Location information for all locations involved in the effort (Tire Reef Collection Sites 6 and 7 coordinates slightly differ from coordinates shown in Figure 1. Table 5 represents actual field collected coordinates).

Site	GPS Coordinates	
	Latitude	Longitude
Tire Reef Collection Site 6	26 08.490 N	80 04.858 W
Tire Reef Collection Site 7	26 08.336 N	80 04.863 W
Nursery	26 07.472 N	80 05.795 W
North Spawning Hub Outplant Site	26 08.653 N	80 05.388 W
South Spawning Hub Outplant Site	25 58.609 N	80 06.000 W
Clipper Lasco Outplant Site	26 07.093 N	80 05.578 W
HC1 Outplant Site	26 00.738 N	80 06.379 W

Table 5. Summary information on destination of all collected colonies.

Colony Relocation	# Colonies
Outplanted and monitored (North and South Hubs and Clipper Lasco)	274
Outplanted and portion surveyed at 6-months (site HC1)	198
Nursery	67
Lost from Nursery	28
Transferred to UM	96
Transferred to NSU	14
Transferred to TSU	23
Total	700

Table 6. Summary of corals transferred by date and institution. The number of colonies involved in each task by date is also included.

Task	Date	Institution	Number of Colonies
Coral Transfer	10/19/2022	Diego Lirman Lab (UM)	9
	11/2/2022	Diego Lirman Lab (UM)	70
	1/10/2023	Abigail Renegar Lab (NSU)	14
	1/12/2023	Diego Lirman Lab (UM)	17
	2/23/2023	Lauren Fuess Lab (TSU)	23

Task: Colony Monitoring

The original Statement of Work (SOW) required a minimum of 25% of the outplanted colonies to be monitored 1-month, 3-months, and 6-months post-outplanting. The approach was modified by monitoring all 274 colonies 1-month, 3-month, and 6-months post-outplanting at three sites (North and South Spawning Hubs and the Clipper Lasco grounding site), which represented 58% of the outplanted colonies, and conduct a one-time monitoring event of the remaining 198 colonies at one outplant site (HC1), which represented 42% of the outplanted colonies (Tables 5 and 7). These 472 colonies represent 67% of the 700 colonies collected and 15 of the 16 collected species (Tables 8 - 10). All collected *S. cubensis* colonies were < 5 cm diameter and remain in the offshore nursery. We modified the approach to provide more information efficiently and effectively on the outplanted colonies. For the 274 colonies at the North and South Spawning Hubs and the Clipper Lasco grounding site, the 1-month survival was 100% and the 3-month and 6-month survival was 99% (Tables 8 - 10). One *A. agaricites* colony was noted as missing after Hurricane Nicole during the 3-month event at the North Spawning Hub. Colonies outplanted at site HC1 (Table 11) were not intended to be fate tracked and as such were not tagged or mapped. Six months after the last colonies were outplanted at site HC1, a roving diver survey was conducted to relocate outplanted colonies and estimate survival at this site. Of the 198 colonies outplanted, 160 colonies were identified (Table 11). Of these 160 colonies 155 were alive and 5 were dead. The remaining 38 colonies were not found, and their fate is unknown.

Partial colony recent mortality on the monitored corals at the Hubs and Clipper Lasco was identified on 37 colonies representing seven species during the 1-month event, and 28 colonies representing seven species during the 3-month event (Table 12). During the 6-month event, 25 colonies from four species were identified with signs of partial recent mortality. Over the entire morning period, colony recent mortality was caused by fish predation (67 colonies) or causes that could not be identified (23 colonies). Colony partial bleaching was identified on 38 colonies (8 species) during the 1-month event, 23 colonies (4 species) during the 3-month event, and 30 colonies (8 species) during the 6-month event (Table 12). The roving diver survey at site HC1 identified three colonies (1 species) with recent mortality caused by predation and 44 colonies (5 species) showing partial or total bleaching.

Table 7. Number of colonies outplanted to each site.

Site	# of Colonies
South Spawning Hub	55
North Spawning Hub	47
Clipper Lasco	172
HC1	198
Total	472

Table 8. Summary information for the monitored colonies outplanted to the North Spawning Hub site. Only colony diameter size classes represented at this site are included (# C = number of colonies and # A = number of colonies alive).

		Size Class (cm)					
		5-10		11-15		16-20	
Event	Species	# C	# A	# C	# A	# C	# A
1-Month	AAGA	5	5	1	1	0	0
3-Month	AAGA	5	4	1	1	0	0
6-Month	AAGA	5	4	1	1	0	0
1-Month	MCAV	2	2	4	4	0	0
3-Month	MCAV	2	2	4	4	0	0
6-Month	MCAV	2	2	4	4	0	0
1-Month	MDEC	1	1	0	0	0	0
3-Month	MDEC	1	1	0	0	0	0
6-Month	MDEC	1	1	0	0	0	0
1-Month	PAST	5	5	8	8	1	1
3-Month	PAST	5	5	8	8	1	1
6-Month	PAST	5	5	8	8	1	1
1-Month	SINT	3	3	4	4	1	1
3-Month	SINT	3	3	4	4	1	1
6-Month	SINT	3	3	4	4	1	1
1-Month	SSID	10	10	2	2	0	0
3-Month	SSID	10	10	2	2	0	0
6-Month	SSID	10	10	2	2	0	0

Table 9. Summary information for the monitored colonies outplanted to the South Spawning Hub site. Only colony diameter size classes represented at this site are included (# C = number of colonies and # A = number of colonies alive).

		Size class (cm)											
		5-10		11-15		16-20		21-30		31-40		40+	
Event	Species	# C	# A	# C	# A	# C	# A	# C	# A	# C	# A	# C	# A
1-Month	AAGA	1	1	2	2	0		0		0		0	
3-Month	AAGA	1	1	2	2	0		0		0		0	
6-Month	AAGA	1	1	2	2	0		0		0		0	
1-Month	CNAT	0		0		0		1	1	1	1	0	
3-Month	CNAT	0		0		0		1	1	1	1	0	
6-Month	CNAT	0		0		0		1	1	1	1	0	
1-Month	DSTO	1	1	0		0		0		0		0	
3-Month	DSTO	1	1	0		0		0		0		0	
6-Month	DSTO	1	1	0		0		0		0		0	
1-Month	MCAV	5	5	0		1	1	2	2	1	1	0	
3-Month	MCAV	5	5	0		1	1	2	2	1	1	0	
6-Month	MCAV	5	5	0		1	1	2	2	1	1	0	
1-Month	MDEC	0		1	1	0		0		0		0	
3-Month	MDEC	0		1	1	0		0		0		0	
6-Month	MDEC	0		1	1	0		0		0		0	
1-Month	PAST	0		4	4	4	4	6	6	0		0	
3-Month	PAST	0		4	4	4	4	6	6	0		0	
6-Month	PAST	0		4	4	4	4	6	6	0		0	
1-Month	PPOR	0		3	3	0		0		0		0	
3-Month	PPOR	0		3	3	0		0		0		0	
6-Month	PPOR	0		3	3	0		0		0		0	
1-Month	PSTR	0		1	1	0		3	3	1		1	1
3-Month	PSTR	0		1	1	0		3	3	1		1	1
6-Month	PSTR	0		1	1	0		3	3	1		1	1
1-Month	SBOU	0		0		0		0		1	1	0	
3-Month	SBOU	0		0		0		0		1	1	0	
6-Month	SBOU	0		0		0		0		1	1	0	
1-Month	SINT	0		5	5	0		2	2	0		0	
3-Month	SINT	0		5	5	0		2	2	0		0	
6-Month	SINT	0		5	5	0		2	2	0		0	
1-Month	SSID	1	1	5	5	2	2	1	1	0		0	
3-Month	SSID	1	1	5	5	2	2	1	1	0		0	
6-Month	SSID	1	1	5	5	2	2	1	1	0		0	

Table 10. Summary information for the monitored colonies outplanted to the Clipper Lasco site. Only colony diameter size classes represented at this site are included (# C = number of colonies and # A = number of colonies alive).

		Size class (cm)											
		5-10		11-15		16-20		21-30		31-40		40+	
Event	Species	# C	# A	# C	# A	# C	# A	# C	# A	# C	# A	# C	# A
1-Month	AAGA	19	19	5	5	1	1	0		0		0	
3-Month	AAGA	19	19	5	5	1	1	0		0		0	
6-Month	AAGA	19	19	5	5	1	1	0		0		0	
1-Month	EFAS	1	1	0		0		0		0		0	
3-Month	EFAS	1	1	0		0		0		0		0	
6-Month	EFAS	1	1	0		0		0		0		0	
1-Month	MCAV	7	7	3	3	2	2	5	5	1	1	0	
3-Month	MCAV	7	7	3	3	2	2	5	5	1	1	0	
6-Month	MCAV	7	7	3	3	2	2	5	5	1	1	0	
1-Month	MDEC	5	5	3	3	0		1	1	0		0	
3-Month	MDEC	5	5	3	3	0		1	1	0		0	
6-Month	MDEC	5	5	3	3	0		1	1	0		0	
1-Month	MMEA	2	2	0		0		0		0		0	
3-Month	MMEA	2	2	0		0		0		0		0	
6-Month	MMEA	2	2	0		0		0		0		0	
1-Month	MYAL	0		0		1		2	2	0		0	
3-Month	MYAL	0		0		1		2	2	0		0	
6-Month	MYAL	0		0		1		2	2	0		0	
1-Month	OFAV	0		0		0		0		0		1	1
3-Month	OFAV	0		0		0		0		0		1	1
6-Month	OFAV	0		0		0		0		0		1	1
1-Month	PAST	11	11	8	8	8	8	6	6	1	1	0	
3-Month	PAST	11	11	8	8	8	8	6	6	1	1	0	
6-Month	PAST	11	11	8	8	8	8	6	6	1	1	0	
1-Month	PSTR	2	2	0		3	3	0		0		1	1
3-Month	PSTR	2	2	0		3	3	0		0		1	1
6-Month	PSTR	2	2	0		3	3	0		0		1	1
1-Month	SBOU	1	1	0		0		4	4	1	1	0	
3-Month	SBOU	1	1	0		0		4	4	1	1	0	
6-Month	SBOU	1	1	0		0		4	4	1	1	0	
1-Month	SINT	15	15	13	13	4	4	1	1	0		0	
3-Month	SINT	15	15	13	13	4	4	1	1	0		0	
6-Month	SINT	15	15	13	13	4	4	1	1	0		0	
1-Month	SSID	23	23	7	7	4	4	0		0		0	
3-Month	SSID	23	23	7	7	4	4	0		0		0	
6-Month	SSID	23	23	7	7	4	4	0		0		0	

Table 11. Summary information of colonies monitored at HC1 using the roving diver survey (C = number of colonies outplanted, A = number of colonies alive, D = number of colonies dead, and NF = number of colonies outplanted but not found).

Species	5-10 cm				11-20 cm				21-30 cm			
	#C	#A	#D	#NF	#C	#A	#D	#NF	#C	#A	#D	#NF
AAGA	14	10	1	3	5	5	0	0	0	0	0	0
MCAV	11	10	0	1	5	4	0	1	2	2	0	0
MDEC	5	4	1	0	2	1	0	1	0	0	0	0
PAST	26	19	1	6	36	23	2	11	13	12	0	1
PSTR	0	0	0	0	1	1	0	0	0	0	0	0
SINT	17	10	0	7	19	17	0	2	1	0	0	1
SSID	34	30	0	4	7	7	0	0	0	0	0	0

Table 12. Number of colonies of each species identified with health conditions during each monitoring event (1 = 1-month event, 3 = 3-month event, and 6 = 6-month event). A separate column was created for each condition observed on corals surveyed at HC1. Bleaching includes colony partial bleaching and bleached.

Species	Recent Mortality Predation				Bleaching				Recent Mortality Unknown Cause			
	1	3	6	HC1	1	3	6	HC1	1	3	6	HC1
AAGA	1	0	0	0	1	0	1	4	1	0	0	0
DSTO	0	0	0	0	1	1	1	0	0	0	0	0
MCAV	0	1	0	0	7	4	3	2	1	4	3	0
MDEC	0	0	0	0	2	0	1	2	0	0	0	0
MYAL	0	2	0	0	0	0	0	0	0	0	0	0
OFAV	0	1	0	0	0	0	0	0	0	0	0	0
PAST	22	10	10	3	1	0	3	6	1	0	0	0
PPOR	0	0	3	0	0	0	0	0	0	0	0	0
PSTR	3	2	0	0	2	0	0	0	0	0	0	0
SBOU	1	0	0	0	0	0	1	0	0	0	0	0
SINT	1	1	0	0	16	10	8	14	0	5	1	0
SSID	6	2	0	0	8	8	12	18	0	0	0	0