Florida Disease Response Coral Rescue and Propagation - NSU

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Final Report

Prepared By:

D. Abigail Renegar, Ph.D.
Kyle Pisano, MSc.
Amanda Travers, MPSc.

Nova Southeastern University

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Management Summary (300 words or less)

The NSU Onshore Coral nursery is a multipurpose, *ex-situ* onshore coral nursery dedicated to support the preservation and restoration of the Florida reef tract. The nursery is a hub for coral nursery activities; housing corals for grow-out/microfragmentation, out planting, teaching restoration practitioners and students, and providing logistical support for a variety of other reef restoration activities through close collaborations and communication with restoration partners and government agencies. The onshore nursery currently holds 7,311 corals in total; 2,373 colonies and 4,938 fragments. A total of 680 corals have been outplanted and 469 corals have been shipped from the onshore nursery systems since the start of 2025. Additionally, 135 organisms have been conditioned through the quarantine systems and 1,200 US gallons of artificial seawater have been upcycled for secondary usage, supporting other labs on the NSU campus.

Executive Summary (max 1 page)

The NSU Onshore Coral Nursery's mission is to serve as a multipurpose, ex-situ onshore facility dedicated to support the preservation and restoration of the Florida reef tract. The nursery is a hub for coral nursery activities, providing a biosecure space for the care of new colonies, diseased/agitated colonies, and fragment grow-out. The nursery facilities support the restoration activities of other NSU researchers including Dr. Gilliam (NSU), Dr. Walker (NSU), and Dr. Figueiredo (NSU). Additionally, we also provide essential support to agencies such as the National Oceanic and Atmospheric Administration (NOAA) & Florida Fish & Wildlife (FWC). The nursery husbandry team also maintains inter-organization and public communication activities, including interactions with other intermediate holding and AZA facilities, participation in weekly conference calls, and troubleshooting and problem solving through email and telephone conferences with partners. NSU continues to utilize the SEACOR systems as quarantine space for newly arrived corals and maintenance animals (such as sea urchins, shrimps, snails, etc.) that are distributed to other coral rescue facilities as well as the labs within NSU's prevue.

Our primary focus continues to be the care and maintenance for the endemic corals in our systems and support for ongoing coral outplant and transport activities, including acclimation of incoming corals to nursery conditions, direct transportation from collection to other project partners when needed, and short-term housing for corals that are pending transplantation. We continue to improve our onshore nursery facilities, such as enhancing filtration and system water volume, and replacing weather-worn equipment such as pumps and water chillers, to improve our utility and husbandry.

The onshore nursery currently holds 7,311 corals in total; 2,373 colonies and 4,938 fragments. A total of 680 corals have been outplanted and 469 corals have been shipped from the onshore nursery systems since the start of 2025.Recent coral collections from construction sites as well corals of opportunity coming into the nursery have positioned us to greatly expand our fragmentation efforts, which have been limited this year by the number of available parent colonies.

Acknowledgements

The NSU husbandry team consists of a dedicated group of NSU students and employees who ensure the well-being of corals in the nursery, including Onshore Nursery manager Kyle Pisano, assistant manager Amanda Travers, and current staff aquarists Austin Blakeslee, Ellen Skelton, Cailey Dornan, and Brady Estrada. Caring for thousands of corals and more than 30 independent coral culturing systems is no small task, especially when care is demanded 365 days a year.

Table of Contents

List of Figures

List of Tables

List of Acronyms

AAGA = *Agaricia agaricites*
AZA = Association of Zoos and Aquariums
DEP = Florida Department of Environmental Protection
FWC = Florida Fish & Wildlife
MDEC = *madracis decactis*
MCAV =*Montastraea cavernosa*
NSU = Nova Southeastern University
NOAA = National Oceanic and Atmospheric Administration
OFAV = *Orbicella faveolata*
PSTR = *Pseudodiploria strigosa*
SCTLD = stony coral tissue loss disease
SINT = *Stephanocoenia intersepta*
SSID = *Siderastrea siderea*

1. Description

Since the beginning of this project, naïve and endemic rescue corals have been housed at NSU in the land-based main building nursery (eight 400-gallon raceways and a comprehensive life support system), the SEACOR system (30 individual 120-gallon tanks, each with fully independent filtration and life support systems) and 2 indoor propagation systems (each with two 200-gallon raceways and independent life support systems).

NSU's role in broader coral rescue and reef restoration efforts has been multifaceted. While primarily acting as a receiving and quarantine facility for incoming corals, NSU has also assisted with logistic issues regarding both rescue and non-rescue coral transportation, shipping, supplies, storage needs, and has provided volunteers support for coral receiving, coral shipping, and other miscellaneous tasks and preparations as needed. We have increased our capabilities to hold other corals beyond the scope of the original non-endemic coral field collections. This effort has included both the SEACOR system and the 4,000-gallon main onshore building nursery at NSU; providing both short-term and long-term housing for corals which are, for example, rescued as part of building and maintenance projects, such as costal construction projects around Port Everglades, or corals bound for transplant off the shores of Broward County. The available facilities are unique in terms of the capability to provide ample short-term quarantine care and long-term life support.

The project scope expanded, in collaboration with Dr. Figueiredo, Dr. Walker, and Dr. Gilliam's efforts in coral propagation, to include micro-fragmentation of key reef-building species. Asexually reproducing corals through fragmentation has the advantage of quickly increasing coral biomass available to restoration efforts, but it does not contribute to increased genetic diversity. Fragmentation consists of breaking adult colonies into multiple smaller pieces, which then are grown in land-based and/or offshore nurseries. Smaller fragments present faster growth rates than larger colonies. This has been hypothesized to be because smaller corals allocate more energy towards growth and away from reproduction, or simply because the perimeter to area ratio is more advantageous for the growth of modular organisms. Microfragmentation of reef-building species impacted by the SCTLD outbreak and extreme heat events needs to be optimized and intensified in land-based and offshore nurseries to significantly enhance their density on the reef, enhance fertilization success, and ultimately promote recruitment success.

The overall goal of this project is to provide continuing support for ongoing coral rescue and propagation (via fragments and microfragments) and to provide support for quarantine, as well as resources to support the cumbersome logistics of transporting corals long distance for restoration.

The outcomes of this project will be incorporated into an ongoing coral disease response effort which seeks to improve understanding of 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 is encouraged when appropriate to avoid duplication of efforts and ensure alignment of needs. Coordination with other Principal Investigators is recommended and required, as appropriate.

2. Methods

2.1. Task 1: Care and maintenance of corals in the onshore nursery

One senior and three staff aquarists are responsible for the care and maintenance of existing and new rescue corals, overseen by the project PI. This task includes maintenance of water quality via weekly water changes in the NSU Building Nursery and SEACOR coral rescue holding systems, daily equipment checks and repairs as necessary to ensure that all systems are operating normally. Regular health inspections are conducted on all colonies in holding. Corals receive regular health inspections on all colonies in holding, are fed three times weekly, and pests, epiphytes, and algae are removed from coral colonies. Any damaged, bleached, or diseased corals are maintained in a separate system(s) for quarantine care and treatment. A daily log of coral care and maintenance activities is maintained. This task also includes acclimation of incoming corals to nursery conditions, as well as preparation and packaging of corals for transport between intermediate facilities and long-term holders. Quarterly updates of the number of corals maintained in the NSU Building Nursery and the SEACOR systems were provided to DEP.

Corals of several species which have been affected by STCLD have been fragmented or microfragmented; this includes corals collected for research purposes in previous years and corals of opportunity which have been collected and brought to NSU. Coral fragments and microfragments are maintained in the NSU Building nursery, Temperature is maintained with a heat exchanger and process chilled water. Filtration consists of a protein skimmer with ozonation, a UV sterilizer, and a media/carbon reactor. A calcium reactor is used to maintain calcium levels and facilitate coral growth. In-tank circulation is provided by submersible powerheads and wave timers. Coral fragments and microfragments are also maintained in two indoor propagation systems (each with two 200-gallon raceways and independent life support systems). For the indoor systems, temperature is maintained with in-line chillers and submersible heaters. Filtration consists of protein skimmers and media/carbon reactors. Calcium reactors are used to maintain calcium levels and facilitate coral growth. In-tank circulation is provided by submersible powerheads and wave timers, and lighting is provided by Ecotech Radion XR30 Pro LED lights. Corals are visually assessed for general health condition daily and fed three times weekly ad libitum to promote growth and enhance survival rates. Water quality is maintained via weekly water changes, with daily equipment checks and maintenance as necessary to ensure that the system is operating normally.

Corals of opportunity have been fragmented and monitored monthly for growth. The colonies consisted *Montastraea cavernosa* (MCAV), *Orbicella faveolata* (OFAV), *colpophyllia natans* (CNAT), three *Stephanocoenia intersepta* (SINT), and seven *Siderastrea siderea* (SSID). To measure size and growth of the fragments, scale referenced photographs were processed using Image J's polygon selection and measurement features, using the metric ruler in each image for scale. The change in amount of living tissue on each fragment is tracked and shown as the average cm^2 for each colony's fragments, the parent colony's surface area is also shown if the whole colony was not used to make fragments.

2.2. Task 2: Inter-organization and public communication

This task includes interactions with other intermediate holding and AZA facilities, including participation by the senior aquarist in weekly conference calls, and troubleshooting and problem-solving through email and telephone conferences with AZA partners. Many of the corals involved in the rescue project have rarely been held in captivity. Sharing observations with holding partners about the behaviors and needs of each of these species has been essential to the success of the project thus far. Public outreach interactions and education about Florida's Coral Reef and the rescue project are also a part of this task.

3. Results

3.1. Task 1: Care and maintenance of corals in the onshore nursery

While NSU currently no longer holds any naive rescue corals, as they have all been transported to Association of Zoos & Aquariums (AZA) facilities or other approved holders, NSU currently holds a diverse inventory of corals native to south Florida. NSU's onshore nursery operations continue to facilitate not only our goals but also other labs such as Dr. Gilliam (NSU), Dr. Walker (NSU), and Dr. Figueiredo (NSU), and we continue to provide a biosecure space for the care of new colonies brought in as corals of opportunity, diseased/agitated colonies, as well as growing fragments, and providing a secure, reliable and flexible space for emergency storage of corals from other facilities. The onshore nursery currently holds 7,311 corals in total; 2,373 colonies and 4,938 fragments of over 30 species. This includes a variety of corals comprised of corals of opportunity, endemic rescue corals, corals propagated from within the nursery, and corals brought in from construction sites around Port Everglades in summer of 2024. Additionally, we provide essential support to government agencies such as the Army Core of Engineers, Florida Fish & Wildlife (FWC), and National Oceanic and Atmospheric Administration (NOAA), taking in coral from environmental contractors when corals moved for mitigation cannot be immediately transplanted. A summary of the current coral inventory is provided in Table 1, and detailed inventory of colonies and fragments in the Onshore Nursery is provided in Figure 1. An inventory of corals moving through the NSU Onshore Nursery between July 2024 and June 2025 is shown in Table 2.

Table 1: Current coral inventory in the NSU On-Shore Coral Nursery

	Colonies	**Fragments**	**Total**
Building Nursery			
Acropora cervicornis	2	300	302
Agaricia agaricites	13	0	13
Dichocoenia stokesi	1	0	1
Diploria labyrinthiformis	1	0	1

Montastraea cavernosa	22	226	248
Madracis decactis	17	100	117
Orbicella faveolata	3	104	107
Porites astreoides	3	8	11
Porites porites	66	19	85
Pseudodiploria clivosa	7	0	7
Pseudodiploria strigosa	3	8	11
Scolymia cubensis	18	0	18
Siderastrea radians	39	0	39
Siderastrea siderea	126	231	357
Solenastrea bournoni	71	138	209
Stephanocoenia intersepta	27	122	149
Total	**419**	**1256**	**1675**
SEACOR Systems			
Agaricia agaricites	1	22	23
Astrangia solitaria	282	0	282
Cladocora arbuscula	47	0	47
Coenocyathus humanni	13	0	13
Colingia sp.	1	0	1
Colpophyllia natans	7	44	51
Dendrogyra cylindrus	0	0	0
Dichocoenia stokesi	1	0	1
Diploria labyrinthiformis	34	262	296
Madcracis decactis	330	100	430
Madracis pharensis	548	0	548
Montastraea cavernosa	0	32	32
Oculina diffusa	82	0	82
Orbicella faveolata	81	507	588
Orbicella franksi	2	132	134
Phyllangia americana	362	0	362
Porites astreoides	32	10	42

Porites porites	2	0	2
Pseudodiploria clivosa	4	221	225
Pseudodiploria strigosa	2	7	9
Rhizomilia maculate	24	0	24
Stephanocoenia intersepta	5	30	35
Siderastrea radians	35	0	35
Siderastrea siderea	74	609	683
Solenastrea bournoni	2	0	2
Total	**1971**	**1976**	**3947**
Indoor Systems			
Colpophyllia natans	1	0	1
Montastrea cavernosa	2	10	12
Porites astreoides	3	174	177
Orbicella faveolata	0	56	56
Porites divaricata	0	83	83
Stephanocoenia intersepta	0	134	134
Siderastrea siderea	0	273	273
Acropora cervicornis	0	712	712
Total	**6**	**1442**	**1448**
Overall totals	**2396**	**4674**	**7070**

The onshore nursery currently holds a large number of coral fragments from xx species. Seventeen corals of opportunity have been fragmented and are being monitored monthly for growth. The fragment survivorship and tissue area is shown in Figure 2, and the fragment growth rate is shown in Figure 3. These fragments are held in the “Building Nursery, ” which has been struggling with algal growth and possible contamination from substrates taken in with corals from the construction projects of Port Everglades. The contaminated substrate has been removed from the nursery but many species of algae remain persistent. One of our scheduled project for summer of 2025 is to transfer the working animals and corals out of the Building Nursery into SEACOR, and then sterilize the Building Nursery LSS. This will provide a clean slate to then move clean coral tissue back in, creating a clean environment with little to no algae. This will produce a clean slate into which the system can recondition and crustose coralline algae can be re-seeded into the nursery. From there, working animals and corals can be slowly moved back into the nursery.

Figure 1. A) % survivorship by species, and B) growth rate by species from 07/01/24 to 06/15/25.

Figure 2. A) Species colony inventory in the Building Nursery, B) species fragment inventory in the Building Nursery, C) species colony inventory in the SEACOR Systems, D) species fragment inventory in the SEACOR Systems, E) species colony inventory in the Indoor Systems, and F) species fragment inventory in the Indoor Systems.

Figure 3. Growth rate for fragments of A) colonies, B) Montastraea cavernosa colonies, C) Orbicella faveolata colonies, D) Pseudodiploria strigosa colonies, E) Siderastrea siderea colonies, and F) Stephanocoenia intersepta colonies.

3.2. Task 2: Inter-organization and public communication

The NSU team continues to participate in public outreach interactions and education regarding the rescue project. This includes communication with aquaculture industry partners, 3rd party environmental contractors, and participating in weekly conference calls with the AZA and our partners in FWC and NOAA. We accept master's program level volunteers once or twice a week (under direct supervision of the husbandry team) to provide opportunities to learn about the coral rescue effort and coral husbandry. Volunteers assist in cleaning systems, re-mounting coral on tiles, and target feeding. NSU's husbandry team collaborated with Dr. Gilliam's Coral Reef Restoration and Monitoring lab to move a subset corals from the offshore nurseries to Texas A&M's new coral lab in September 2024. The Onshore Nursery team has also been collaborating with NOAA, providing a small subset of Broward County corals to conduct climatology experiments at their Miami lab. We continue to nurture relationships with our existing partners, and forge new relationships with the Army Core of Engineers, Environmental Contractors/Advisors such as Pinnacle Scientific, and Non-profits such as the Reef Discovery Center.

4. Discussion

The mission of the NSU Onshore Coral nursery is to serve as a multipurpose, *ex-situ* onshore coral nursery dedicated to support the preservation and restoration of the Florida reef tract. The nursery is a hub for coral nursery activities; hosting corals for grow-out/micro-fragmentation, holding corals for out planting, holding endemic corals that are pending shipment to other holders, providing support for nearby coral holders, and quarantining maintenance animals. The nursery provides a biosecure space for the care of new colonies, diseased/agitated colonies to be treated, and fragment grow-out of stoney corals. This facilitates not only our own specified goals but also other labs such as Dr. Gilliam (NSU), Dr. Walker (NSU), and Dr. Figueiredo (NSU). Additionally, we also provide essential support to government agencies such as the Army Core of Engineers &

Florida Fish & Wildlife (FWC), taking in coral from environmental contractors when corals moved for mitigation cannot be immediately transplanted. Going forward, our focus continues to be the care and maintenance for the endemic corals in our systems and support for ongoing coral transfer activities, including acclimation of incoming corals to nursery conditions, and preparation and packaging of corals, direct transportation from collection to other project partners when needed, and short-term housing for corals that are pending transplantation. We continue to make improvements to our onshore nursery facilities, such as enhancing filtration and system water volume, to improve our overall utility and improve husbandry.

The nursery husbandry team maintains inter-organization and public communication activities, including interactions with other intermediate holding and AZA facilities, participation in weekly conference calls, and troubleshooting and problem solving through email and telephone conferences with partners. NSU is continuing to utilize the SEACOR system as quarantine space for maintenance animals (Such as sea urchins, shrimps, snails, etc.) that can be distributed to other coral rescue facilities and NSU's internal labs.

The onshore nursery currently holds 7,311 corals in total; 2,373 colonies and 4,938 fragments. A total of 680 corals have been outplanted and 469 corals have been shipped from the onshore nursery systems since the start of 2025.