

A close-up photograph of a coral polyp, showing its numerous yellowish-orange tentacles with white tips, set against a blurred blue background.

Restoration 2021 Expansion & Advances

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Restoration Program Manager

RESTORATION
EDUCATION
SCIENCE

 **CORAL**
RESTORATION
FOUNDATION™

RESTORATION 2021

- In 2021, we aim to return **41,000 corals** at nine sites
 - 21,615 staghorn
 - 14,939 elkhorn
 - 4,700 boulder
- Efforts in support of M:IR
 - Carysfort Complex
 - Horseshoe Reef
 - Cheeca Rocks
 - Sombrero Reef
 - Newfound Harbor
 - Looe Key
 - Eastern Dry Rocks
- To support restoration efforts 2021 will focus on **capacity building and innovation** within nurseries and restoration methods.



Expansion

Nursery-based

- Carysfort expanded from 100 to 160 structures.
- Key West expanded from 50 to 150 structures
- Addition of Pickles table nursery
- Addition of Looe Key nursery



Nursery-based Advances

Novel Coral Propagation Methods

- Multi-species
- Corals collected from FKEC structures from Marathon to Card Sound
- Represent novel source of coral w/o damaging wild stands
- 458 colonies from 13 species
- Established in new Pickles table nursery as an intermediate step.



Nursery-based Advances

Coral Propagation Methods

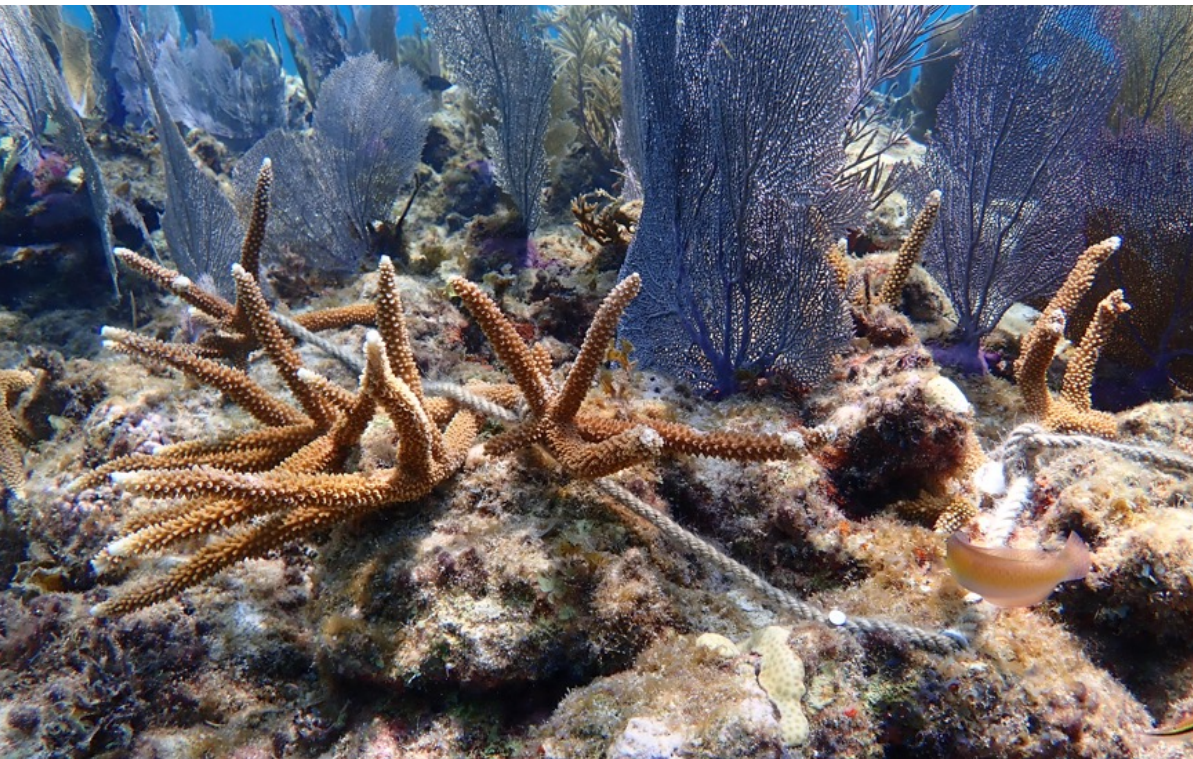
- Pillar Coral
- Investigating both in-situ and ex-situ fragmentation methods and nursery performance
- Assist R&D phase 1 of M:IR
 - Goal to produce stock for outplant efforts in phase 2



Outplant-based Advances

Staghorn novel methods

- In 2019, we began developing techniques that will allow us to restore **ecosystem functionality** more quickly.
- This work involves getting larger corals out onto the reef – immediately restoring **structural complexity**.
- We are working with **sustainable materials** including bamboo and hemp rope.



Outplant-based Advances

Boulder coral novel methods

- Developed in collaboration with the Coral Restoration Consortium Engineering/Innovations group
- Engineered structures for outplanting boulder corals
 - Can “skirt” in nursery first
 - Expedited planting
 - Provides pristine substrate



WORK SUPPORTED BY:

NOAA #NA19NMF4630260

Monroe County TDC

Ocean Reef Club

Restore Act

National Fish & Wildlife Foundation *(NOAA & Armaco)*

And many others...

WORK PERMITTED UNDER:

FKNMS-2019-012-V1

FKNMS-2019-193

FWC and ACOE

THANK YOU

FOR SPREADING OCEAN AWARENESS



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Coral Reproduction + Restoration

SAC Meeting 2/16/21

Dr. Hanna Koch

Postdoctoral Research Fellow

Coral Reef Restoration Program

Mote Marine Laboratory

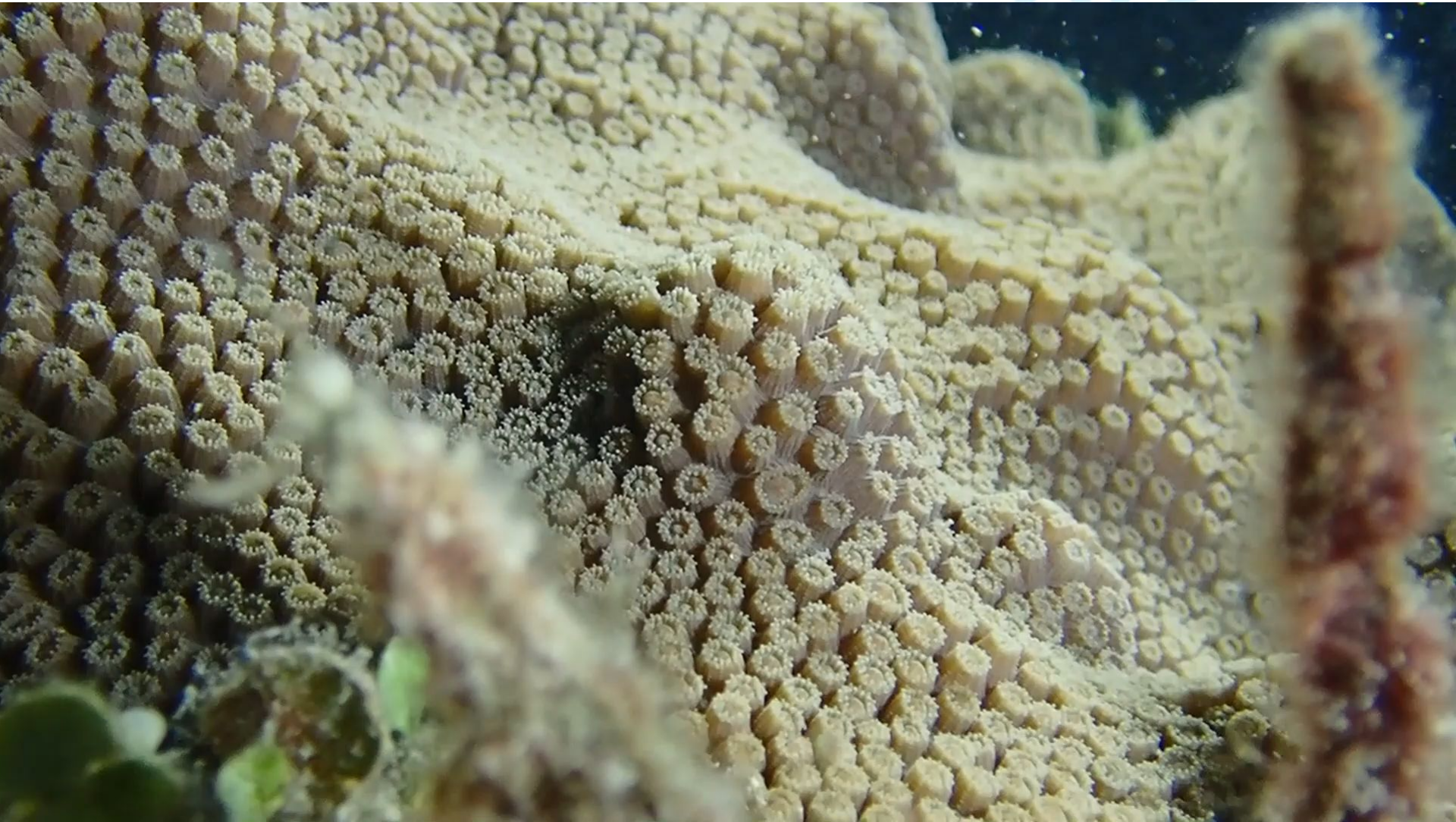
Summerland Key, FL



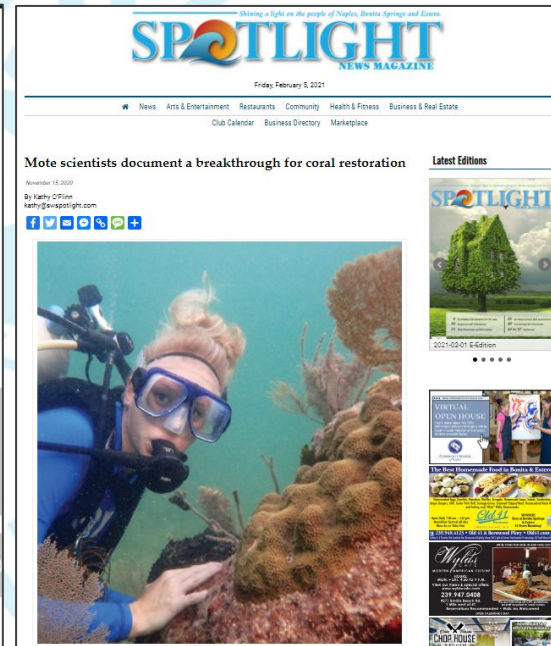
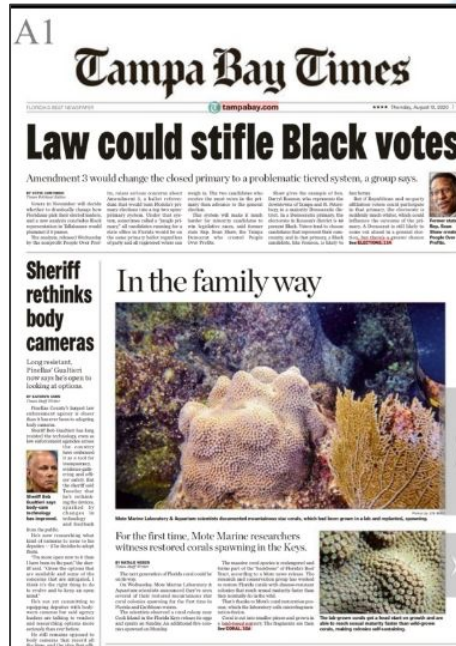
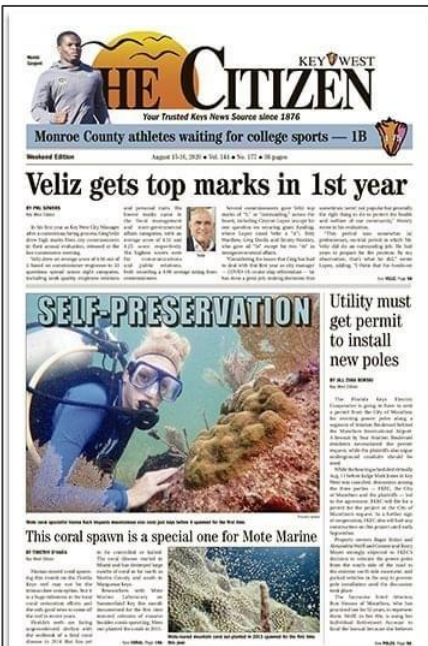
NATIONAL MARINE
SANCTUARIES
FLORIDA KEYS

Restored mountainous star corals spawn

Orbicella faveolata



First corals of any slow-growing massive or mounding species documented to sexually reproduce after being restored to the reef



TheScientist

EXPLORING LIFE, INSPIRING INNOVATION

NEWS & OPINION MAGAZINE SUBJECTS MULTIMEDIA

Search...

Restored Corals Spawn Hope for Reefs Worldwide

Hanna R. Koch, Erinn Muller, Michael P. Crosby | Feb 1, 2021

Novel technologies establish a new paradigm for global coral reef restoration, with in situ spawning of mature, environmentally resilient corals in five years instead of decades.

32 World

Coral grown in lab is thriving on reef

United States
Will Pavia New York

Coral were "outplanted" in 2015 on a reef near Cook Island, on the Lower Keys at the southernmost tip of Florida. Before this year's spawn, in which entire colonies release eggs and sperm in a blizzard, a scientist from the laboratory held nightly dives to assess the state of her specimens. The laboratory said it appeared that they were going to join in.

Hanna Koch, its reproduction specialist, said that she had seen eggs and sperm in the corals, ready to be released. The laboratory said that these were the first known corals of any massive or mounding species that have been documented to be sexually mature after being restored in Florida or Caribbean waters.

The laboratory added that the

Mote's outplants are sexually mature," Dr. Koch said. "I have been monitoring them for several summers now but we have a lot of stressors on our reefs, including temperature stress, and bleaching, hurricanes and disease, so I wasn't sure if our corals would have the additional energy required to put towards sexual development."

They appeared resilient, she said. "We are eagerly awaiting to observe them spawn this month or next."

Researchers at the Florida Aquarium are due to announce a similar breakthrough involving pillar corals, another threatened species.

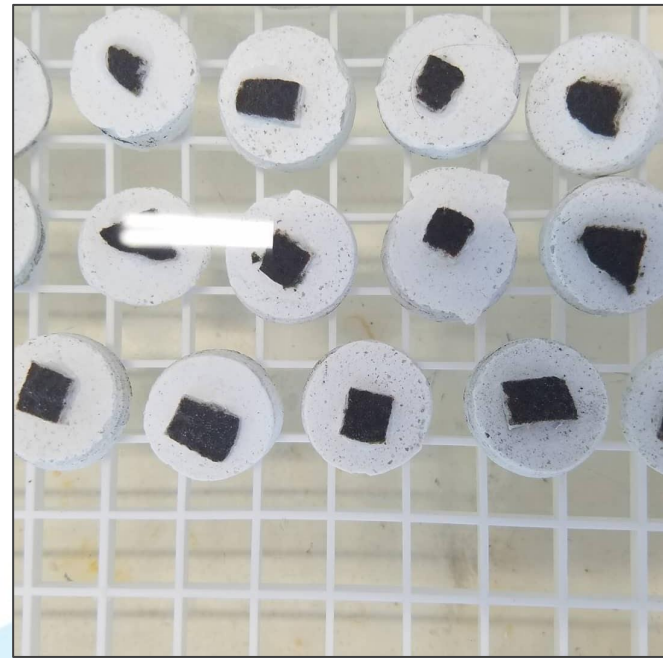
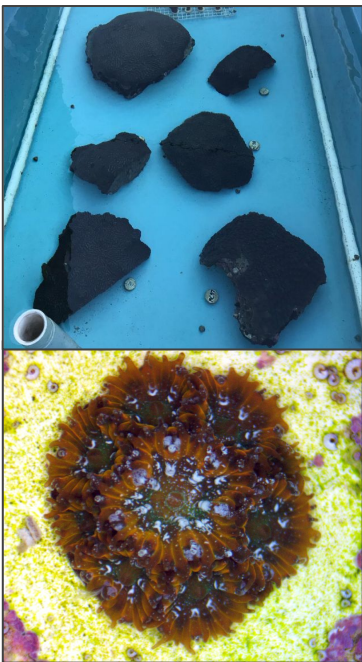
The aquarium said that its researchers had spawned the coral for the second year in a row "through lab induced techniques." The Mote Marine

Laboratory said it had used a method in which corals are broken into tiny fragments that are grown separately and then encouraged to join together.

Using this technique, corals that can take decades to reach sexual maturity were found to become capable of spawning after five years.

The breakthrough was billed as a milestone in the effort to restore reefs damaged by pollution, disease and the warming of the oceans.

"Dr. Koch's finding is proof that this method works and that we can produce reproductively viable corals of slow-growing coral species in only a handful of years," a spokeswoman for the laboratory said. "This provides hope for bringing back Florida's coral reef from the brink of functional extinction."



Microfragmentation + land-based nursery grow-out





Outplanting + reskinning



Monitoring



Cook Island Case Study (August 2020)

- Natural reproductive rhythms
 - Spawned during predicted peak window (NAFM) & timeframe (MAS)
 - Can cross-fertilize with outplants + wild colonies
 - Maximizes diversity
- High synchrony
 - Spawned within 10-min window
 - Supports more successful fertilization
- Resilient
 - Survived:
 - Bleaching events
 - Category-4 hurricane
 - SCTLD (most)
 - 2 treated with antibiotics
 - Spawned after being cored



Acropora assisted sexual reproduction

Staghorn (*A. cervicornis*)

Stress-tested parental genotypes

3 yrs = >1500 new sexually produced genotypes into Mote's restoration gene pool

Outplanted:

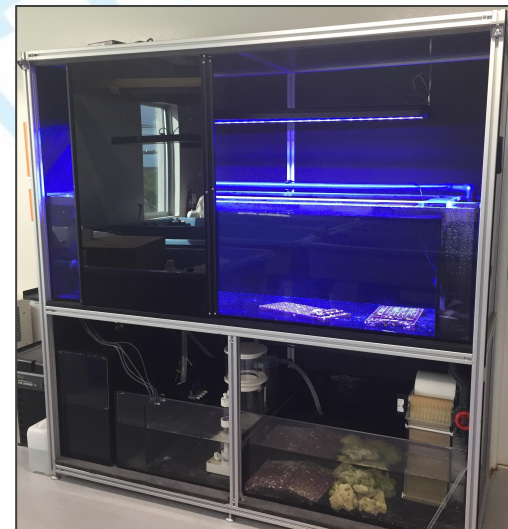
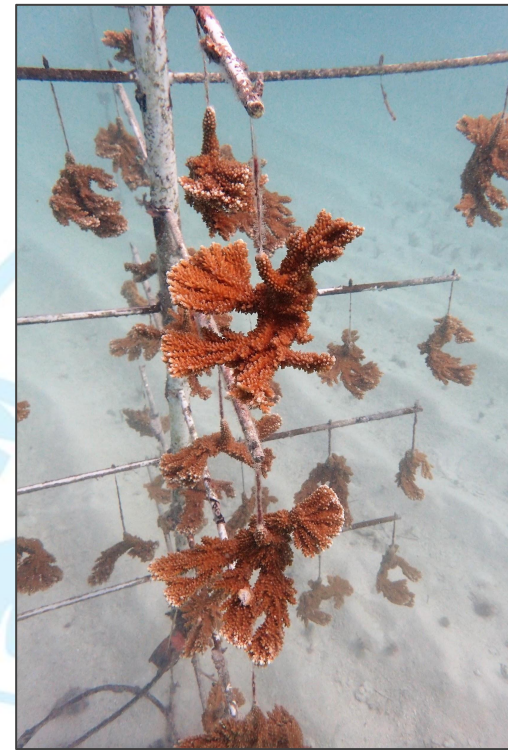
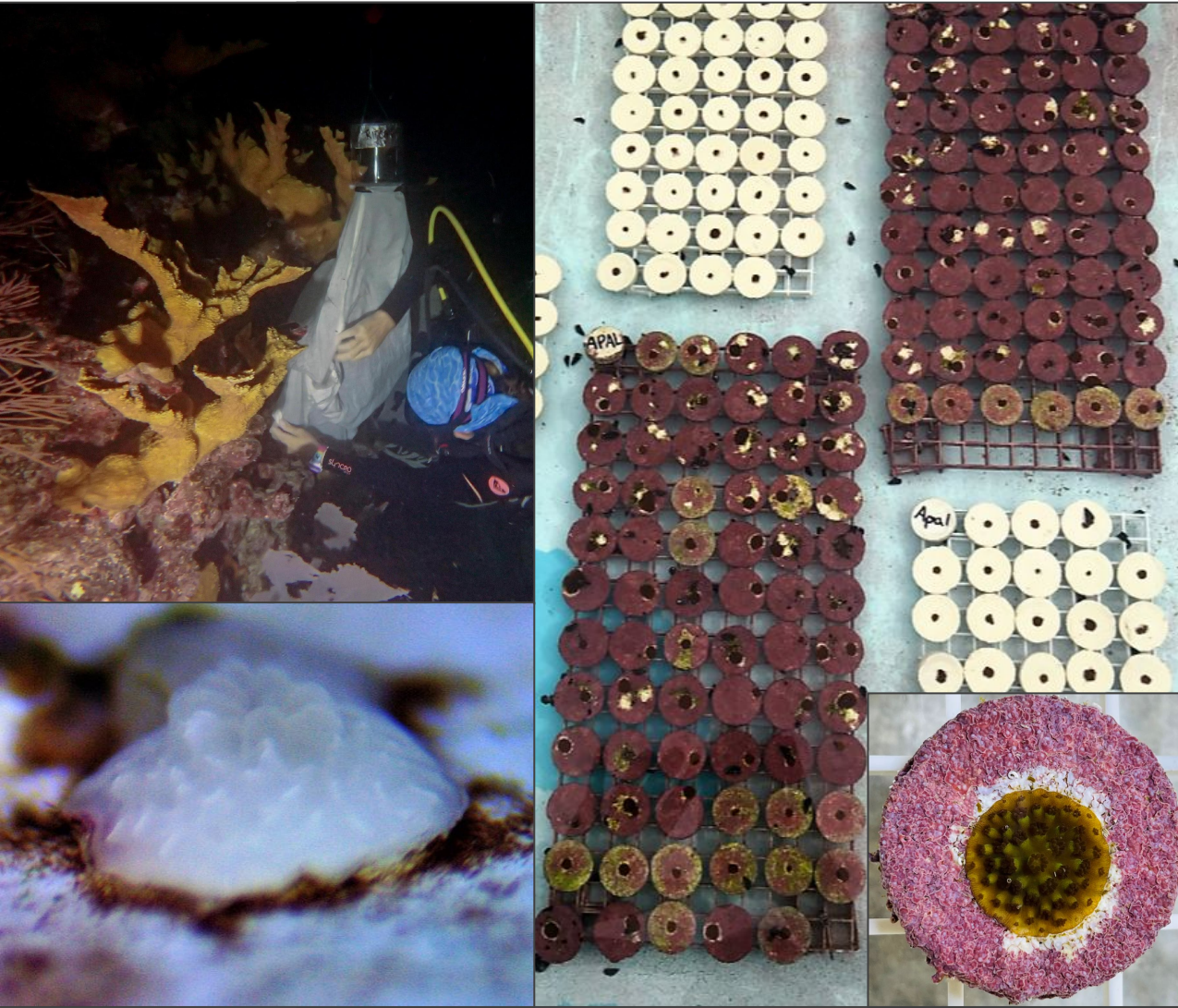
300 genotypes, > 1750 corals,
100% genotype survival, 96% frag survival



Acropora assisted sexual reproduction

Elkhorn (*A. palmata*)

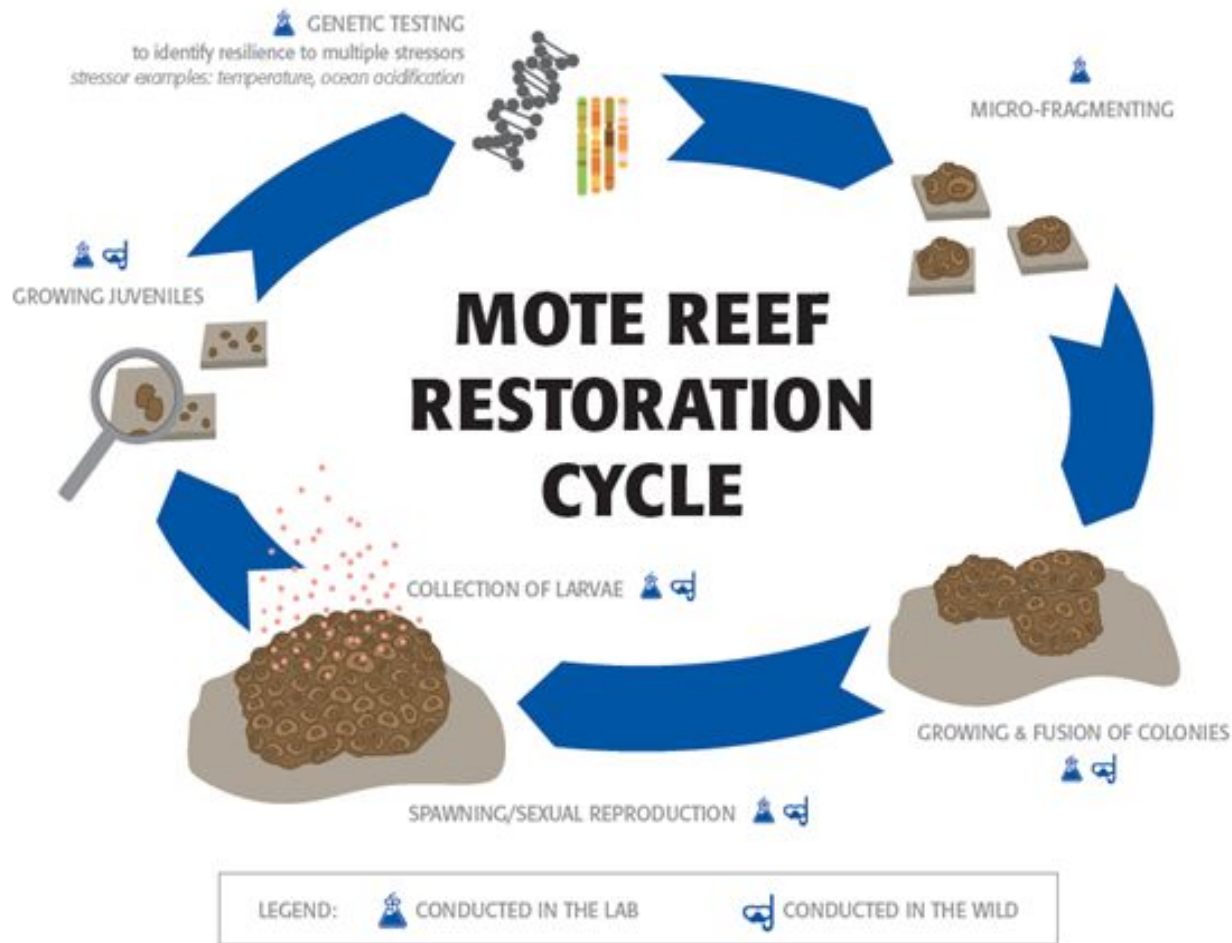
~300 new sexually produced genotypes



Implications

- Promotes faster population & ecosystem recovery
 - Quicker recolonization of dead coral heads
 - Rapidly increases living coral cover
 - **Faster onset of sexual maturity/reproduction**
 - Diversity generated more quickly & more likely retained
- Sources for assisted sexual reproduction work
- Should work for any other species/region of the world

Integration + upscaling



Mote's coral genotype holdings currently consist of **>1,600 genotypes** from **17 species**, with **~3k** additional genotypes from **3 species** that are expected to be added over **next years**



MISSION: ICONIC REEFS



Reef Renewal



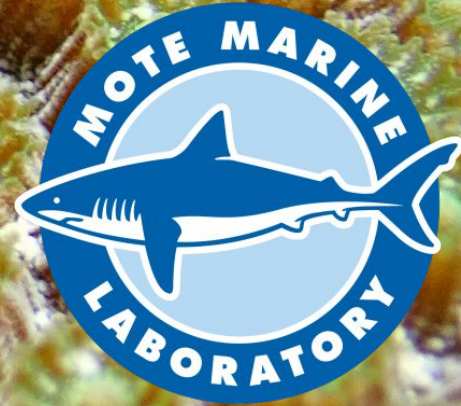
National
Marine Sanctuary
Foundation



The Nature
Conservancy



Thank you



NATIONAL MARINE
SANCTUARIES
FLORIDA KEYS

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Reef Renewal USA

- Florida Keys based 501 (c) 3
- 20 Species of Coral
- Community based volunteer program



Reef Renewal USA Regional Coral Nurseries

Looe Key

Marathon/FWC

Tavernier



Acropora Corals

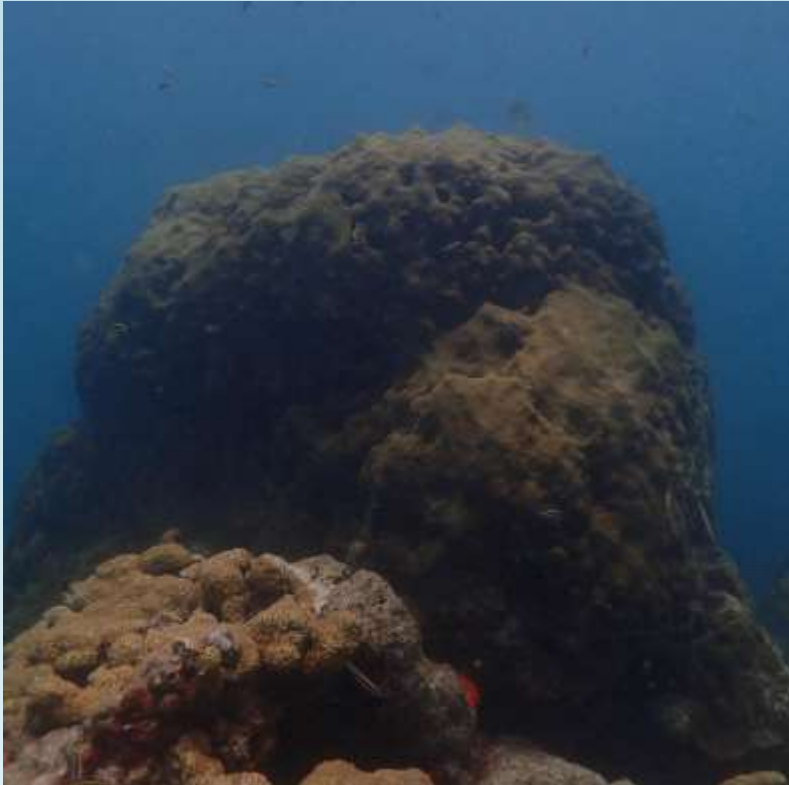


Elkhorn Coral
Acropora palmata



Staghorn Coral
Acropora cervicornis

Star corals in the Genus *Orbicella*



Mountainous Star Coral
Orbicella faveolata



Lobed Star Coral
Orbicella annularis



Boulder Star Coral
Orbicella franksi

Other Star Corals



Giant Star Coral
Montastrea cavernosa



Smooth Star Coral
Solenastrea bournoni



Blushing Star Coral
Stephanocoenia intersepta

Other Star Corals



Massive Starlet Coral
Siderastrea siderea



Elliptical Star Coral
Dichocoenia stokesi

Brain Corals



Knobby Brain Coral
Pseudodiploria clivosa



Grooved Brain Coral
Diploria labyrinthiformis

Brain Corals



Boulder Brain Coral
Colpophyllia natans



Symmetrical Brain Coral
Pseudodiploria strigosa

Other Corals



Knobby Finger Coral
Porites furcata



Mustard Hill Coral
Porites astreoides



Pillar Coral
Dendrogyra cylindrus

Other Corals



Rough Cactus Coral
Mycetophyllia ferox



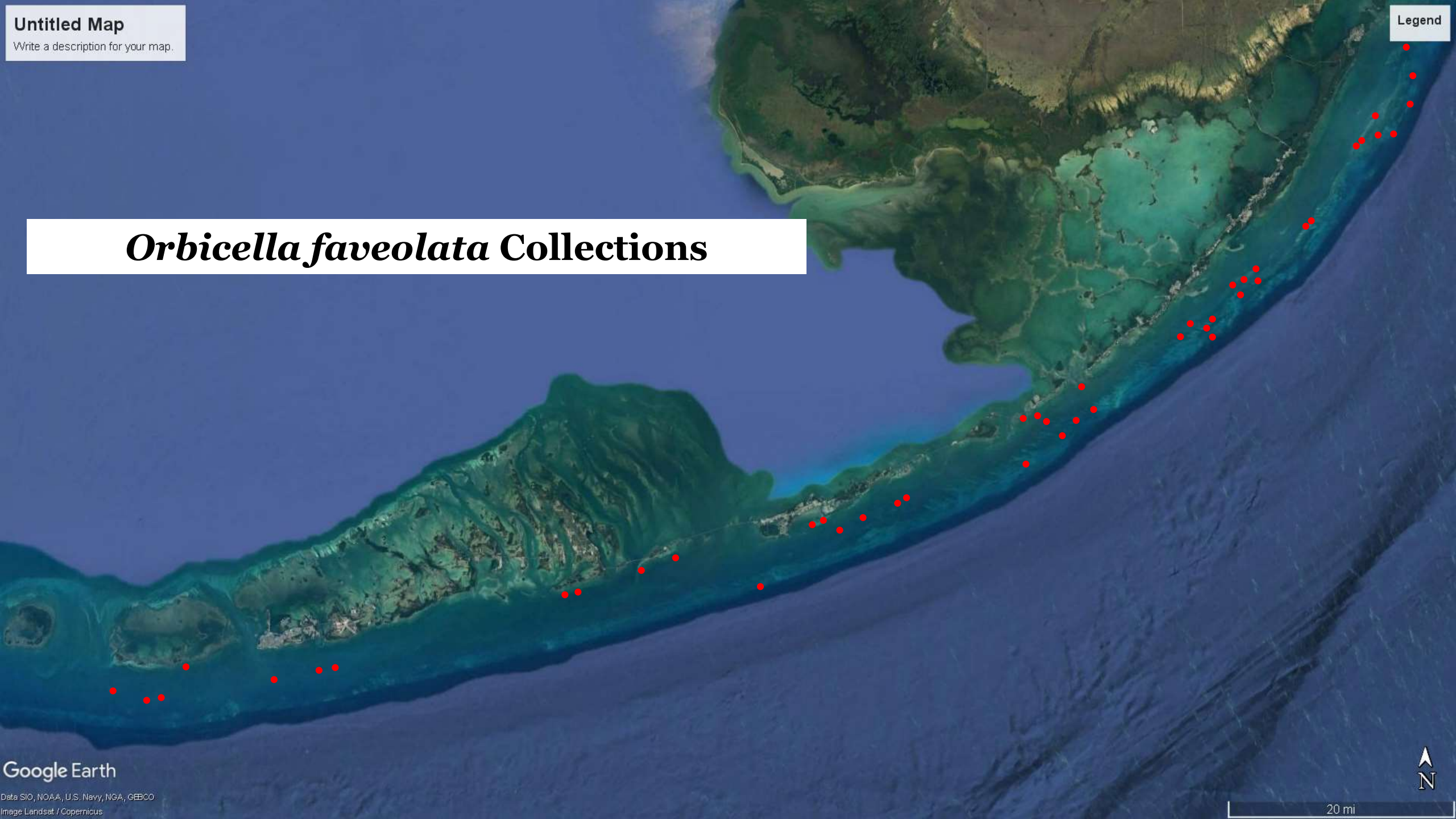
Ivory Tree Coral
Oculina diffusa



Blade Fire Coral
Millepora complanata

Looking for the Survivors

- Collecting corals from throughout the Keys
- Collecting corals from multiple habitat types
 - Inshore
 - Offshore
 - Mid channel
- Looking for corals that survived:
 - 2010 Cold Fronts
 - 2014/2015 Bleaching
 - Ongoing Stony Coral Tissue Loss Disease



Untitled Map

Write a description for your map.

Legend

Orbicella faveolata Collections

Collecting Corals



Tagging and measuring at the Reef



Tagged coral at the nursery

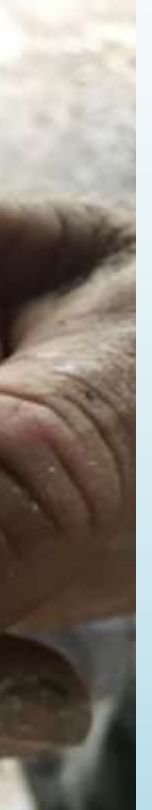
Processing Corals on Land

- Initial Collections
- Drilling, Trimming, Mounting



Processing Corals on Land

- Initial Collections
- Drilling, Trimming, Mounting



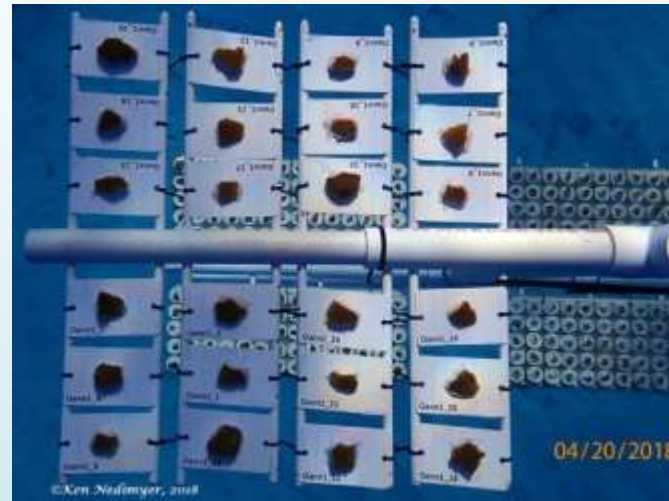
Mounting Broodstock Corals

- Initial Collections
- Drilling, Trimming, Mounting
- The Broodstock System

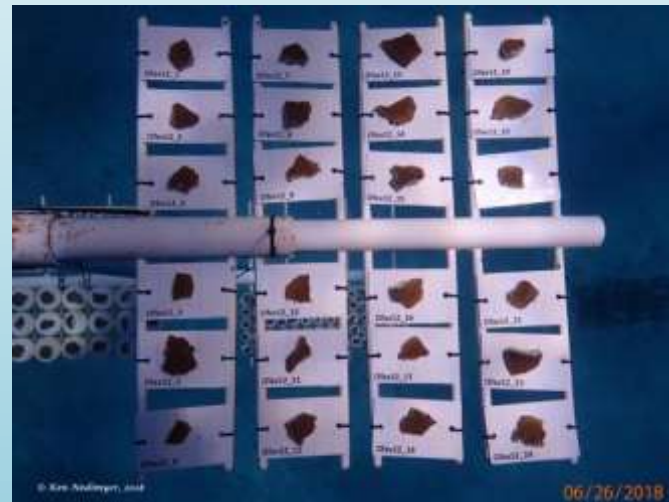
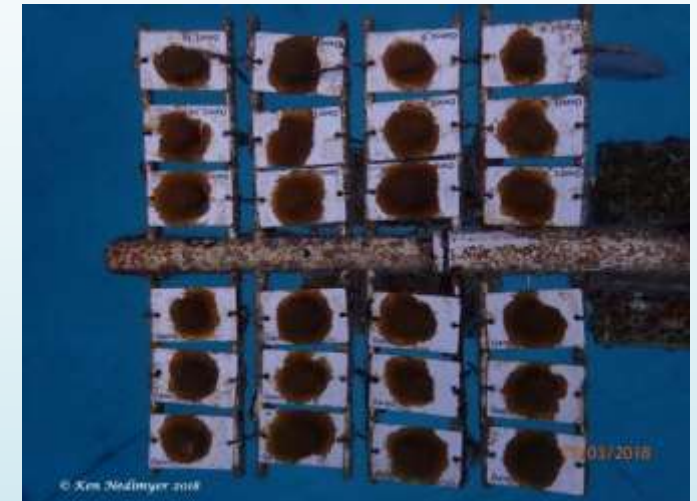


Broodstock Growout

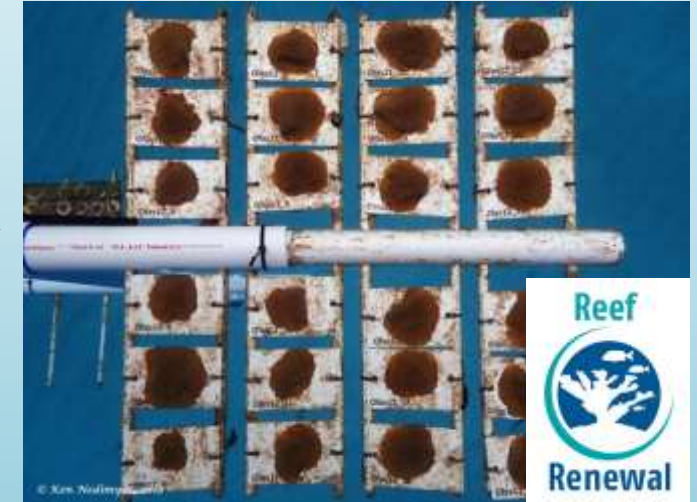
- Initial Collections
- Drilling, Trimming, Mounting
- The Broodstock System



→
6 months



→
4 months

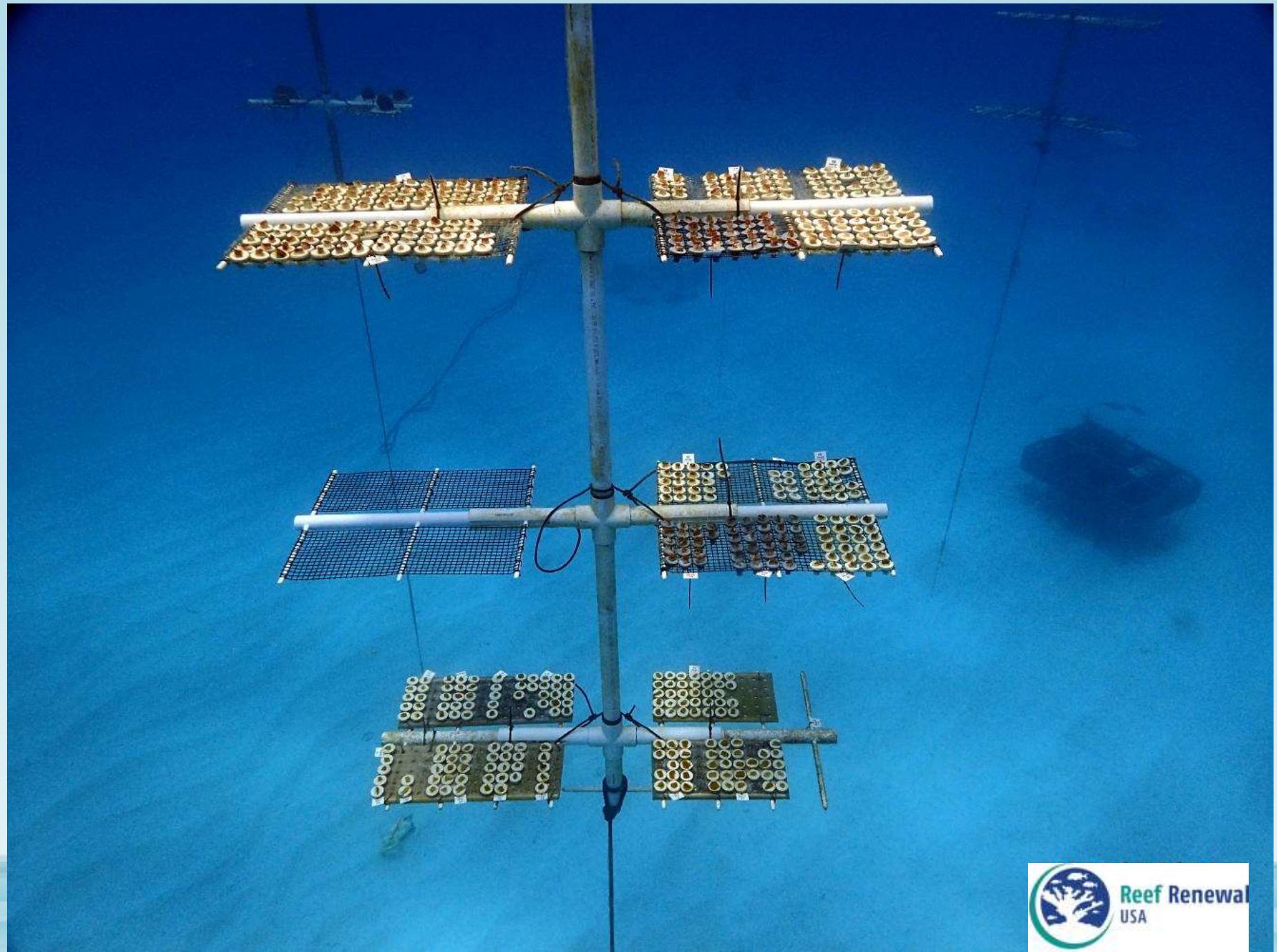


Mounting MicroFrag

- Initial Collections
- Drilling, Trimming, Mounting
- The Broodstock System
- The Grow Out System



Modular Grow out Tree



Knobby Brain Coral

Pseudodiploria clivosa



Replacing Trees with Ropes

2021/01/18

Rope Nurseries at the Reef

2021/01/06



Rope Nurseries at the Reef

2020/10/30



Expedited Outplanting



2020/05/09