

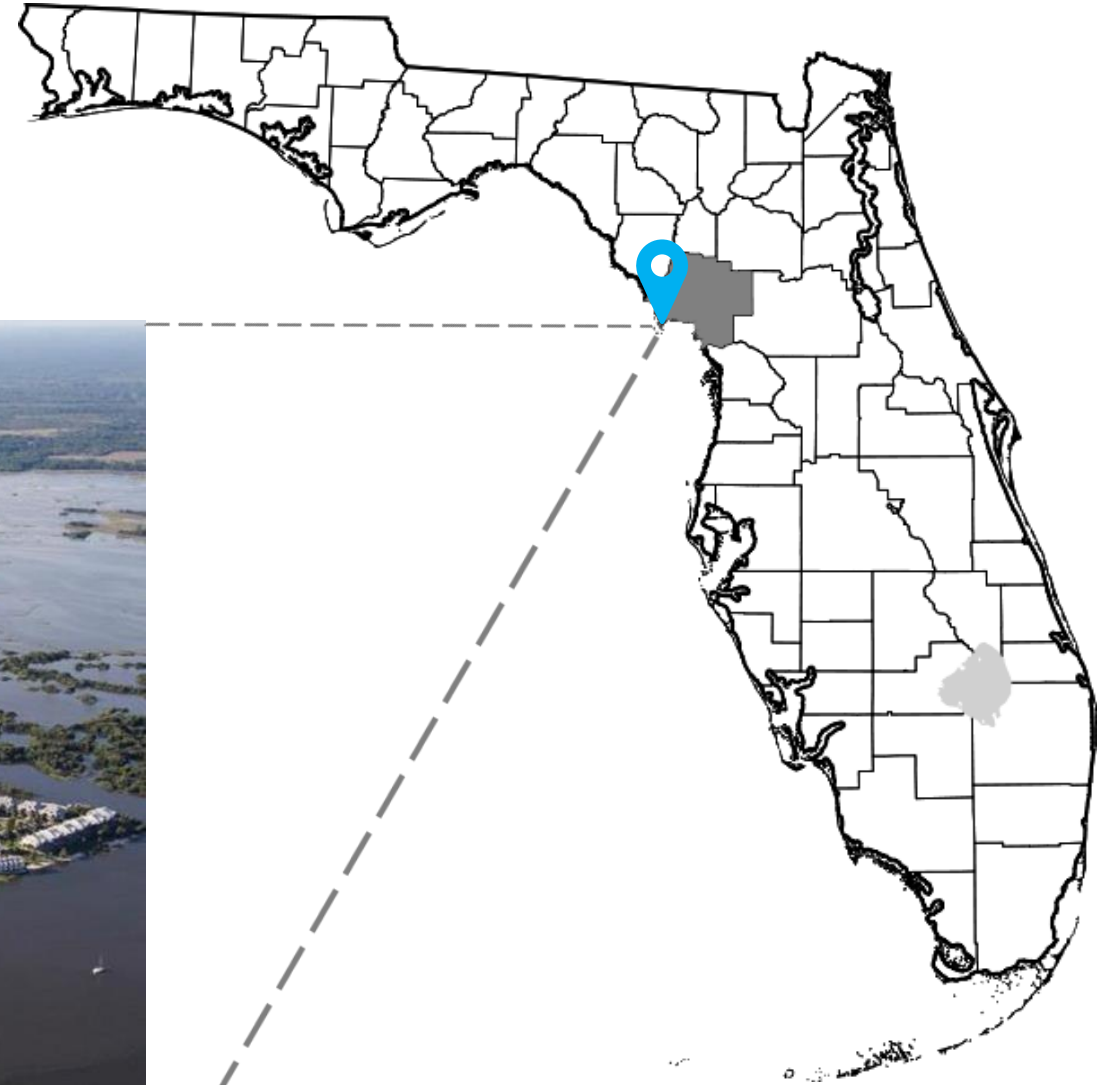
An aerial photograph of a coastal area. In the foreground, a wooden dock with a covered boat is situated in the water. A long line of white buoys extends from the dock towards the right. A road runs along the coast, bordered by a stone wall. Behind the road, there are several buildings, including a large white building with a balcony and a smaller one. The background shows a large body of water with many small islands and a dense line of trees.

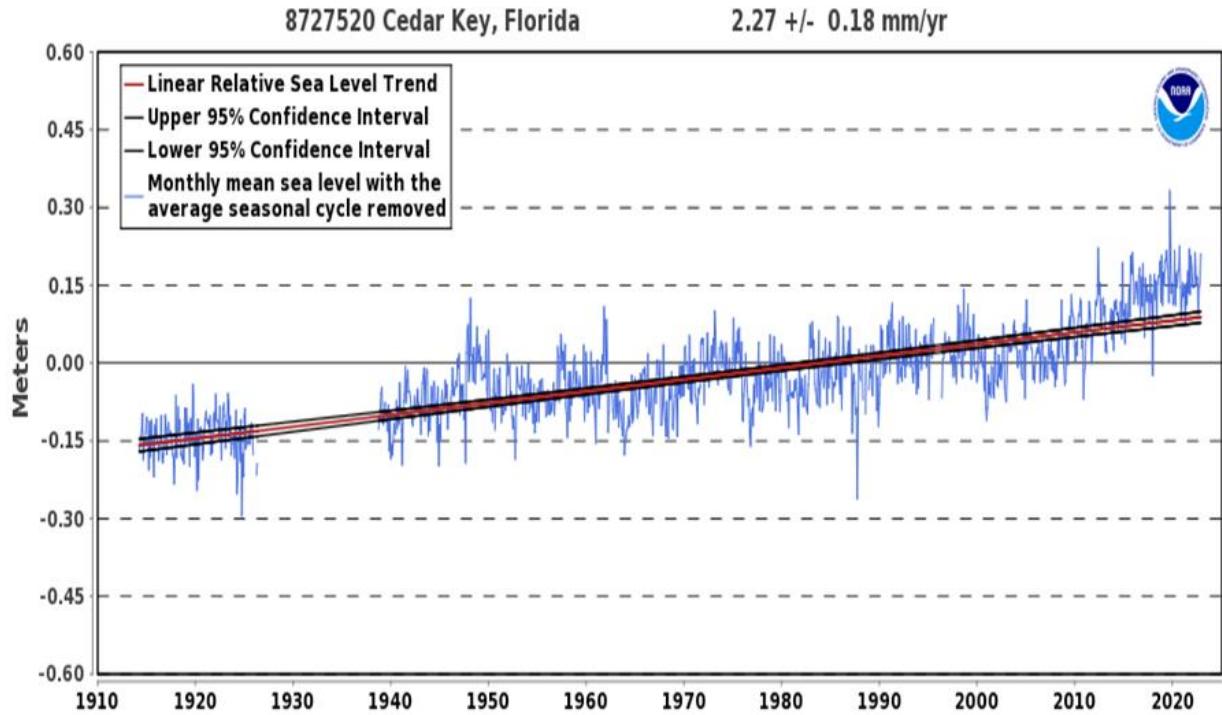
Nature-based Solutions to Coastal Hazards in Florida's Gulf of Mexico

Haley Cox

Florida Sea Grant, UF/IFAS Nature Coast
Biological Station

Cedar Key, Florida





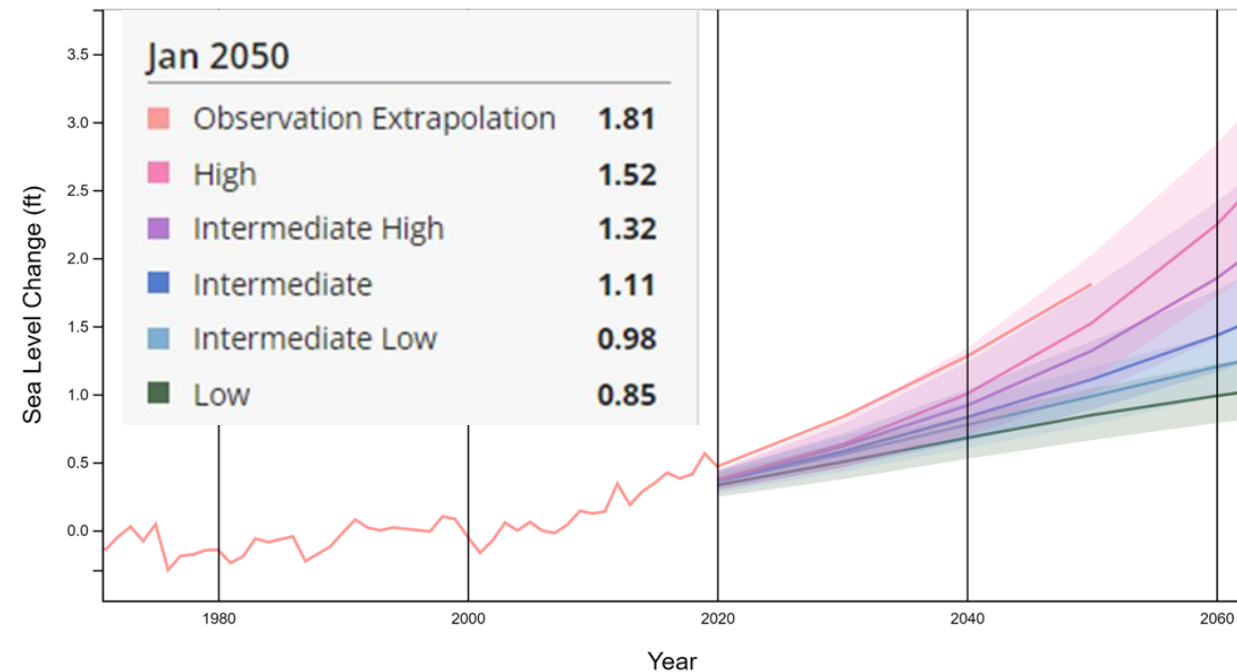
Sea Level Rise

30 cm (11.8 inches)

Cedar Key is experiencing the fourth-highest rate of sea level rise acceleration in the U.S. (NOAA).

- Observed trends outpace extreme scenarios from models.

Interagency Sea Level Rise Scenario Tool localslr.org



Storms and Flooding

- Frequency and intensity of extreme events
- Stormwater and tidal flooding



Stormwater flooding during high tide



Coverage of
Hurricane Idalia,
Aug. 2023

@jimcantore via
X® and The
Weather Channel

1961



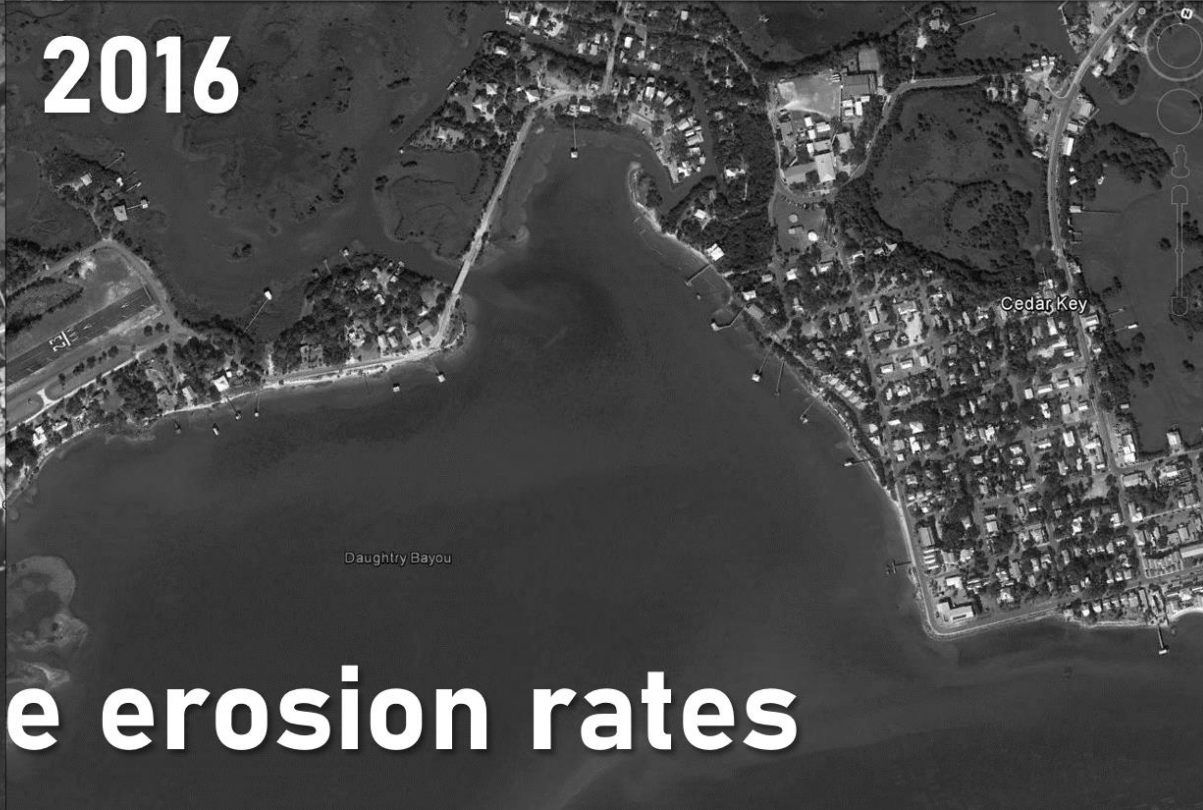
1974



1994



2016



Rapid shoreline erosion rates

UF-Cedar Key Community Collaboration 2016-2022



Living Shoreline Benefits

LSLs are nature-based alternatives to armored shorelines (hardened infrastructure) that can:

- Reduce erosion
- Attenuate wave energy
- Protect and improve water quality
- Enhance fisheries habitat and biodiversity



Funding Sources

Living shoreline projects in Daughtry Bayou were funded through:

- FDEP Resilience Planning Grant
- EPA Gulf of Mexico Program Grant
- FWC State Wildlife Grant

Joe Rains Beach

Low and high marsh with sill in front of bulkhead

LIVING
SHORELINE



Effects of Hurricane Idalia (2023)



BEFORE (2019)



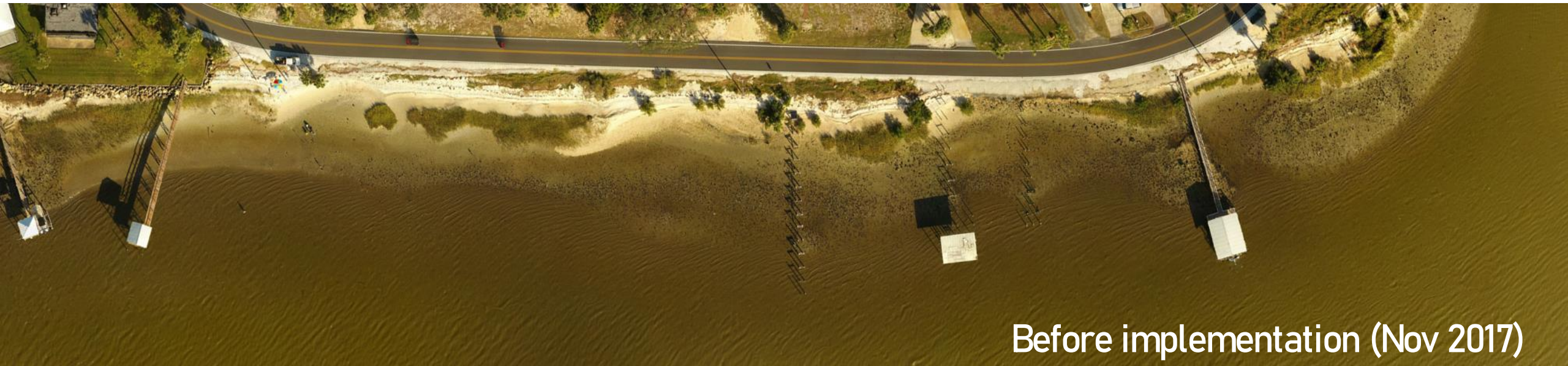
AFTER (1 day post-surge)



An aerial photograph showing a coastal area with a road, buildings, and water. The road, Airport Road, runs along the water's edge. To the left of the road is a low-lying dune area with sparse vegetation. Further out in the water are several detached reef breakwaters, which are long, narrow structures made of concrete blocks. The water is a deep blue, and the sky is a pale, hazy blue. The overall scene depicts a coastal infrastructure project in a marshy area.

Airport Road

Low and high marsh, low-profile dune, and detached reef breakwaters in front of road infrastructure



Before implementation (Nov 2017)



June 2023



BEFORE (6/30/2023)

Airport Road before and after Hurricane Idalia

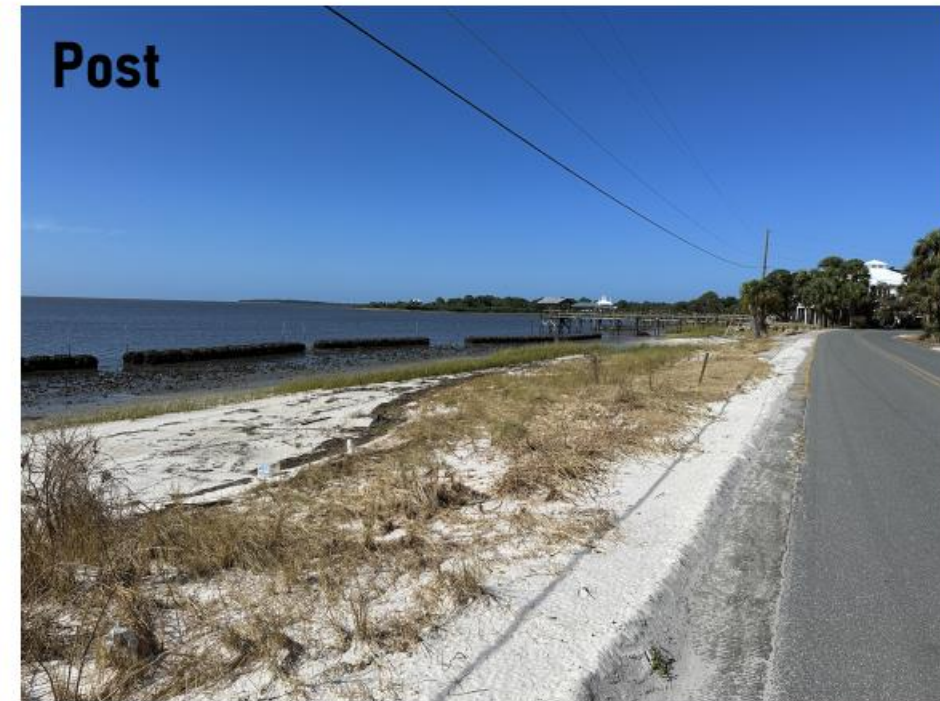


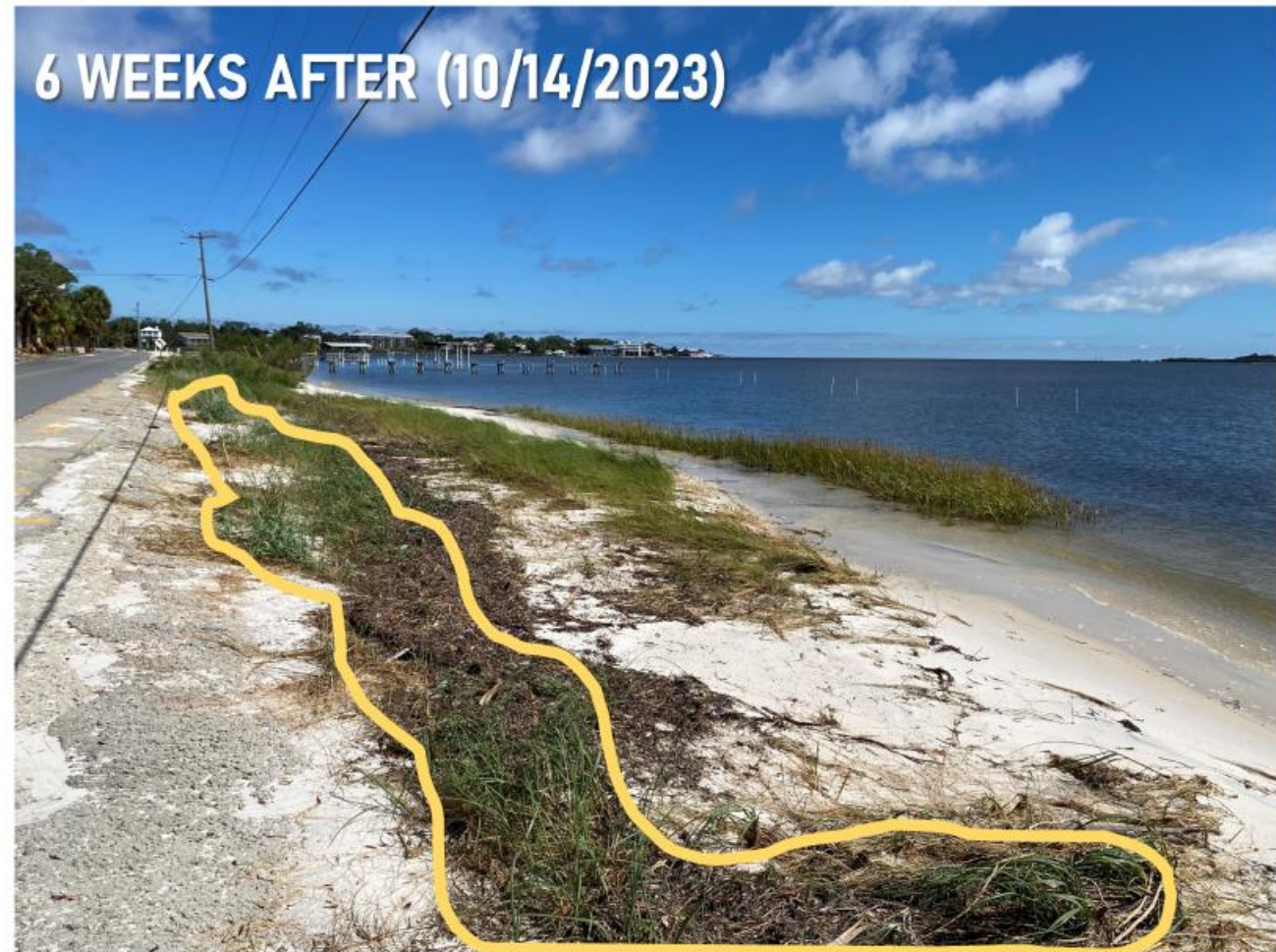
AFTER (9/4/2023)



Little to no loss of sand, but signs of redistribution along shoreline are visible.

Signs of salt stress in dune/high marsh vegetation from inundation.





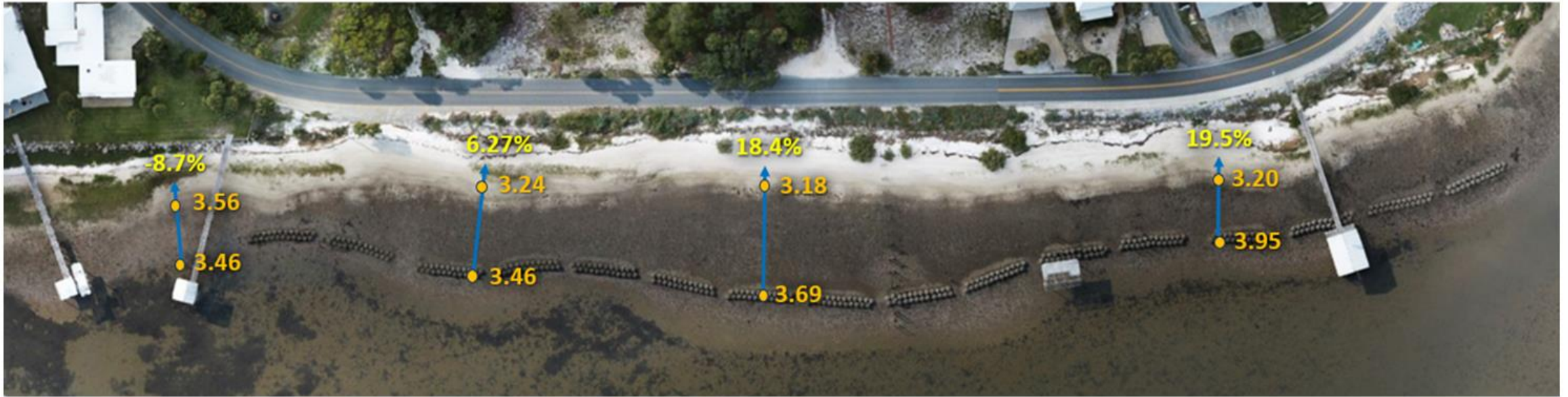
Dune and high marsh vegetation on Airport Road recovering from salt stress after Idalia, particularly *Panicum amarum* (bitter panicgrass).

5 DAYS AFTER (9/4/2023)

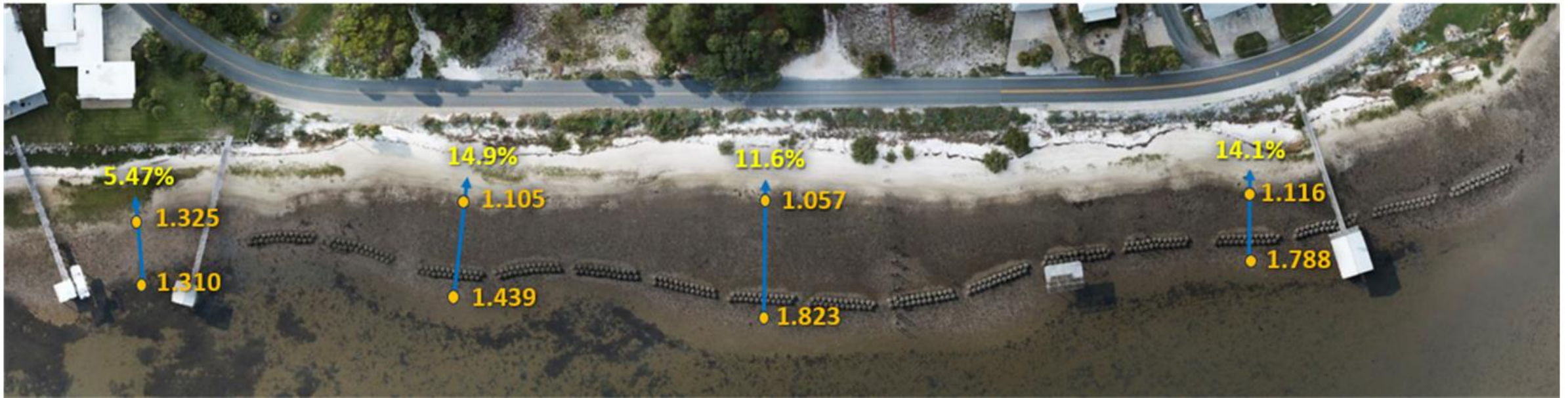


Wave gauge

Maximum incident wave height and attenuation along Airport Road, ft



Maximum incident wave power and attenuation along Airport Road, kW/m



An aerial photograph showing a residential area with several houses and palm trees. A road, G Street, runs horizontally across the middle of the image. To the right of the road is a large body of water, likely a marsh or bay. A boat is visible in the water, and a long, narrow structure, possibly a sill or oyster point bar, extends from the shore into the water. The text "G Street" is overlaid in large white letters in the center of the image.

G Street

Low and high marsh with sill and oyster point bars in front of road infrastructure



G Street (2016) ↑

↓ G Street (2023)



Living shoreline intervention

**Shoreline recession
outside project area**

Aug 2023 (During Idalia)



Oct 2023 (6 weeks post-Idalia)



Aug 2023 (Pre-Idalia)



Sept 2023 (Post-Idalia)



Oct 2023 (6 weeks after Idalia)



**Living shoreline protected
“toe” of hardened
infrastructure**

G Street after Idalia



No erosion

**Erosion outside
project area**

Maximum incident wave height and attenuation along G Street, ft



Maximum incident wave power and attenuation along G Street, kW/m

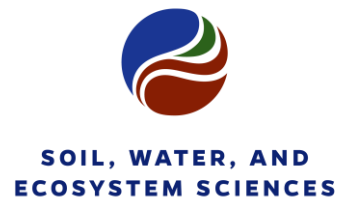


Successes

- Built community partnerships through co-design process
- Shorelines remained intact and protected road infrastructure
- Minimal losses of vegetation and sediment
- Preliminary data suggests that wave attenuation occurs during surge events



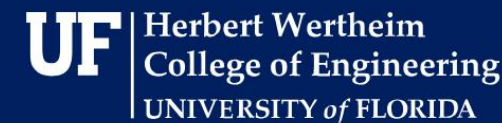
Acknowledgements: Dr. Savanna Barry, Dr. Mark Clark, Dr. Elix Hernandez



Continued Collaboration

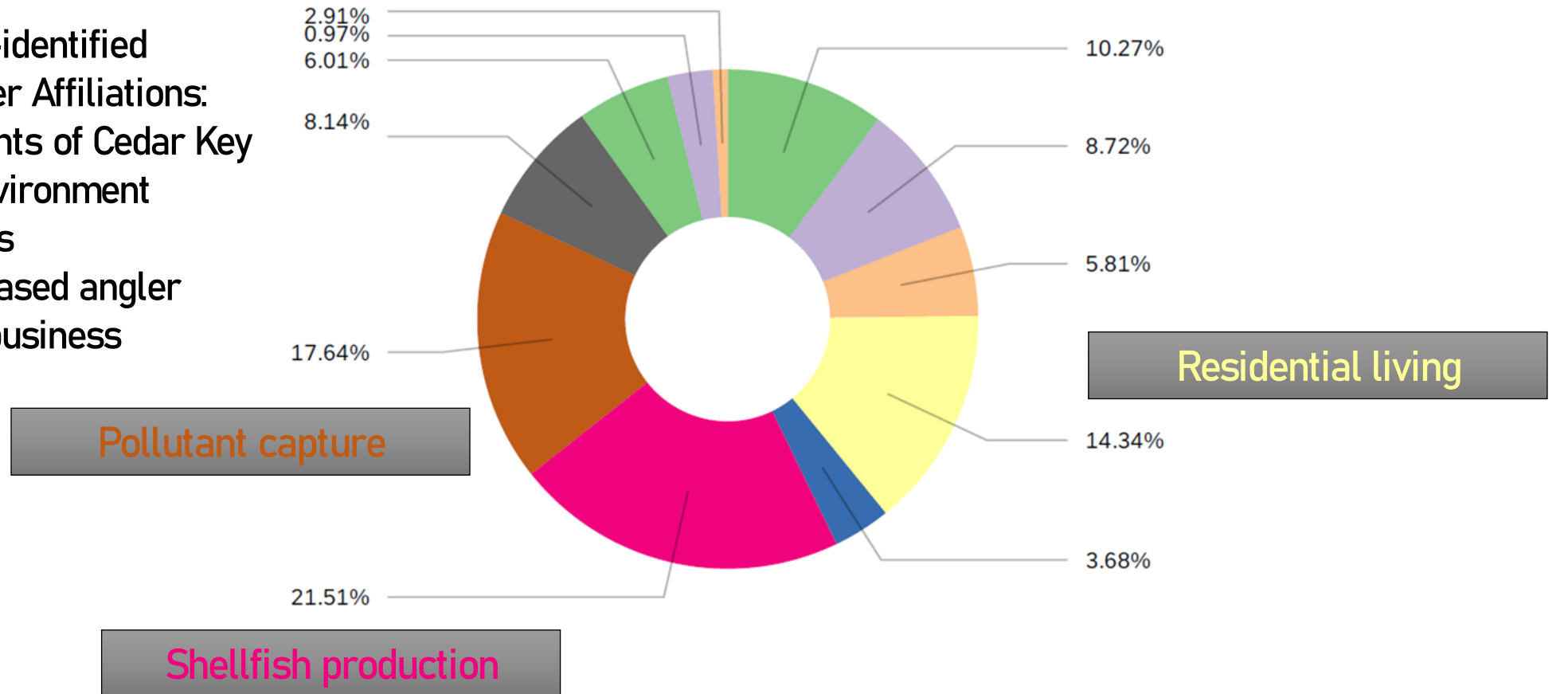
Cedar Key ShOREs: Shoreline Options for Resilience and Equity

- Funded by National Academy of Sciences (NAS) Gulf Research Program (GRP)
- Planning grant awarded in 2022
- Interdisciplinary project team: Micheal Allen, Eban Bean, Carla Brisotto, Jessica Brusso, Sue Colson, Mark Clark, Jiayang Li, Thomas Ruppert, Jason von Meding, & Xiao Yu



Critical shoreline functions to safeguard:

- Top 5 Self-identified Stakeholder Affiliations:
1. Residents of Cedar Key
 2. The environment
 3. Tourists
 4. Boat-based angler
 5. Local business



- Angling
- Boating access
- Beach tourism
- Residential living
- Swimming
- Shellfish production
- Pollutant capture/buffering
- Carbon sequestration (capture and removal of carbon dioxide from the atmosphere)
- Emergency service access
- Other recreational activities
- Other

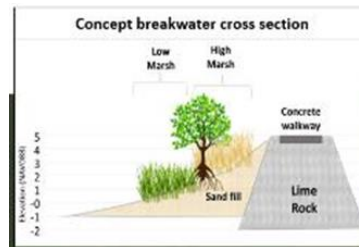
Community Workshops

Shoreline

- Focused on reducing erosion and restoring historic shoreline morphology

Stormwater

- Introduced GSI concepts and options for Cedar Key



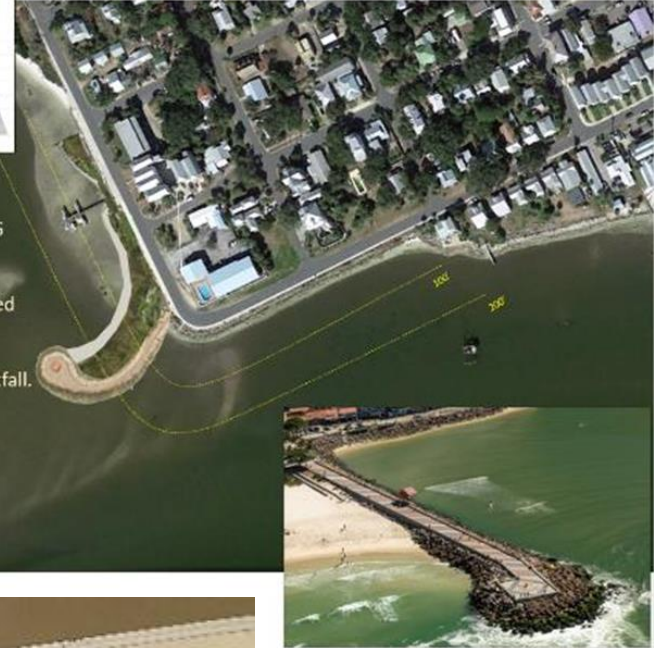
Benefits:

- Restores aspects of historic sand spit
- Wave and current attenuation along G Street
- Holistic "nature-based" approach
- Public access enhanced & concentrated away from road right-of-way

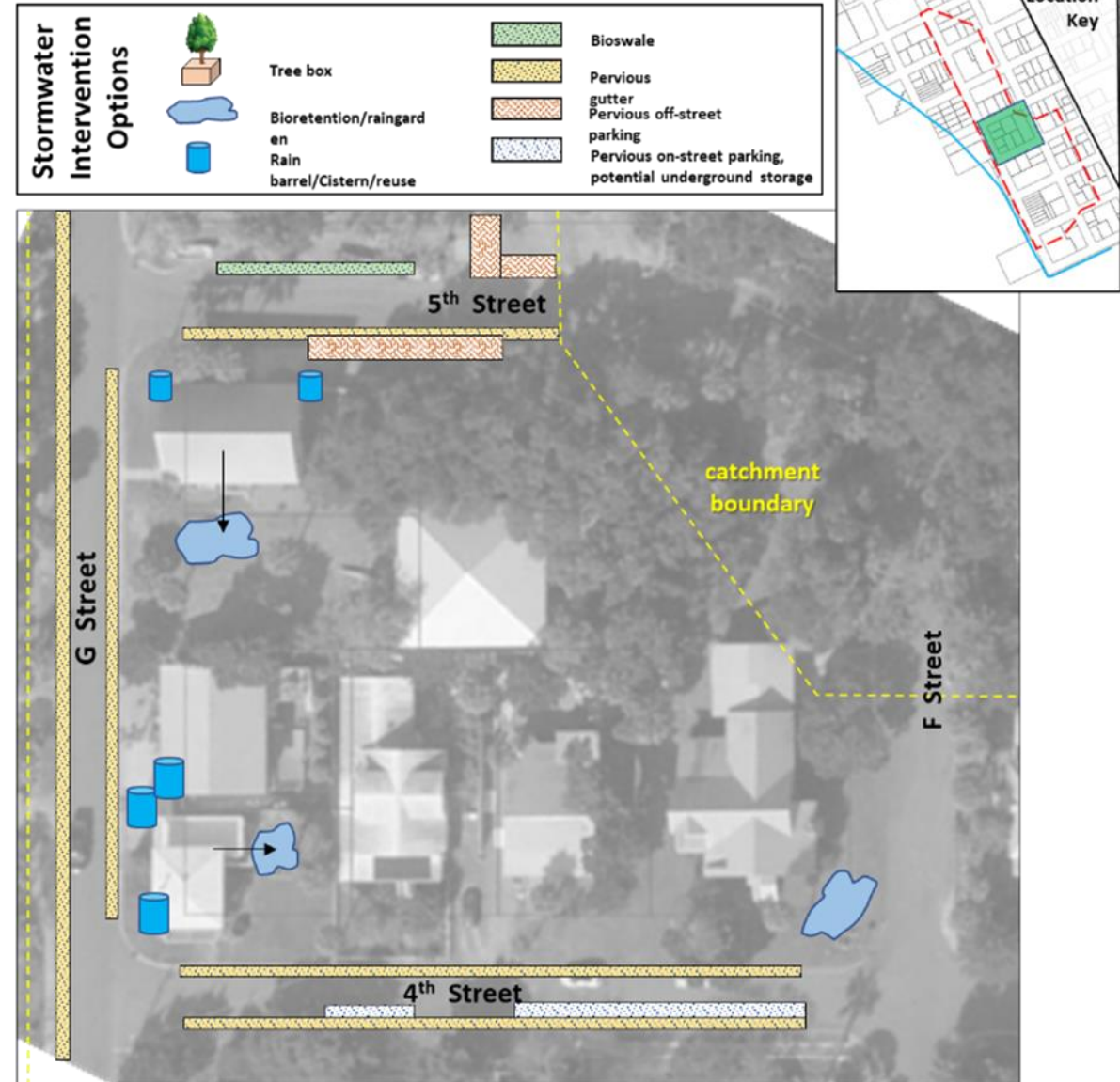
Limitations:

- Conflicts with existing stormwater outfall.
- May increase sedimentation around dock.
- Requires maintenance of public infrastructure and aspects of living shoreline (mangroves)

Option 2: Single Sea Groin



Conceptual Design



Outcomes

Stormwater retrofits to existing infrastructure:

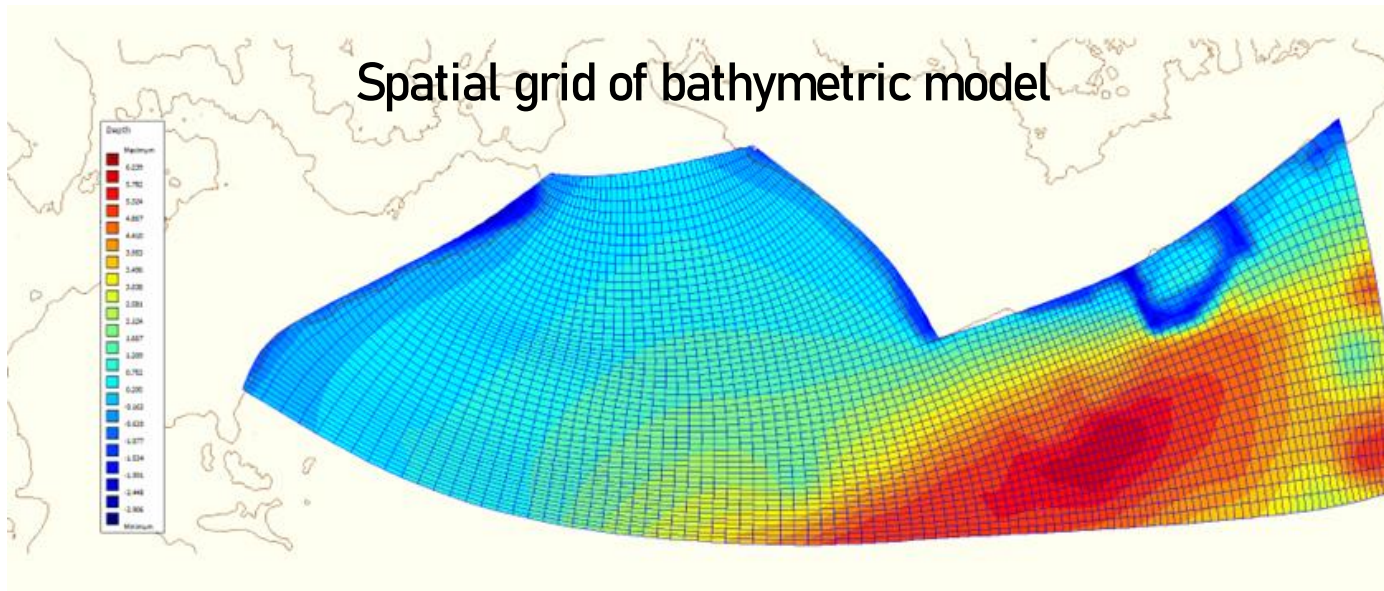
- Inline check valves installed in 2023 (after workshop)
- Operation TRAP – Catch basin filters (LittaTrap™) installed to prevent trash/debris pollution



Next Steps

Now funded for Phase II

- Hydrodynamic and stormwater modeling
- Continual refinement of designs
- Permitting



Nortek Eco™ (ADCP)

Acknowledgements

Interns: Isaac Coleman, Gracie Hejmanowski, Molly Allen, Haleh Mehdipour

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Florida's Nature Coast Conservancy

Cedar Key Aquaculture Association

NASEM Gulf Research Program for funding



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The content is solely the responsibility of the authors and does not necessarily represent the official views of the Gulf Research Program or the National Academies of Sciences, Engineering, and Medicine.