Development of a Sponge Restoration Strategy for Florida Bay

Greater Everglades Ecosystem Restoration Conference

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Florida Fish & Wildlife Conservation Commission

Fish & Wildlife Research Institute

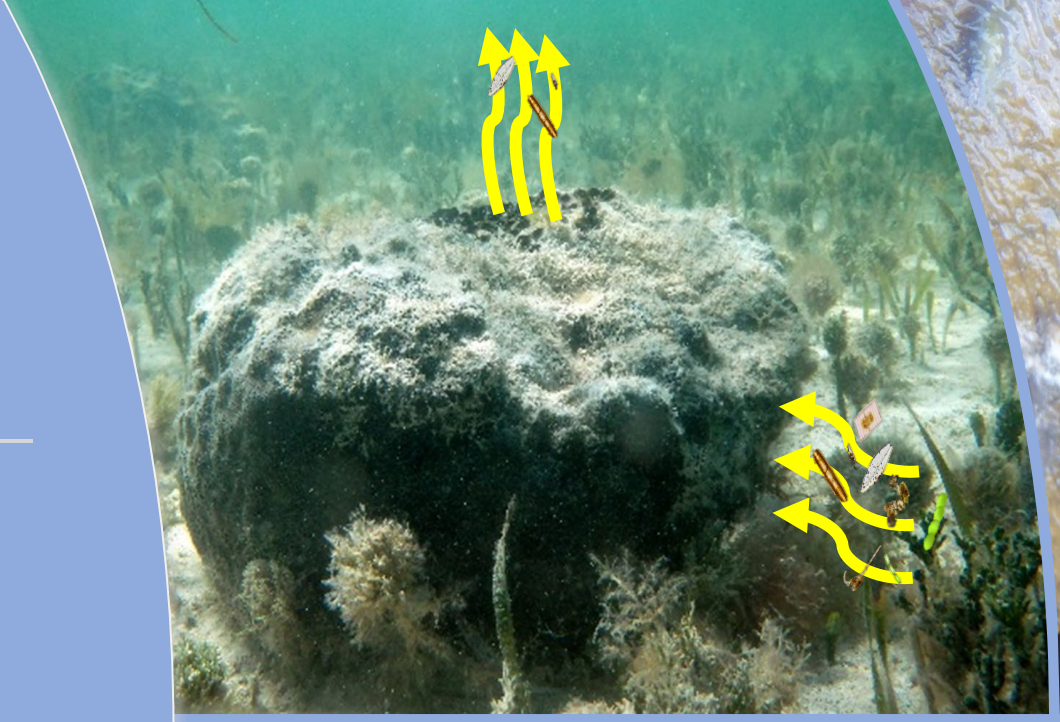
South Florida Regional Laboratory

Hard-Bottom Communities of Florida Bay

- Calcium carbonate bedrock overlain with a layer of unconsolidated sediment
- Community typified by sponges, octocorals, small scleractinian coral, algae
- Sponges historically dominated the heterotrophic biomass

Ecological Importance of Sponges

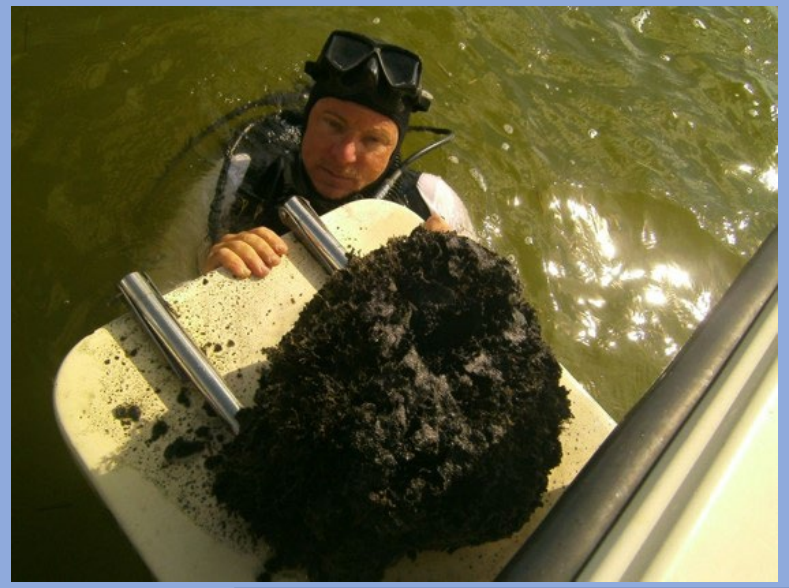
- Nutrient Cycling
- Remove organic particulate matter
- Habitat for animals that live around sponges
- Habitat for many commensal organisms

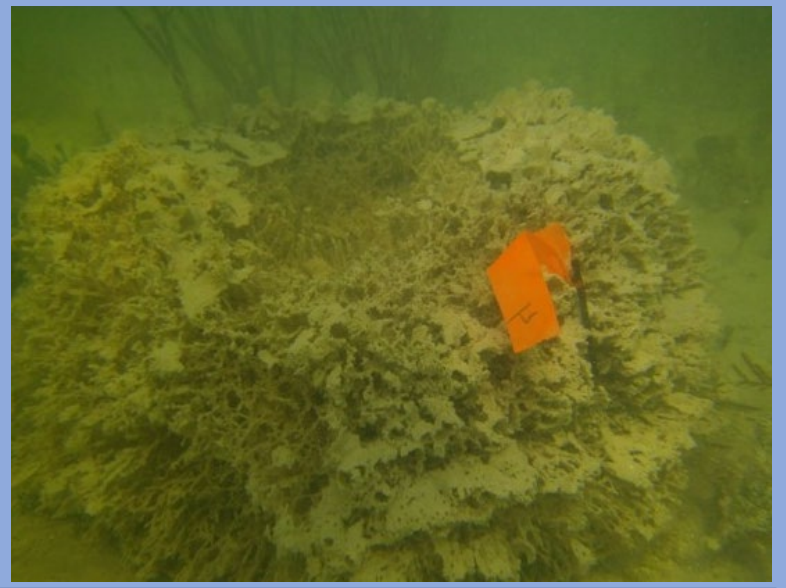


Hard-Bottom Communities of Florida Bay - Connectivity to Florida's Coral Reef

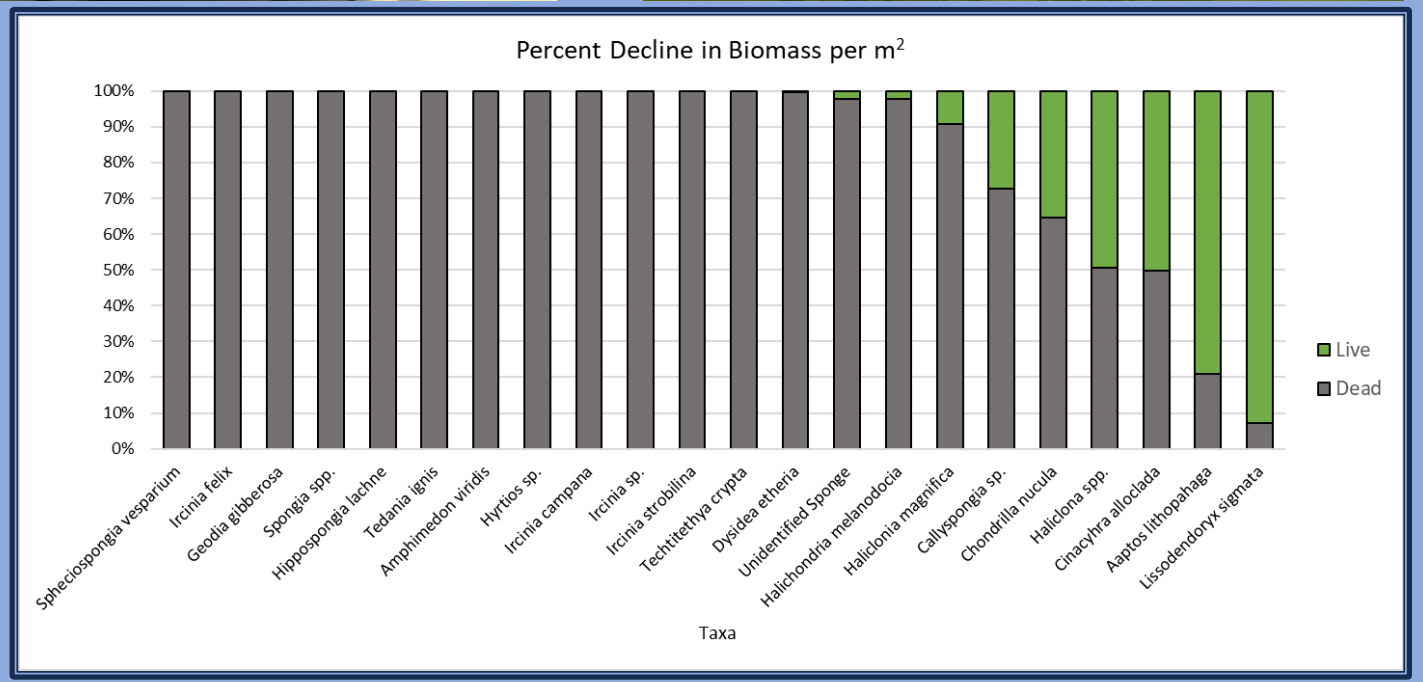
Cyanobacterial Bloom-Associated of Mortality of Sponges

- First Documented in 1991





- 2013 bloom in central Florida Bay
- Complete loss of most sponge species; all the larger structure-forming species



Cyanobacterial Bloom Timeline

- Moderate Resolution Imaging Spectroradiometer (MODIS) Satellite Imagery
- Correction for cyanobacteria blooms in FL Bay (Cannizzaro *et al*., 2019)

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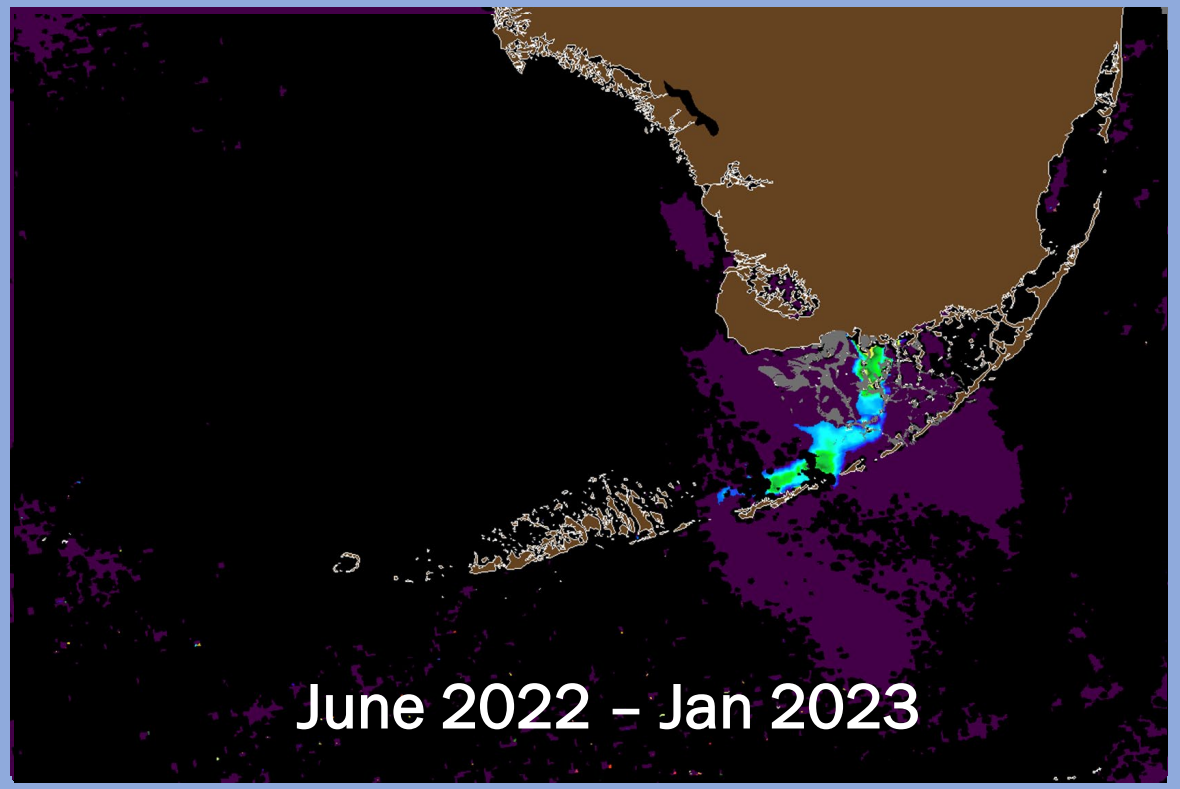
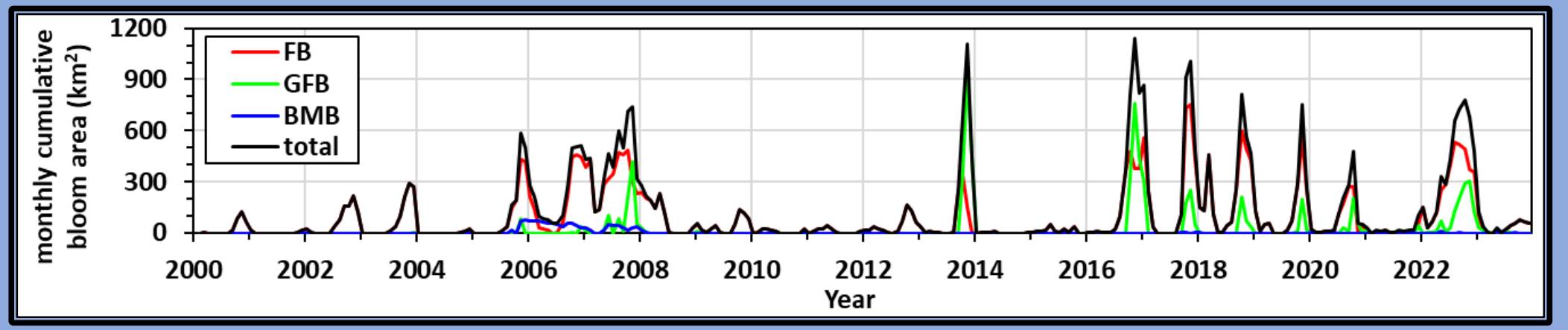
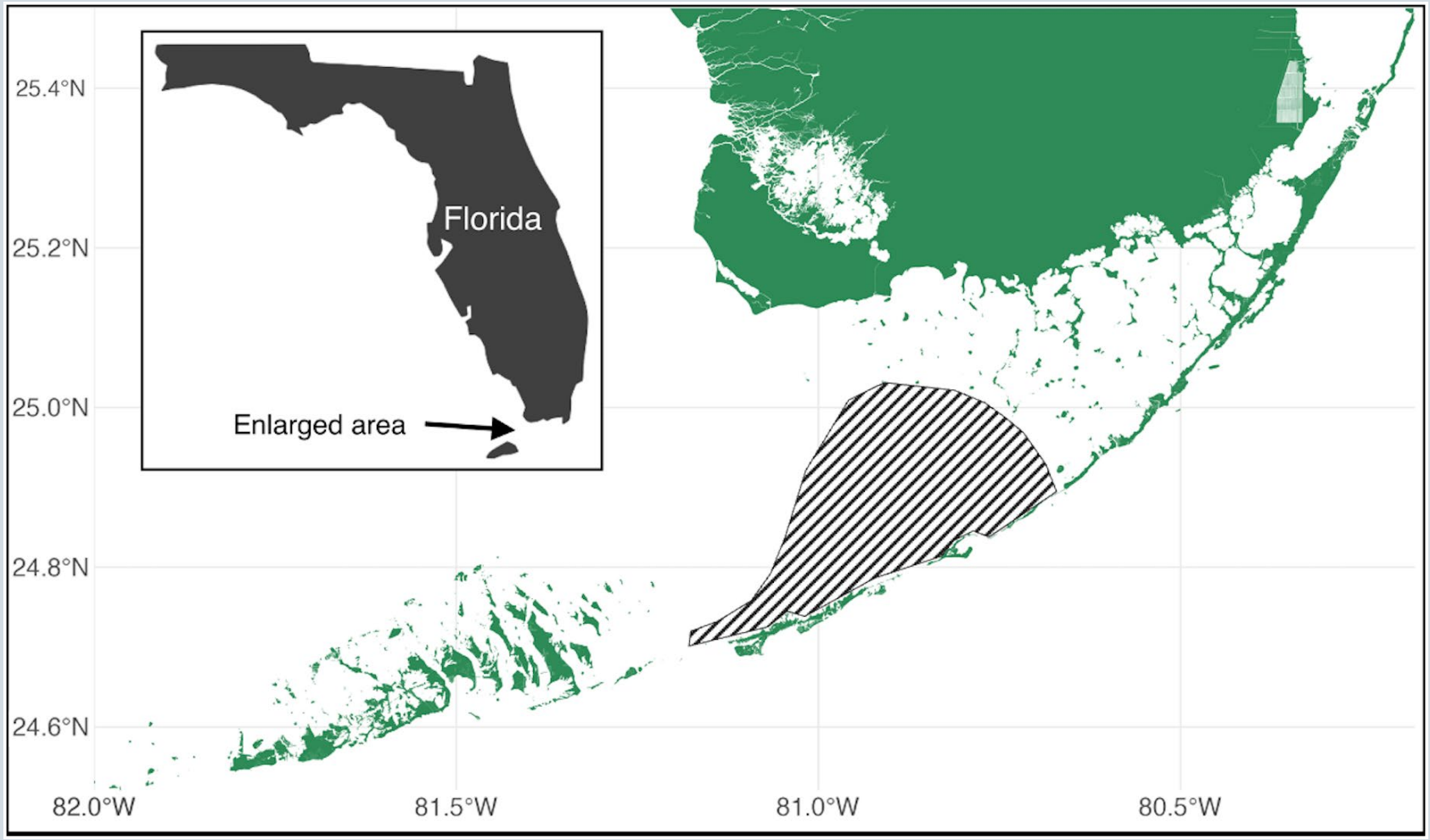
- Blooms becoming more frequent



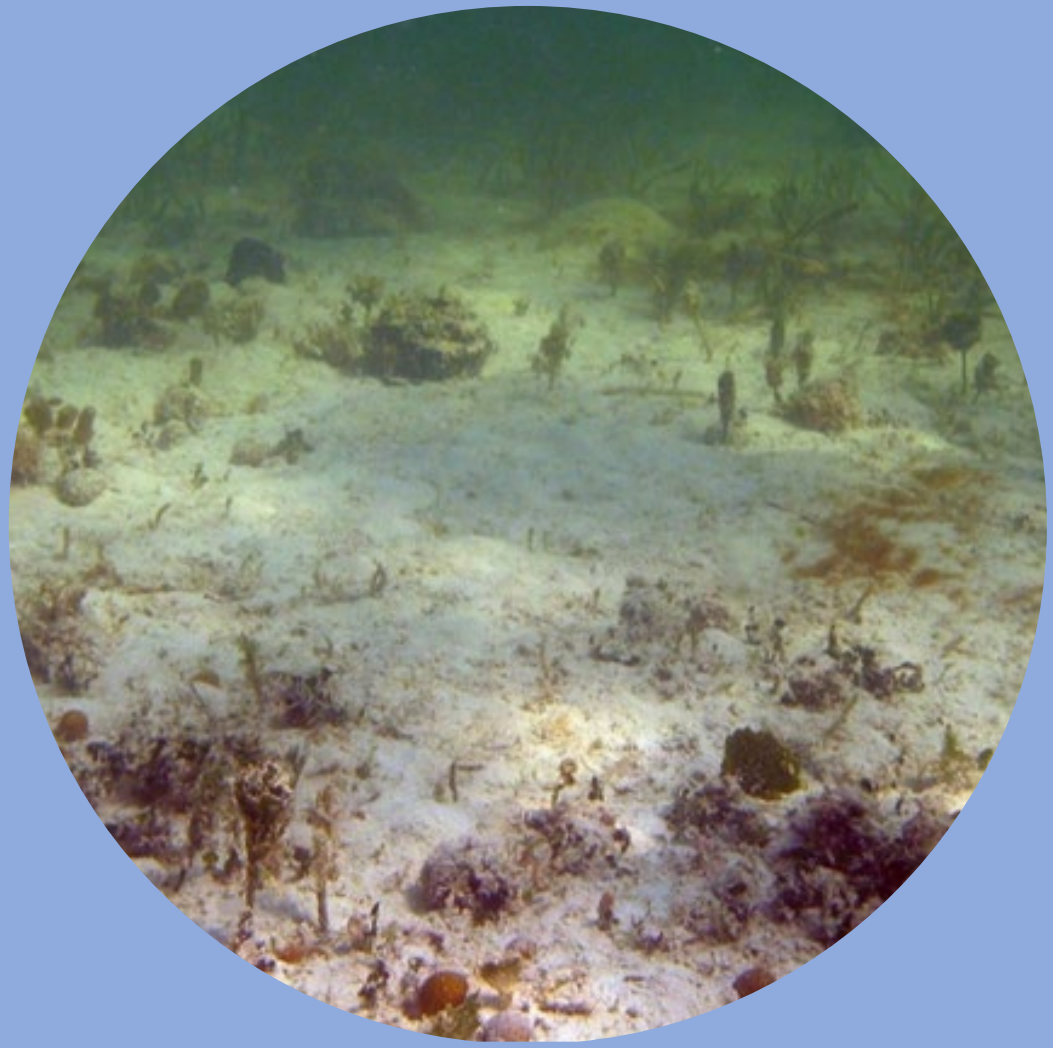


**Bloom definition: Cyanobacterial Chl-a (Chl_{CI}; Cannizzaro et al., 2019) > 5 mg m^{-3}

Repeated periodic cyanobacteria blooms have caused sponge die-offs throughout the Bay



Butler *et al*. 2021. Setting the foundation for renewal: restoring sponge communities aids the ecological recovery of Florida Bay. Ecosphere 12 (12), e01502



Beginnings of Sponge Restoration Research

- Grounded in sponge biology and ecology
  - Sponge propagation
    - Identifying amenable species
    - Timing of transplants
  - Effect of transplants on ecosystem processes

esa ECOSPHERE

SPECIAL FEATURE:
HONORING CHARLES H. PETERSON, ECOLOGIST

Setting the foundation for renewal: restoring sponge communities aids the ecological recovery of Florida Bay

Jack Butler,[1,]† William C. Sharp,[2] John H. Hunt,[2] and Mark J. Butler IV[1]

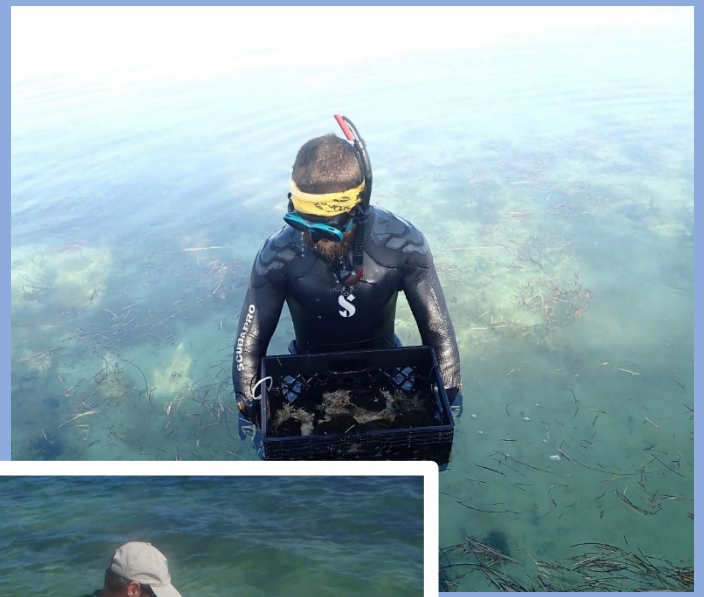
Scaling-up Sponge Community Restoration

Sandfly Key Sponge Nursery

2020

"Scaling-up Sponge Community Restoration"

- Produced ~18,000 sponges of 6 species
- Conducted largest sponge outplant yet attempted in Florida Bay 15,000 sponges
- Estimated restoration costs on a per sponge basis $



Florida Fish and Wildlife Conservation Commission

United States Environmental Protection Agency

Bonefish & Tarpon Trust

Old Dominion University

Sea Grant Florida

The Nature Conservancy

Florida Keys Environmental Fund, Inc.

Sponge Restoration Under Continued Environmental Stress

- *"Scaling-Up Sponge Restoration in Florida Bay"*

- Develop a risk-adverse strategy to guide sponge restoration in Florida Bay

A Sponge Restoration Strategy That Mitigates Risk

- A strategy that incorporates:
  - Documenting historic cyanobacteria blooms
  - Historic near-shore hard-bottom mapping & surveys of the sponge community
  - Sponge life history characteristics
  - Costs associated with sponge restoration

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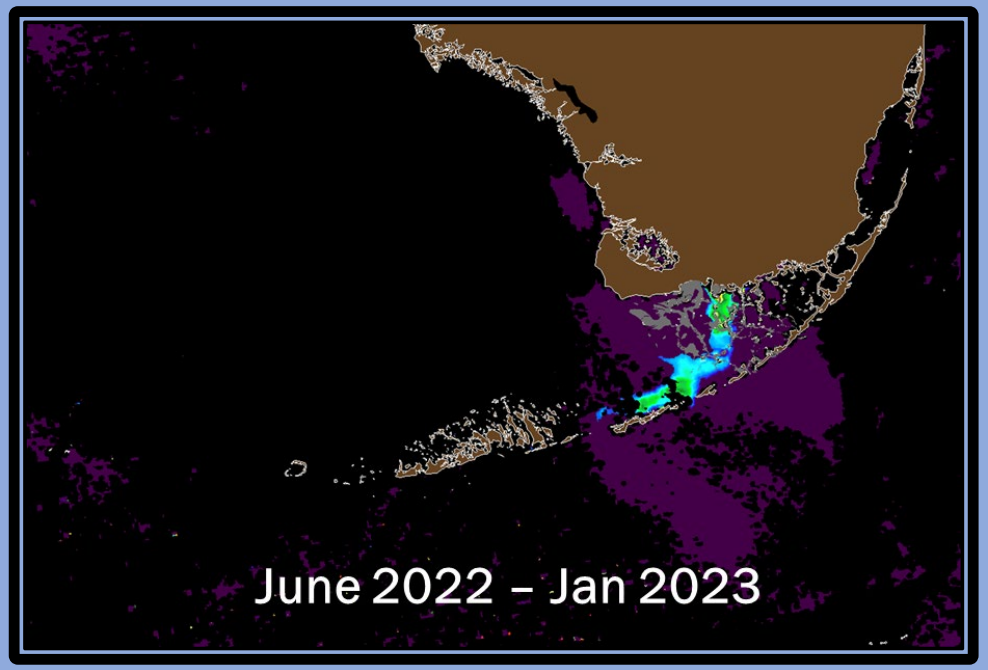
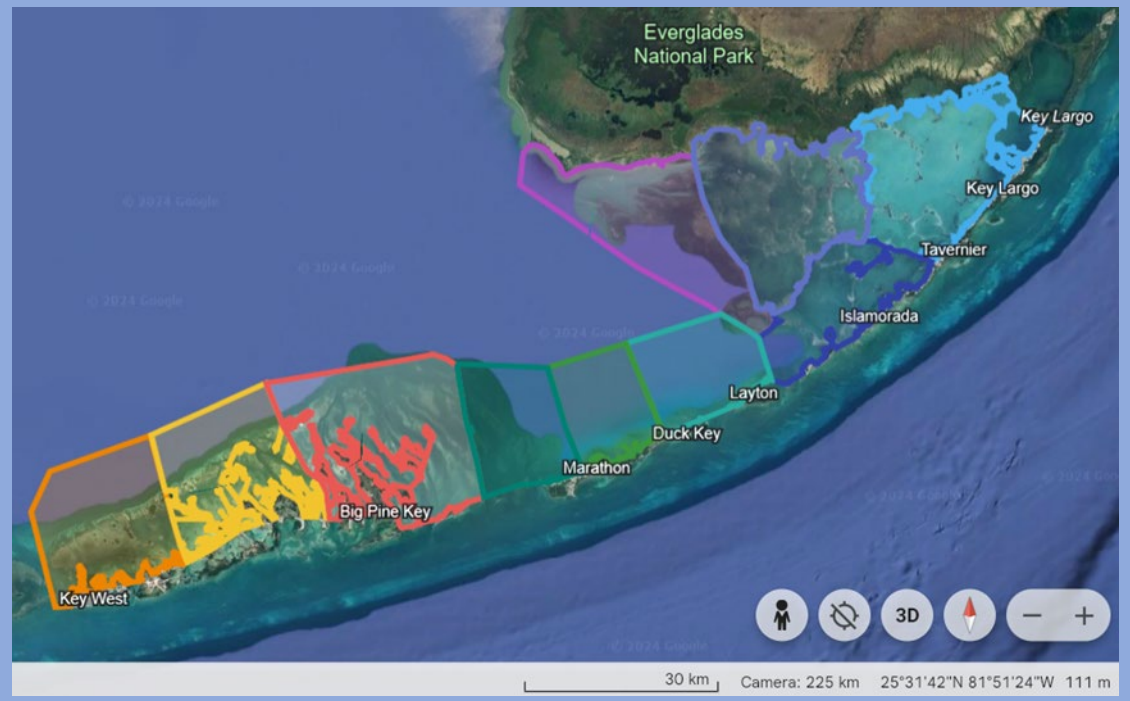
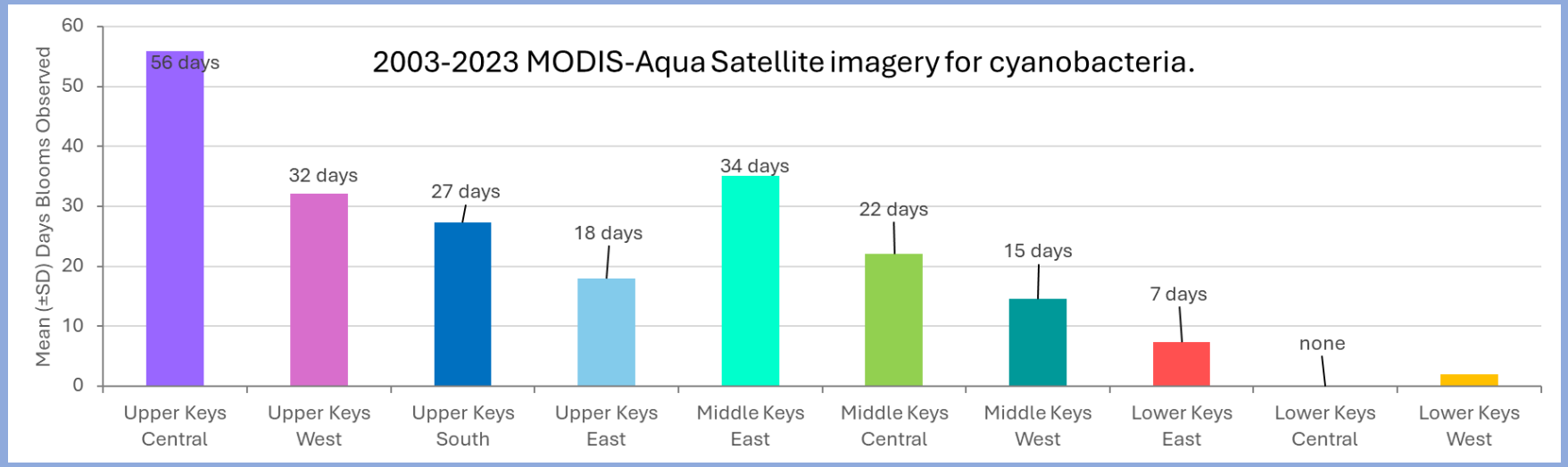


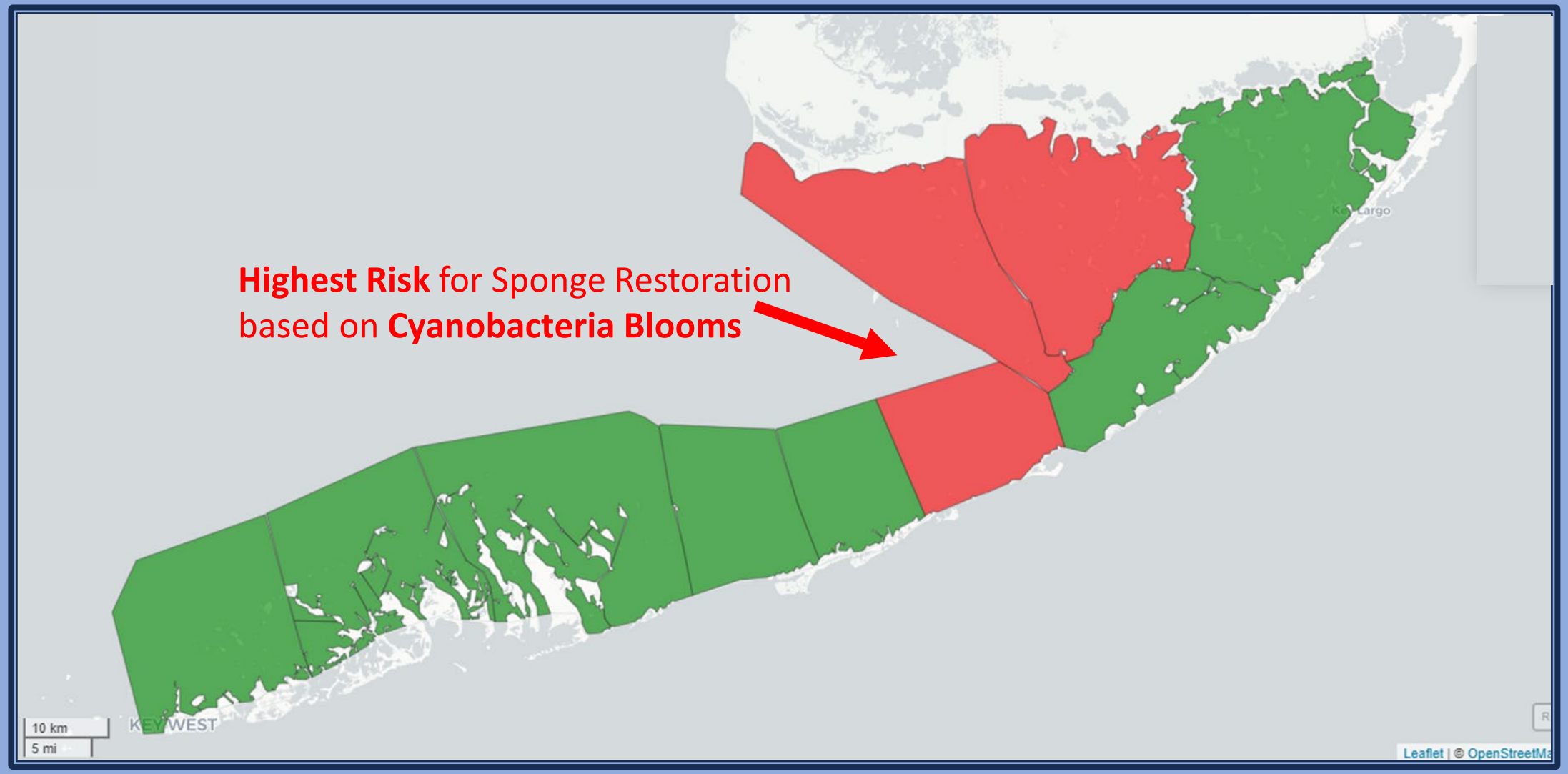
Documenting Historic Cyanobacteria Blooms

- Historic spatial and temporal dynamics of blooms





Documenting Historic Cyanobacteria Blooms



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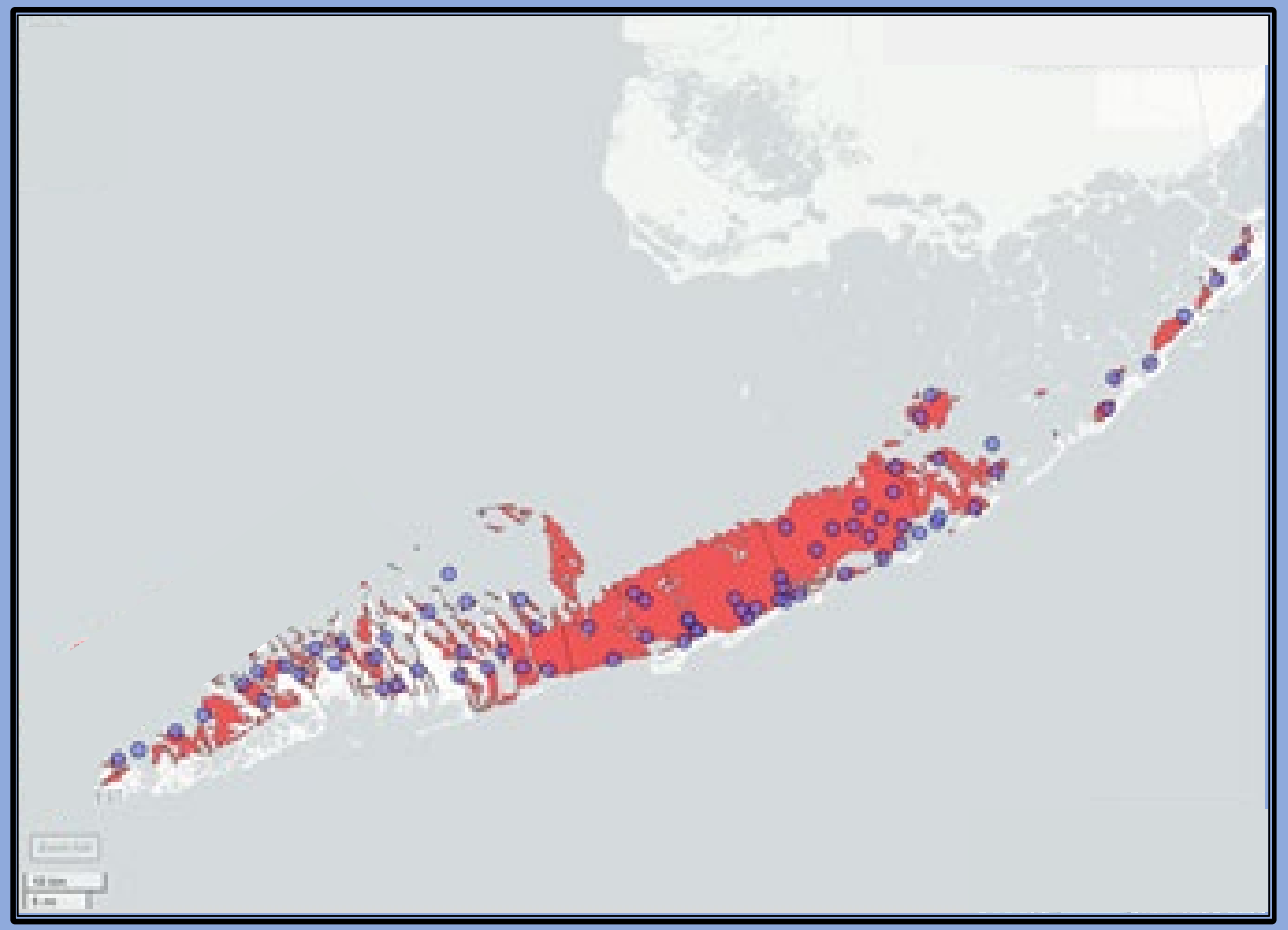
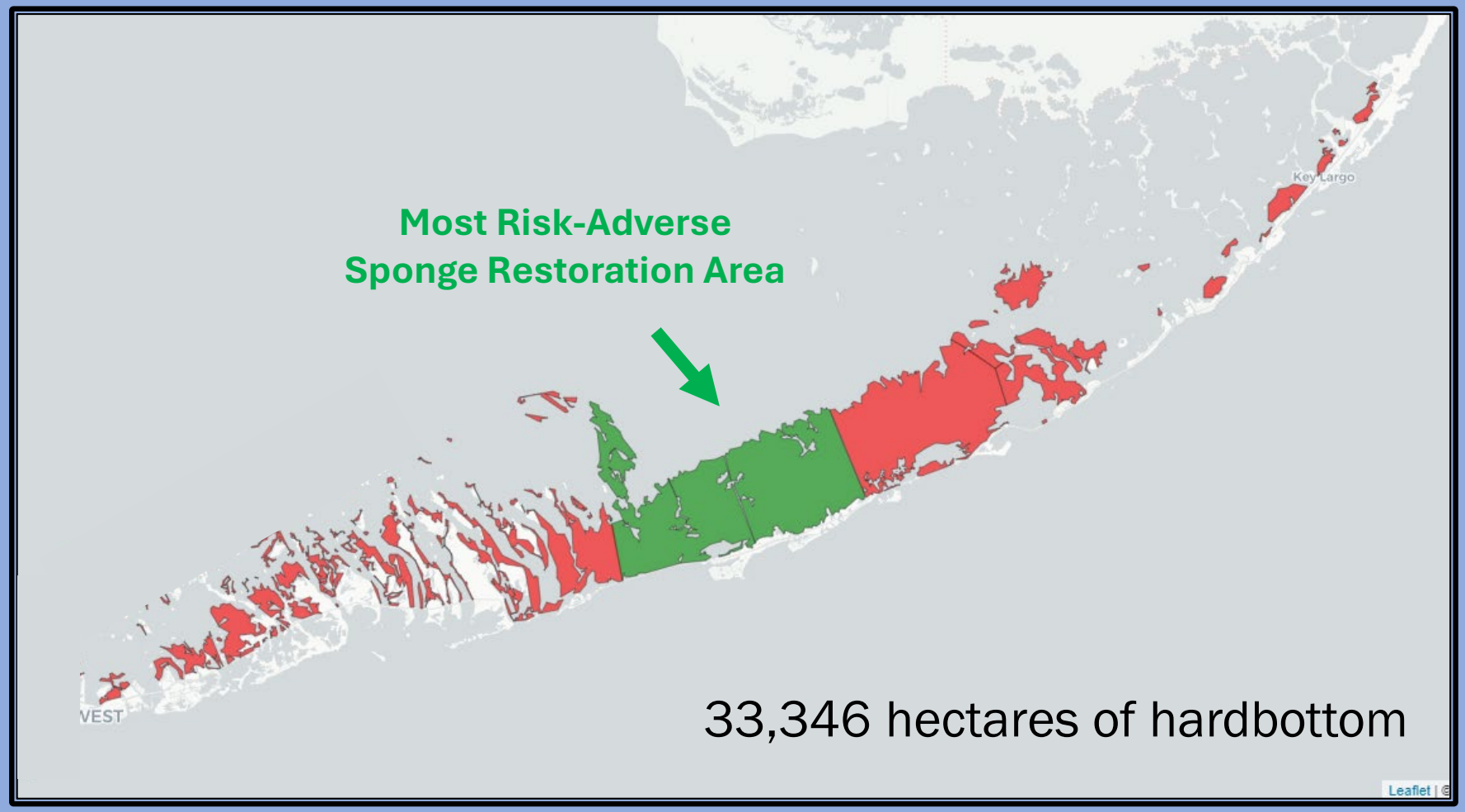
Historic Near-Shore Hard-Bottom Mapping & Sponge Community Surveys

- Using FWRI 1990s–2011 Coral and Hard-bottom GIS data
- Sponge communities identified from 2002 surveys



Combining Historic Occurrence Data, Hard-Bottom Mapping & Sponge Community Surveys



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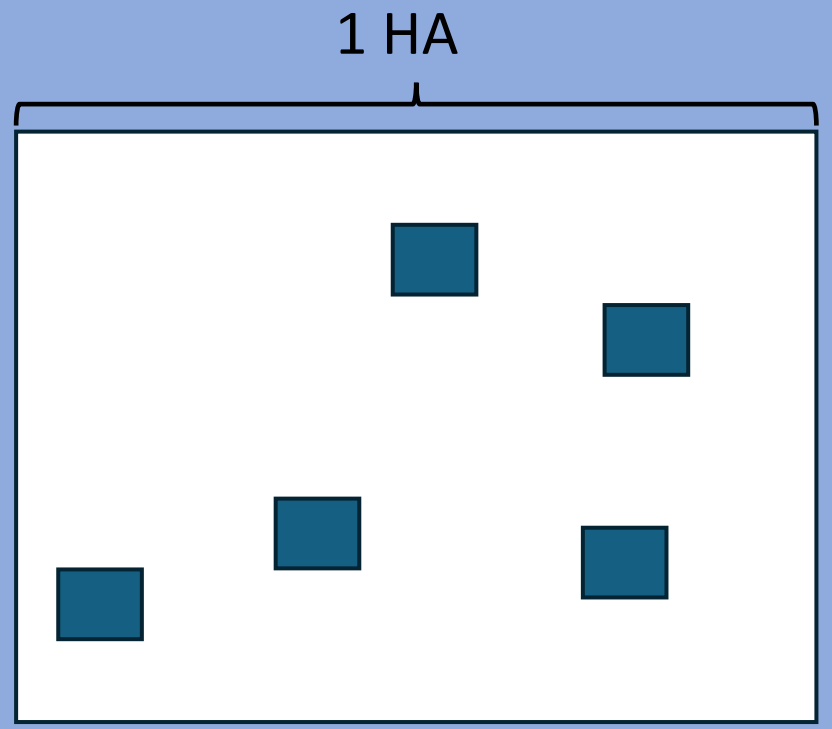
Sponge Life History Characteristics

- Short larval duration limits dispersion and recruitment
- Outplanting to optimize recruitment of sexually-produced larvae
- Outplant sites: Combine mean sponge densities from 2002 surveys with higher density plots that serve as potential “spawning hubs”

	Number of individual sponges	
Species	**Restoration Area 1 Hectare**	**Spawning Hub 0.01 Hectare**
Loggerhead	600	30
Yellow	100	10
Glove	100	10
Sheepswool	100	10
Vase	500	42
Brown Branching	200	20
Total	1600	122



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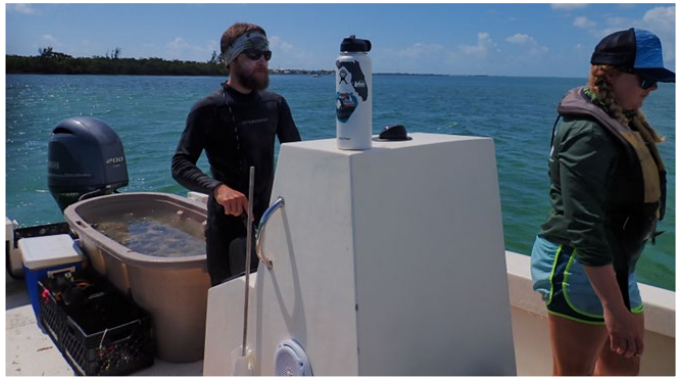
Costs associated with sponge restoration



Date	No. Personnel	Field Day (hrs)	Nursery	Trailering Miles	Vehicle Fuel Consumption (Gals.)	Time Propagating Sponges (hrs)	Total Man-Hours	Vessel Hours	Vessel Engine Hours	Paver-Mounted Sponge Cuttings	Limestone-Mounted Sponge Cuttings	Total Sponge Cuttings
3/3/2016	3	6.0	Stirrup Key	0.5	0.1	3.0	18.0	4.0	1	161	38	199
3/7/2016	6	6.0	Stirrup Key	0.5	0.1	5.0	36.0	6.0	1	652	0	652
3/8/2016	6	6.0	Stirrup Key	0.5	0.1	2.0	36.0	4.0	2	199	0	199
3/14/2016	3	6.0	Burnt Point	10.8	0.7	4.0	18.0	5.0	1	250	0	250
3/17/2016	4	6.0	Sandfly Key	18.0	1.2	3.0	24.0	4.0	1	299	0	299
3/31/2016	3	6.0	Rachel Key	0.5	0.1	3.0	18.0	3.8	0.75	300	0	300
4/1/2016	3	6.5	Rachel Key	0.5	0.1	4.0	19.5	4.5	0.5	254	0	254
4/4/2016	4	6.0	Burnt Point	10.8	0.7	3.0	24.0	4.0	1	256	0	256
4/8/2016	4	4.0	Stirrup Key	0.5	0.1	2.5	16.0	3.0	0.5	209	0	209

Costs associated with sponge restoration

Estimated Cost per Ha to achieve the restoration objective			
Mean propagation cost per sponge	**Mean outplant cost per sponge**	**Mean total cost per sponge**	**Cost per hectare Rest + 5 small Hub (2,210 sponges/ha)**
$8.54	$3.84	$12.38	$27,359.80

Next Steps…

- Complete sponge restoration strategy document
- Submit to south Florida resource managers for comment: late 2025 target
- Continue sponge ecological-based research to refine sponge restoration practices
  - Test the species-specific tolerance of sponges to cyanobacteria cells cultured from previous blooms in Florida Bay

Summary

- The sponge communities have been drastically affected during the past several decades
- A risk-adverse sponge restoration strategy is fundamental to preserve the Bay's ecological function
- The project PIs recommend this sponge restoration strategy, when completed, be incorporated into the greater Everglades Restoration Effort

Acknowledgments

DEP's Florida Coastal Management Program

Florida Keys National Marine Sanctuary

Permit # FKNMS-2024-144