

Use of UAV-flown LiDAR and Georadar to Assess the Geomorphological Impact of Hurricane Ian Along the Southwest Florida Coast

*36th National Conference on Beach Preservation Technology
Michael Savarese¹, Dhruvkumar Bhatt¹, Christopher Daly¹, Felix Jose¹, Rachel Rotz¹, & Ilya Buynevich²*

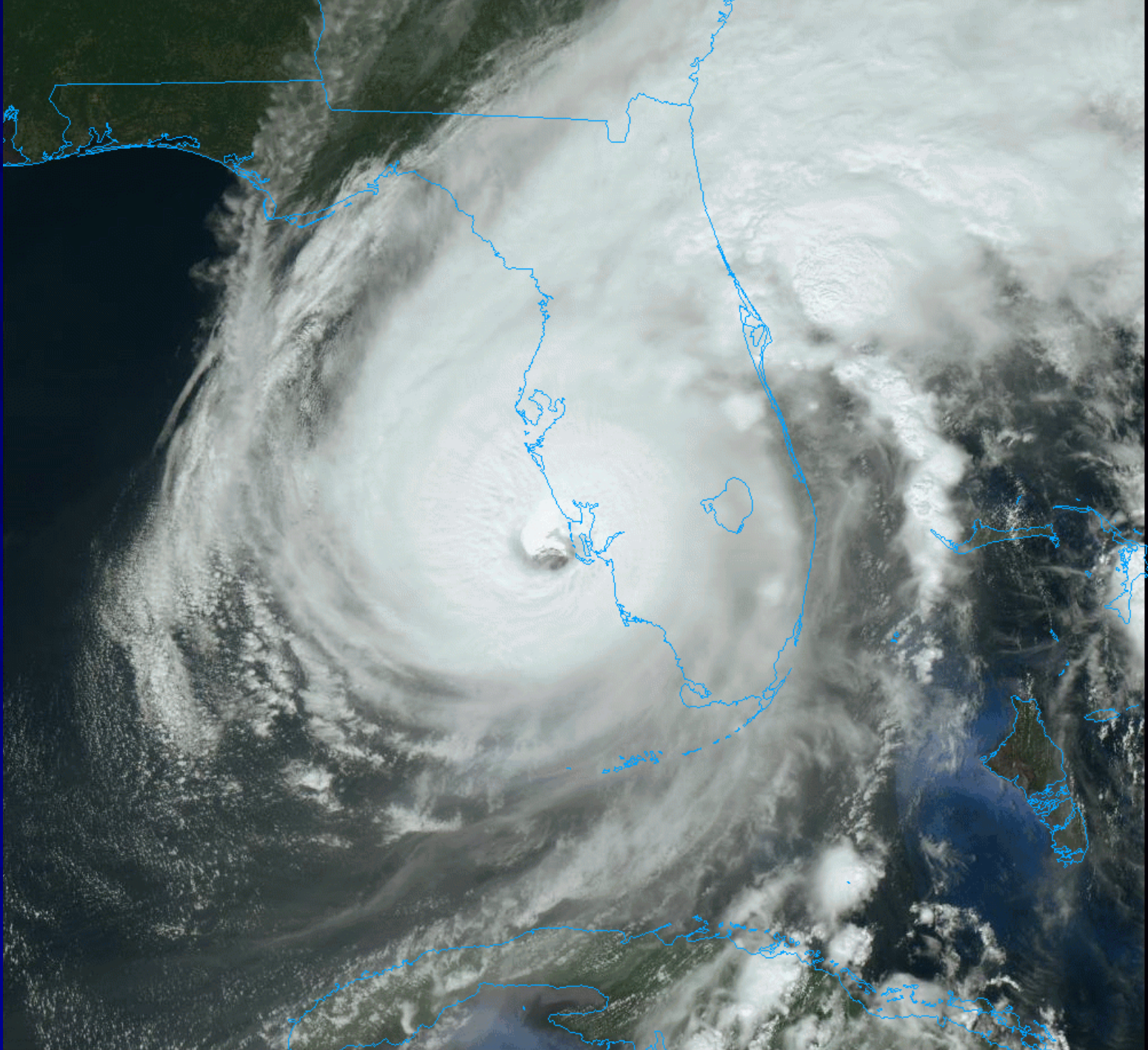
February 1, 2023





Hurricane Ian: A Biography

- 1. Made landfall on Cayo Costa at 3:05 PM on Sept 28, 2022
- 2. Strong Cat 4 with 150 mph sustained wind; 940 mbar
- 3. Forward speed of 8 mph
- 4. Covered most of FL
- 5. Emerged from Cuba as a Cat 2, then fueled to Cat 4
- 6. SWFL always east of the eye; onshore winds

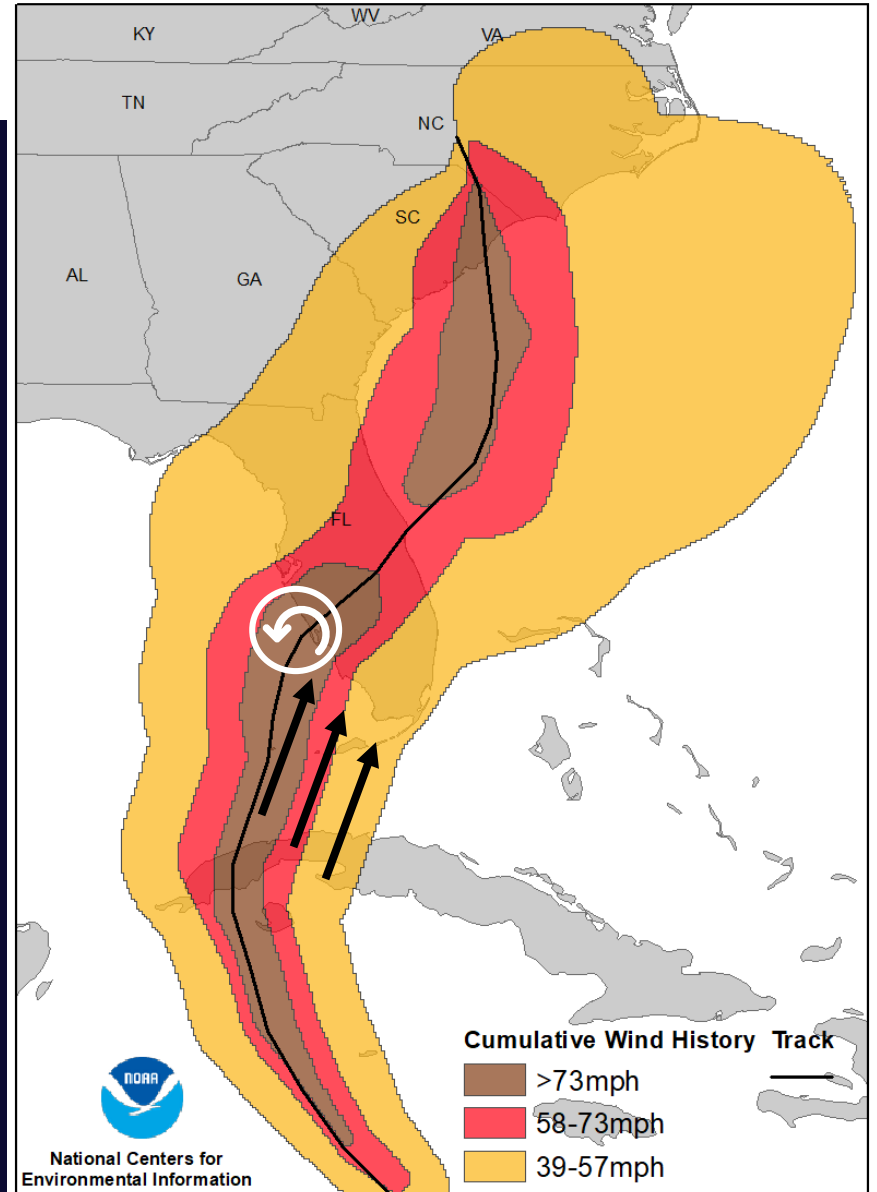


Ian's Wind Field and Storm Surge



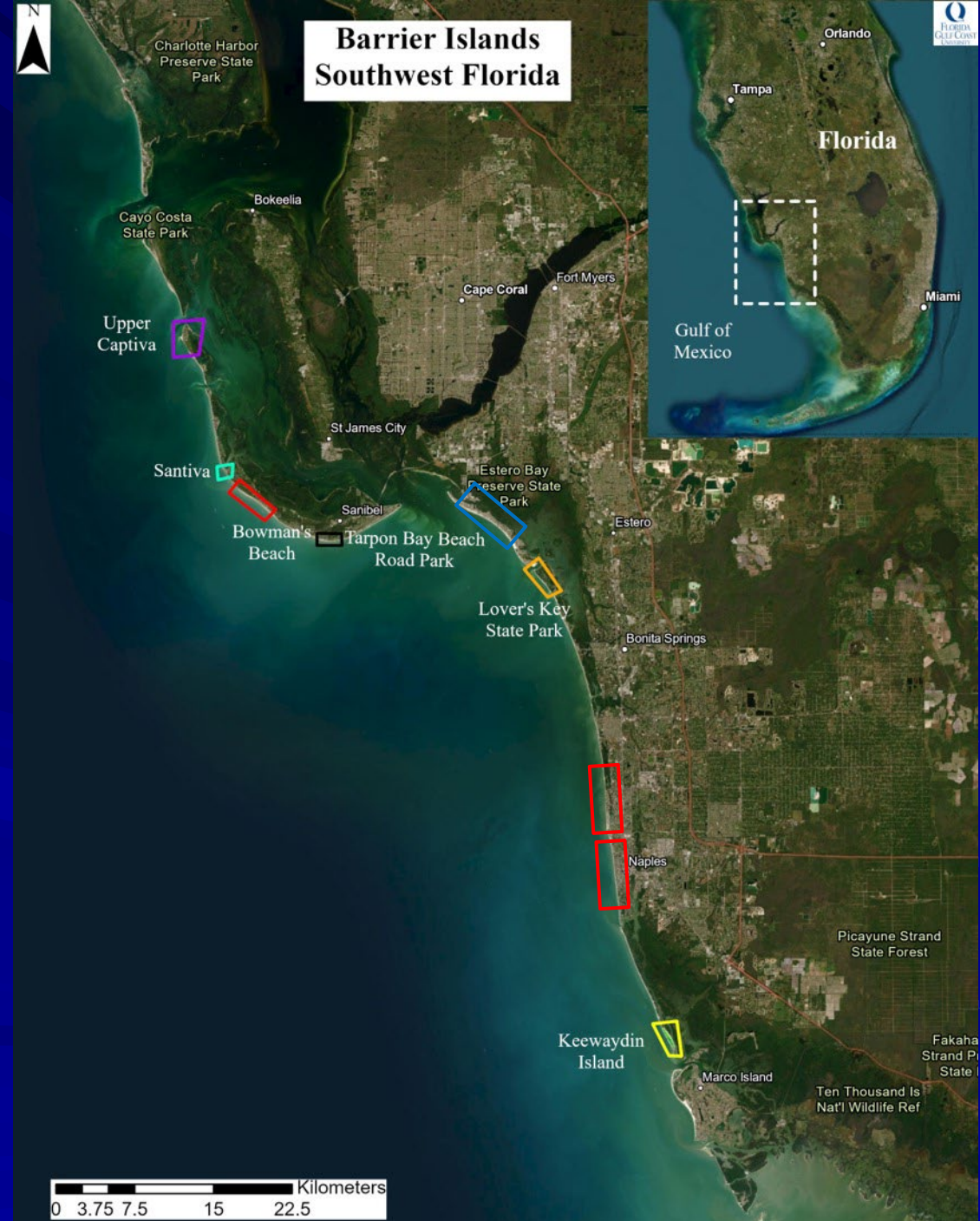
Hurricane Ian's Track

Hurricane Ian Track and Wind History

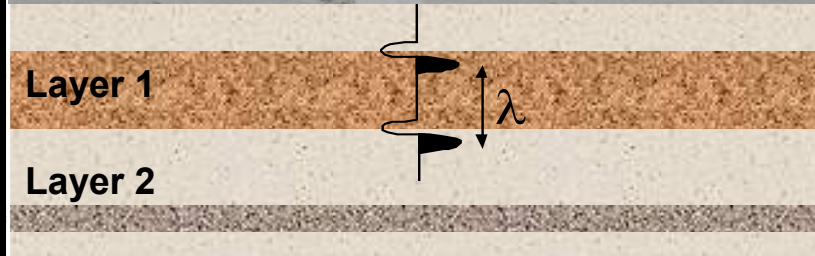


Assessing Ian's Geomorphic Impacts: Methods

1. Ground-penetrating radar (GPR) to reveal history in sediments below the surface.
2. UAV-based LiDAR: produce high-resolution DEMs.
3. Comparing pre- and post-Ian maps. Summer 2022 flights or 2018 LiDAR.
4. Quantify sediment volume gained or lost.
5. Able to assess resilience capacity of coastal segments.
6. Florida Sea Grant rapid response award starting Feb 1, 2023.



Ground-Penetrating Radar (GPR)



electromagnetic waves

Drone & LiDAR Sensor

Drone / Sensor Specifications:

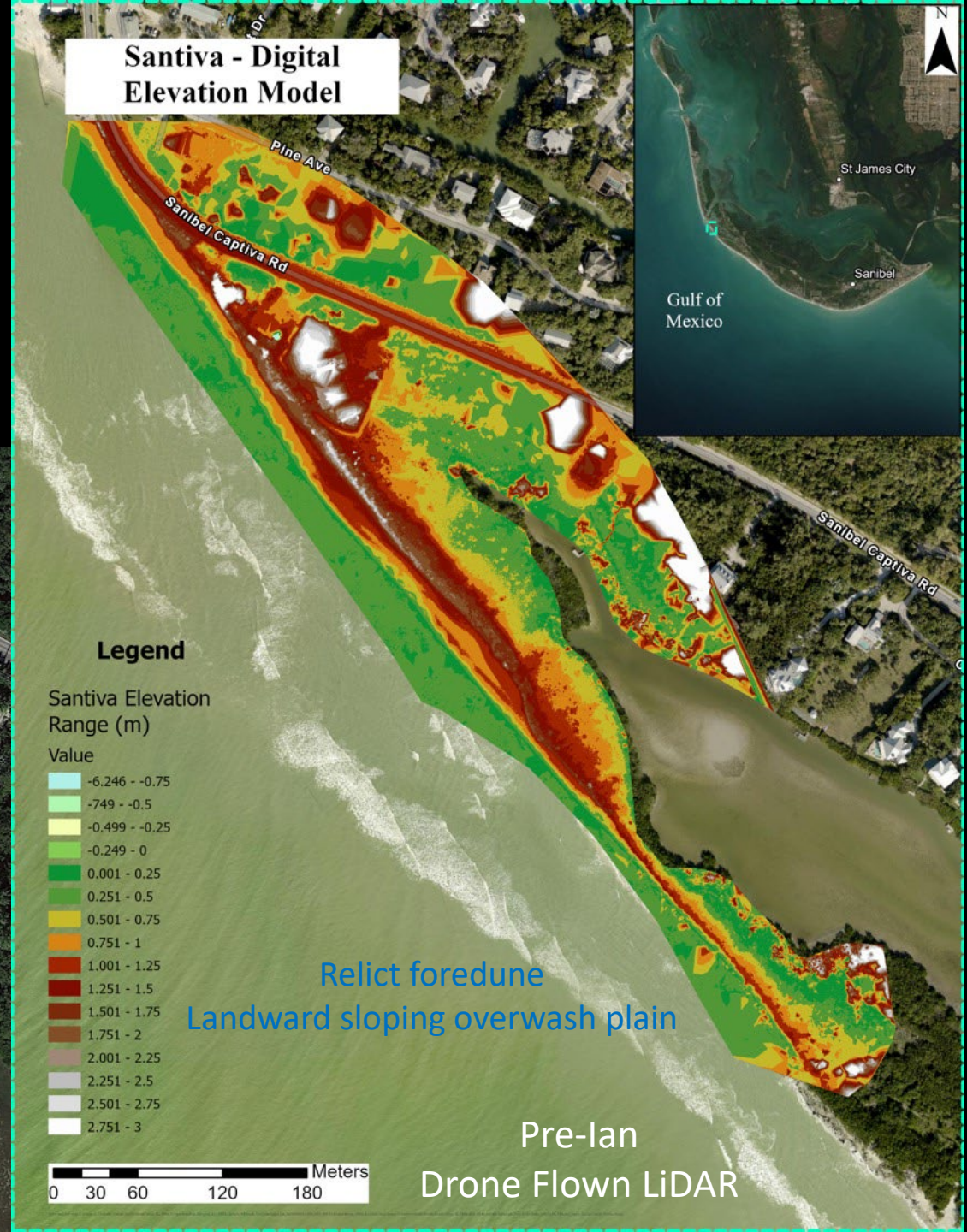
- DJI M 600 Pro
- Velodyne HDL-32E Sensor
- Flight Height ~165 ft (50 meters)
- Flight Speed ~14 mph
- 80% Side Overlap, 60% Front Overlap



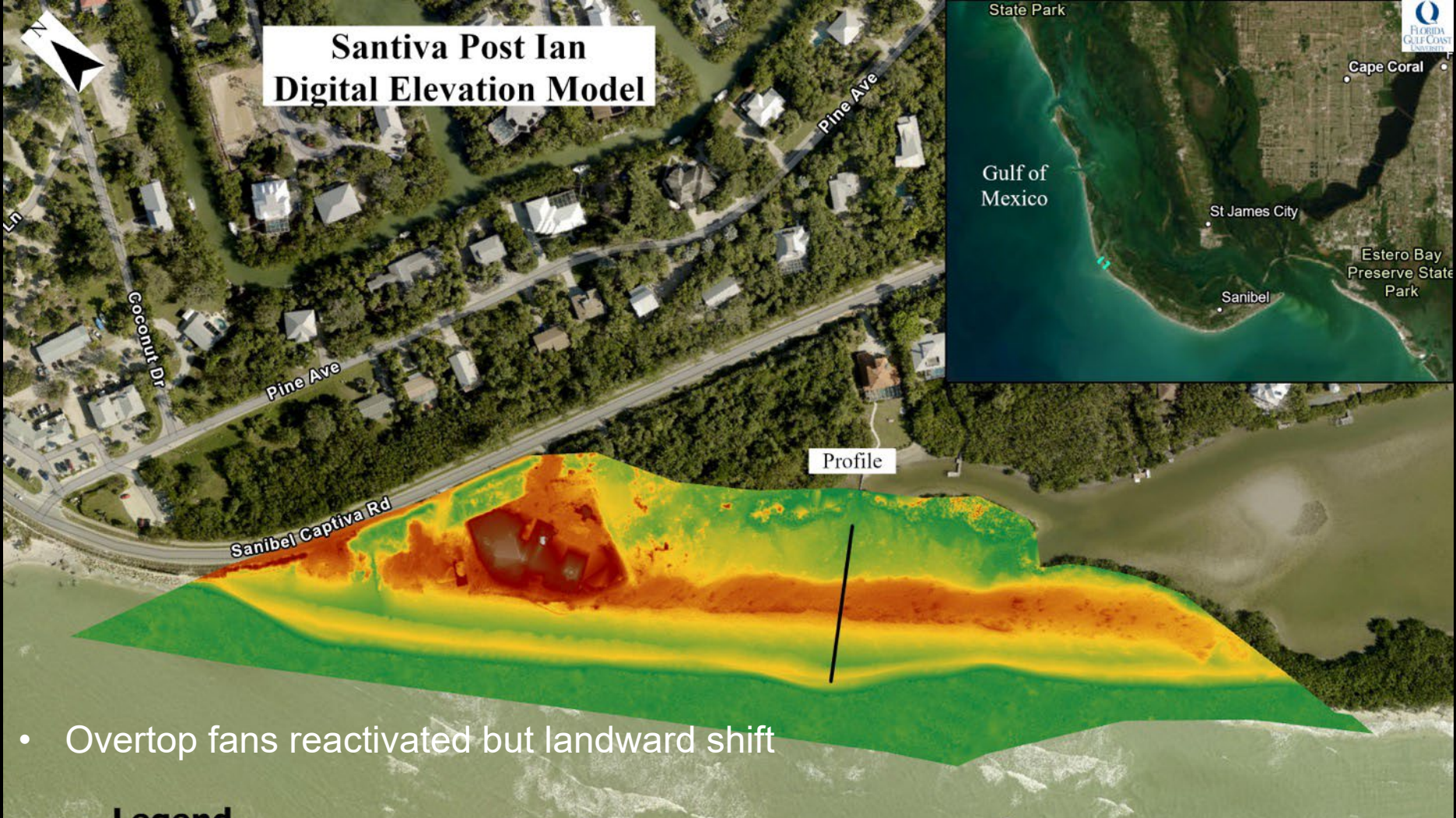
Finding I: Ebb Surge Channel Formation

- Coming in: high surge with wave set-up above:
 - Sheet overtopping and overwash with wholesale sediment movement & deposition behind the foredune.
 - Foredunes destroyed or deflated.
- Going out: surge height lower:
 - Drainage cuts channels; incises incoming surge deposits.
 - Channels form preferentially along de-vegetated paths and between foundation footprints.
- Lessons learned from previous storms:
 - Ike (2008), Hugo (1989), Ivan (2004), Harvey (2017).

Santiva, NW Region of Sanibel Island

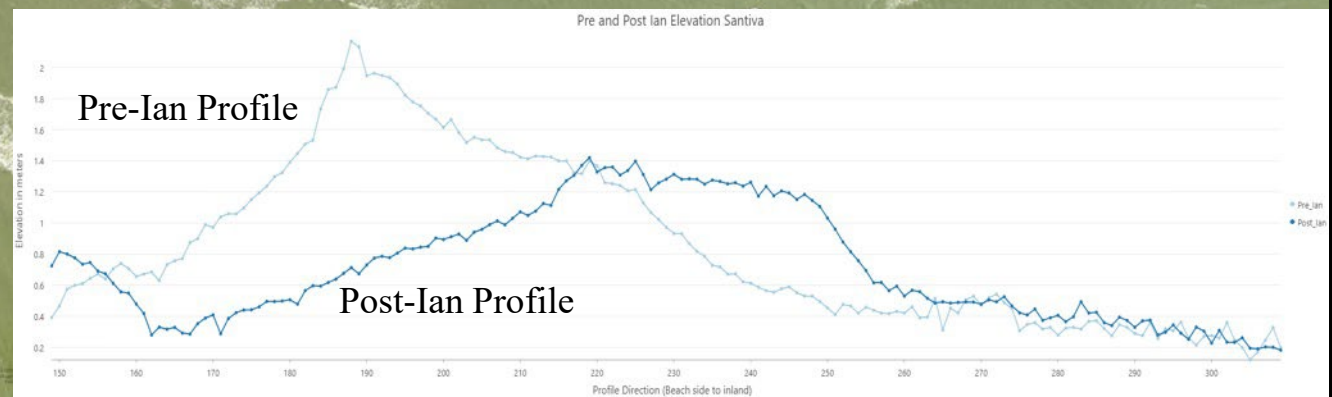
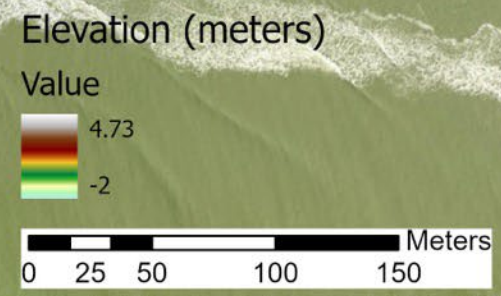


Santiva Post Ian Digital Elevation Model

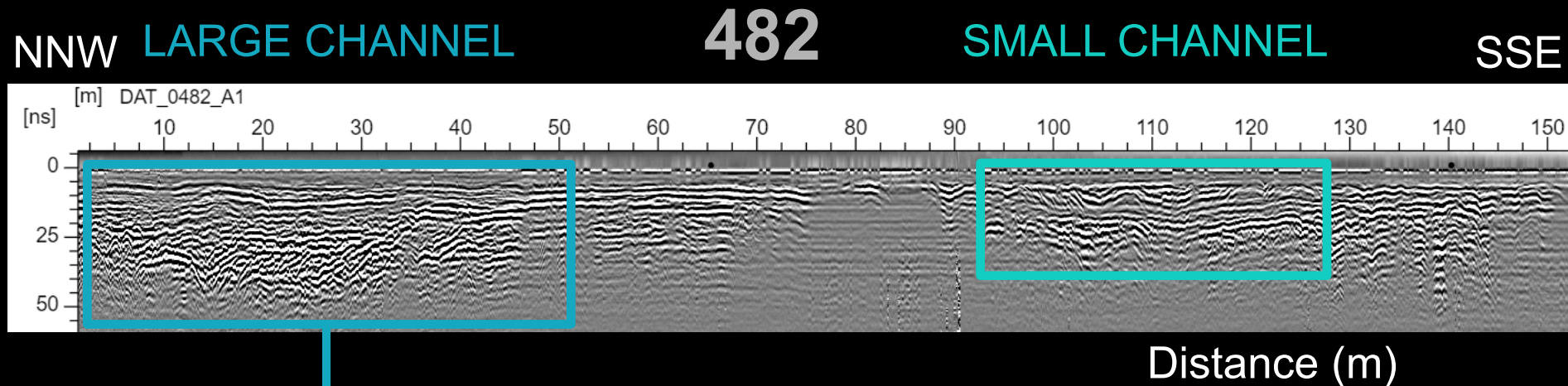


- Overtop fans reactivated but landward shift

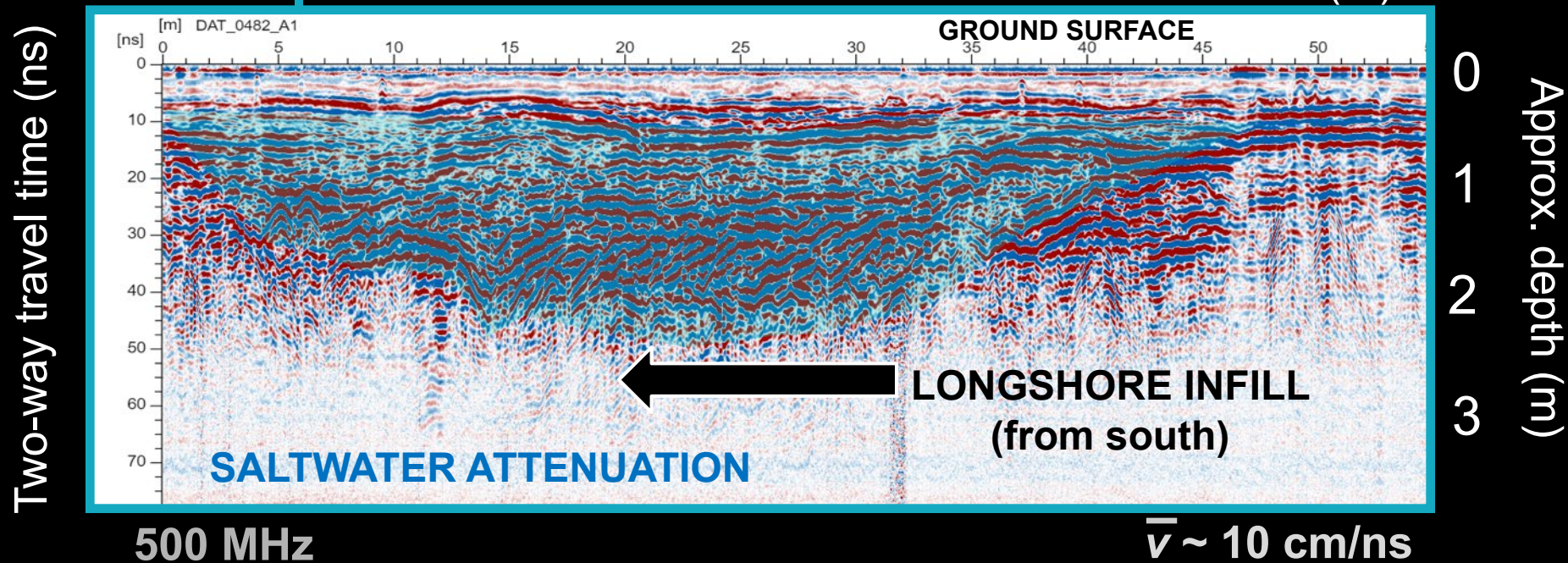
Legend



GPR Blind Pass (“Santiva”), FL



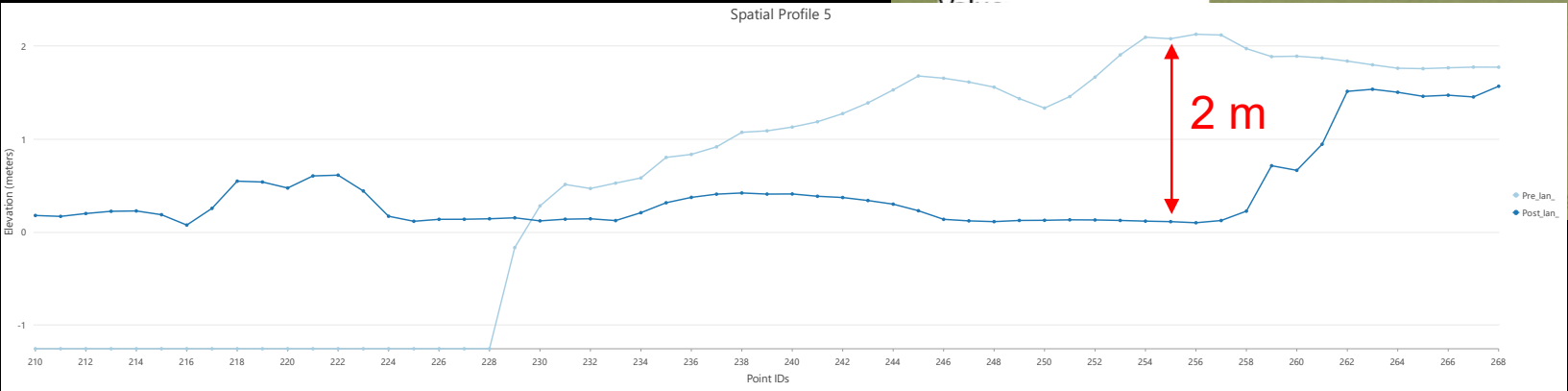
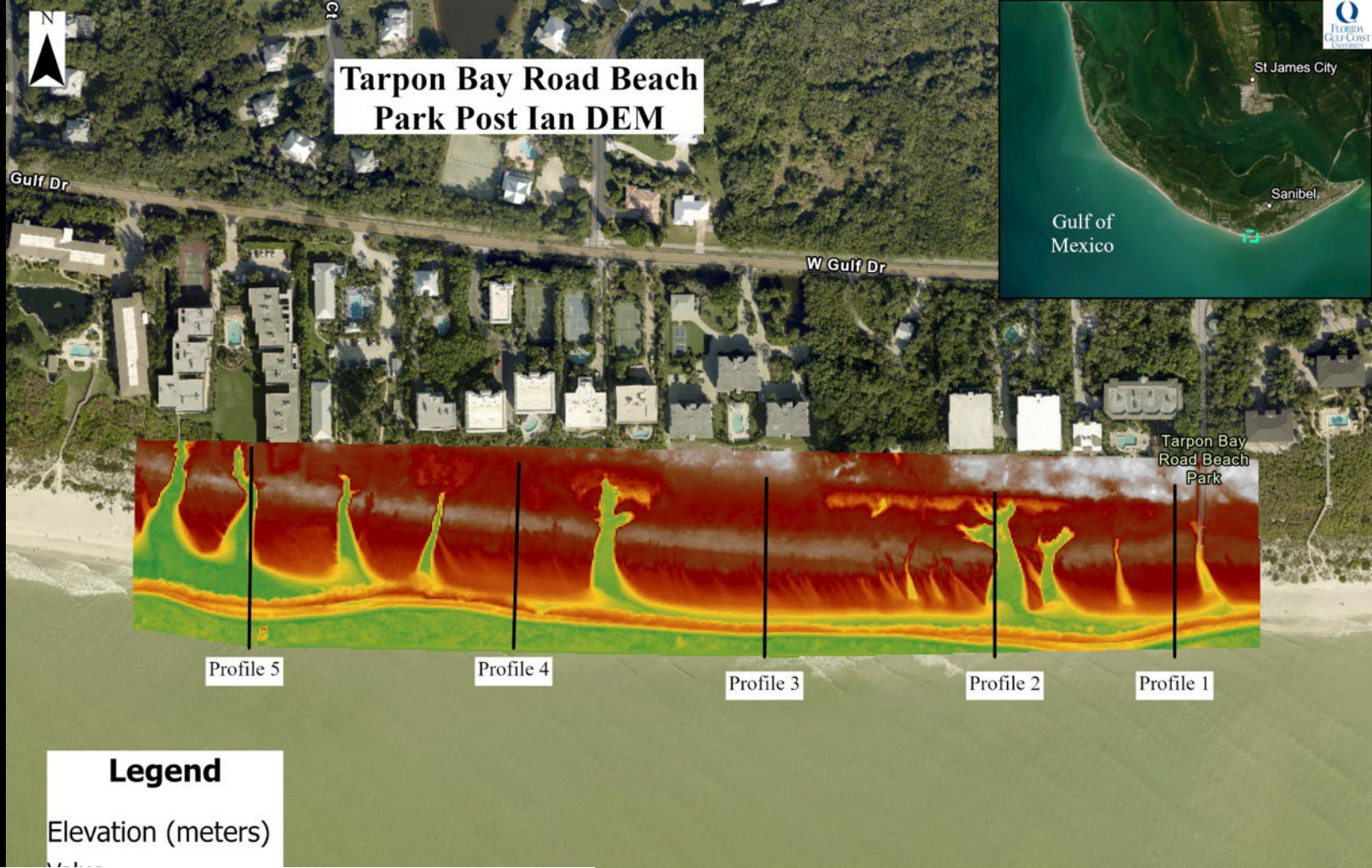
- 2 buried channels, each > 20 m wide.
- Neither channel obvious from surficial geomorphology.
- Overtop deposition since at least 1995.
- One with laterally prograded fill due to longshore transport.



Tarpon Bay Rd Beach

Pre flown 2018
Post flown Oct 25, 2022

- Ebb surge tidal channels (profile 5)
- Overtop fan deposition (profile 3)

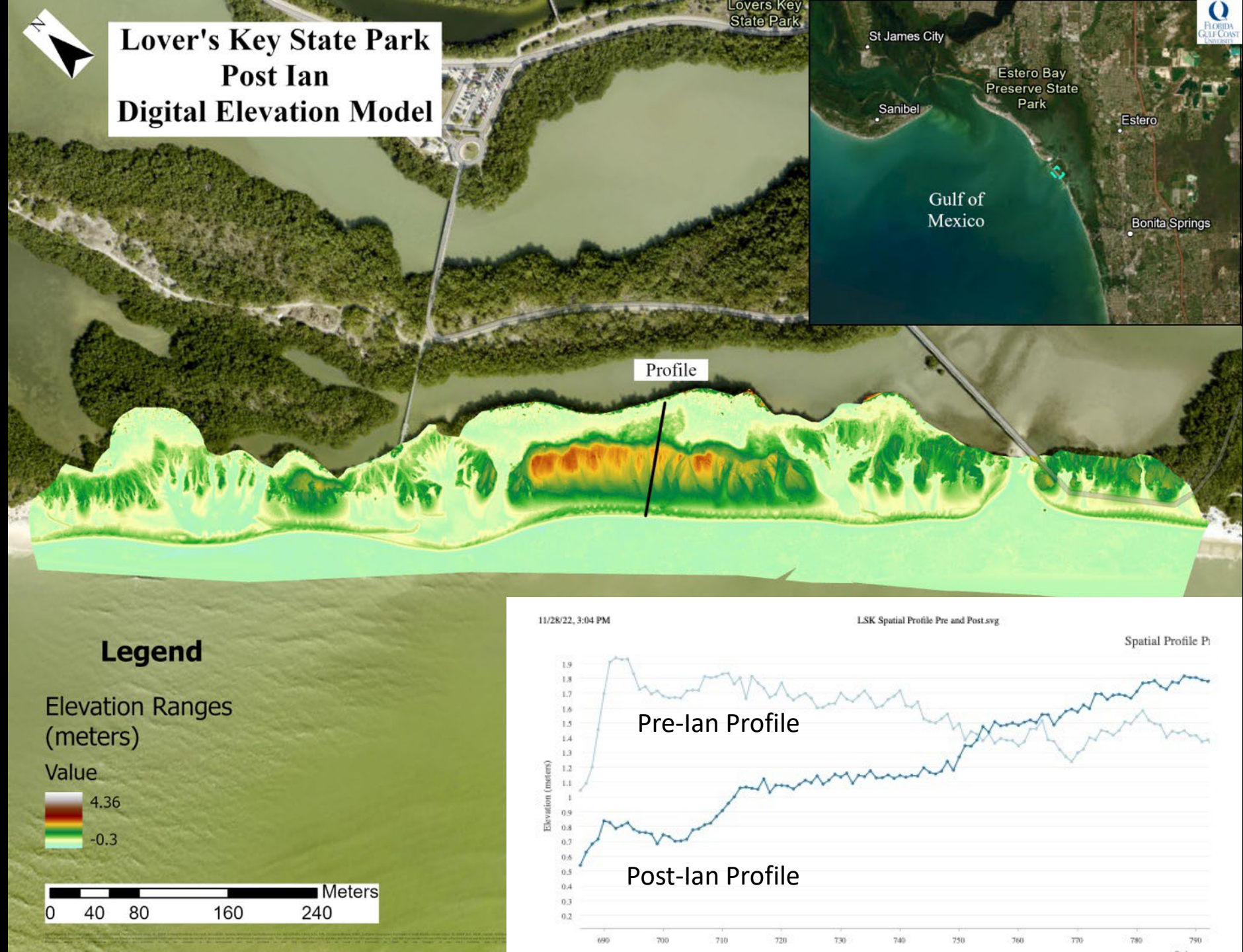


Story Map: Sanibel Tarpon

Lover's Key

Pre flown May, 2022
Post flown Oct 19, 2022

- Ebb surge erosional event
- At profile, overtop fans reactivated but landward shift





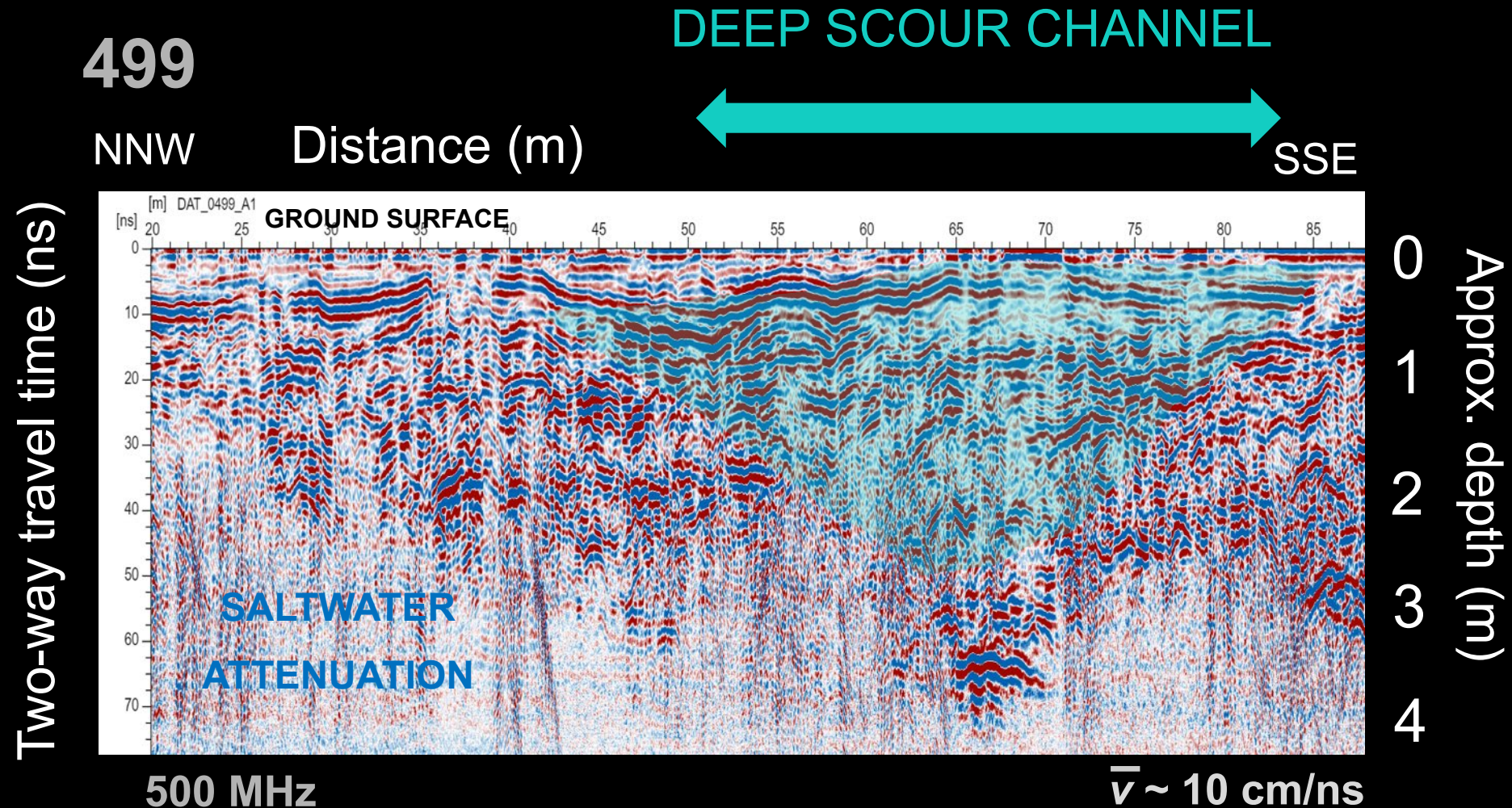
Lover's Key

Ebb Surge Channels

Sanibel at Tarpon Bay Rd Beach



GPR → Lovers Key State Park, FL



History of surge channel erosion on Lover's Key, Santiva, Ft Myers Beach

Finding II: Erosion In Front of Sea Walls

- Sea walls held ground in some and failed in other locations.
- In Naples, older, buried sea walls were exhumed.
- Extensive erosion occurred in front of sea walls.

Central Fort Myers Beach

Pre flown 2018
Post flown 1st week Dec, 2022

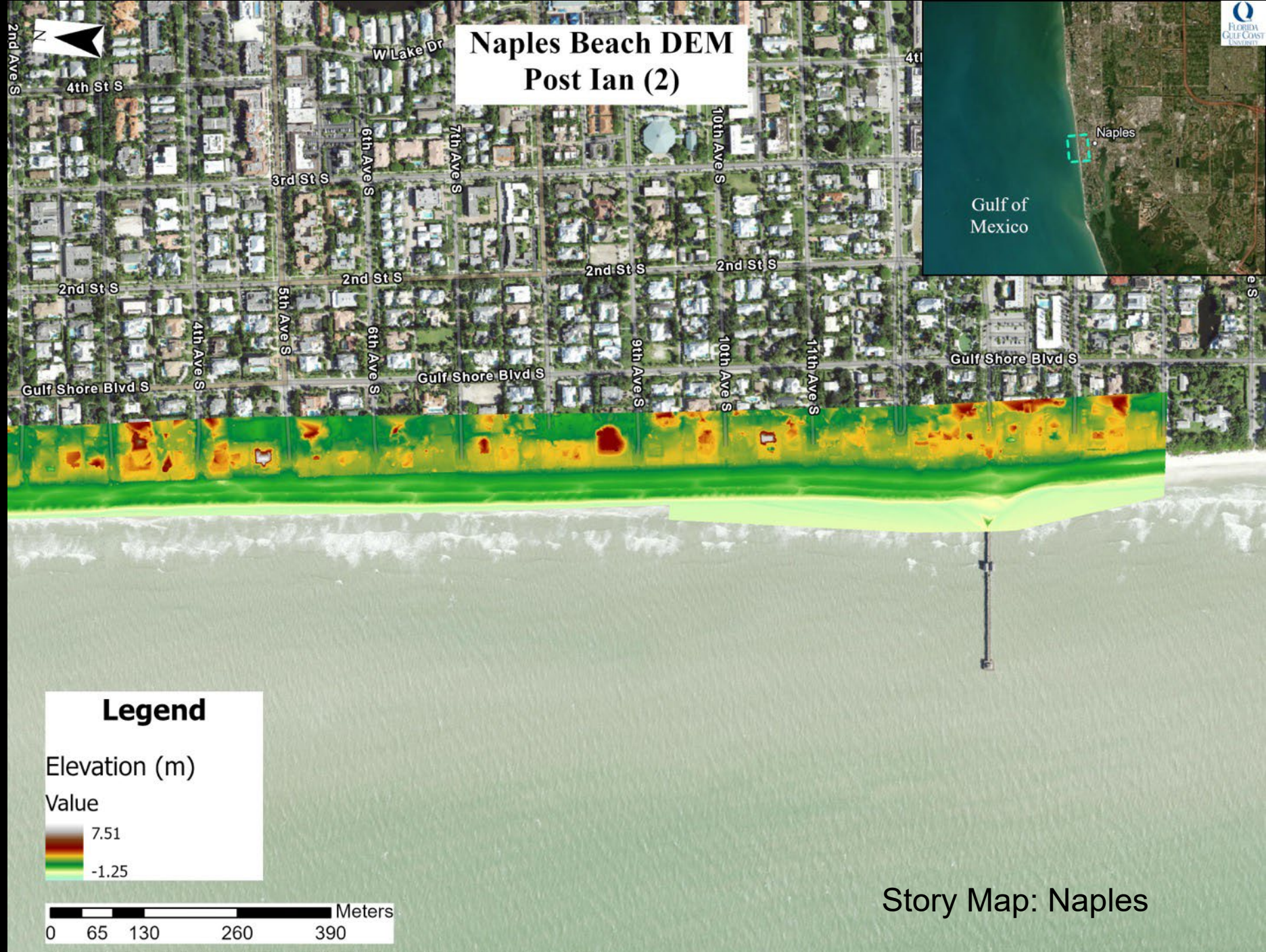
- Prolific ebb surge tidal channel formation
- Overtop sand deposition
- Significant sediment erosion in front of sea wall



Naples Beach South

Pre flown 2018
Post flown Nov 30, 2022

- Minor ebb surge tidal channel formation
- Overtop sand deposition
- Set back of sea wall; old sea wall revealed
- Significant sediment erosion in front of old sea wall





Ft Myers Beach

Sea Wall Effects



Naples Beach Near Pier

Finding III: Strainplains More Resilient

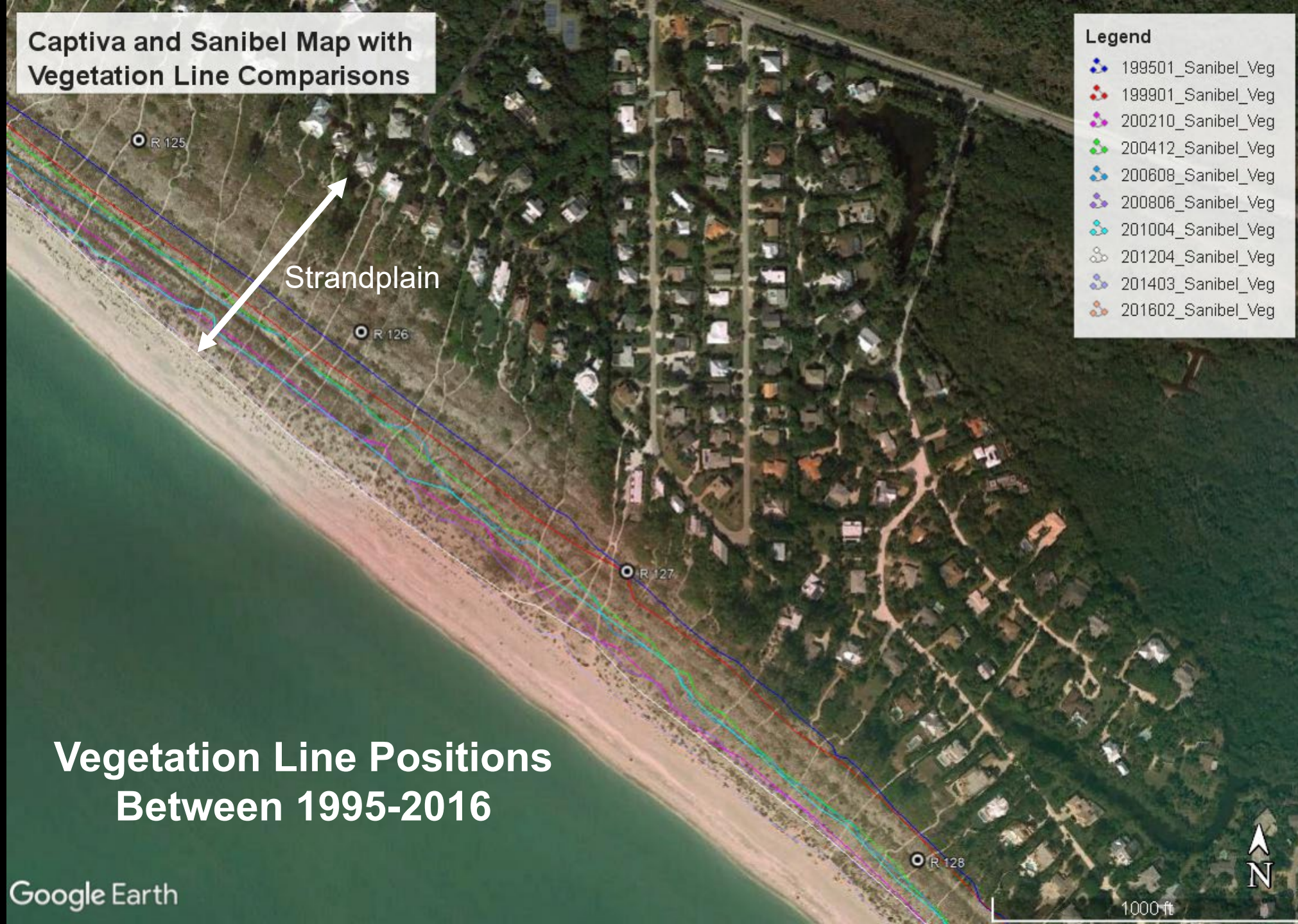
- Areas where coast has prograded; new ridges added to seaward over time.
- Benefitted Sanibel and, we suspect, North Captiva and Cayo Costa.
- No or little ebb surge channel formation.
- Erosion of the foredune.

Captiva and Sanibel Map with Vegetation Line Comparisons

- Legend**
- 199501_Sanibel_Veg
 - 199901_Sanibel_Veg
 - 200210_Sanibel_Veg
 - 200412_Sanibel_Veg
 - 200608_Sanibel_Veg
 - 200806_Sanibel_Veg
 - 201004_Sanibel_Veg
 - 201204_Sanibel_Veg
 - 201403_Sanibel_Veg
 - 201602_Sanibel_Veg

Strandplain

**Vegetation Line Positions
Between 1995-2016**

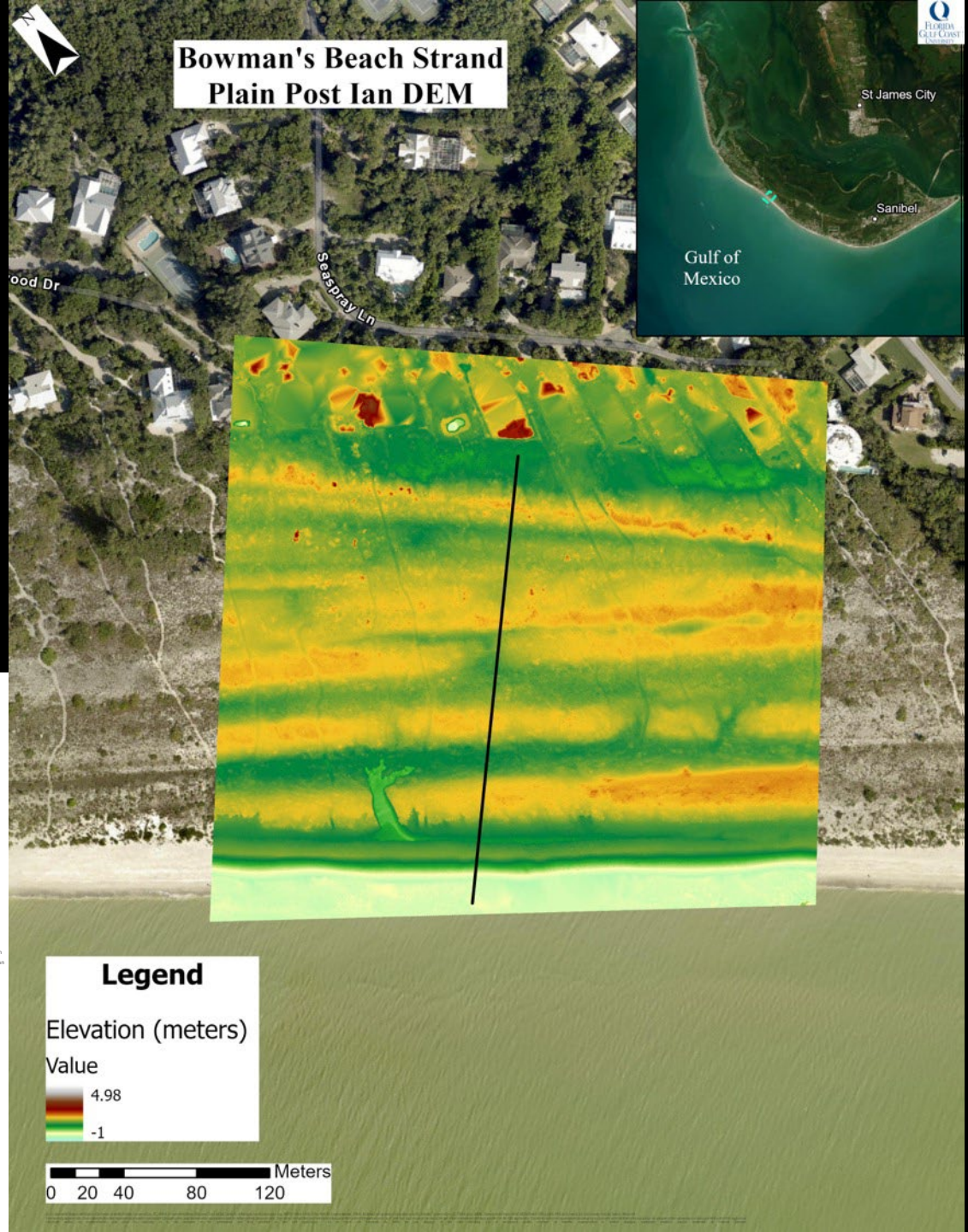
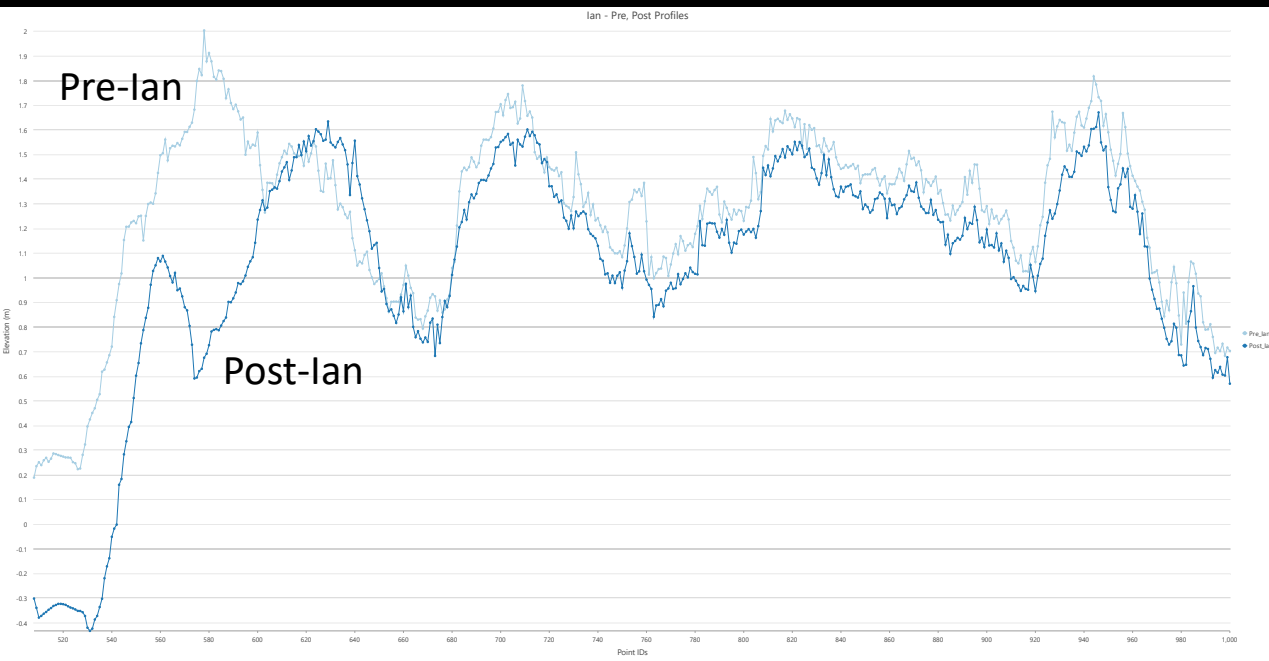


Bowman's Strandplain at Sea Spray

Pre flown Sep 7, 2022

Post flown 1st week Nov, 2022

- Foredune overtopped
- No significant erosion
- Strandplain resilience



Management Implications

- Restrictions on development to minimize ebb surge erosion.
- Importance of foredune height; dune restoration & renourishment.
- Advantages and disadvantages bestowed by sea walls.



Thanks . . .

Acknowledge:

- Funding from FL Department of Environmental Protection, NSF Geopath Program, NOAA
- Pending funding from Florida Sea Grant
- Many students
- Our hearts go out to all the SWFL coastal communities who were impacted by the storm “that arrived too early”