2024-2025 SE FL KJCAP Reef-building-coral Disease Intervention and Preparation for Restoration

Final Report

Florida Department of Environmental Protection
Coral Protection and Restoration Program

2024-2025 SE FL KJCAP Reef-building-coral Disease Intervention and Preparation for Restoration

Final Report

Prepared By:

Brian K. Walker, Hunter Noren, Reagan Sharkey, Samantha Buckley, Sasha Wheeler, Alexandra Wagner, Robert Spekis, and Tristan Buckell

Nova Southeastern University
Halmos College of Arts and Sciences
8000 N. Ocean Drive
Dania Beach, FL 33004-3078

June 15, 2025

Completed in Partial Fulfillment of PO C3D4C8 for

Florida Department of Environmental Protection
Coral Protection and Restoration Program
8000 N Ocean Dr.
Dania Beach, FL 33004

This report should be cited as follows:
Walker B.K., Noren H., Sharkey R., Buckley S., Wheeler S., Wagner A., Spekis R., and T. Buckell. 2025. 2024-2025 SE FL KJCAP Reef-building-coral Disease Intervention and Preparation for Restoration Final Report. Florida DEP. Miami, FL. 30p.

This report was prepared for the Florida Department of Environmental Protection, Coral Protection and Restoration Program by Nova Southeastern University. Funding was provided by the Florida Department of Environmental Protection Award No. C3D4C8. The views, statements, findings, conclusions, and recommendations expressed herein are those of the authors and do not necessarily reflect the views of the State of Florida or any of its sub-agencies.

Table of Contents

List of Figures

List of Tables

List of Acronyms

FAU	Florida Atlantic University Harbor Branch Oceanographic Institute
DEP	Florida Department of Environmental Protection
ORCP	Office of Resilience and Coastal Protection
FWC	Florida Fish and Wildlife Conservation Commission
NSU	Nova Southeastern University
KJCAP	Kristin Jacobs Coral Aquatic Preserve
FCR	Florida's Coral Reef
SCTLD	stony coral tissue loss disease
SE FL	Southeast Florida
NOAA	National Oceanic and Atmospheric Administration
NCRMP	National Coral Reef Monitoring Program
CIMAS	Cooperative Institute For Marine And Atmospheric Studies
GIS	Geographic Information System

Acknowledgements

Thank you to the Florida Department of Environmental Protection's Coral Protection and Restoration Program (DEP CPR) and NOAA CRCP for supporting these efforts. We thank the Florida Coral Disease Advisory Committee for the large number of volunteers assisting in the meeting and planning of coral disease efforts. We thank Lisa Gregg for assisting with permitting. Thanks to the DEP CPR staff including Brooke Robinson and Kylie Morgan for contract and report-review coordination. Thanks to Miami-Dade Regulatory & Economic Resources for striketeam field assistance. Thank you to Amanda Zummo, Allie Kozachuk, Zach Graff, Whitney Schwab, Maya Becker, Zachary Niedermaier, and Austin Blakeslee at the NSU GIS and Spatial Ecology lab for field assistance.

Management Summary (300 words or less)

Coral diseases have caused enormous impacts to coral populations globally perpetuating the rapid need for large-scale coral reef restoration. SCTLD exemplifies that coral diseases are more devastating than ever before. However, implementing recent disease intervention techniques from the restoration toolbox reduces the necessity for costly and time-consuming post hoc restoration techniques.

Our work shows that SCTLD is still prevalent in the region, interventions are still needed, and these efforts are saving corals. This year, interventions helped maintain species diversity and ecosystem services within the KJCAP and kept alive some of the largest and oldest animals in Florida. Monthly monitoring and treatments have reduced the loss of live tissue area and provided valuable information on the temporal and spatial variations of colonies with lesions. Corals not regularly treated with disease interventions have had drastic declines in live tissue area. Regular disease intervention is restoring colony health and saving the large priority corals, preempting post hoc restoration. For example, the current live tissue area of all previously treated large corals is 436.9 m^2. This is the equivalent to the area of a regulation sized NBA basketball court of live coral tissue. That equates to 1,092,250 2 x 2 cm coral restoration fragments.

Our reconnaissance for coral restoration sites identified two new notably large *Orbicella faveolata* colonies, three areas of exceptional coral diversity or density, and an exceptionally large patch of live *Madracis sp.* These sites are of high value to the State of Florida for restoration and eco-tourism.

The monthly large coral monitoring data have been invaluable in linking environmental drivers to disease dynamics. Higher water temperatures, amounts of water following out of the inlets, and rainfall account for 66.2% of the temporal variability in the number of diseased colonies. Understanding these dynamics can help with water management strategies. Caution should be taken when choosing coral restoration sites as to avoid areas more prone to disease.

Executive Summary

SCTLD was first discovered in the Kristin Jacobs Coral Aquatic Preserve (KJCAP) in 2014 and remains present in the region. As of May 15, 2025, a total of 1,964 colonies of seventeen species were treated by the coral disease interventions strike teams in the KJCAP since 2018 (including the experimental sites, but not the large priority corals) totaling 1,102 meters of treatment. Between July 1st, 2024 and May 15, 2025, a total of 70 colonies were treated on eight species. The amount and species of corals treated in broad scale recon surveys indicates that there are still some survivors of highly and intermediately susceptible species in the area succumbing to the disease. Broadscale treatments were halted in February by Florida Fish and Wildlife Conservation Commission and not permitted to continue.

Large priority corals still required monthly visits to ensure their survival. Of the 108 monitored corals between July 1 and May 15, 2025, a total of 153 antibiotic ointment treatments were conducted on 31 colonies. Twenty treatments failed, equating to 86.9% effectiveness on lesions. The number of new infections varied throughout the period. July and November were the months with the highest treatments. September had the highest total treatment length. Monthly visits should continue to maximize treatment success and capture new infection frequencies.

During this reporting period, NSU divers conducted a total of 109 recon and striketeam intervention dives over 21 dive days. Our reconnaissance for coral restoration sites identified two new notably large *Orbicella faveolata* colonies, three areas of exceptional coral diversity or density, and an exceptionally large patch of live *Madracis sp.*

The large coral new treatment data collected herein and previously were summarized to evaluate statistical relationships to environmental predictors funded by DEP PO B9CAF9, C3D88F, and EPA award SF02D21722. They were also used to evaluate the outcomes of the SCTLD Resistance Research Consortium (RRC) laboratory analyses funded by DEP B8A48D and the EPA grant. They were the primary dataset for the FDEP hydrographic modeling (C1FC2C), the continuation of the SCTLD RRC (C2205D), and the 2025-26 expansion of the water quality modeling to the whole FCR.

1. BACKGROUND

Florida's Coral Reef is currently experiencing a multi-year disease-related mortality event, that has resulted in massive die-offs in multiple coral species. Approximately 21 species of coral, including both Endangered Species Act-listed and the primary reef-building species, have displayed tissue loss lesions which often result in whole colony mortality. First observed near Virginia Key in late 2014, the disease has since spread to the northernmost extent of Florida's Coral Reef, and southwest past the Marquesas in the Lower Florida Keys into the Dry Tortugas. The best available information indicates that the disease outbreak is continuing to spread throughout the Caribbean. Given the large temporal and geographic range of this Stony Coral Tissue Loss Disease (SCTLD), the virulence of the still-unidentified pathogen(s), and its likely continued rate of progression, management efforts have focused on proactive intervention techniques to save remaining corals at targeted sites.

In 2024, DEP funded this project (award C3D4C8) to continue KJCAP coral disease intervention and restoration activities ongoing since 2018 (DEP PO# B2A150, B48140, B46AD7, B3C3AD, B558F2, B7B6F3, B96800, C00BAE, C20F00, C2003, C229F7) with the expectation of supporting existing collaborations. These actions included maintaining the monitoring and continued treatment of 100 priority large corals, conducting broadscale strike team reconnaissance and disease interventions, maintaining a large *Orbicella* corals of opportunity nursery and reskinning large corals, and the identification of unique colonies and sites (e.g. location of remaining highly susceptible species, remaining high coral density sites, restoration candidate sites). Information from these previously-funded activities has strengthened local partnerships and provided data on treatment effectiveness, saved the largest large colonies from extreme tissue loss, and facilitated probiotics testing. It also provided data on tissue loss rates, survivor sites, new infection rates through time, and classifying large corals into categories based on infection rates setting up the study design for the SCTLD Resistance Research Consortium (RRC).

This report summarizes the progress from our continued KJCAP coral disease interventions through May 15, 2025, including the monitoring and continued treatment of the priority large corals, broadscale strike team reconnaissance and disease interventions, the identification of unique coral disease survivor sites, and the nursery maintenance, propagation, and outplanting of corals of opportunity of the most resilient *Obricella* corals on the reef to restore the coral populations in southeast Florida.

2. PROJECT DESCRIPTION

One goal of this project is to perform disease interventions on the remaining reef-building coral species with active disease in the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA). These activities are essential to saving the remaining corals in SE FL affected by disease that have the potential of recovering and building new reef structure. Coral disease intervention treatments included smothering diseased tissue, creating a disease-break to arrest disease progression and covering the newly exposed skeleton with chlorinated epoxy and/or amoxicillin. The first objective was to apply these interventions to the 100 priority large corals as necessary to maintain their health and continue monthly

monitoring. The second objective was to conduct broader-scale strike team disease intervention efforts in partnership with Smithsonian, Florida Atlantic University, DEP, Broward County, and Miami-Dade County to help save diseased colonies throughout the KJCAP. A third objective was to further field test new permitted intervention techniques and materials (e.g. Smithsonian probiotics) including whole colony treatments as they are conceived, developed, and permitted.

A second goal of this project was to collect information to inform and aid in planning future Coral ECA restoration efforts. Future restoration will need to identify survivors for sexual reproduction, genetic analyses, and experimentation on stress hardening and disease resistance. Therefore, we identified unique coral disease survivor sites to make restoration activities more efficient.

A third goal of this project was to maintain a nursery of corals of opportunity of the most resilient corals, then propagate and outplant them to the reef to restore the coral populations in southeast Florida. These activities harvested the recently broken pieces of the resilient colonies as corals of opportunity (COOs), propagated smaller pieces via microfragmentation, and strategically outplanted them to increase chances of successful sexual reproduction. Outplants were used to try and restore the surfaces of other previous large colonies that recently died from SCTLD to living structures once again. Effects of genotype, region, and predator exclusion devices were also tested.

The outcomes of this project will be incorporated into an on-going coral disease response effort which seeks to improve understanding about the scale and severity of the coral disease outbreak on Florida's Coral Reef, identify primary and secondary causes, identify management actions to remediate disease impacts, restore affected resources, and ultimately prevent future outbreaks. As such, collaboration amongst partners was encouraged when appropriate to avoid duplication of efforts and ensure alignment of needs. Coordination with other Principal Investigators is recommended and required, as appropriate.

3. METHODOLOGY

The antibiotic paste treatments were conducted under the State of Florida Special Activity License Permit SAL-24-2022-SRP and SAL-25-2022A-SRP which authorized the cutting of disease-breaks and the application of disease treatments containing amoxicillin and chlorine. The restoration activities were conducted under SAL-24-2515-SCRP.

3.1. Broad-scale Coral Disease Intervention Strike Team (Task 2)

Southeast Florida coral disease intervention strike teams, consisting of personnel from NSU, Broward County, and Miami-Dade County, conducted disease intervention at various sites throughout both counties. Intervention sites were chosen based on previous information on the locations of diseased corals and high priority county sites. The NSU efforts discussed in this report targeted locations between Hillsboro Inlet and Biscayne National Park while avoiding known existing monitoring stations and experimental sites. At each location, divers towed a GPS buoy recording divers' movement along the reef

track. Once a diseased coral was located, the time of treatment was recorded. Each coral was tagged and measured, photographed, and treated. GPS coordinates were loaded into ArcGIS and the locations that corresponded to each time recorded during treatment were copied into a GIS shapefile. All treated coral locations were supplied to FWC for inclusion in the Coral Disease Intervention Dashboard: https://arcg.is/0L1LWX.

3.2. Monthly Interventions to 100 Large Corals (Task 3)

The largest known corals in the region were prioritized for monitoring and disease interventions. From September 2018 – June 2019, approximately 60 corals began being monitored and treated on a monthly basis. This increased to 90 colonies in July 2019, but it took several periods to establish all 90. As of October 2021, there were a total of 107 corals in the priority database. All priority corals were photographed monthly and visually assessed by a diver estimating the percentage of live tissue, diseased tissue, bleached tissue, recent mortality, and old mortality. If SCTLD was found, the lesion was treated with antibiotic paste. All margins were treated with the Ocean Alchemists antibiotic ointment CoreRx B2B with amoxicillin (1:8 ratio by weight). Photographs were taken of all areas before treatment at both the 0.5 m standard distance and wider scenes. The length of each treatment was estimated using a standardized scale in the photographs. Lesion treatments were determined failures if the active disease continued progressing past the treatment line. Treatment success was calculated as the reciprocal of the percentage of treatment failures. All prioritized colonies were tagged with a yellow tag with a unique number and instructions to photograph the coral and submit the photo to www.SEAFAN.net/tags (Figure 1).

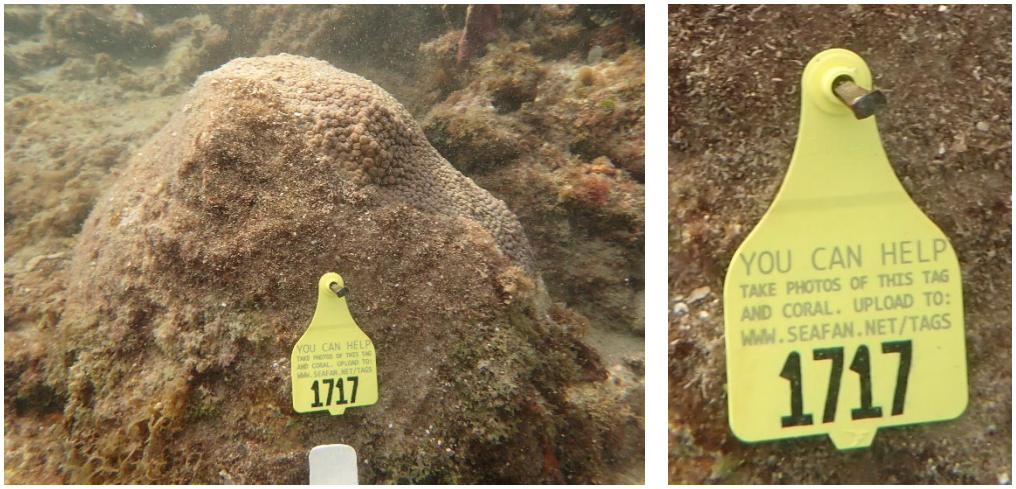

Figure 1. Example of coral tag placed on or next to each treated coral.

3.3. Recon sites (Task 4)

Reconnaissance throughout Broward and Miami-Dade was conducted by coral disease response strike teams to identify corals and/or sites that respond better to treatments or that have resisted infection to-date and to identify unique coral disease survivor sites. Recon

was performed during strike team disease interventions and other opportunistic times. Divers visited sites and haphazardly searched the area towing a GPS buoy to find locations of visually noticeable high coral density or richness and to identify if disease is present. If disease was found, these locations were treated and mapped. Large colonies of any species and smaller colonies of the species hit hardest by SCTLD (e.g. *M. meandrites*, *E. fastigiata*, *D. stoksii*, *C. natans*, *D. cylindrus, D. labyrinthiformis*) were mapped.

3.4. Maintain coral nursery and reskin large corals (Task 5)

Our ex-situ *Orbicella faveolata* restoration funding started in 2019 as part of the SE FL restoration hub. Six tanks were established at NSU's outdoor facility to quarantine, fragment, and grow out fragments from COO of large colonies. Seeded with two other awards from FDEP, many strides were made in optimizing procedures for success. We continued to maintain our coral nursery and restoration activities. Fragments were sourced from corals of opportunity. Thirty arrays of seven coral fragments (210 total) on pucks mounted on a single cement outplant mold touching each other were placed on various large (> 1 m) dead *Orbicella faveolata* skeletons restore live coral tissue to the structure. Arrays of multiple genotypes were placed on the same large dead coral to promote natural fertilization success. The outplants were photographed periodically to determine survivorship, growth, and possible disease infections, and conduct disease interventions if necessary.

3.1. COO Collections:

This work was conducted under the State of Florida Special Activity Licenses SAL-23-2515-SCRP and SAL-24-2515-SCRP. In total, 11 COOs were collected from offshore expeditions along the SE Florida coast between Fort Lauderdale beach and Key Biscayne (Table 1). In general, corals were photographed underwater, brought up to the surface, measured, labeled, wrapped in bubble wrap (when necessary), and housed in an insulated cooler for the 30-60-minute transport to shore. The water inside the cooler was changed every 15 minutes or if it deviated ±5 F. Once onshore, corals were dipped in Lugol's solution for 15 minutes – 1 hour as described in the product's instructions, photographed, and drip acclimated (when temperatures differed between in-situ and ex-situ systems by ±5 F) into their ex-situ Seacor nursery tanks for quarantine.

Table 1. COO collections for genotypes LC-114, LC-056, LC-119, LC-124, & LC-041.

Date	Label	Spp.	#	Source Location	Temp	Tank	Tank Temp	Treatment
2/26/2025	LC-080	OFAV	1	S. Biscayne	75F	S23	78F	n/a
2/26/2025	LC-024	OFAV	2	S. Biscayne	75F	S23	78F	n/a
2/26/2025	LC-124	OFAV	1	N. Biscayne	75F	S23	78F	n/a
2/26/2025	LC-009	OFAV	2	FTL	75F	S23	78F	n/a
2/26/2025	LC-052	OFAV	1	FTL	75F	S23	78F	n/a
2/26/2025	LC-190	OFAV	1	Hollywood	75F	S23	78F	n/a
3/6/2025	LC-023	OFAV	1	N. Biscayne	77F	S3	78F	Lugol Dip
3/7/2025	LC-119	OFAV	2	N. Biscayne	77F	S3	78F	Lugol dip

3.2. **Husbandry Conditions ex-situ:**

The outdoor Seacor systems of the NSU coral nursery are in independent 120-gallon acrylic tanks, covered by two layers of rain-resistant shade cloth (80% and 50%) with an optimal PAR reading of 50-200 µmol m-2 s-1 (Figure 2). Each tank's salinity is maintained at 35-36 ppt using bidiurnal reverse osmosis water changes to replace evaporated water and micronutrients. A submersible heater and a chiller are used to maintain the desired temperature of 77° F. Water quality tests are performed weekly to maintain an alkalinity of 7.1-7.7 dKh, with other tests prescribed as needed. Feeding of Golden Pearls (3g/1L), Roti Feast (10mL/L), Oyster Feast (10mL/L), and Reef-Roids (3g/1L) was performed between 2-3 times per week. Algal growth is controlled using protein skimmers, herbivorous snails and urchins, and manual removal weekly to minimize coral-algae competition.

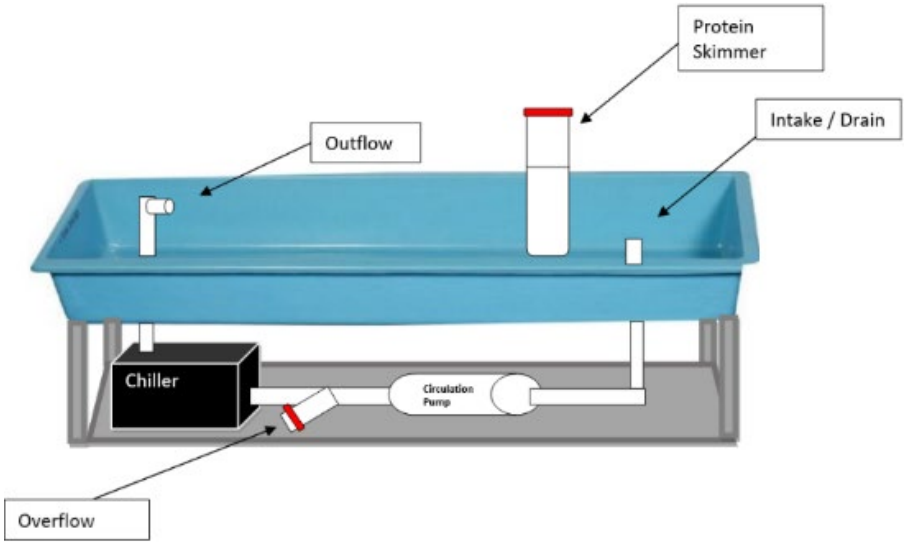

Figure 2. Seacor Tank Diagram.

3.3. **Microfragmentation:**

In total, 25 ramets (large pieces and small-fractured pieces) were cut into 599 fragments during the project (Table 2). Microfragmentation was conducted according to a modified version of the methods outlined in Forsman et al., 2015. In general, microfragment pieces (or "Frags") were cut into 1 – 4 cm² fragments using a Gryphon© 37" AquaSaw Diamond Band Saw under a sun shade (in days of high solar irradiance), glued to 1 - 1.25 inch diameter ceramic and limestone pucks, and grown in the above-described recirculating tanks until they reached sufficient size and health for outplanting. Table 3 shows the treatments conducted during this period.

Table 2. Fragment treatment schedule.

Date	Tank	Spp.	old	new	Ramet	Made	Treatment
1/28-2/3/2025	S4	OFAV	Tire1	n/a	1	163	Amino + FR + Lugol
45685	S4	OFAV	LC-009	LC-009-A	1	49	Frag Recover
45685	S4	OFAV	LC-047	LC-047-B	1	26	Frag Recover
45691	S4	OFAV	UK Ramet	UK-2/3/25	1	14	Amino + Lugol
45691	S5	OFAV	LC-052	LC-052-C	1	16	Amino + Lugol
45714	S24	OFAV	ECA-1	ECA-1-X	1	7	Amino + Lugol
45714	S24	OFAV	ECA-2	ECA-2-X	2	6	Amino + Lugol
45714	S24	OFAV	ECA-3	ECA-3-X	1	5	Amino + Lugol
45714	S24	OFAV	ECA-4	ECA-4-X	1	7	Amino + Lugol
45714	S24	OFAV	ECA-5	ECA-5-X	1	9	Amino + Lugol
45714	S24	OFAV	ECA-6	ECA-6-X	1	12	Amino + Lugol
45729	S24	OFAV	Keys-1	Keys-1-1	1	14	Amino + Lugol
45729	S24	OFAV	Keys-2	Keys-2-1	1	11	Amino + Lugol
45729	S24	OFAV	Keys-3	Keys-3-1	1	19	Amino + Lugol
45729	S24	OFAV	Keys-4	Keys-4-1	1	29	Amino + Lugol
45729	S24	OFAV	Keys-5	Keys-5-1	1	12	Amino + Lugol
45729	S24	OFAV	ECA-1-6	ECA-1-4	1	44	Amino + Lugol
45729	S24	OFAV	ECA-2-1	ECA-2-1	1	26	Amino + Lugol
45729	S24	OFAV	ECA-3-4	ECA-3-4	1	25	Amino + Lugol
45730	S24	OFAV	ECA-4-3	ECA-4-3	1	19	Amino + Lugol
45730	S24	OFAV	ECA-5-7	ECA-5-2	1	46	Amino + Lugol
45730	S24	OFAV	ECA-6-7 + ECA-6-11 + ECA-6-12	ECA-6-3	3	40	Amino + Lugol

Table 3. Treatments conducted during this period.

Date	Treatment	[x]	Tank	Duration	Spp
7/10/2024	Lugol	light tea	S2	10min	OFAV
7/18/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/19/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/20/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/21/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/22/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/23/2024	Cipro	40mg/L	S2	2hrs	OFAV
7/26/2024	Lugol	light tea	S6	10min	OFAV
7/26/2024	Lugol	light tea	S6	10min	OFAV
10/1/2024	Cipro	40mg/L	S6	2hrs	OFAV
10/2/2024	Cipro	40mg/L	S4	2hrs	OFAV
10/3/2024	Cipro	40mg/L	S4	2hrs	OFAV
10/4/2024	Cipro	40mg/L	S4	2hrs	OFAV
10/5/2024	Cipro	40mg/L	S4	2hrs	OFAV
10/6/2024	Cipro	40mg/L	S4	2hrs	OFAV
4/11/2025	Cut Down + Lugol	Light tea	S3	10min	OFAV

3.4. **Outplanting:**

On March 13, 2025, NSU received a coral health certification for 210 *O. faveolata* fragments. Thirty cement convex domes constructed with Titian American LLC. Portland-Limestone Cement Type 1 L cast in an 18 cm diameter, 2 cm thick plastic bowl was determined as the easiest and most effective way to create the outplanting molds. Domes were designed so a circular array of 7 fragments of the same genotype could fit countersunk within it. This design gave the best chance that the fragments will fuse together and quickly create a reproductive colony. On March 21 and March 24, 2025, 7 fragment plugs were epoxied flushed to each of the 30 cement convex domes using 2-part Apoxie Sculpt Modeling Compound (Figure 3). The cement domes were then placed in ex-situ nursery tanks until ready to outplant (Figure 4).

Three denuded colonies, LC-008, LC-019 and LC-076 were selected as outplant colonies. LC-008 is located off Hollywood Beach, Florida, while LC-019 and LC-076 off Miami Beach (LC-019) and Key Biscayne (LC-076). On March 24, 2025, colonies for outplanting were visited and prepped. Surveys to assess disease within the areas were conducted. No disease was reported. Colonies were also prepped using a NEMO angle grinder to smooth and clear benthic fauna from the surface of the colony.

A Standard Operating Procedure manual was developed. Divers were trained on the protocols before outplanting. On March 25, 2025 and March 26, 2025 210 *O. faveolata* fragments were outplanted to the three large coral skeletons, LC-008, LC-019 and LC-076. Ten domes were outplanted to each colony (n=30) (Figure 5). Colonies LC-019 and LC-076 had ten domes of the same genotype (Tire1) outplanted each of the colonies (Figure 6). LC-008 had three domes of genotype LC-056 and seven domes of genotype LC-009 outplanted to the colony.

After outplanting, fragments were monitored at 1 week and 1 month post outplanting. Photos were taken at each monitoring event and predation, survivorship, disease, paling, or bleaching were noted if present.

Monitoring activities for previous outplantings were also conducted from June 2024 till May 2025. The May 2024 and December 2023 outplantings were monitored monthly until one year post outplanting. Due to extreme weather, data was unable to be collected for May 2024 seven-month post outplant monitoring and December 2023 one-year post outplant monitoring. February 2023 outplanting was also monitored for 18 months and two-year post outplant monitoring. Photos were taken at each monitoring event and predation, survivorship, disease, paling, or bleaching were noted if present.

Figure 3. Lab manager, Hunter Noren and Graduate Research Assistant, Tristian Buckell epoxying fragments to outplanting domes.


Figure 4. Domes in ex-situ nursery awaiting outplanting.

Figure 5. Graduate Research Assistant, Zach Niedermaier epoxying outplanting domes to coral skeleton.

Figure 6. 70 *Orbicella faveloata* fragments outplanted to colony LC-019 off Miami Beach.

4. RESULTS

All broad-scale strike team activities have been reported to FWC's coral disease intervention dashboard (https://arcg.is/0L1LWX).

4.1. Broad-scale Coral Disease Intervention Strike Team (Task 2)

As of February 20th, 2025, a total of 1,964 colonies have been treated by the coral disease interventions strike teams in the KJCAP since 2018 (including the experimental sites, but not the large priority corals in section 4.2) (Figure 7). The total number of treatments by species were 1,515 *Montastraea cavernosa*, 199 *Orbicella faveolata*, 65 *Pseudodiploria strigose,* 63 *Pseudodiploria clivosa*, 45 *Colpophyllia natans*, 32 *Solenastrea bournoni,* 17 *Diploria labyrinthiformis*, 8 *Stephanocoenia intersepta*, 6 *Dichocoenia stokesii,* 4 *Mycetophyllia aliciae*, 3 *Siderastrea siderea*, 2 *Meandrina meandrites*, 2 *Orbicella annularis*, 1 *Porites astreoides*, 1 *Orbicella franksi*, 1 *Agaricia agaricites*, and 1 *Dendrogyra cylindrus.*

Out of the 1,964 colonies, 1,839 (93.6%) were treated with antibiotic ointment (1,400 *M. cavernosa*, 194 *O. faveolata*, 62 *P. strigose,* 62 *P. clivosa*, 43 *C. natans*, 32 *S. bournoni,* 17 *D. labyrinthiformis*, 8 *S. intersepta*, 6 *D. stokesii,* 4 *M. aliciae*, 3 *S. siderea*, 2 *M. meandrites*, 2 *A. annularis*, 1 *P. astreoides*, 1 *O. franksi*, 1 *A. agaricites*, and 1 *D. cylindrus.*); 109 (5.6%) corals were treated with chlorinated epoxy (102 *M. cavernosa*, 4 *O. faveolata*, 2 *P. strigosa*, and 1 *C. natans*); and 16 (0.8%) corals were treated with CoreRx B2B without antibiotics that were not successful (13 *M. cavernosa,* 1 *O. faveolata,* 1 *P. clivosa,* and 1 *C. natans*).

A total of 1,102.4 meters of antibiotic paste treatments, 68.6 meters chlorinated epoxy treatments, and 6.4 meters of CoreRx Base treatments were performed totaling 1,177.4 meters. That's over 3 times the height of the Empire State Building. The average treatment length per coral was 59.9 cm which varied by species: *M. cavernosa* = 62.2 cm, *O. faveolata* = 63.4 cm, *P. clivosa* = 46.3 cm, *P. strigosa* = 41.8 cm, *C. natans* = 41.8 cm, *S. bournoni* = 59.5 cm, *D. labyrinthiformis*= 42.6 cm, *S. intersepta* = 17.4 cm, *D. stokesi* = 12.3 cm, *M. aliciae* = 23.3 cm, *S. siderea* = 55.7 cm, *M. meandrites* = 11 cm *O. annularis* = 82.5 cm, *P. astreoides* = 28 cm, *O. franksi* = 12 cm, *A. agaricites* = 10 cm, and *D. cylindrus* = 63 cm.

Between July 1st, 2024 and February 20th, 2025, a total of 70 colonies were treated with antibiotic paste by the coral disease interventions strike teams in the KJCAP (not including the large priority corals (Section 4.2) and probiotics (Section 4.4)) (Figure *8*). The total number of treatments by species were 41 *M. cavernosa*, 20 *O. faveolata*, 3 *P. strigosa,* 2 *P. clivosa,* 1 *M. meandrites*, 1 *O. annularis,* 1 *S. bournoni*, and 1 *S. intercepta.* These totaled 286.10 meters of antibiotic ointment treatments were performed. The average treatment length per coral was 40.9 cm which varied by species: *M. cavernosa* = 35.9 cm, *O. faveolata* = 58.6 cm, *P. strigosa* = 14.7 cm, *P. clivosa* = 41.5 cm, *M. meandrites* = 8cm, *O. annularis* = 16 cm, *S. bournoni* = 62 cm, *S. intersepta* = 6 cm.

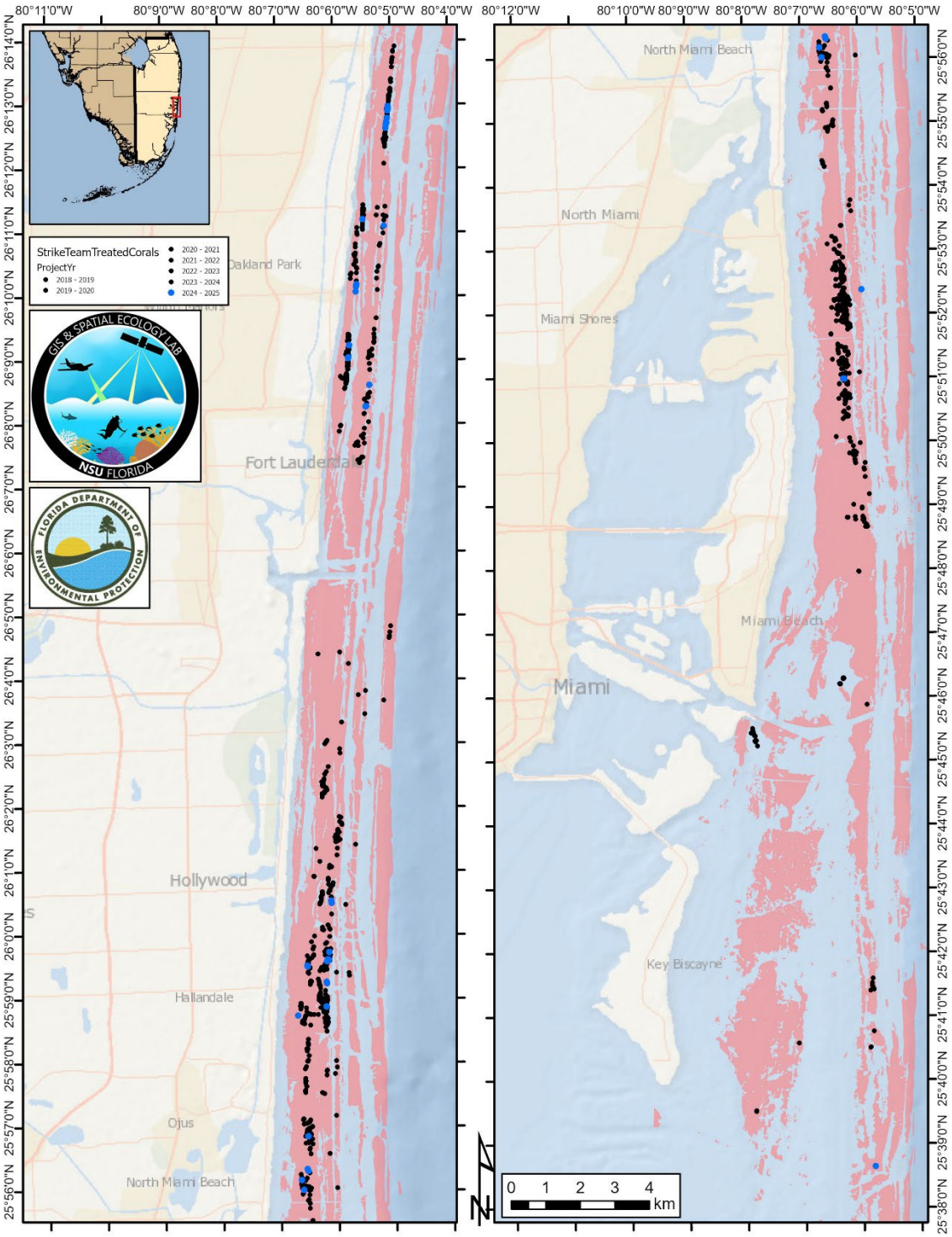

Figure 7. The location of the 1,964 strike team treated corals as of February 20, 2025. The blue dots are 51 of the 70 colonies treated during the current project period. The GPS didn't work for several dives and we do not have locations for those.

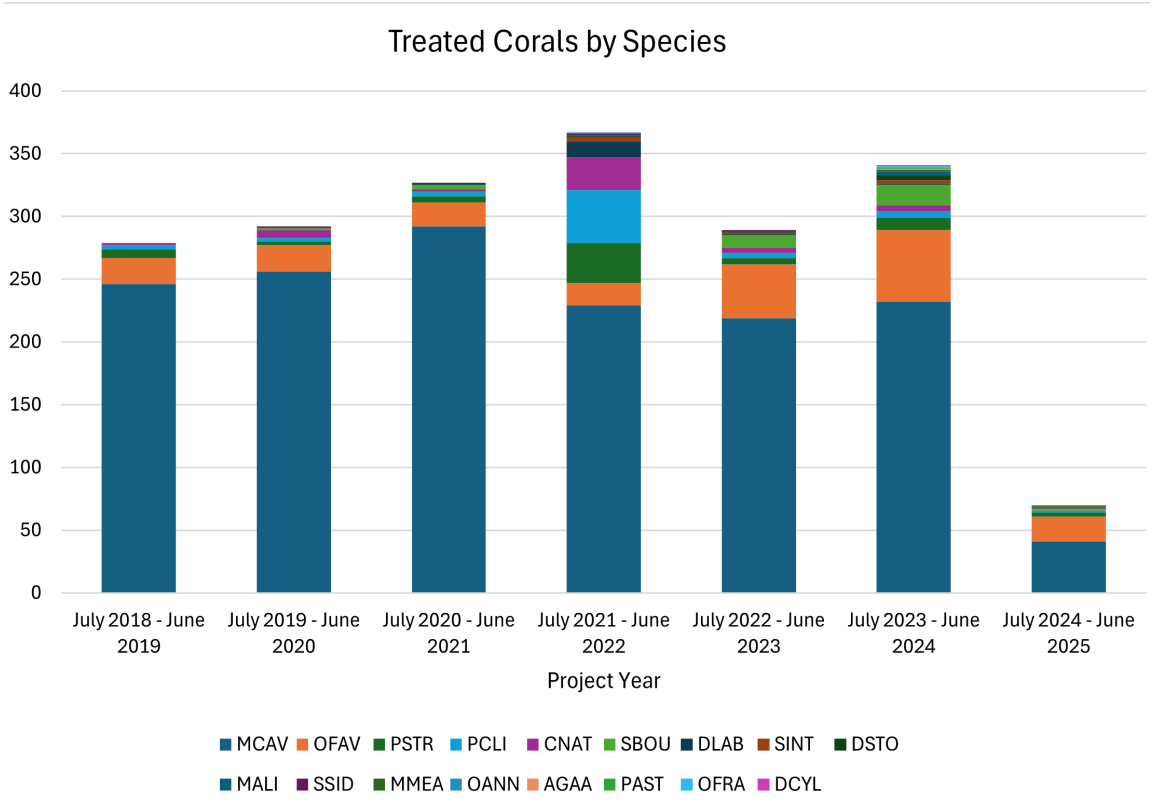

Figure 8. The number of strike team treated corals by species by project year. Only 70 were treated this year due to the non-renewal of our permit to treat striketeam colonies. Diseased corals are still present in the shallow reef habitats and are going untreated.

4.2. Monthly Interventions to 100 Large Corals (Task 3)

a. Treatment Success

Figure 9 illustrates the locations of all 108 priority corals. Not all monitored corals required treatments this period; 31 corals (28.7%) were treated, and 77 corals (71.3%) did not show active lesions (Figure 10 and Table 4). The proportion of colonies requiring treatment varied between species, with 29 out of the 85 (34.1%) monitored *Orbicella* spp., and 1 of the 14 *M. cavernosa* (7.1%) requiring treatment. One *Orbicella* colony (MC-019) decreased from 55% to 1% living tissue area from December 2023 to August 2024.

Over the project period (July 2024 to May 2025), a total of 153 antibiotic ointment treatments were conducted on 31 large colonies. 20 treatments failed, equating to 86.9% effectiveness on lesions.

The comparison of effectiveness between full and reduced strength Coral Cure treatments was not attainable due to lack of permitting. We performed some early initial comparison treatments on large corals, but decided the large corals were not a good test subject. Or permit to perform striketeam was not renewed so we could not perform this test.

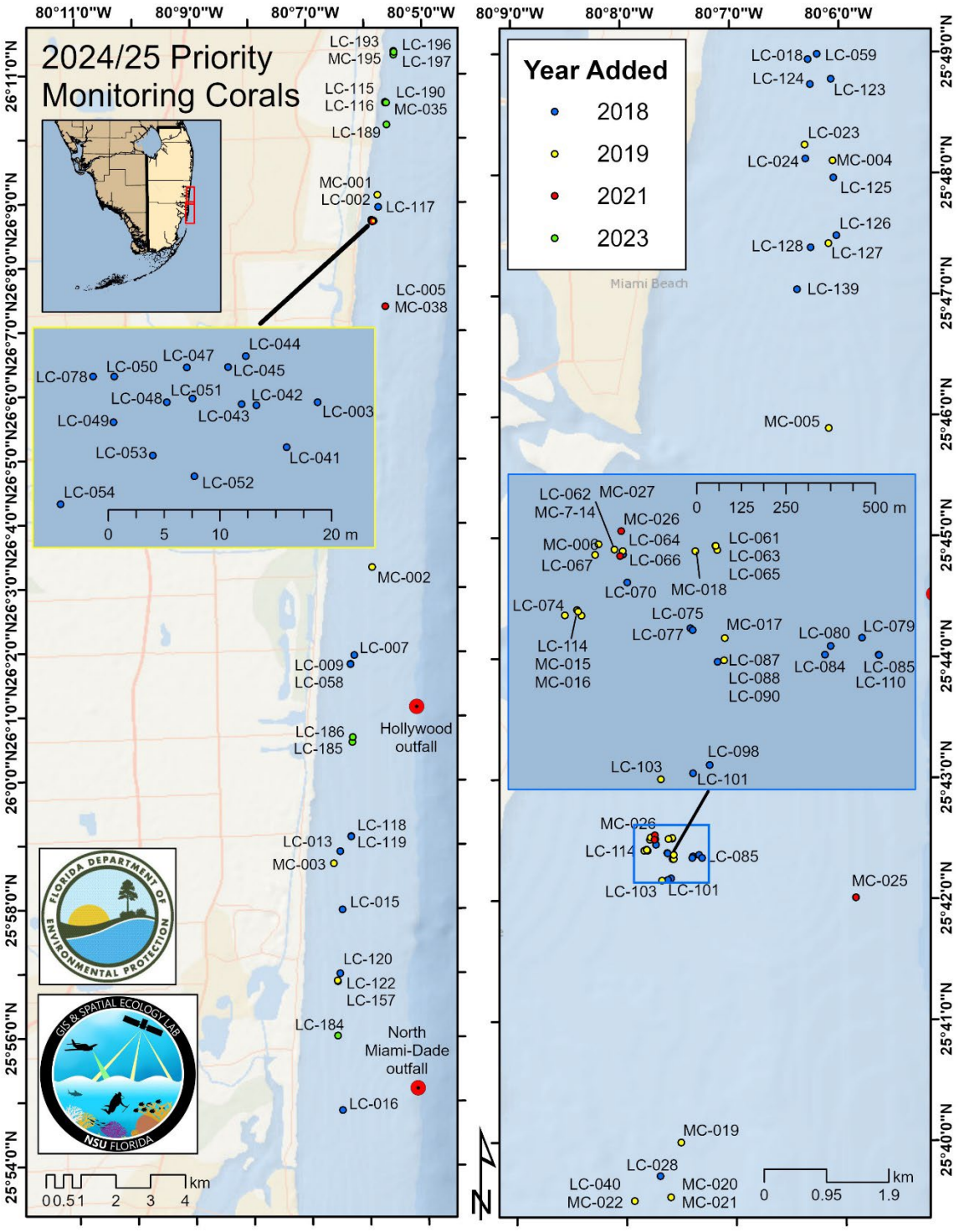

Figure 9. Map of the large priority monitoring corals colored by the year they were added to the monitoring.

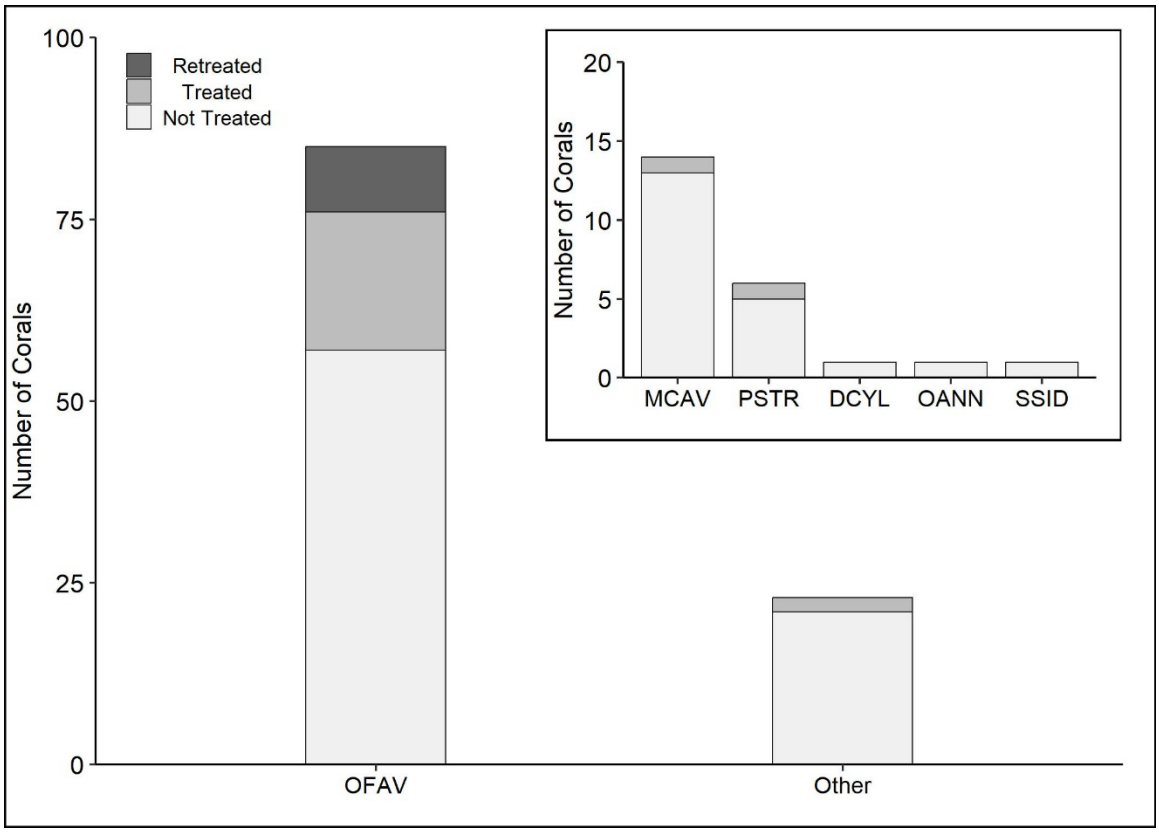

Figure 10. Total number of corals monitored and Not Treated (no disease), Treated (once), and Retreated for each species from July 2024 to May 2025. "Other" has been enlarged to show the number of treatments for the less abundant species.

Table 4. Total antibiotic ointment treatments by species from July 2024 – May 2025.

	MCAV	OFAV	PSTR	ALL SPECIES
Total Colonies	14	85	6	108
Total Treated Colonies	1	29	1	31
% Treated	7.1%	34.1%	16.6%	28.7%

a. Temporal Infection Patterns

All disease lesions were treated at each monitoring period, thus the total number of new treatments indicates the amount of new disease found on the monitored corals over time after their initial visit. Figure 11 summarizes the number of new treatments required (light gray) and percentage of diseased corals (black) per monitoring period for all corals during the project period. The number of new infections and corals with disease varied through time with relatively low numbers of treatments and disease prevalence, especially compared to the previous two monitoring years. Figure 12 summarizes the amount of treatment required in each period. Treatments and percentage of colonies diseased returned to values similar to 2019-2021 (Figure 13), indicating that temperature stress in 2022-2023 could help explain higher SCTLD prevalence in the KJCAP.

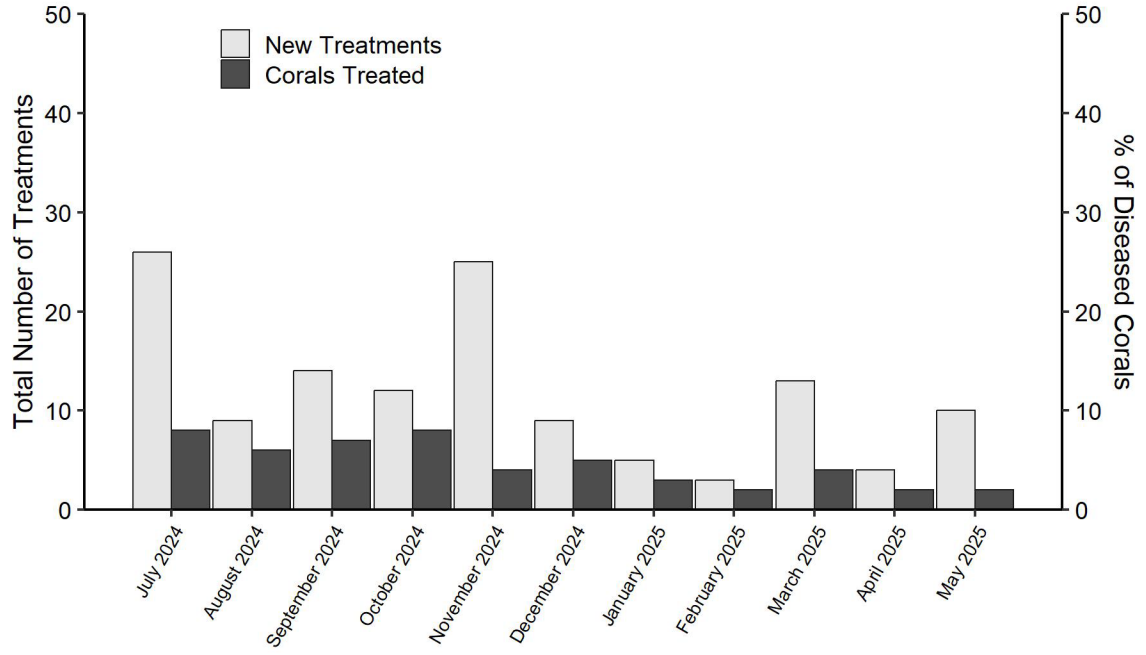

Figure 11. The number of new treatments (light gray) on all corals used as a proxy for new infections and the percentage of diseased corals (black) by treatment period.

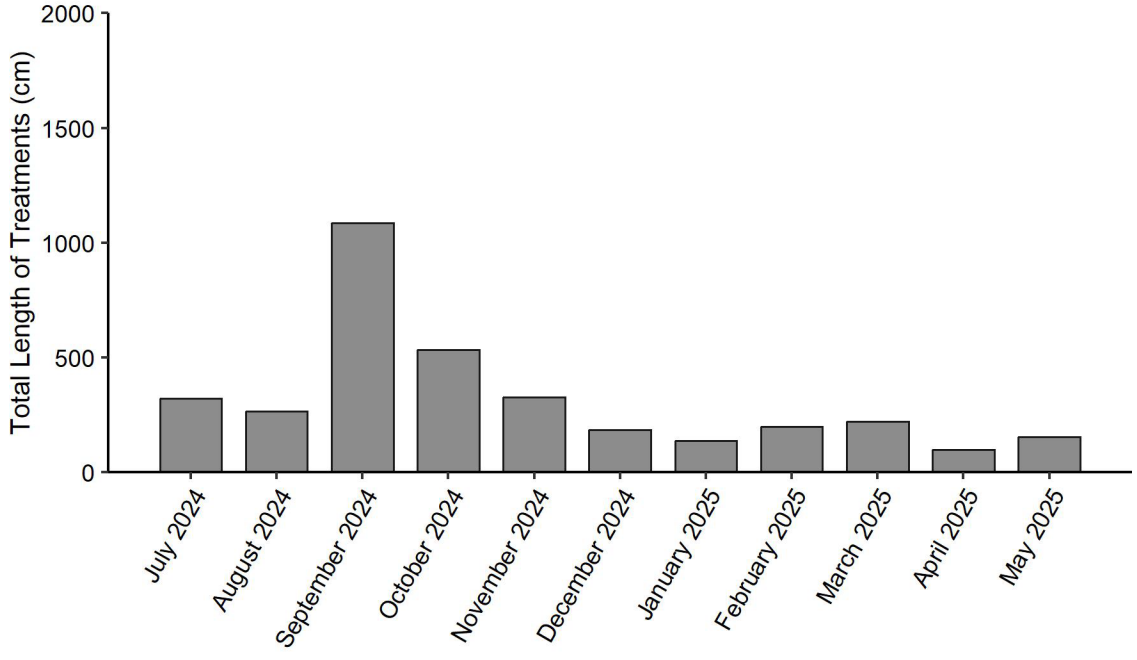

Figure 12**.** The total treatment length (cm) on all corals by monitoring period. Shaded area indicates antibiotic ointment treatments.

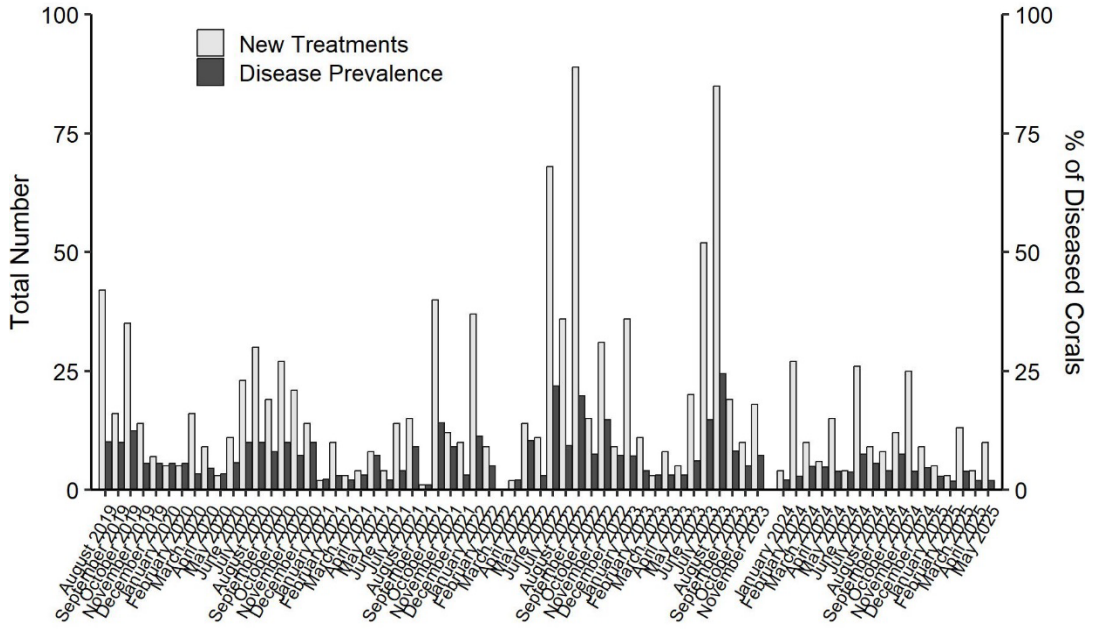

Figure 13. The number of new treatments (light gray) on all corals used as a proxy for new infections and the percentage of diseased corals (black) by treatment period since 2019.

4.3. **Recon sites (Task 4)**

During this period, reconnaissance was conducted during 61 striketeam dives and 48 LCM non-priority dives over 21 days. Divers were looking for abnormally large, healthy colonies as well as areas of high coral density or diversity. We identified two new notably large *Orbicella faveolata* colonies, three areas of exceptional coral diversity or density, and an exceptionally large patch of live *Madracis sp.* measured roughly 16m x 23m with smaller unmeasured patches surrounding it (Figure 14, Table 5). We also revisited 68 non-priority colonies to assess their condition. Of the 68 non-priority colonies visited, 56 still had some remaining live tissue. Figure 15 illustrates a map of the recon sites and Table 6 lists all of the recon sites found to date.

Table 5. Recon sites identified during this reporting period.

Site name	County	Coordinates	Description	Date
Large *Orbicella faveolata* #12	Dade	N 25.809333, W 80.104117	Large healthy OFAV, less than 5% mortality, over 1m in size, ~10 meters S of LC-021	5/15/2025
Large Madracis Patch MP1	West Palm Beach	N 26.524249 W 80.032178	Large patch of Madracis	5/20/2025
NCRMP 3100	Broward	N 26.216003, W 80.085373	ACER Patch	6/27/2024
Haulover Moorings	Miami-Dade	N 25.936583, W 80.110823	High density of MCAV	10/24/2024
RS 12	Miami-Dade	N 25.976033, W 80.103378	High density of MCAV	10/24/2024
RS 65	Miami-Dade	N 25.996662, W 80.103185		10/24/2024
FTL Mooring Balls	Broward	N 26.1265, W 80.091484	Large OFAV, approximate coordinates	11/26/2024

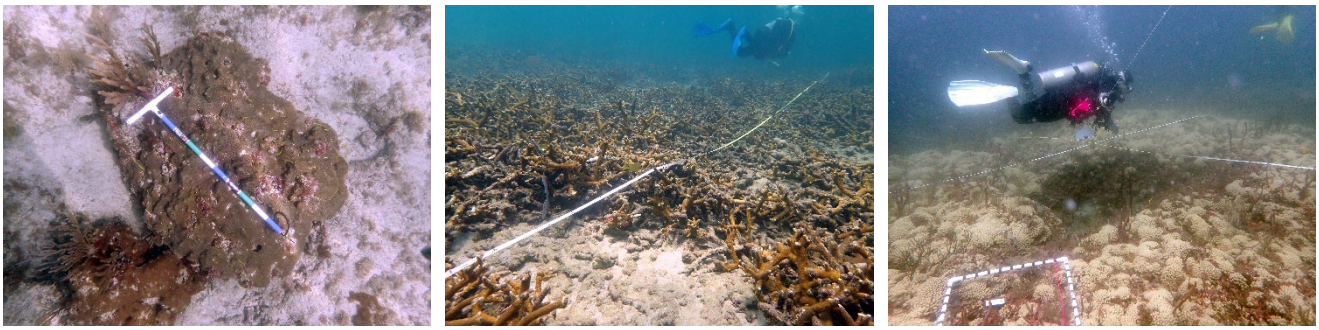

Figure 14. Pictures of the new large *Orbicella faveolata* colony 12, NCRMP 3100, and MP1 (from left to right).

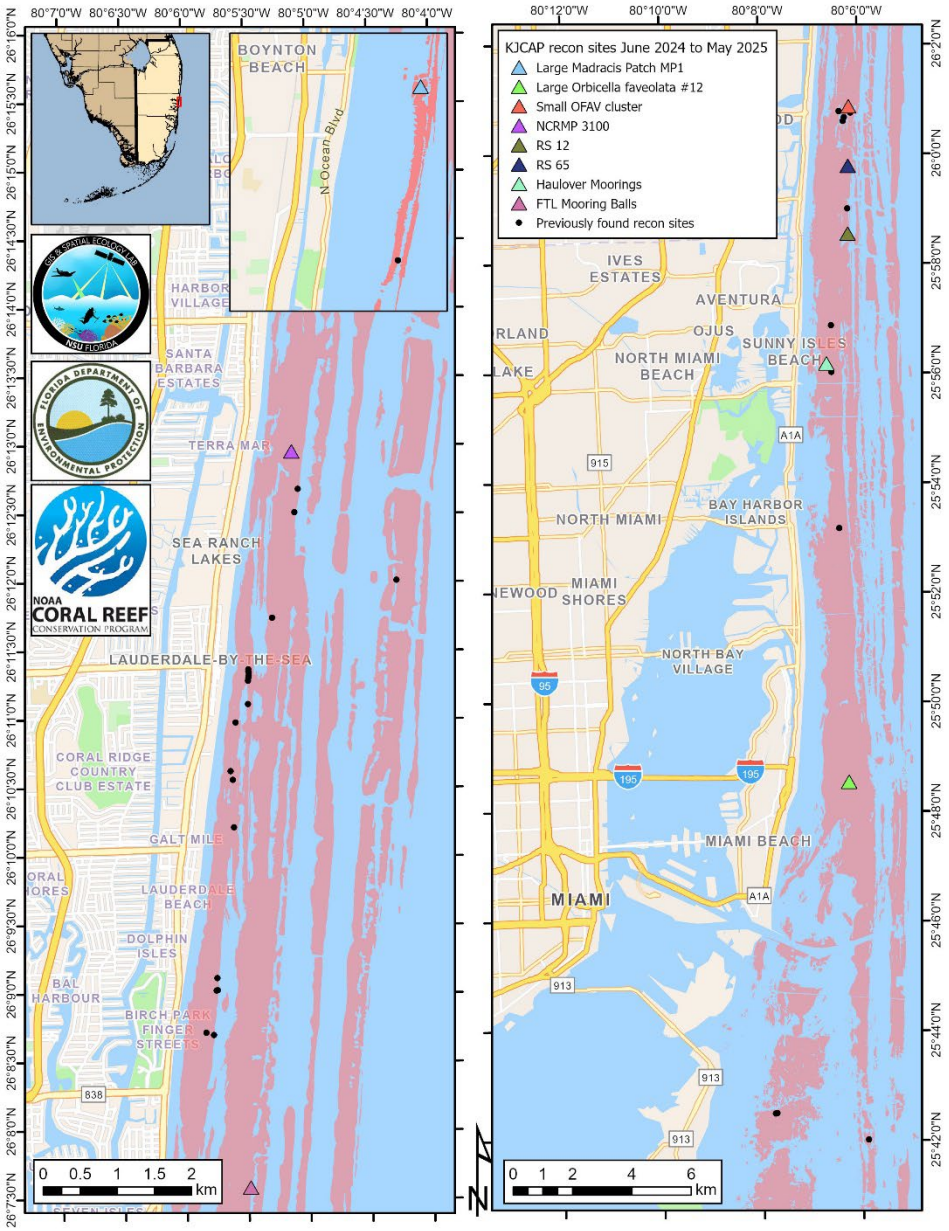

Figure 15. The location of recon sites found during the project period.

Table 6. Preliminary information on all of the recon sites of interest identified to-date.

Nr	Site name	County	Coordinates	Description
1	*Dendrogyra* Colony (MC-025)	Dade	N 25.700211, W 80.098248	Located a live Dcyl colony on a shallow reef in South Miami Dade
2	Pompano Moorings	Broward	N 26.211332, W 80.084531	Nice relief, high coral cover and diversity
3	High Relief Ledge Reef	Broward	N 26.200196, W 80.071329	High rugosity deep reef, appeared to have coral colonies, lots of large fish
4	Broward Large Coral Cluster	Broward	N 26.145267, W 80.097367	Cluster of large OFAV
5	Biscayne Large Coral Cluster	Dade	N 25.708467, W 80.12895	Cluster of large OFAV
6	High MCAV Density Site 1	Dade	N 25.88624, W 80.106852	High density of MCAV on a patch reef.
7	High MCAV Density Site 2 (NCRMP site 3204)	Broward	N 26.151909, W 80.095806	Near BS2 High Density of large MCAV and some CNAT, observed some SCTLD
8	LC-122, LC-157	Broward	N 25.94788, W 80.10913	LCM on 11/24/2020 noted many diseased MCAV and Ofav
9	Commercial Pier Cluster (South point)	Broward	N 26.185208, W 80.09145	High density of MCAV
10	Commercial Pier Cluster (North point)	Broward	N 26.189059, W 80.091318	High density of MCAV
11	LC-2893	Broward	N 26.188383, W 80.091359	Large OFAV Colony
12	LC-2523	Broward	N 26.189161, W 80.091371	Large OFAV Colony
13	LC-2522	Broward	N 26.189415, W 80.091368	Large OFAV Colony
14	*Pseudodiploria strigosa*	Broward	N 26.189059, W 80.091318	Large PSTG Colony
15	High density Mcav (Brooke's Site)	Broward	N 26.144958, W 80.096331	High density of MCAV
16	High Density Mcav (BS2)	Broward	N 26.150397, W 80.09594	SSI Probiotic Site (High density of MCAV)
17	*Acropora cervicornis* Multiple patches	Broward	N 26.195693, W 80.088124	Area with extensive A. cervicornis thickets
18	Single Live Dedrogyra Pillar	Broward	N 26.013177, W 80.102561	Old Dendrogyra colony skeleton with single live pillar
19	High Density MCAV Site (BS3)	Broward	N 26.188045, W 80.091429	High density MCAV site along 1st reef
20	Large *O. annularis* #1 (5915)	Broward	N 26.177027, W 80.09383	Large OANN colony 91%old dead but over 5.8m across
21	Large *O. annularis* #2	Broward	N 26.170234, W 80.093439	Large OANN colony #2 over 6m across, high living tissue coverage
22	Large *O. faveolata* (5029)	Broward	N 26.175988, W 80.093569	Large OFAV colony 3.6m x3.15m
23	High density MCAV site (also many Ofav)	Broward	N 26.012524, W 80.10229	High rugosity reef with very high density MCAV (also many Ofav)
24	Small OFAV cluster (3 colonies close, many nearby, near above site)	Broward	N 26.01474, W 80.102898	Unusually high density of OFAV
25	Large *Orbicella faveolata* #1	Broward	N 26.150438, W 80.095793	Large *Orbicella faveolata* >90% live and healthy
26	Large *Orbicella faveolata* #2	Dade	N 25.70833, W 80.12949	>1.5m *Orbicella faveolata* 60% live
27	Large *Orbicella faveolata* #3	Broward	N 26.188699, W 80.091328	~4m *Orbicella faveolata* 85%live and healthy

28	Large *Orbicella faveolata* #4	Broward	N 26.182942, W 80.093148	>2m *Orbicella faveolata* >85%live and healthy
29	Large *Orbicella faveolata* #5	Broward	GPS shutoff	~3m *Orbicella faveolata* >90% live and healthy
30	Large *Orbicella faveolata* #6	Broward	GPS shutoff	*Orbicella faveolata* >1.5m, healthy
31	Large *Madracis* patch	West Palm Beach	N 26.489237, W 80.037500	Large patch of Madracis
32	Large *Orbicella faveolata* #7 (Tag3522)	Dade	N 25.933700, W 80.10921	Very healthy and lg Ofav. Just north of Haulover, Approx 3.5m tall and 3m across. 85-90% live
33	Large *Orbicella faveolata* #8 (Tag5385)	Broward	N 26.208512, W 80.085002	Large very healthy Ofav with several other large Ofav nearby (slightly smaller and less healthy). Possible site for restoration
34	Large *Orbicella faveolata* #9	Broward	N 26.013, W 80.10621667	Large Healthy Ofav, less than 5%mortality (Found and shared by Gilliam Lab)
35	Large *Orbicella faveolata* #10 (Tag5991)	Broward	N 26.010072, W 80.104728	Large healthy Ofav, Less than 5% mortality. Found during StrikeTeam over 2.15m across
36	Large *Orbicella faveolata* #11 (Tag5893)	Broward	N 26.011201, W 80.104353	Large Ofav approx 2m across less than 15% total mortality
37	High density and diverse coral reef	Broward	N 25.983443, W 80.103496	High density and diversity dive starting at RS-66 start 11:46 and end at 13:07.
38	Large *Orbicella faveolata* #12	Dade	N 25.809333, W 80.104117	Large healthy OFAV, less than 5% mortality, over 1m in size, ~10 meters S of LC-021
39	Large Madracis Patch MP1	West Palm Beach	N 26.524249 W 80.032178	Large patch of Madracis
40	NCRMP 3100	Broward	N 26.216003, W 80.085373	ACER Patch
41	Haulover Moorings	Miami-Dade	N 25.936583, W 80.110823	High density of MCAV
42	RS 12	Miami-Dade	N 25.976033, W 80.103378	High density of MCAV
43	RS 65	Miami-Dade	N 25.996662, W 80.103185	
44	FTL Mooring Balls	Broward	N 26.1265, W 80.091484	Large OFAV, approximate coordinates

4.4. **Maintain coral nursery and reskin large corals (Task 5)**

Preliminary results of the March 2025 outplanting indicated that 99.5% of the fragments remained attached and 7.7% showed signs predation after 1 month (Figure 16). Colony LC-008 was the only outplant location that experienced predation. Minor predation was observed on most fragments, however one array experienced heavy predation with one fragment tissue completely removed (Figure 17).

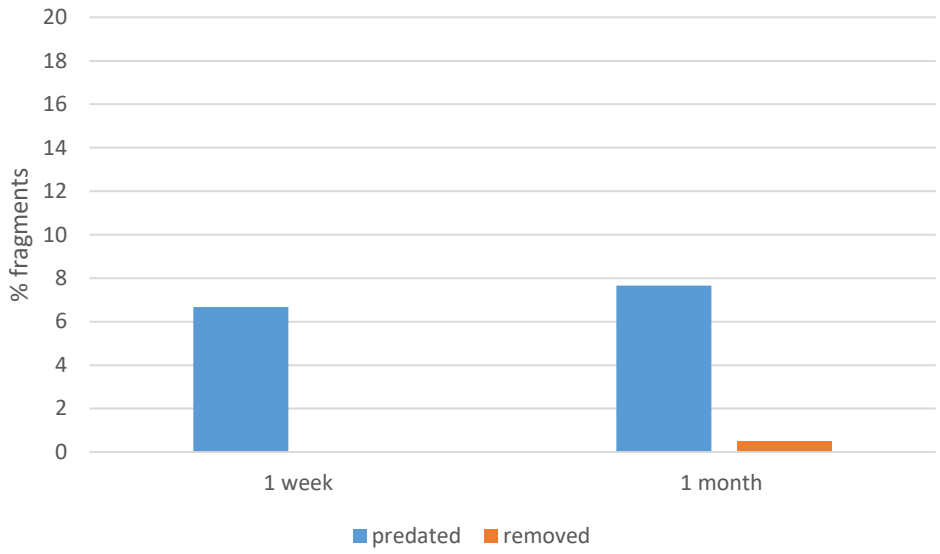

Figure 16. Percentage of total fragments predated (blue) or removed (orange) on outplant colony LC-008.

Figure 17. Photo of predation on outplant colony LC-008 one month post outplanting.

5. SIGNIFICANCE

Restoring healthy coral tissue to these structures is vital to reinstate ecological functionality, stave off bioerosion, maximize chances of sexual reproduction, and produce a generation of disease-resistant coral. Evaluating and developing best practices for outplanting is important in scaling up *O. faveolata* restoration efforts.

Next Steps

Predation and survivorship will continue and be monitored along with analyses of outplant tissue growth every month for 1 year. A statistical analysis will be conducted to show location and genotypic variation in growth and predation.

6. DISCUSSION

Coral diseases have caused enormous impacts to coral populations globally perpetuating the rapid need for large-scale coral reef restoration. SCTLD exemplifies that coral diseases are more devastating than ever before. When a virulent disease like SCTLD ravages a coral ecosystem, it significantly alters the population's demographics and causes local extinctions. However, recent disease intervention techniques are over 85% effective at stopping lesions. Implementing these in the restoration toolbox reduces the necessity for costly and time-consuming post hoc restoration techniques (e.g. microfragmentation, coral husbandry, and outplanting).

Our work shows that SCTLD is still prevalent in the KJCAP nearshore habitats, that interventions are still needed, and that these efforts are worthwhile. This past year, interventions helped maintain species diversity and ecosystem services and kept alive some of the largest and oldest animals in Florida. Although disease interventions are very effective at stopping disease lesions, they do not provide protection against reinfection. This requires regular visits to ensure colony survival. Since disease intervention response during such an event is virtually impossible on a landscape scale, priorities must be considered. Intervention activities were allocated between prioritizing saving certain colonies by regular monitoring and treating large areas without the intent to monitor. The latter involves a team of divers, known as a strike team, covering large areas of reef, treating coral lesions that they encounter, tagging treated colonies, and recording their locations. The purpose of the strike team was to maximize the area covered to treat as many disease lesions as possible without the intent of returning to monitor treatment success. By treating more of the remaining corals less susceptible to SCTLD, more live coral tissue and genetic diversity are saved. This allows post hoc restoration to be focused on the species more susceptible to SCTLD that are now functionally extinct.

Prioritizing the largest, oldest colonies of reef-building species is imperative to preserve the high fecundity, ecological function, and genetic diversity of the most resilient corals. Large corals have a higher reproductive potential thereby increasing the natural ability to replenish the reef as well as harness the potential for assisted reproduction through gamete collection. Their size also preserves ecological functions such as existing reef structures and habitats. As a proxy for age, coral size is an indicator of their resistance to previous perturbations which may indicate higher fitness.

Monthly monitoring and treatments have reduced the loss of live tissue area and provided valuable information on the temporal and spatial variations of colonies with lesions. Corals not regularly treated with disease interventions have had drastic declines in live tissue area. Regular disease intervention is restoring colony health and saving the large priority corals

from SCTLD and is an efficient method to save live tissue area preempting slower, more costly post hoc restoration efforts.

By stopping disease lesions, *in situ* disease interventions can save a higher magnitude of live tissue in comparison to the amount that can be generated from years of microfragmentation. Our intervention activities have saved species and size classes that would take decades to achieve through asexual restoration at a fraction of the cost that equivalent restoration would require to achieve similar coral cover. Considering the KJCAP large coral monitoring alone, the current live tissue area of all previously treated large corals is 436.9 m^2. This is the equivalent to the area of a regulation sized NBA basketball court of live coral tissue. Assuming 2 x 2 cm (4 cm^2) outplant frags, that equates to 1,092,250 coral restoration fragments. Granted, we can't assume all tissue would've been lost without treatment or that the treatments are 100% effective or what will be lost if we stop monitoring those corals today, but it gives a rough estimate of the restoration effort required to get a similar amount of tissue. There is also the considerable advantage that the saved corals are already reproductive, and the largest ones have the most reproductive potential. Disease interventions have the added benefit of reducing disease loads as well. But the use of antibiotics poses an unknown risk in the environment.

Our reconnaissance for coral restoration sites identified two new notably large *Orbicella faveolata* colonies, three areas of exceptional coral diversity or density, and an exceptionally large patch of live *Madracis sp.* These locations are good targets for periodic strike team activities to recon for lesion outbreaks and perform interventions when necessary. These locations can also be useful in collecting hardened colonies that may be more resistant to the disease. The Madracis patch opens new research opportunities to uncover including how and why these patches persist amidst increasing stressors and amidst an SCTLD epidemic, given they are presumed susceptible. These new corals/sites are of high value to the State of Florida. These colonies can be used as genetic stock for gamete collections for assisted reproduction. They can also be monitored and treated for disease to assist in understanding disease dynamics and coral resistance to disease.

Spatiotemporal disease patterns occur on portions of Florida's Coral Reef, where SCTLD is endemic. Frequent monitoring and successful disease interventions have kept diseased corals alive, revealing variable lesion outbreak patterns where some colonies frequently or occasionally exhibit new lesions, while others appear resistant to SCTLD and have never been observed with lesions. The monthly monitoring data have been invaluable in linking environmental drivers to disease dynamics (Walker et al., 2021). Higher water temperatures, amounts of water following out of the inlets, and rainfall account for 66.2% of the temporal variability in the proportion of diseased colonies. Understanding these dynamics can help identify the disease and optimum times to treat. Caution should be taken when choosing coral restoration sites as to avoid areas more prone to disease.

7. RECOMMENDATIONS

Continue monthly monitoring and treatment of large priority corals – Monitoring these colonies has saved many from extinction. Monthly monitoring and treatment have

facilitated the classification of corals based on differing infection rates which has informed the design of the SCTLD Resistance Research Consortium.

Continue broad-scale strike team efforts – Conducting strike team efforts to reduce the active SCTLD prevalence and save the genetic diversity remaining on the reef.

Continue use of antibiotic ointment CoreRx B2B and amoxicillin (1:8 weight ratio) – Perform margin treatment and appropriate disease-break interventions using antibiotic paste on SCTLD lesions.

Continue opportunistic recon for potential new monitoring colonies and restoration sites.

Continue public outreach for SEAFAN and other citizen reporting mechanisms to educate the public on reporting diseased corals.

Avoid areas prone to increased coral disease when choosing restoration sites.