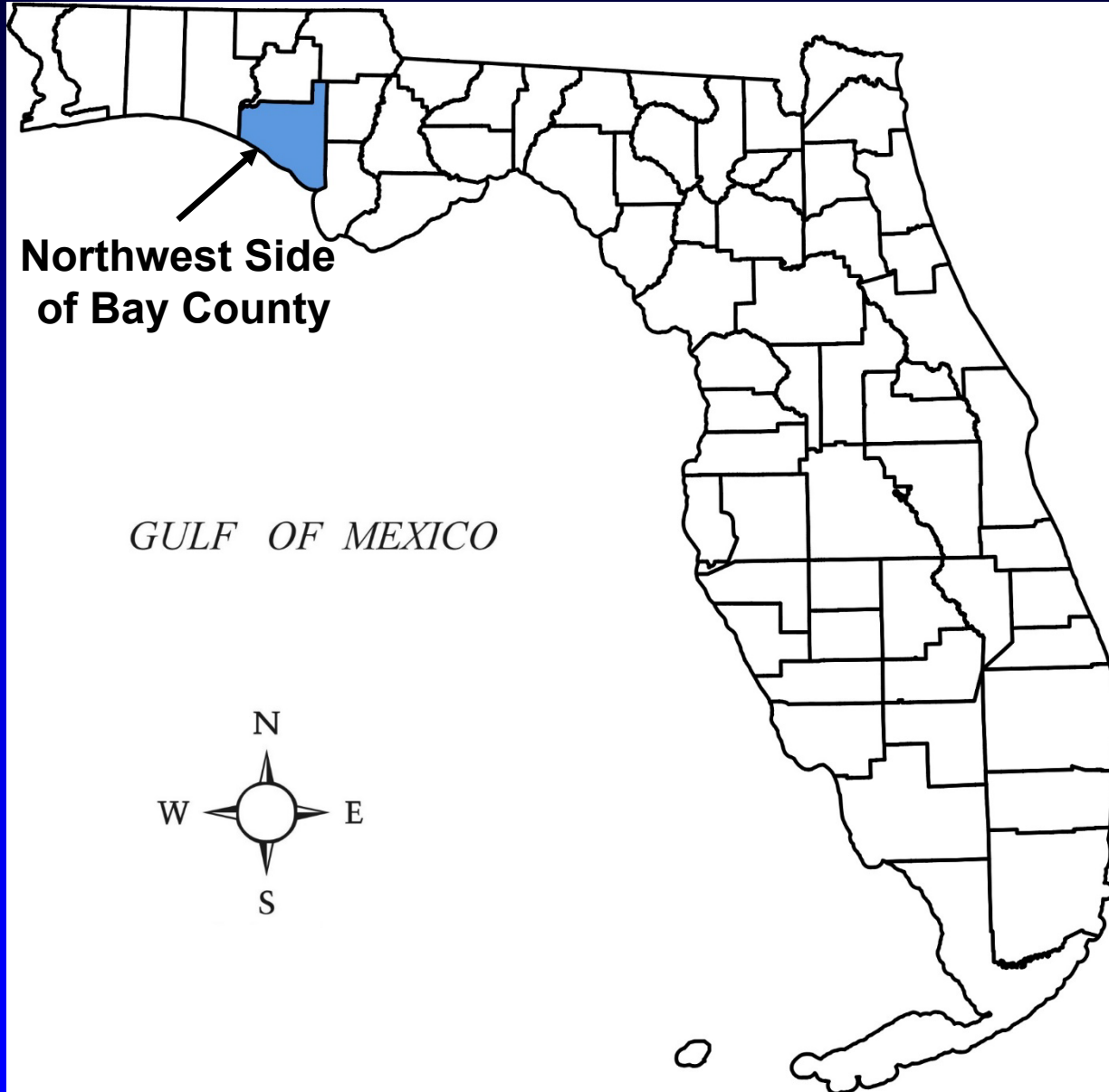


The Measured Fate of Beach Nourishment Sand at Panama City

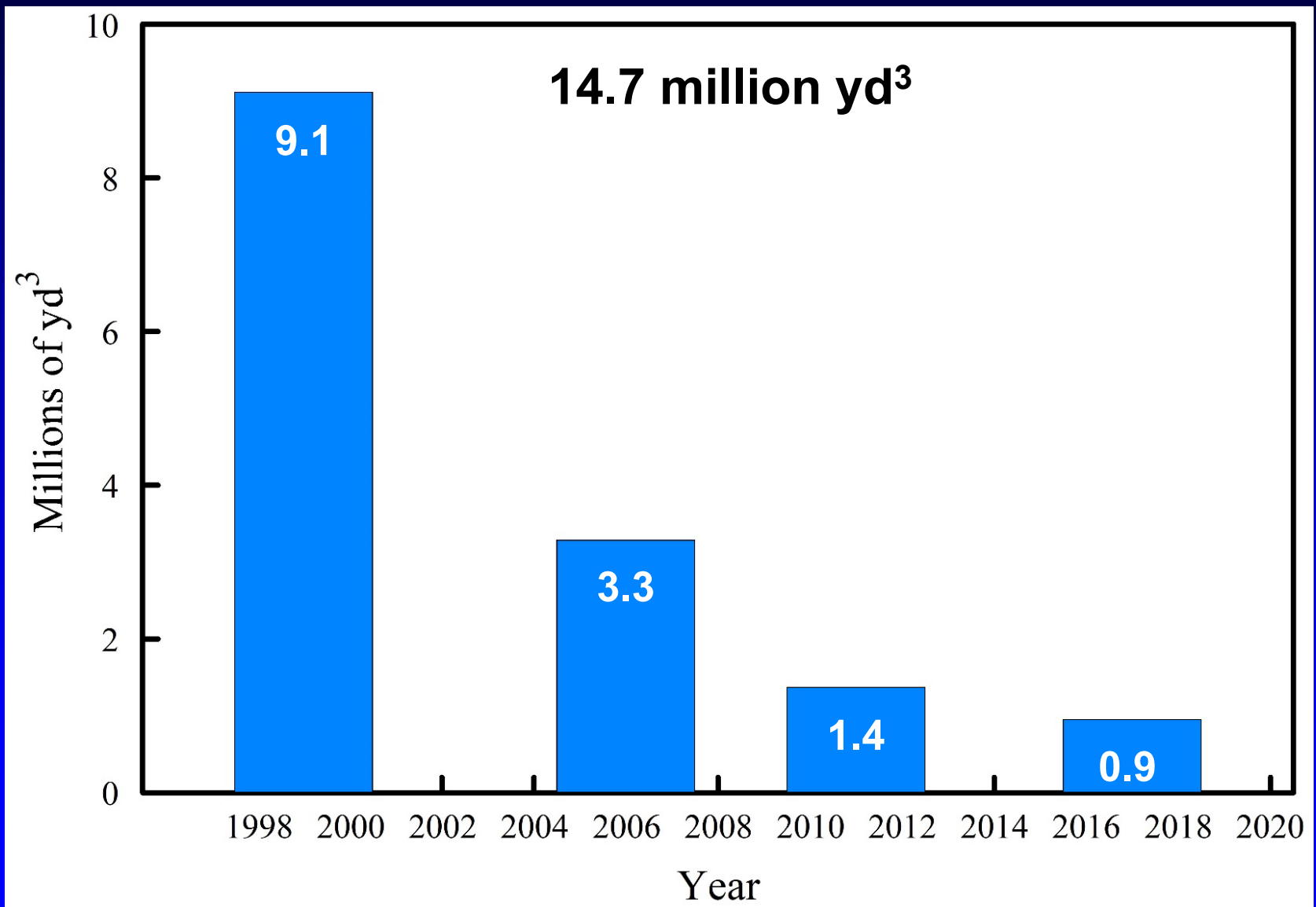


Journal of Coastal
Research (2023)

Panama City Beach



Nourishment Started ~ 25 years Ago



Where Has the Sand Gone?



Why Do We Care?

- Because of the perception that nourishment sand does not last:
 - “All the sand washed away” (Wilson et al 2017)
 - “Sand has gone missing” (Jacksonville Today 2020)
 - “Lost to storms” (Washington Post 2022)



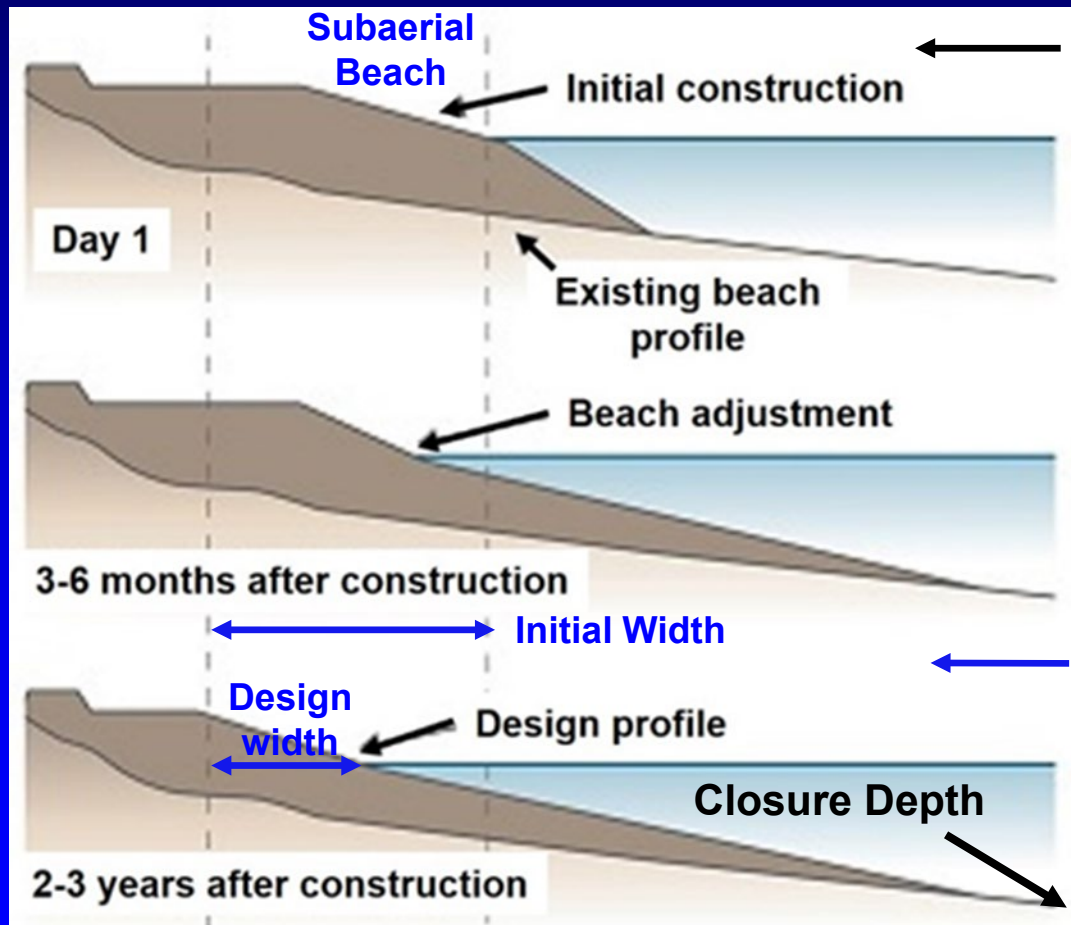
Has Sand Gone Missing?



Is it Slipping Through Our Fingers?

Why is There a Perception?

- Primary reason - profiles must be nourished to closure depth, and we let nature will handle this



Sand Largely Placed on the Subaerial Beach

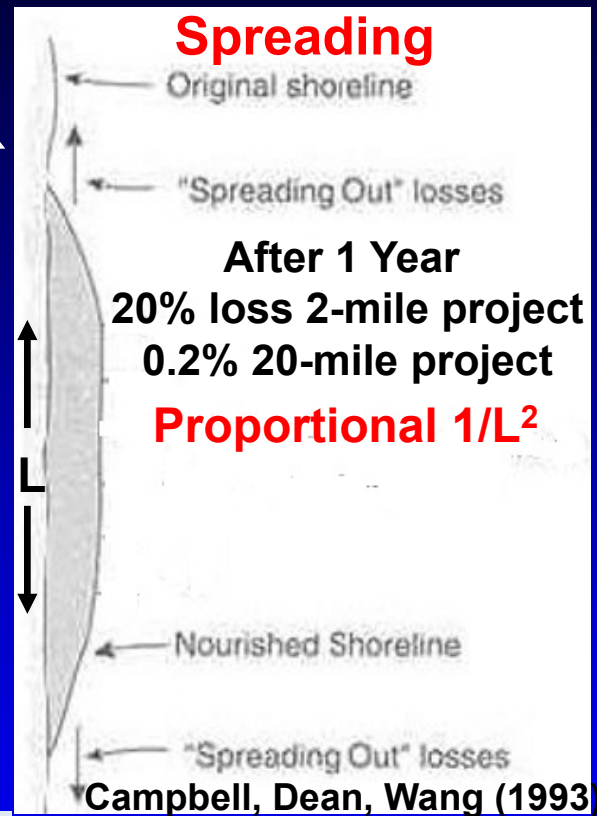
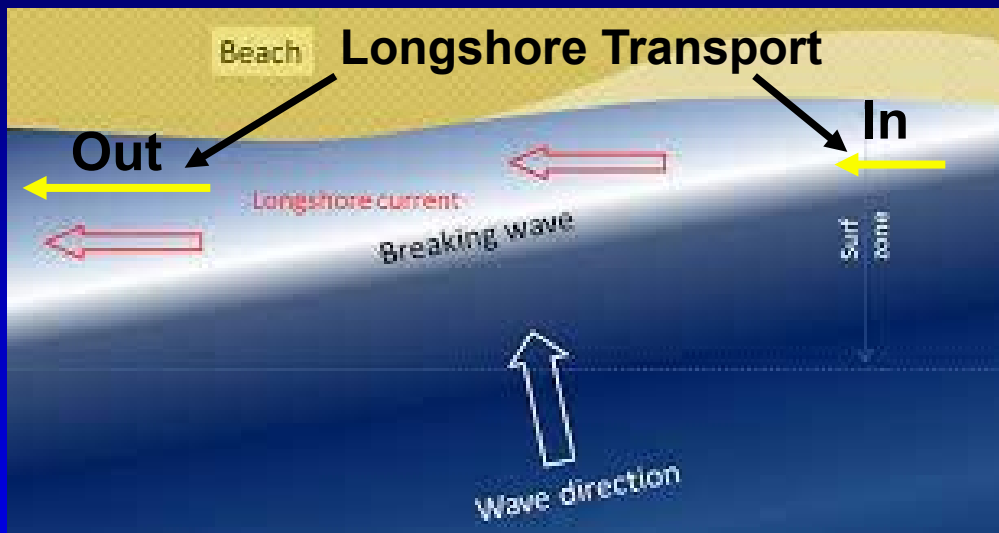
- Cheapest
- Ensures uniformity
- Easy to Measure to Pay

Initial Width is Typically Twice the Design Width

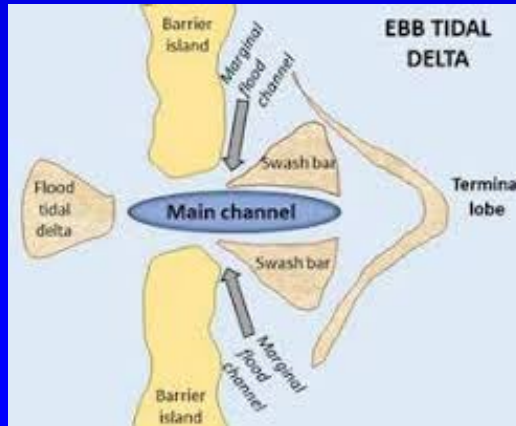
Nature Makes it Happen

Actual Losses

- Spreading loss for short projects
- Longshore transport can cause loss



- Inlet shoals take sand out of the littoral system



**Bypassing
Needed**

Nourishment Has Been Tracked Indirectly

- Equilibrium profile concept relating shoreline width and volume change was used successfully to track sand on the Florida east and South Carolina coasts (Houston, 2018; 2021)
- But measurements are needed that track volume directly



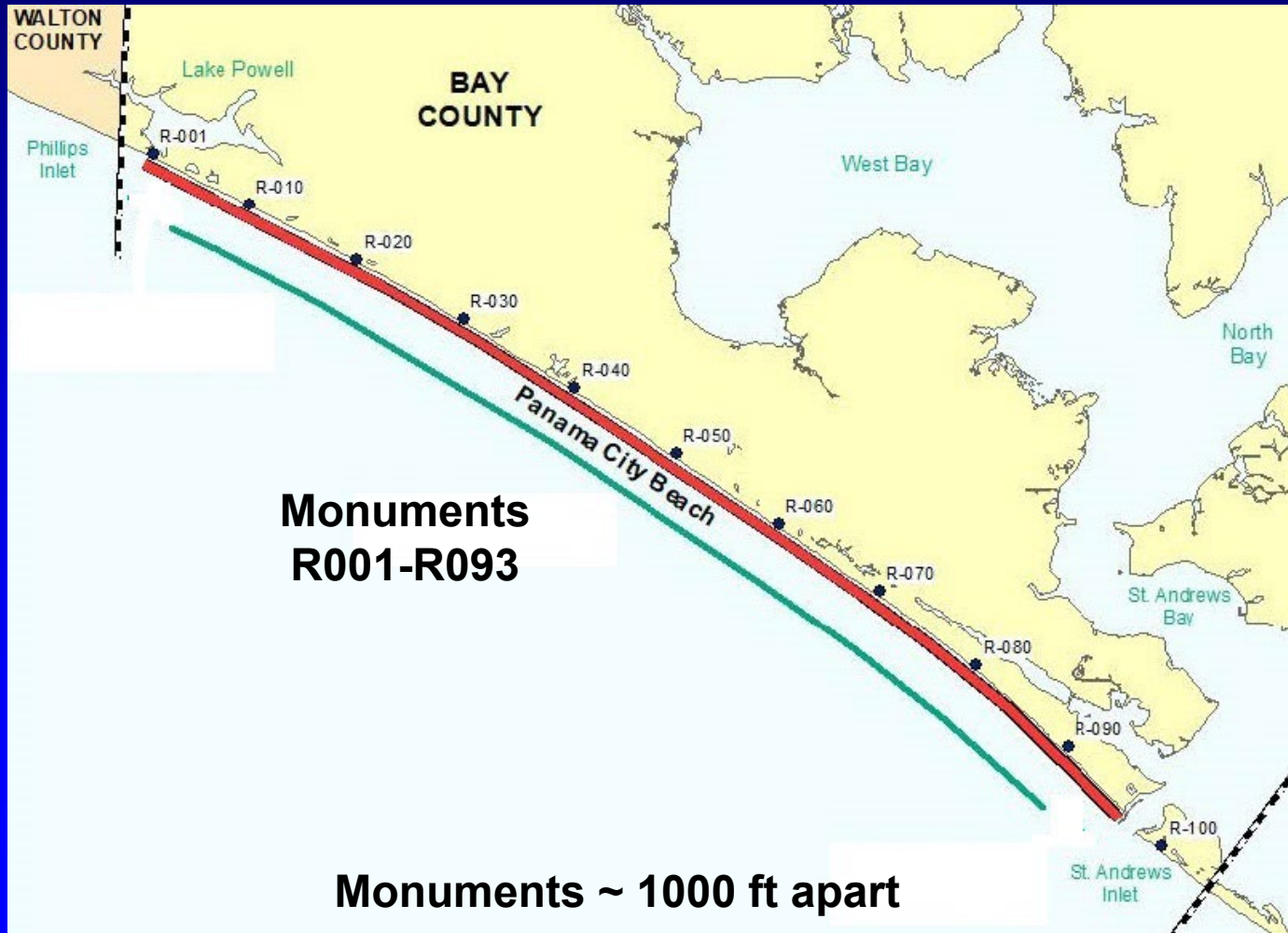
Panama City Beach is Ideal to Track

- 18-mile length (spreading losses $< \frac{1}{4} \%$)
- Longshore losses are relatively low
- There are no inlets

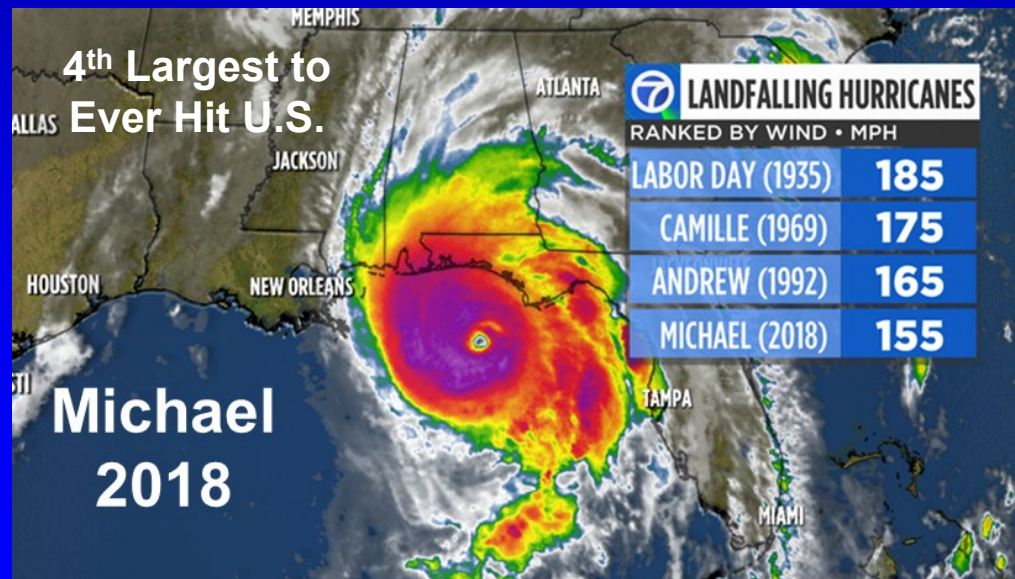
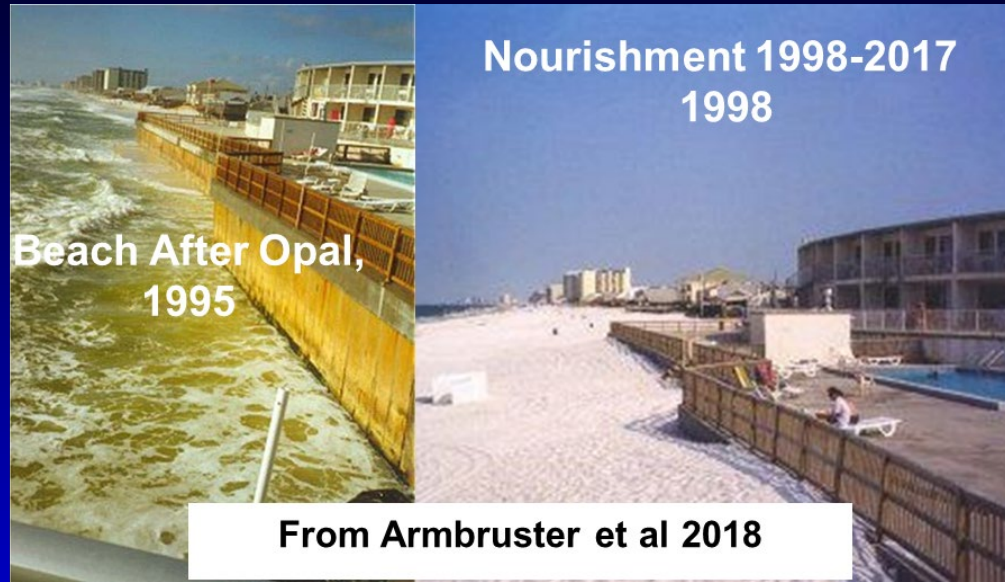


Panama City Beach Nourishment Project

- FDEP has profile measurements at 93 monuments that were made following Hurricanes Opal (1995) and Michael (2018), so sand can be tracked



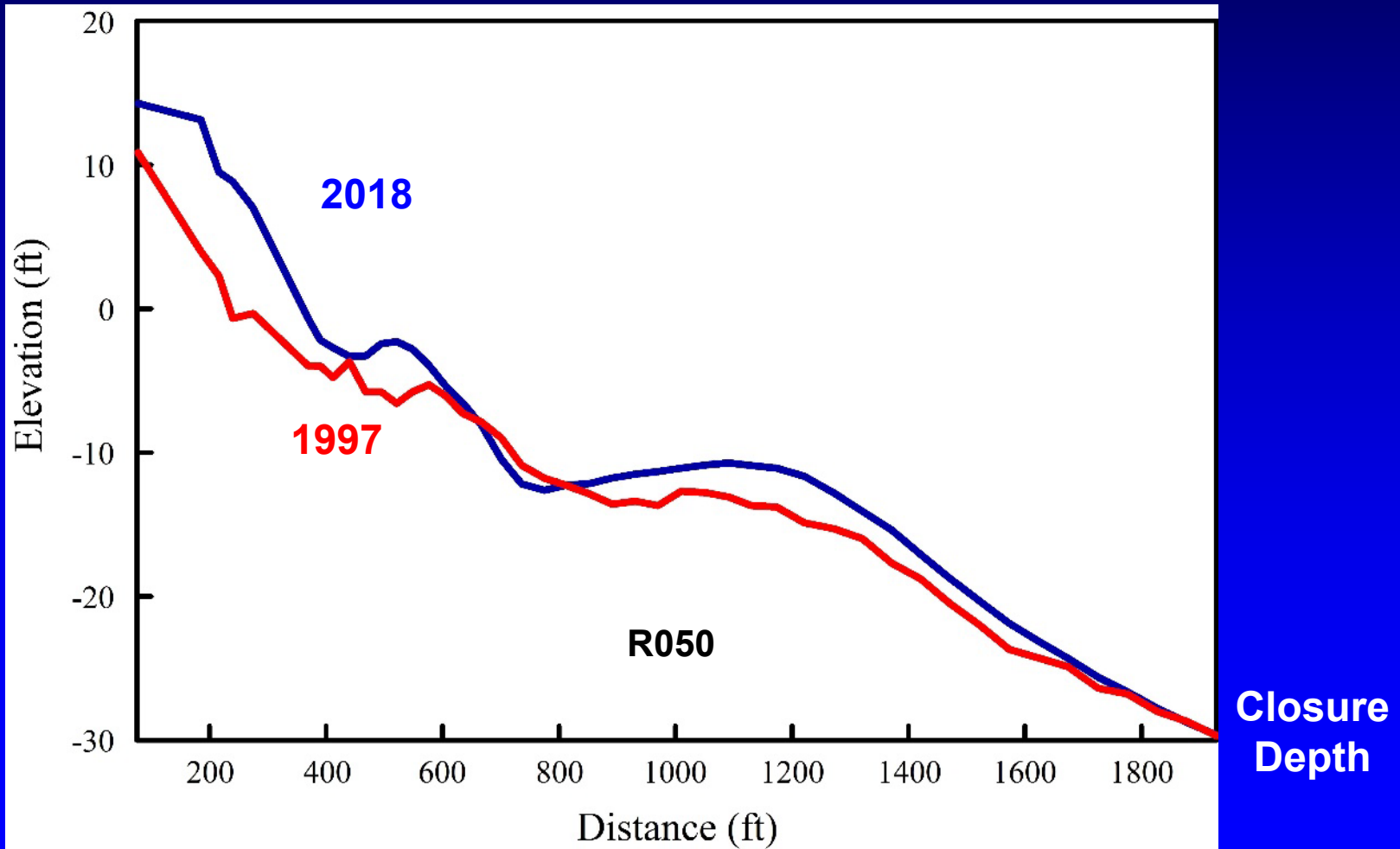
Track Sand Post Opal to Post Michael



Came ashore 20 miles from Panama City Beach

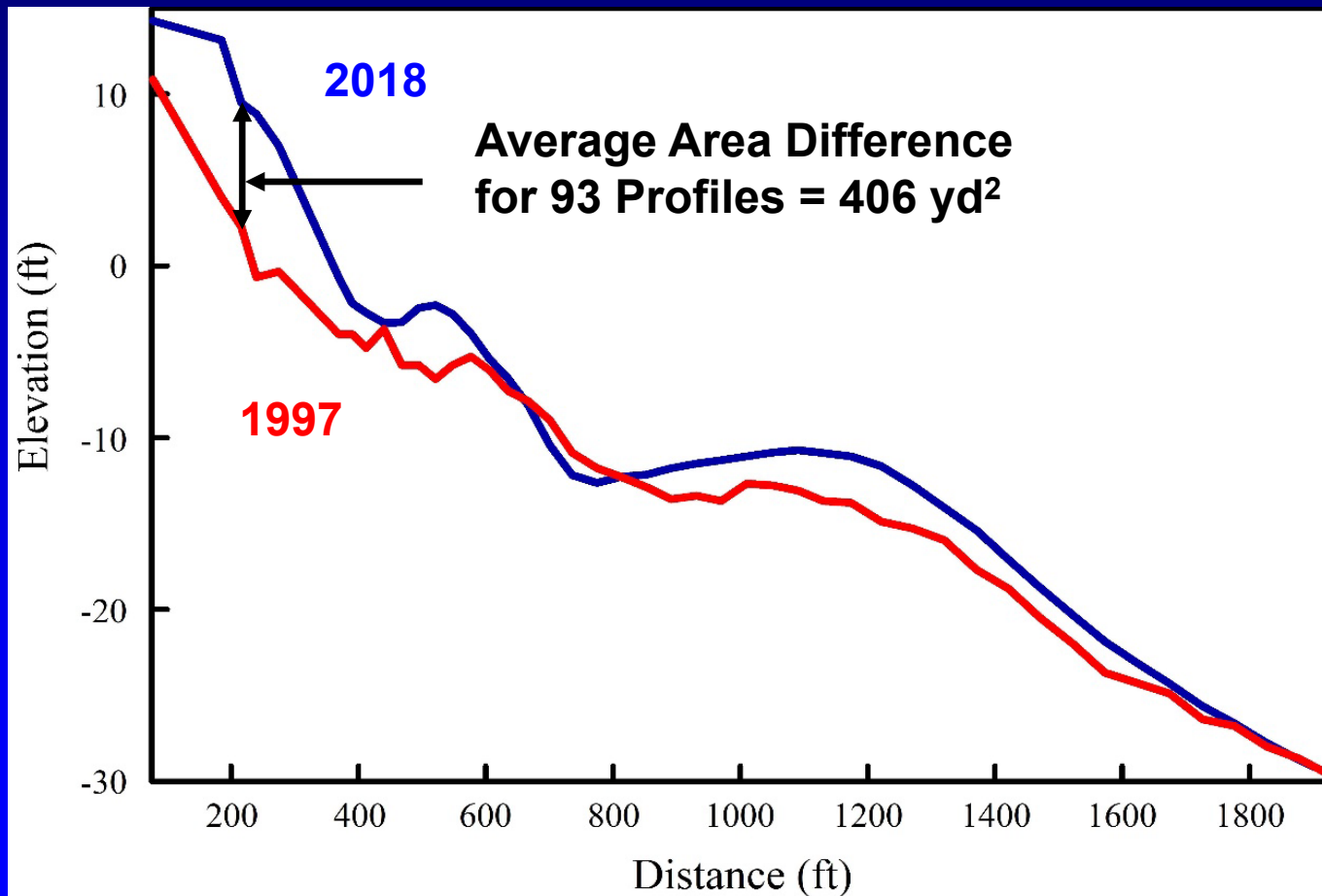
Found Closure Depth to be 30 ft

- At a 30-ft depth, the average separation of pre-nourishment and post-Michael profiles for the 93 monuments is just 1 mm



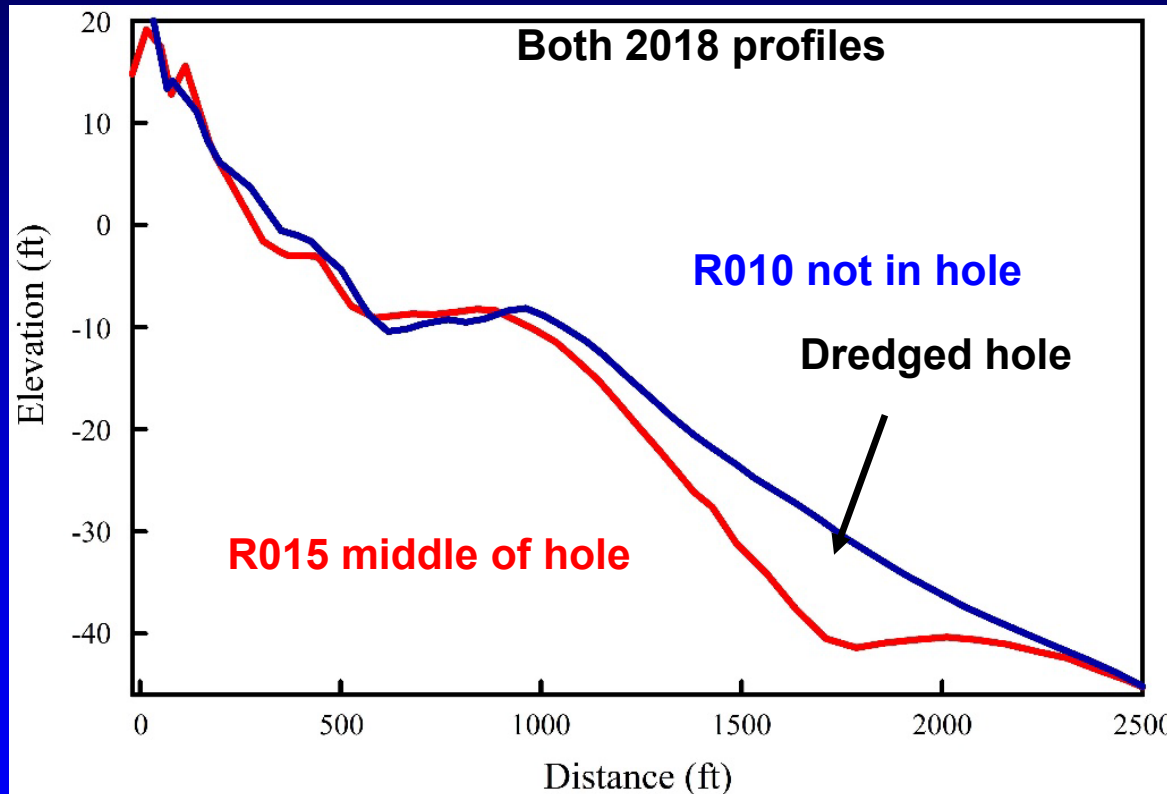
Sand on Profiles

- The sand volume on profiles is the area difference between the 93 pre-nourishment and post-Michael profiles multiplied by profile separation = 12.8 ± 0.4 million yd^3



Loss Due to Dredge Holes

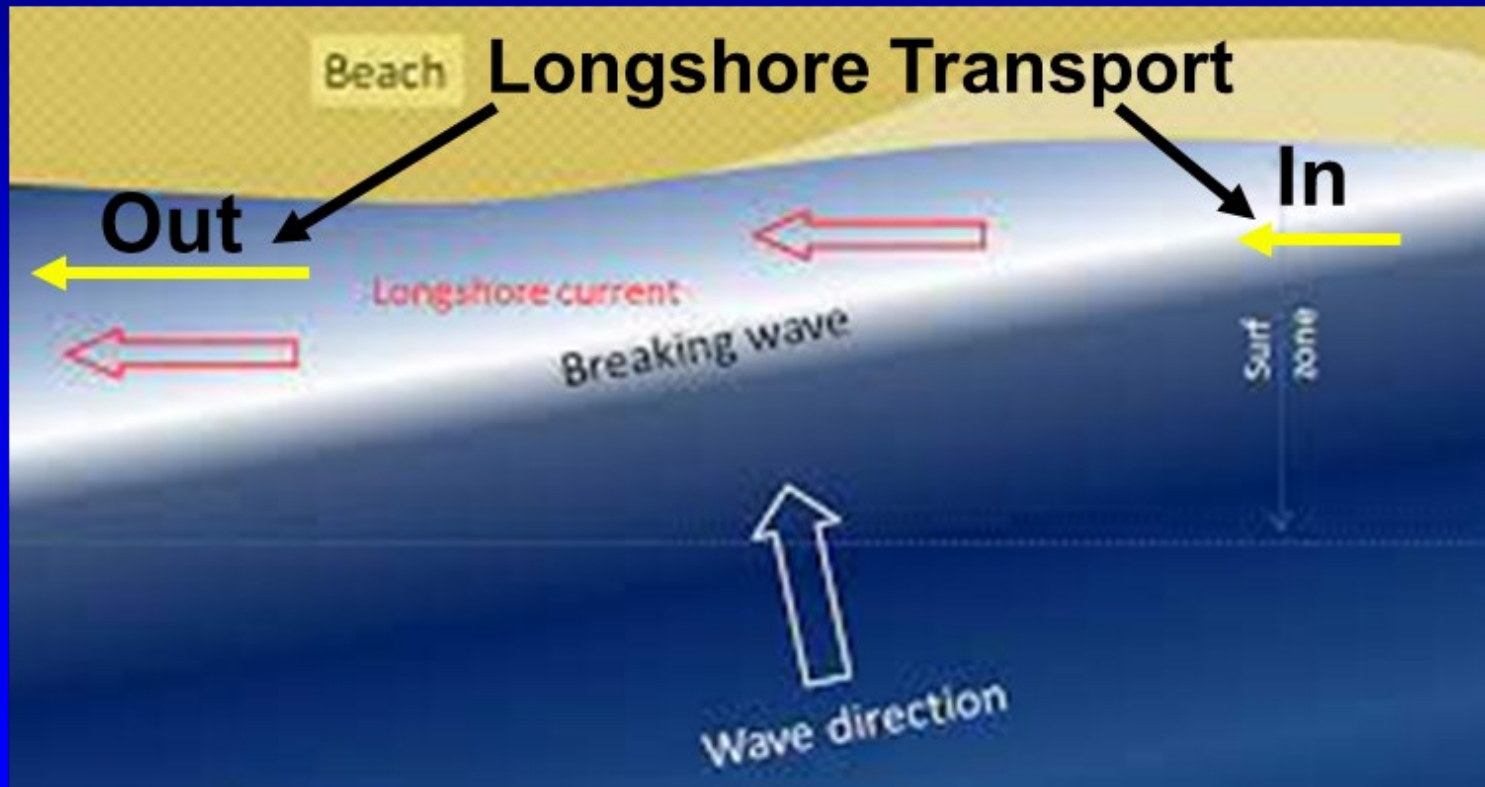
- Nourishment sand for monuments R011-R022 was dredged from an area within closure depth creating “holes”



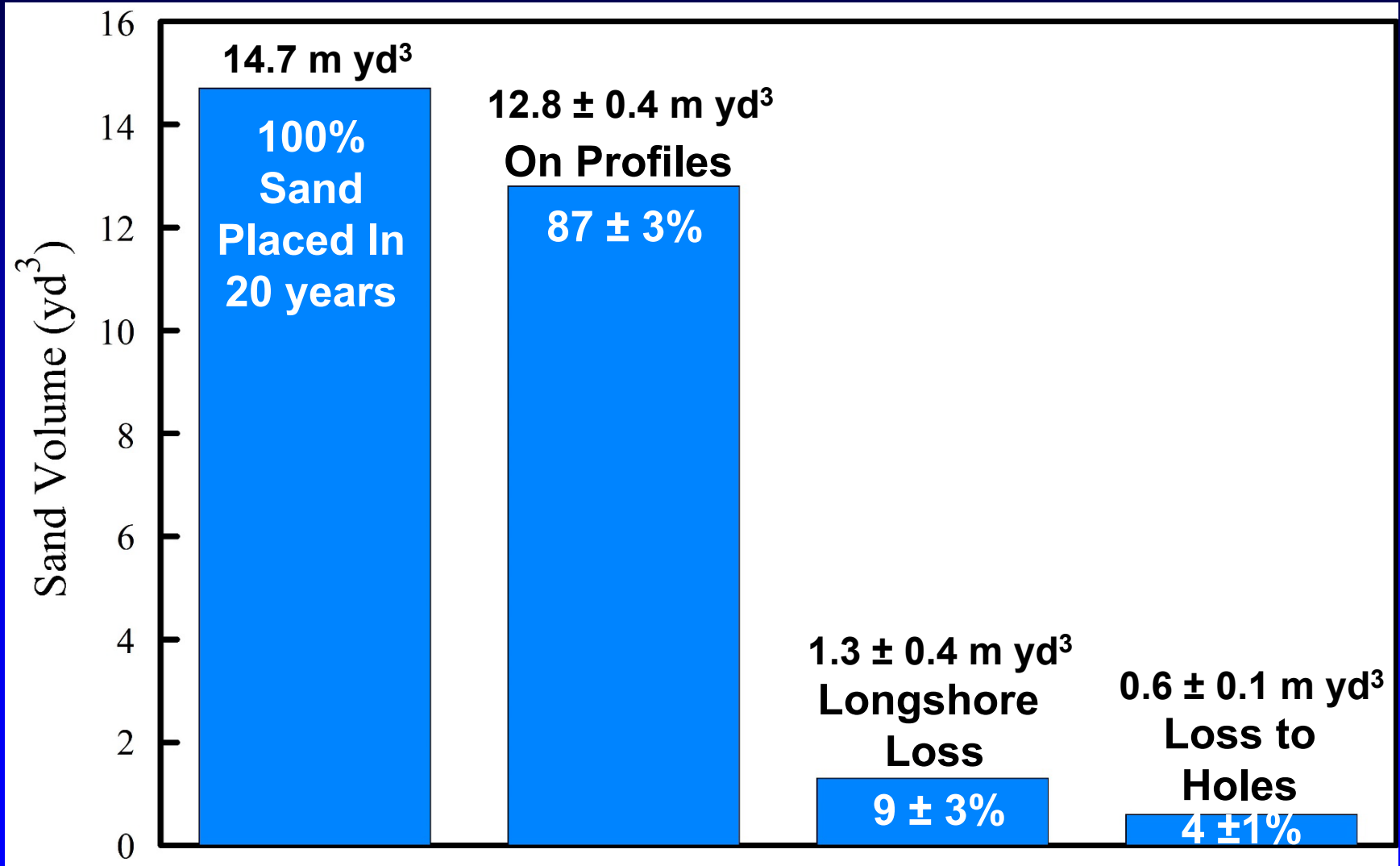
- Comparing sand gain on profiles R011-R022 to bounding profiles, yields a loss from 1998-2018 of 0.6 ± 0.1 million yd^3

Longshore Transport Loss

- Longshore loss = Nourishment placed - sand remaining - sand lost to holes = 1.3 ± 0.4 million yd^3
- Studies have roughly estimated a longshore loss of 1.6 ± 0.5 million yd^3

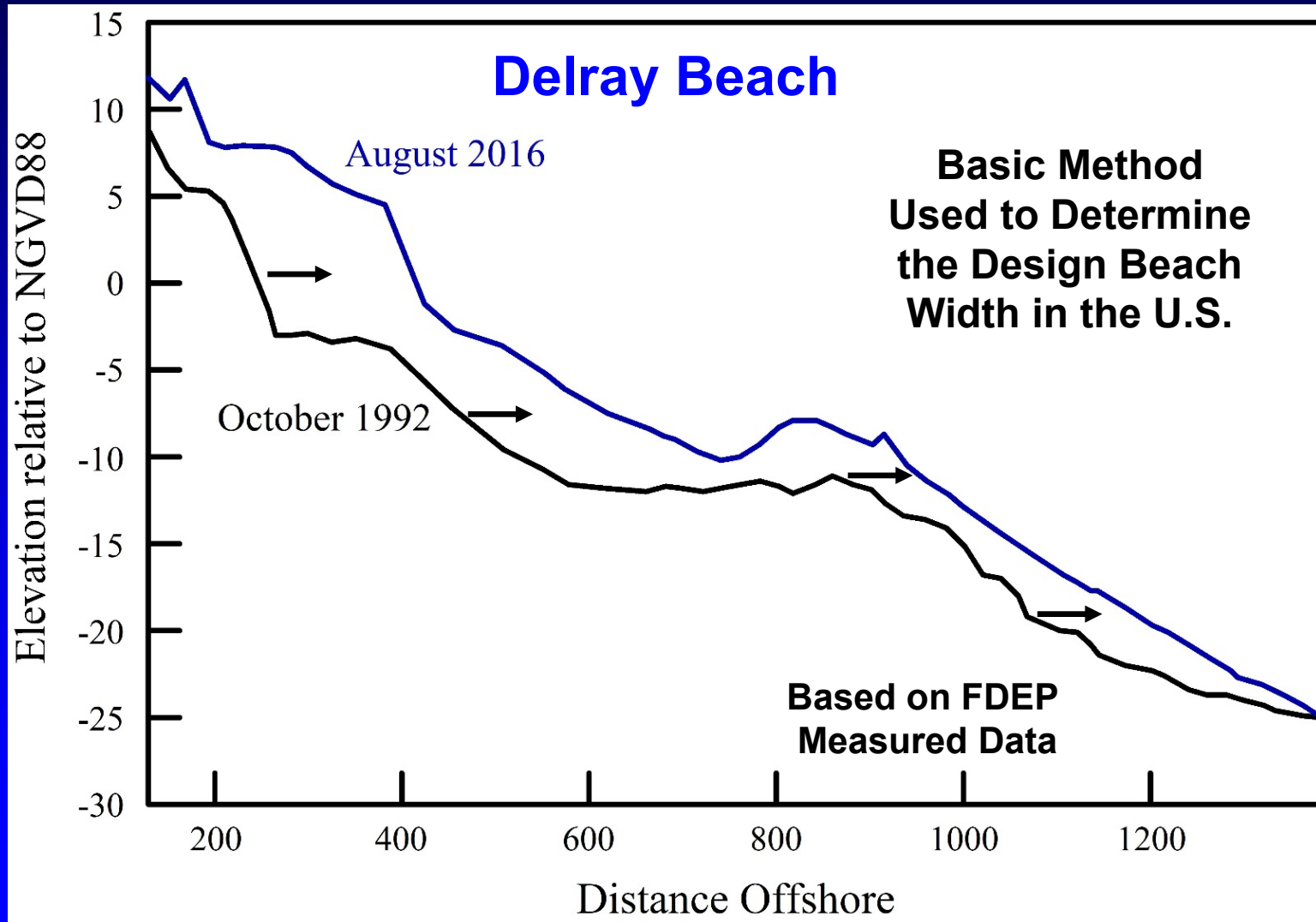


20-Year Fate Even After Category 5 Hurricane Michael



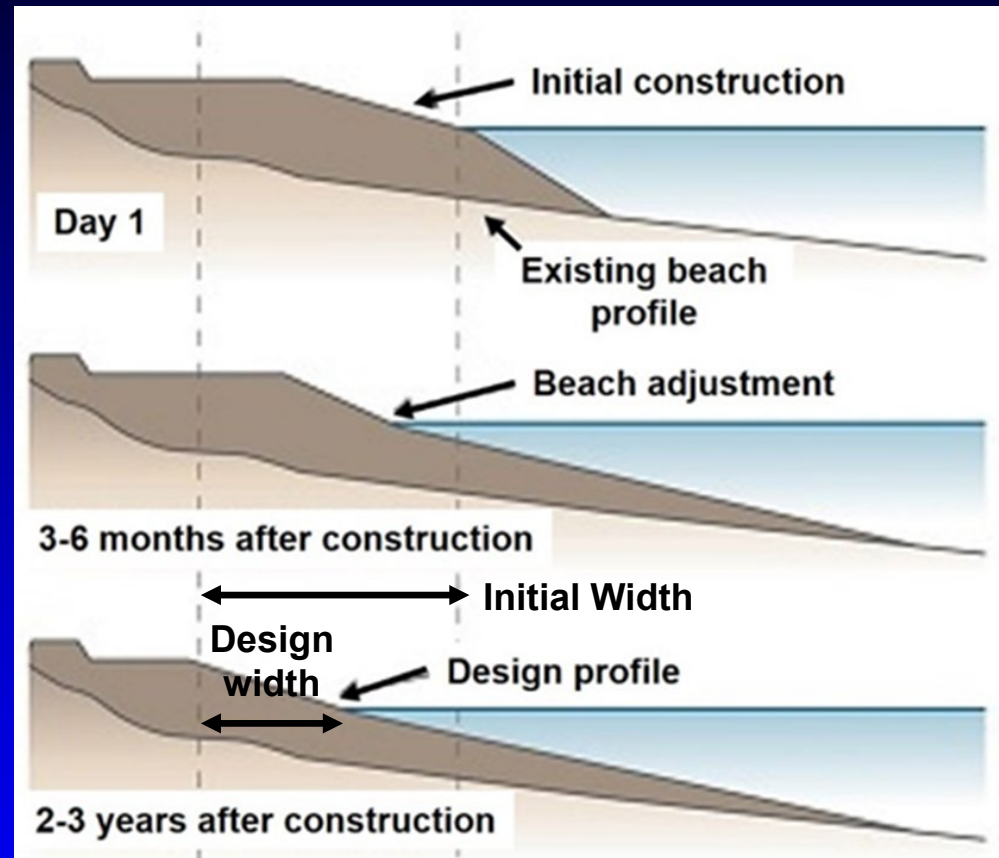
Design Width ~ Equilibrium Concept

- Beach nourishment roughly translates the profile seaward



Time to Reach Equilibrium

- Typically 2-3 years
- Panama City has relatively mild waves between episodic hurricanes – takes longer
- Can determine design beach width from the sand volume placed:

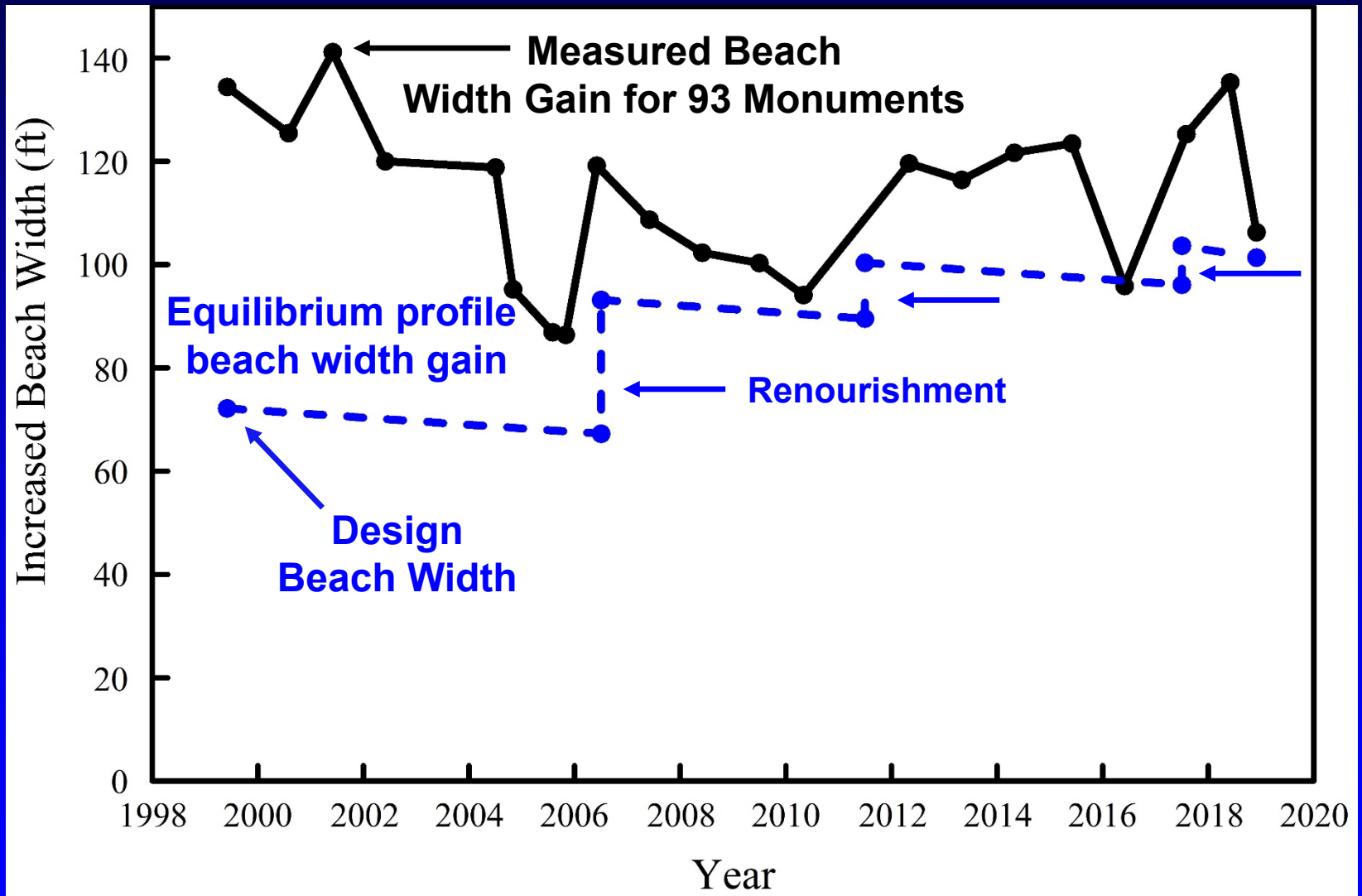


$$X = \frac{V}{[(h_* + B) * L]}$$

X is shoreline change, V is volume, h_* is closure depth, B is beach berm elevation, L is shoreline length

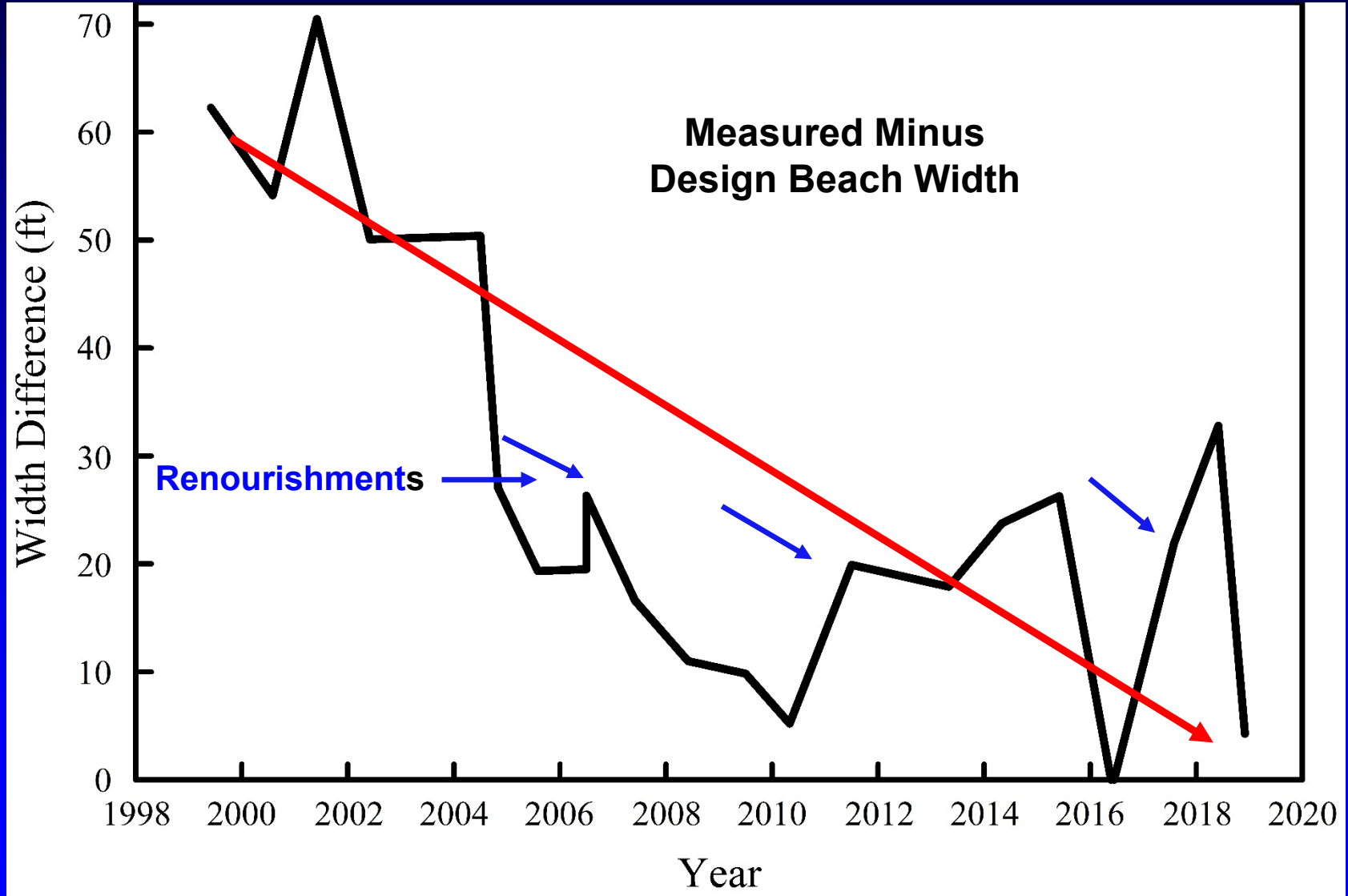
Movement to Equilibrium Profiles

- Measured average beach width gain for 18-mile shoreline



Years to Move to Design Beach Width

- Zero in the plot is when the design beach width occurs



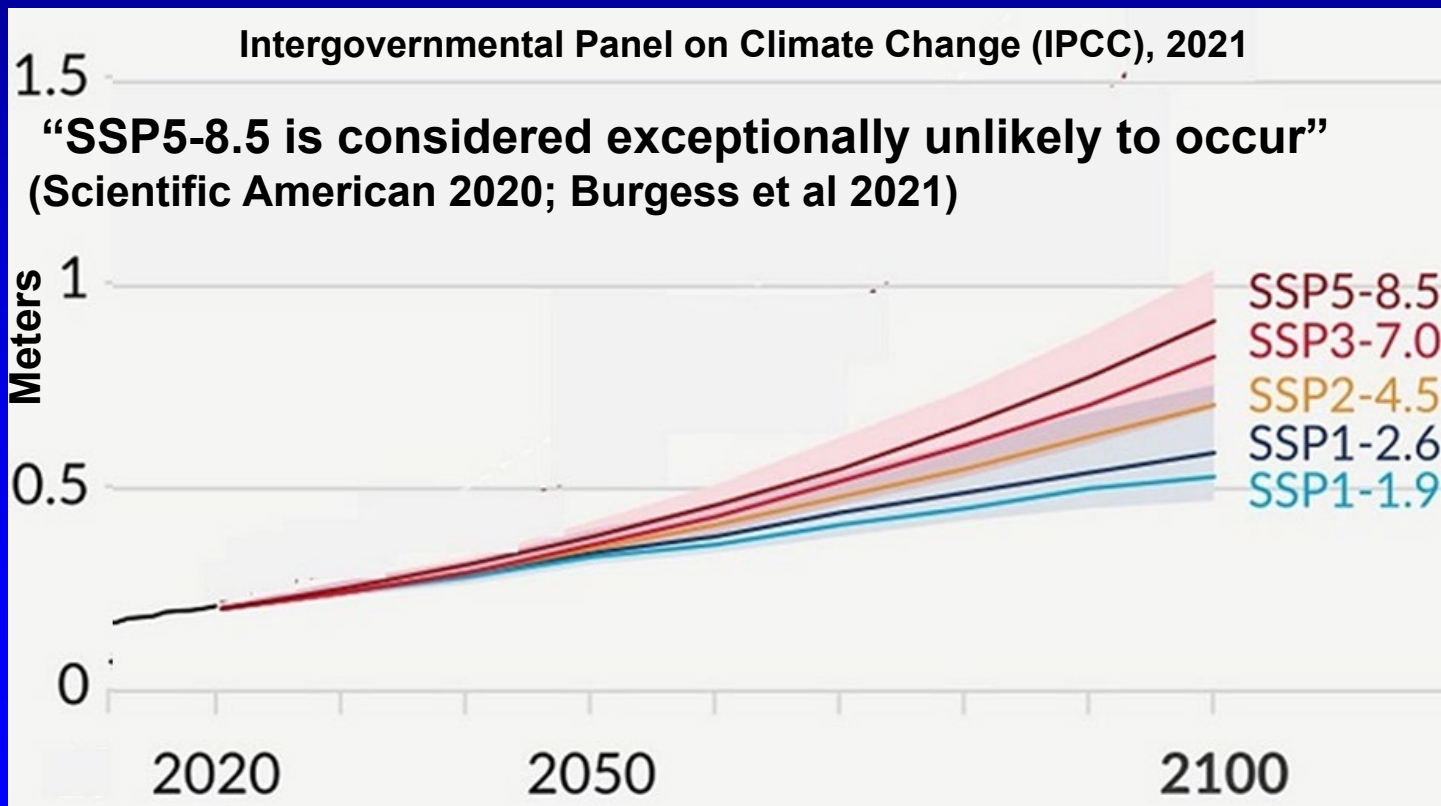
Shoreline Change

- With 87% of the sand still on profiles after 20 years, the equilibrium profile concept predicts the shoreline should have gained 101 ft in width
- The measured average beach width gain was 106 ft and was still approaching the design width



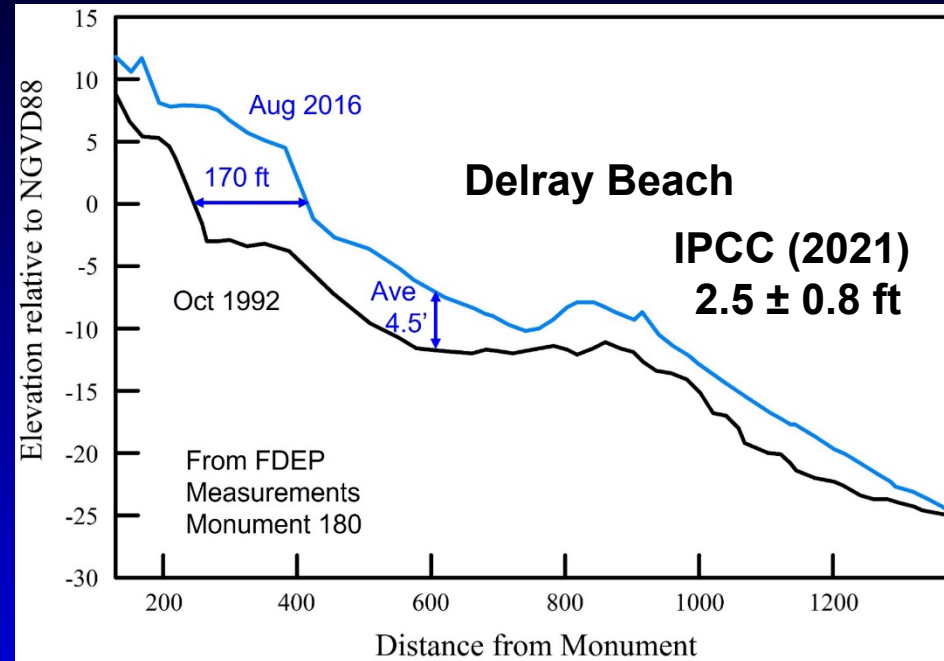
Profile Rise

- Beach nourishment raised measured profiles by 2.4 ± 0.3 ft relative to a fixed datum
- Rise is comparable to rise of 2.5 ± 0.8 ft by 2100 projected by IPCC (2021) for its worst-case temperature scenario (SSP5-8.5) of +5 degrees Celsius



Profile Rise is Not Surprising

- Delray Beach raised profiles 4.5 ft in 24 years despite storms and longshore losses



- Florida beaches that continue to be nourished at the rate of the past 30 years will rise sufficiently to offset sea level rise to 2100 and beyond (Houston 2020)
(Back bay areas are a different story)

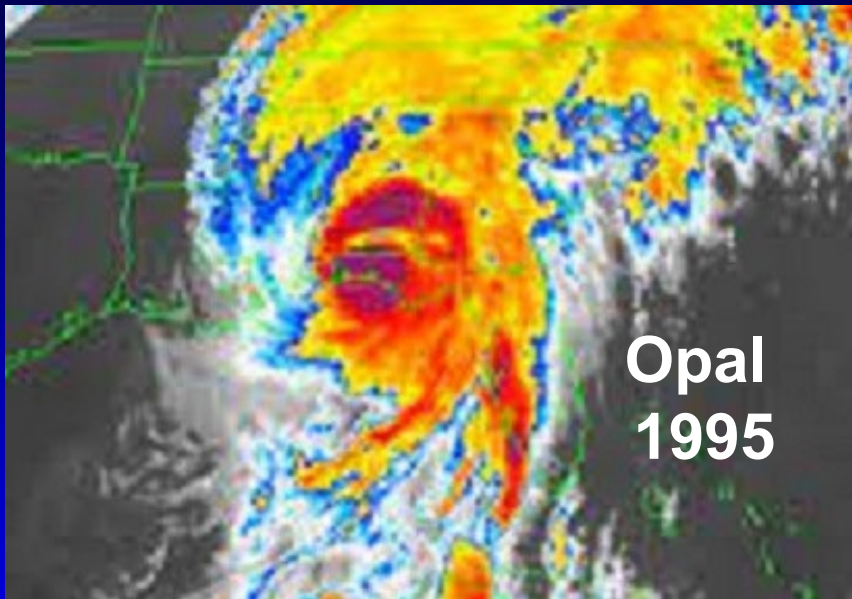
Did Nourishment Achieve Goals?

- The primary goal of the Corps of Engineers was protection of infrastructure with recreation a secondary goal



Infrastructure Protection

A Tale of Two Hurricanes



“Marginally a Category 3 hurricane” when it came ashore about 80 miles from Panama City
(National Hurricane Center, 1995)



“Category 5 storm”, the 4th strongest to ever hit the US when it came ashore < 20 miles from Panama City (NOAA, 2019)

Massive Damage During Opal

- Opal caused **“massive”** surge/wave damage to 471 coastal structures at Panama City beach (FDEP, 2019)
- **“I went down Front Beach Road and in both directions you could see nothing but debris”** Panama City Beach Manager Richard Jackson (MyPanhandle.com, 2022)



Nourishment Protected Against Michael

- During Hurricane Michael, beach nourishment sand “protected all beach fronting development and infrastructure along Panama City Beach.” There was wind damage, but no surge/wave damage (FDEP 2019)
- Opal caused “massive” surge/wave damage. Michael none.



Did Nourishment Achieve Recreation and Tourism Goals?

- The primary goal of locals was recreation and tourism with infrastructure protection a secondary goal

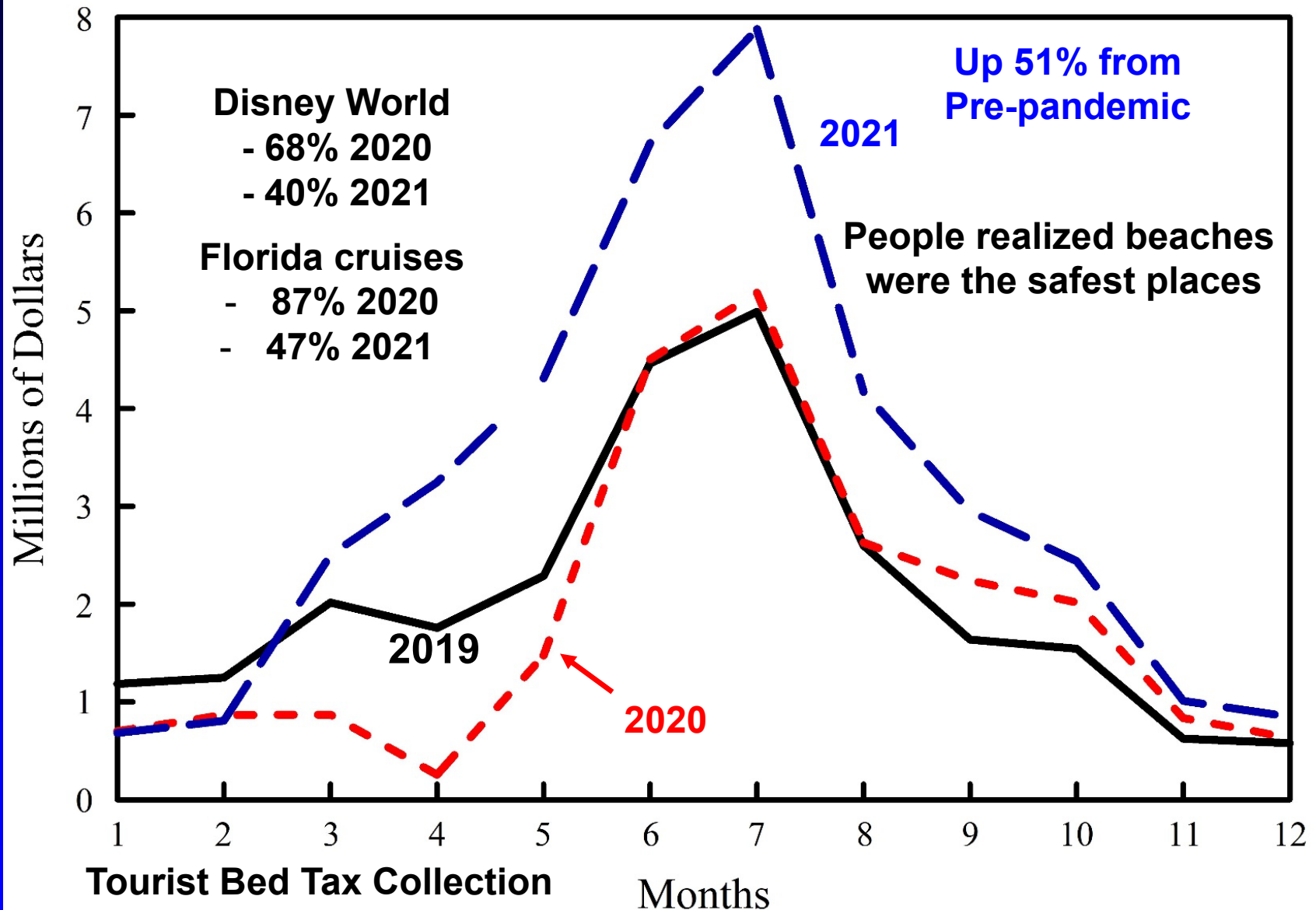


Recreation and Tourism

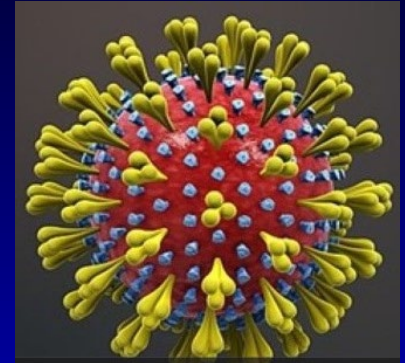
- Tourism is Bay County's largest industry, generating over \$3 billion in income and supporting 20,000 jobs
- Panama City Beach has a population of 15,000, which increases to 100,000 during peak summer months (PanamaCityBeach.com, 2022)



Panama City Tourism - COVID



People Were Correct- Beaches Safe



- **“Beaches and parks are some of the safest places you can gather”** (Professor Linsey Marr, expert, airborne virus transmission, Virginia Tech, 2021)
- **“Within minutes, the majority of the virus is inactivated on surfaces and in the air in direct sunlight”** (Dr. Paul Dabisch, Department of Homeland Security’s biodefense research laboratory, 2020)
- **“There has never been a COVID-19 outbreak linked to a beach ever, anywhere in the world”** (Mark Woolhouse, Professor of infectious disease epidemiology, University of Edinburgh, 2021)
- **“Near-absent are examples of transmission at beaches”** (Washington Post 2021)

Recreation and Tourism Goal Met

- 4 months after Michael, Panama City Beach was named by TripAdvisor in a poll of millions of travelers as the 3rd best beach in America out of 352 beaches (MyPanhandle.com 2019)
- In 2021, Newsweek reported that Panama City Beach tied Huntington Beach, CA, as the most popular beach in America in terms of number of visitors (Newsweek 2021)



Conclusions

- **Sand has not gone missing:**

About 90% is still in place, widening beaches > 100 ft even after 20 years and Hurricane Michael



Panama City Beach Today

- **Nourishment protects:**

Opal caused “massive” surge/wave damage”, but Michael caused no surge/wave damage



Opel Damage
471 Structures

Conclusions

- Panama City made the right decision:

Had a Choice



After Opal

Without Nourishment



After Michael

With Nourishment

The End



Panama City Beach