RIP CURRENT DYNAMICS AND BEACH PROFILE EVOLUTION IN PANAMA CITY BEACH, FLORIDA

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Acknowledgements: Panama City Beach Convention & Visitors Bureau (CVB), Dan Rowe, Lisa Armbruster, Tara Brenner, P.E., P.G., and Steve Keehn, P.E.

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FLORIDA SHORE & BEACH PRESERVATION ASSOCIATION
A League of Cities and Counties on Beach and Coastal Issues

38th Annual National Conference on Beach Preservation Technology
February 2025, Panama City Beach, Florida

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STUDY PURPOSE & METHODOLOGY

- Provide an objective assessment of rip current processes as it relates to occurrences along the renourished beaches of Panama City Beach:
  - Review published literature and related research on the topic
  - Identify contributing factors for the formation of rip currents
  - Evaluate the evolution of the beach profile and nearshore morphology over time
  - Assess the contributing coastal processes and compare to similar locations
- The effort presented herein is not intended to be an exhaustive review
- Results presented to the Panama City Beach TDC in August 2024

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RIP CURRENT DEFINITIONS

Traditional

Shepard (1936)

- *A circulation pattern of water from waves breaking on a beach with the return flow moving rapidly back out to sea through narrow channels in the surf zone*

Contemporary

Leatherman (2011)

- *A strong seaward-flowing current generated by waves breaking on a beach that moves offshore as a concentrated flow at all depths and extends through the surf zone*

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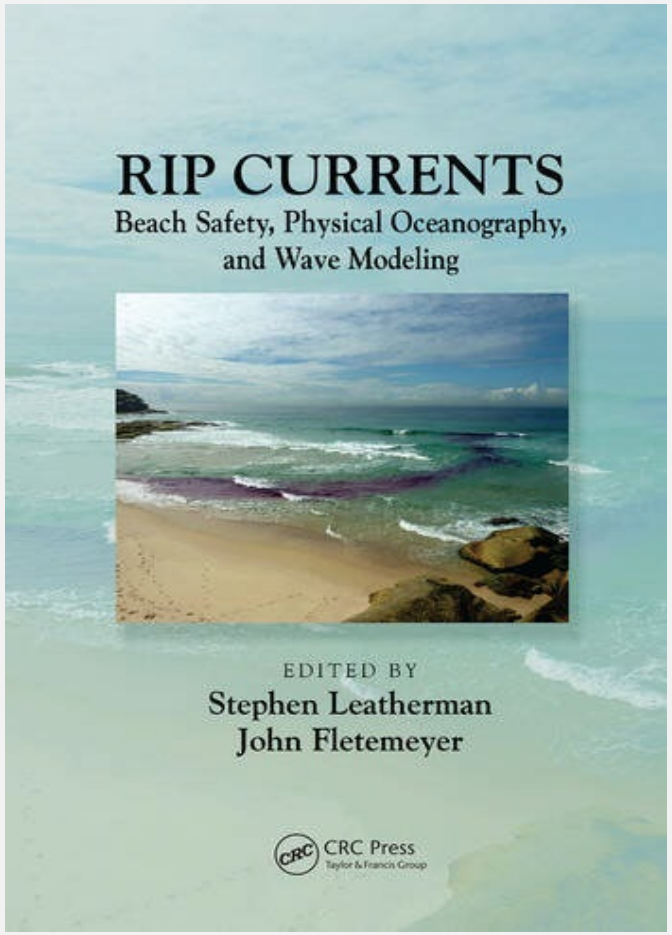

FIRST INTERNATIONAL RIP CURRENT SYMPOSIUM

- Florida International University, Miami, FL, Feb 17-19, 2010
- ***"More than 100 coastal scientists, engineers, forecast meteorologists, lifeguard chiefs, and other practitioners from ten countries participated in this three-day conference …"***
- Rip current research from all over the world; examples include:
  - Long Island, NY
  - Ocean City, MD
  - Florida Gulf Coast
  - Florida Atlantic Coast
  - Kill Devil Hills, NC
  - Great Lakes Region
  - United Kingdom
  - Brazil

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RIP CURRENT PROCESSES

- Entirely an “in-water” circulation process

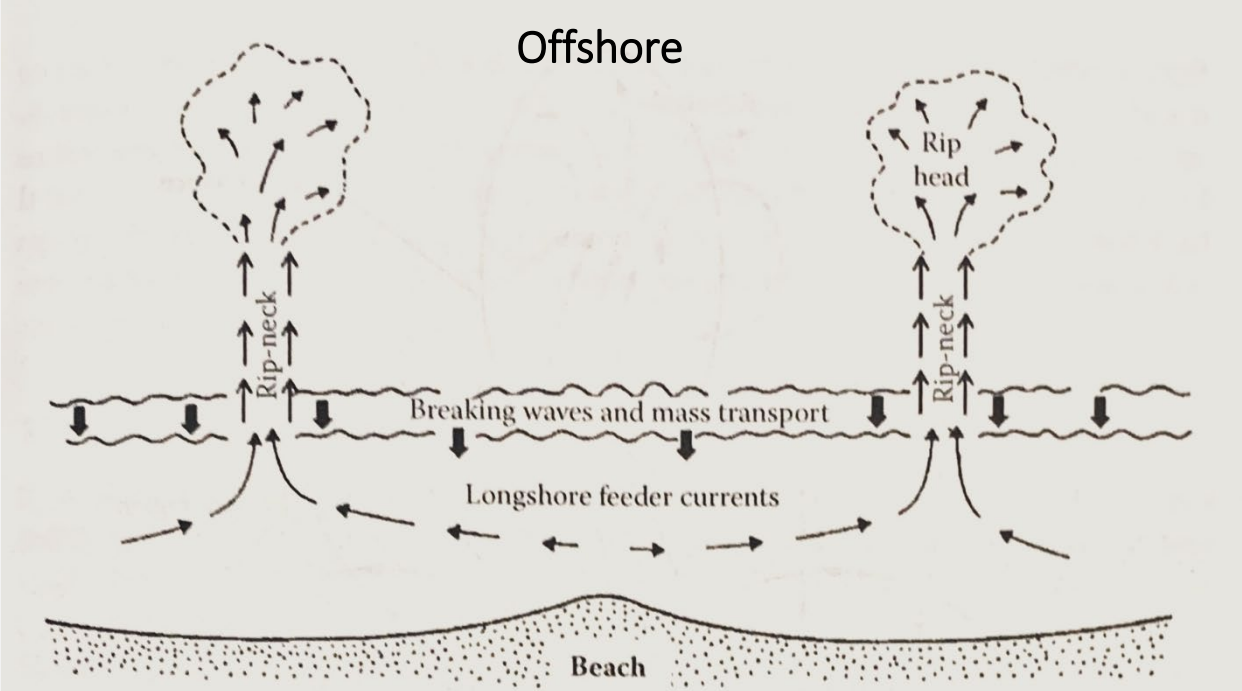

FIGURE 1.2 Traditional paradigm of rip current circulation typically shows flow extending well beyond the surf zone. (*Source:* Modified from Komar, 1998. *Beach Processes and Sedimentation*, 2nd ed. Prentice Hall, New York.)

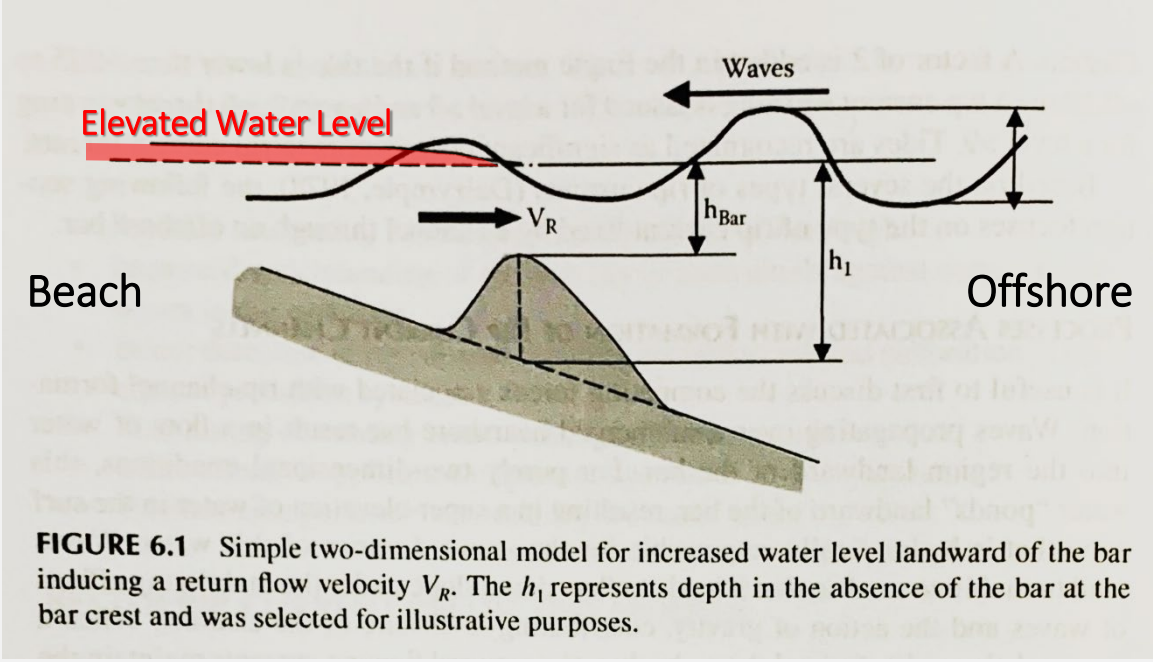

FIGURE 6.1 Simple two-dimensional model for increased water level landward of the bar inducing a return flow velocity V_R. The h_1 represents depth in the absence of the bar at the bar crest and was selected for illustrative purposes.

- Source: Leatherman & Fletemeyer, 2011, CRC Press, Proceedings from the First International Rip Current Symposium, Florida International University, Miami, FL, Feb 17-19, 2010

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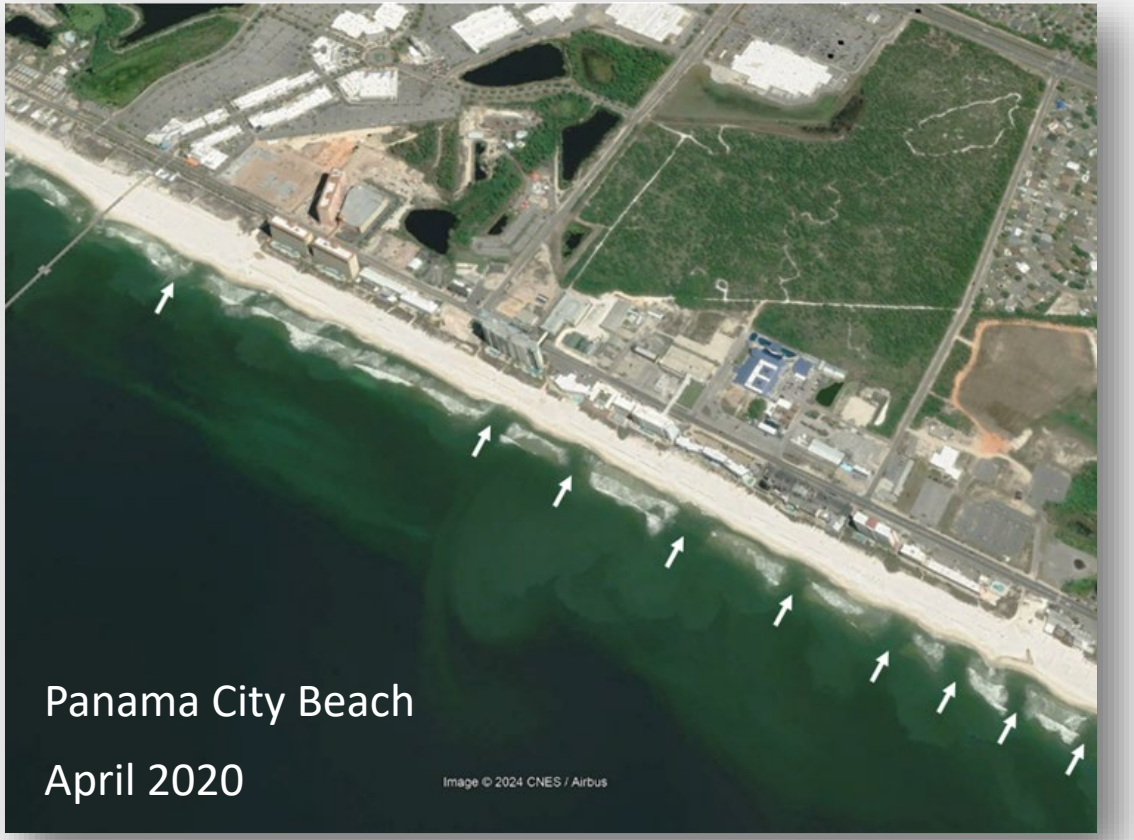
CONTRIBUTING FACTORS

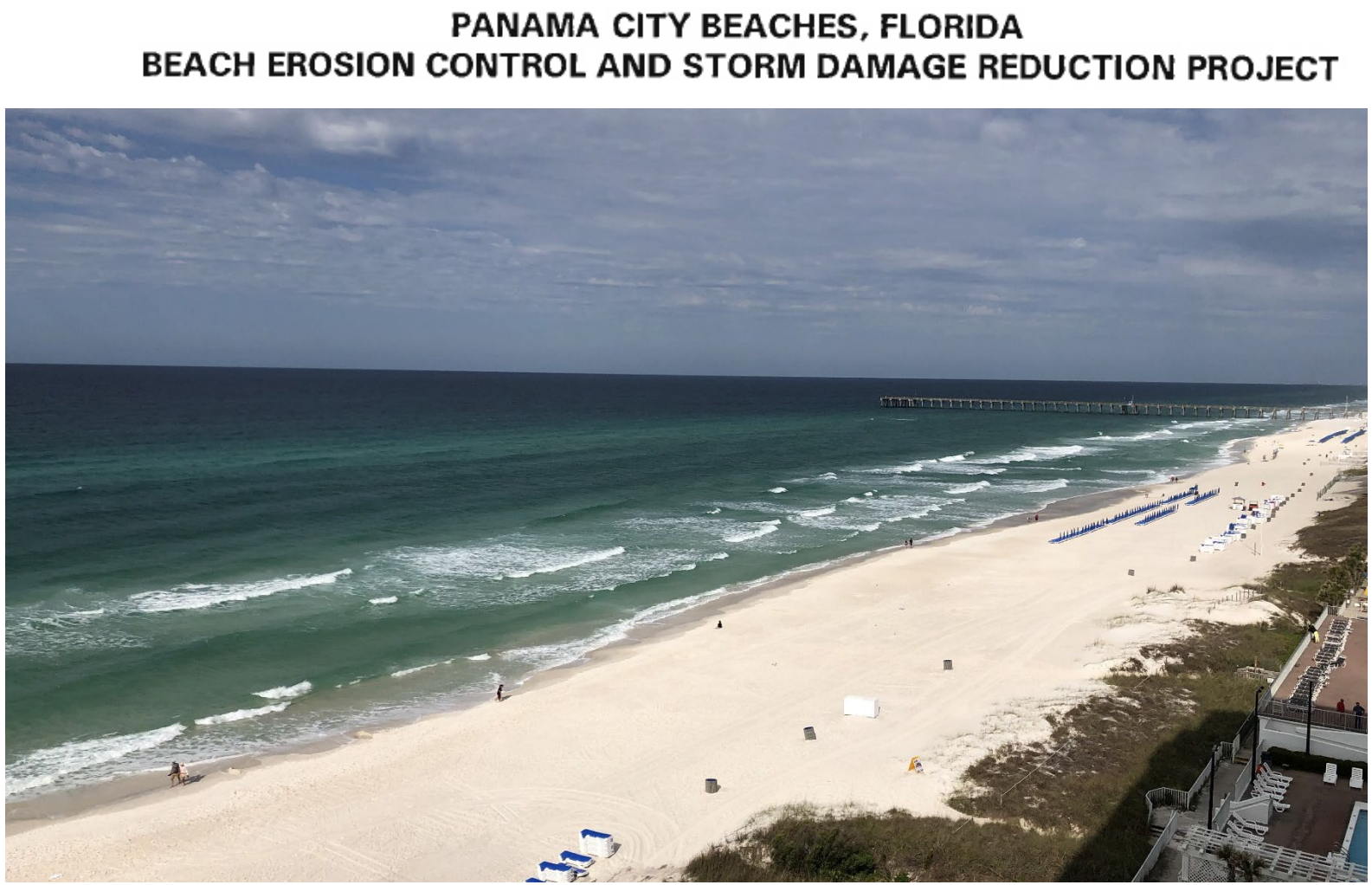
- Three main factors:
  - Wave characteristics
    - Height, period, direction
  - Nearshore sand bar formations
    - Presence/absence
  - Alongshore variability
    - Nearshore perturbations



- Other contributing factors:
  - Structures
  - Tidal elevation
  - Dynamic interactions between waves and bathymetry

PRE-PROJECT CONDITIONS

PANAMA CITY BEACH PROJECT



Construction Date	Location	Placed Volume (cy)	Administrator	Contractor
1998/1999	R-4 to R-91 (16.5 mi)	9,100,000	TDC	GLDD
2005/2006	R-1 to R-91 (17.5 mi)	3,300,000	USACE/TDC	Weeks Marine
2011	R-1 to R-29 R-85 to R-92 (8 mi)	1,370,000	USACE	GLDD
2017	R-OC to R-3 R-34 to R-40 R-52 to R-57 R-87 to R-91 (4 mi)	950,000	TDC	Weeks Marine
2021/2022	R-1 to R-41 R-62 to R-91 (13.7 mi)	2,300,000	USACE	GLDD

- 18 miles of beachfront
- Federally authorized
- First project in 1998/99
- 17 million cubic yards
- High quality sand

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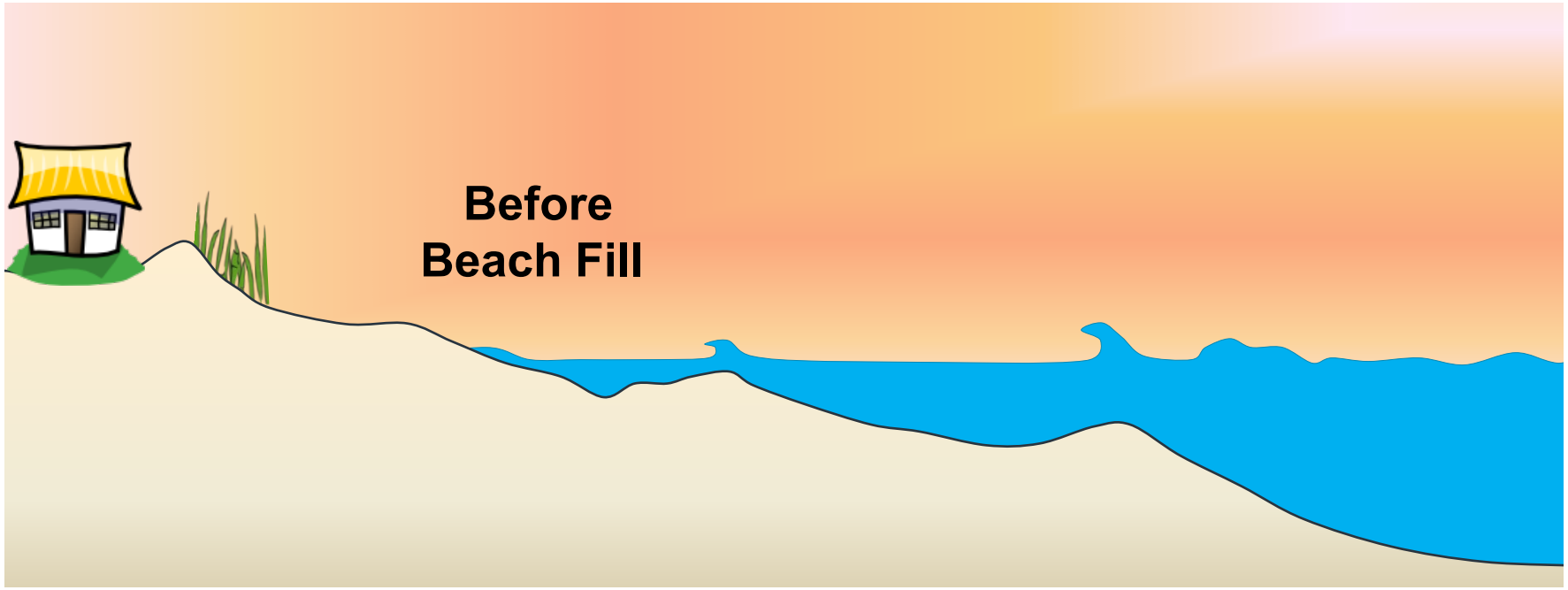
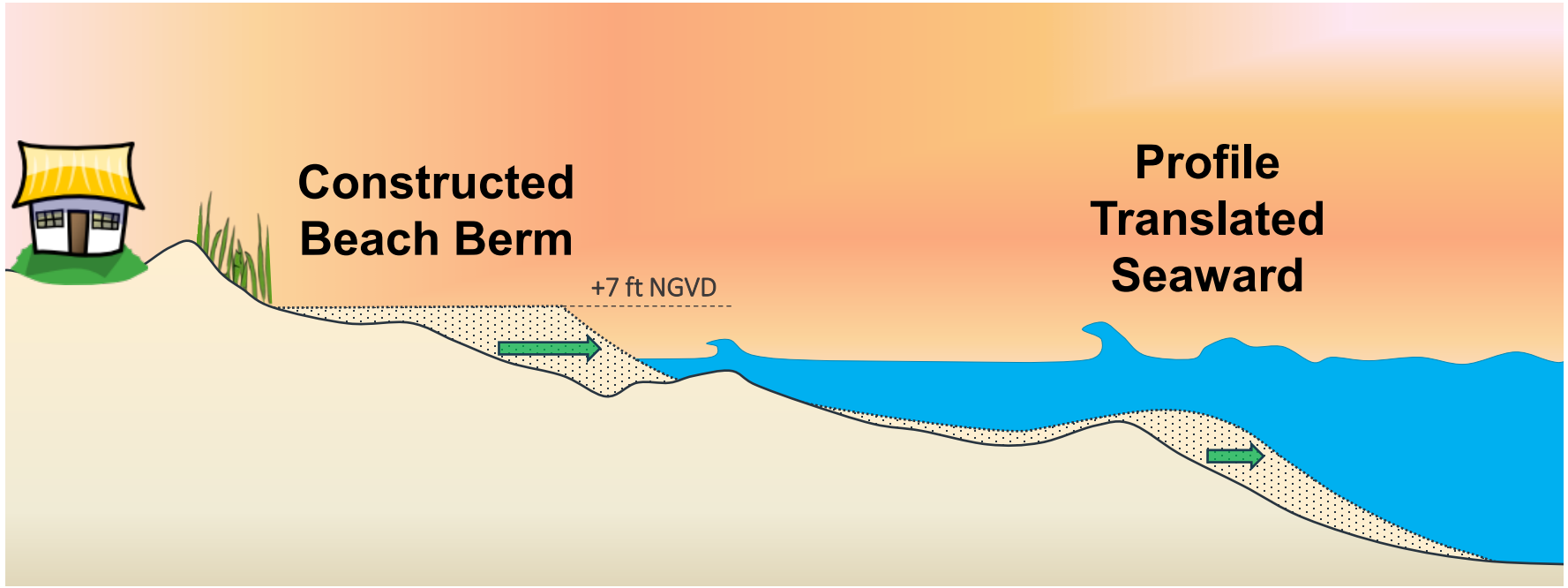
BEACH PROFILE TRANSLATION

- Pre-Project Conditions

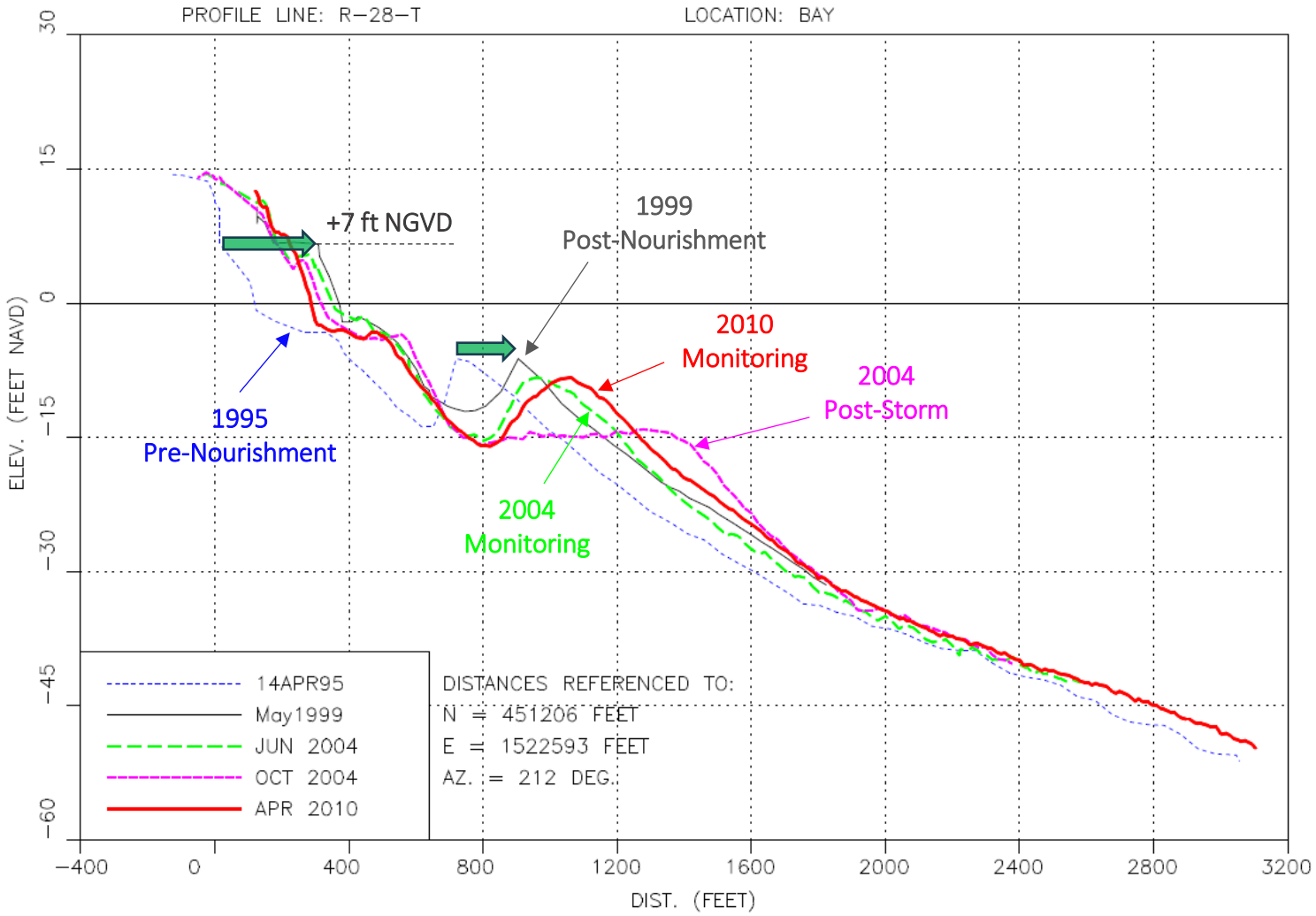


BEACH PROFILE TRANSLATION

- Post-Project Conditions



BEACH PROFILE EXAMPLE



- Profile translation from pre- to post-nourishment
- Storm waves flatten offshore bar and push sand into deeper water
- Post-storm profiles shows sand bar recovery
- Nearshore and offshore bar evident in all surveys as “double bar” profile

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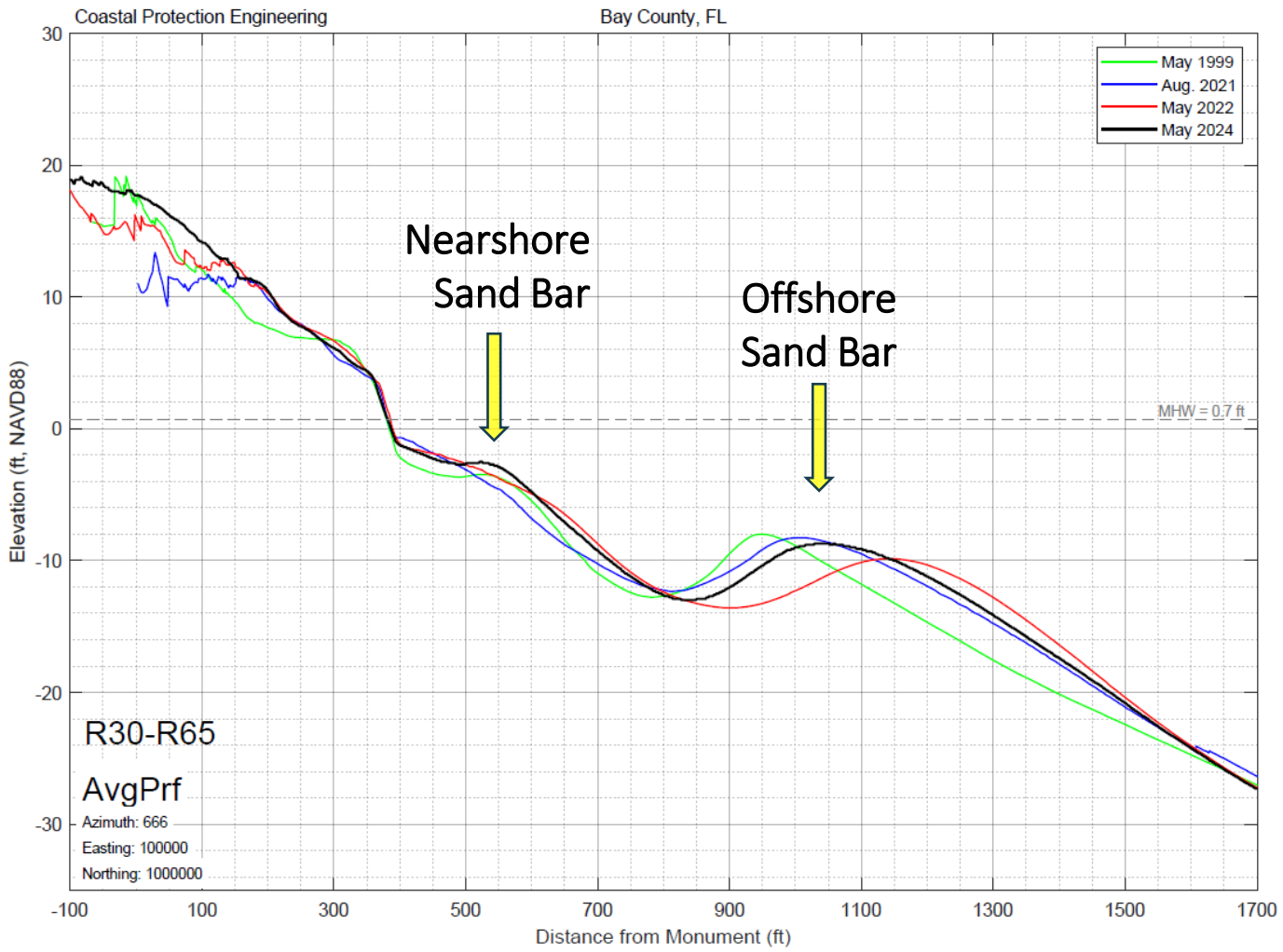
“AVERAGE PROFILE” ANALYSIS

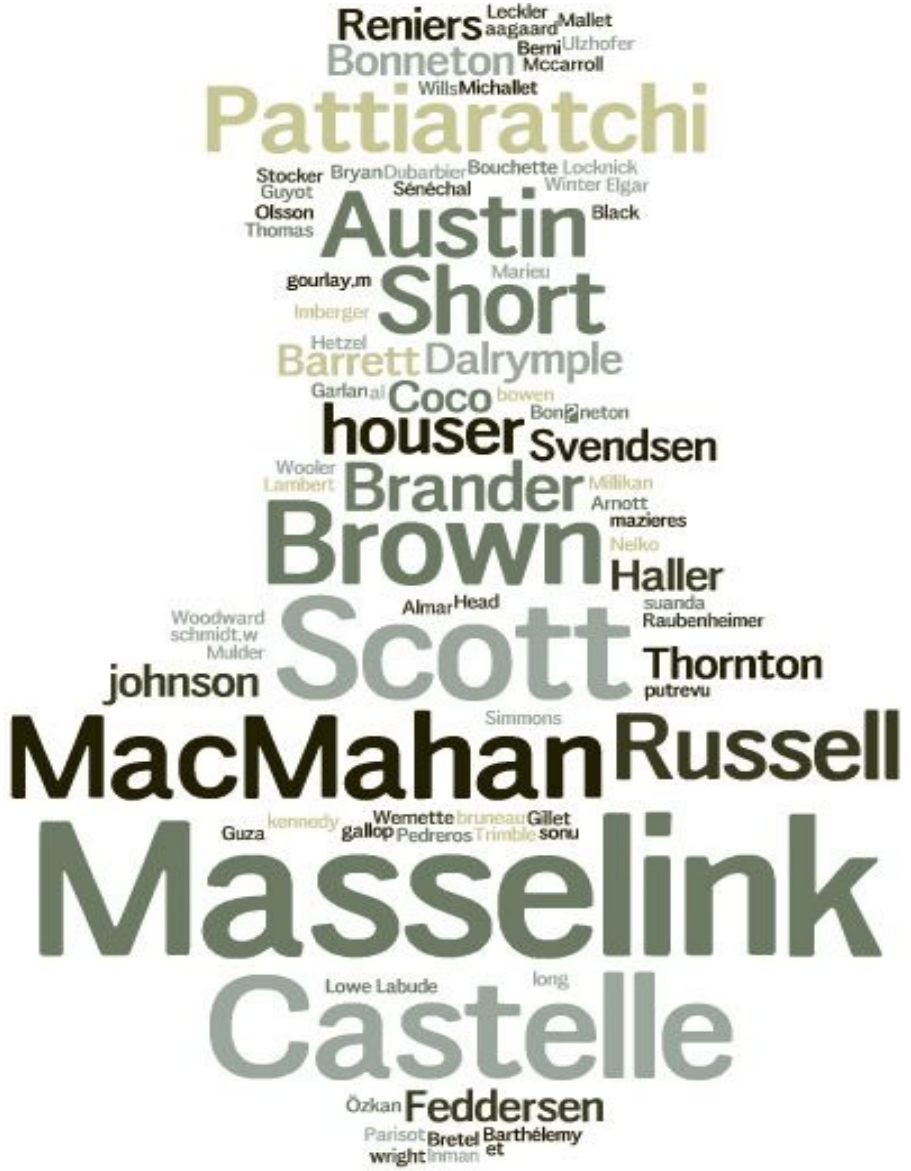


- Average of 35 locations in Panama City Beach
- Consistent occurrence of “double bar” shape
- Offshore sand bar movements governed by wave action:
  - Smaller waves - shallower and closer to shore
  - Larger waves - deeper and further offshore

LITERATURE REVIEW

- Over 40 technical references considered
- Literature review and analyses related to rip current science and beach morphology:
  - Theory of rip currents
  - Rip current types
  - Parameters that control development of rip currents on sandy beaches
  - Beach types

***Hypothesis**: beach nourishment would only affect the occurrence and magnitude of rip currents if the "beach type" changed …*



BEACH TYPE CLASSIFICATIONS

Wright and Short (1984)

Benedet *et. al.* (2004)

Benedet, Pierro, and Henriquez (2007)

MORPHODYNAMIC VARIABILITY OF SURF ZONES AND BEACHES: A SYNTHESIS*

L.D. WRIGHT and A.D. SHORT

Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, VA 23062 (U.S.A.)
Coastal Studies Unit, Department of Geography, University of Sydney, Sydney, N.S.W. 2006 (Australia)

Marine Geology, 56 (1984) 93—118
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

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Coastal Engineering 51 (2004) 839–861

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An International Journal for Coastal, Harbour and Offshore Engineers

www.elsevier.com/locate/coastaleng

Predicting the effect of beach nourishment and cross-shore sediment variation on beach morphodynamic assessment

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Impacts of coastal engineering projects on the surfability of sandy beaches

Shore & Beach ■ Vol. 75, No. 4 ■ Fall 2007

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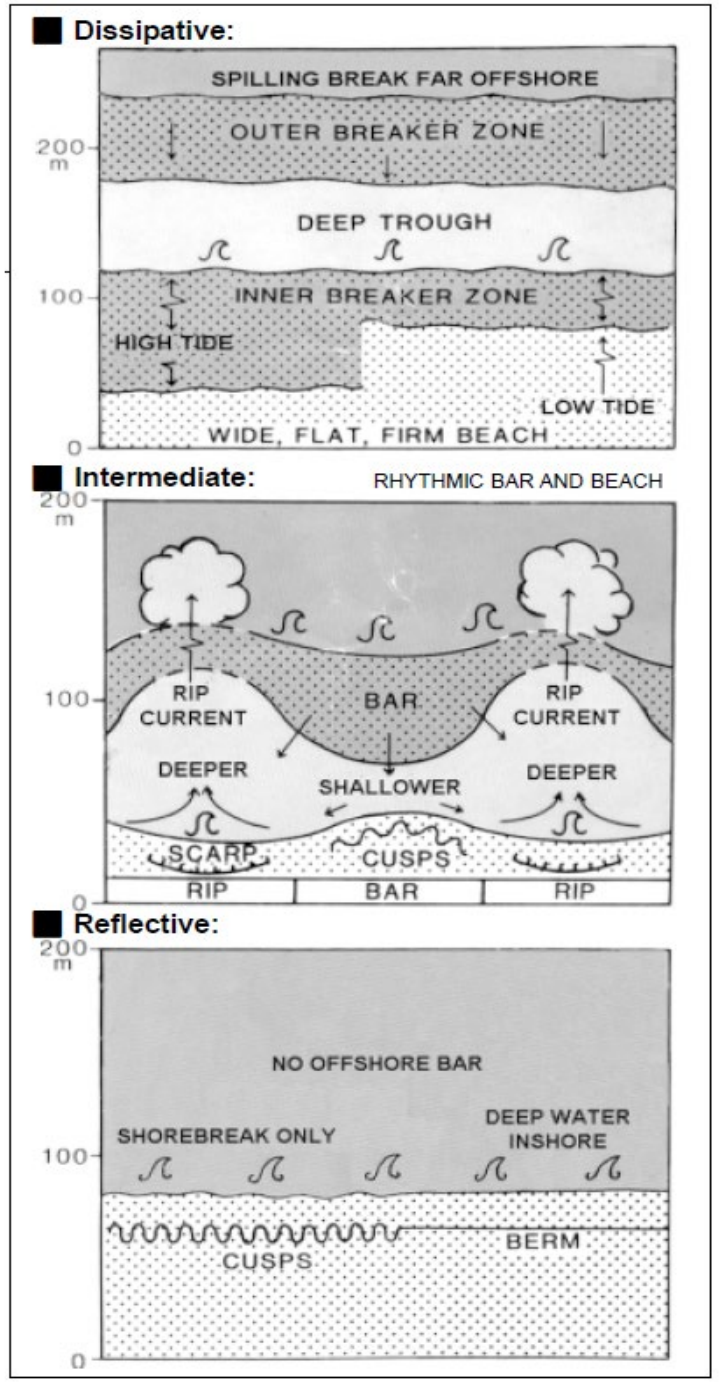

SAND COMPATIBILITY

- **Pre-Nourishment Mean Grain Size:**
  - 1997 = 0.28 mm
  - Intermediate Beach Type
- **Post-Nourishment Mean Grain Size:**
  - 1999 = 0.34 mm
  - 2004 = 0.33 mm
  - 2009 = 0.28 mm
  - 2017 = 0.38 mm
  - 2023 = 0.38 mm
- **Did the beach type change?**

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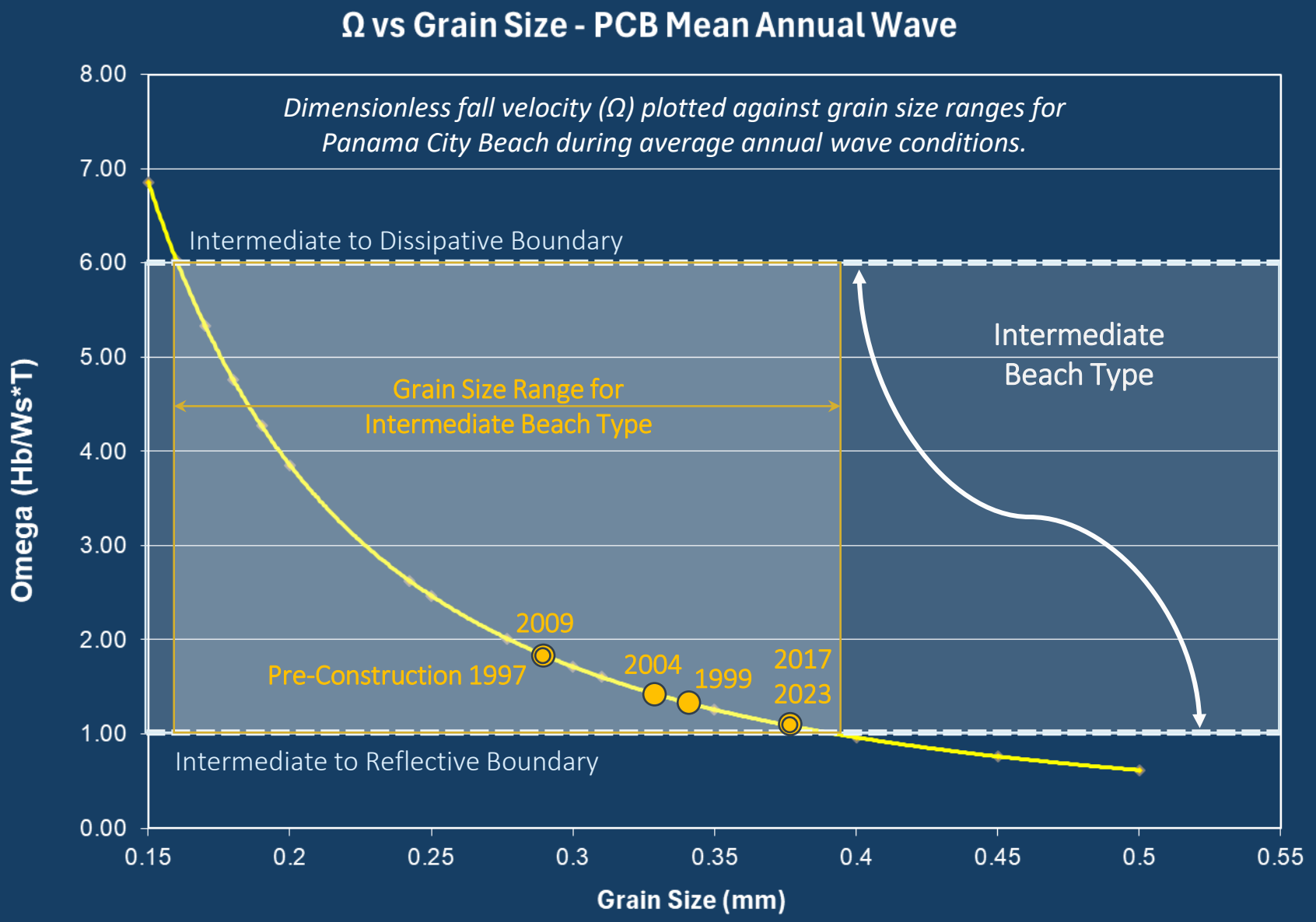
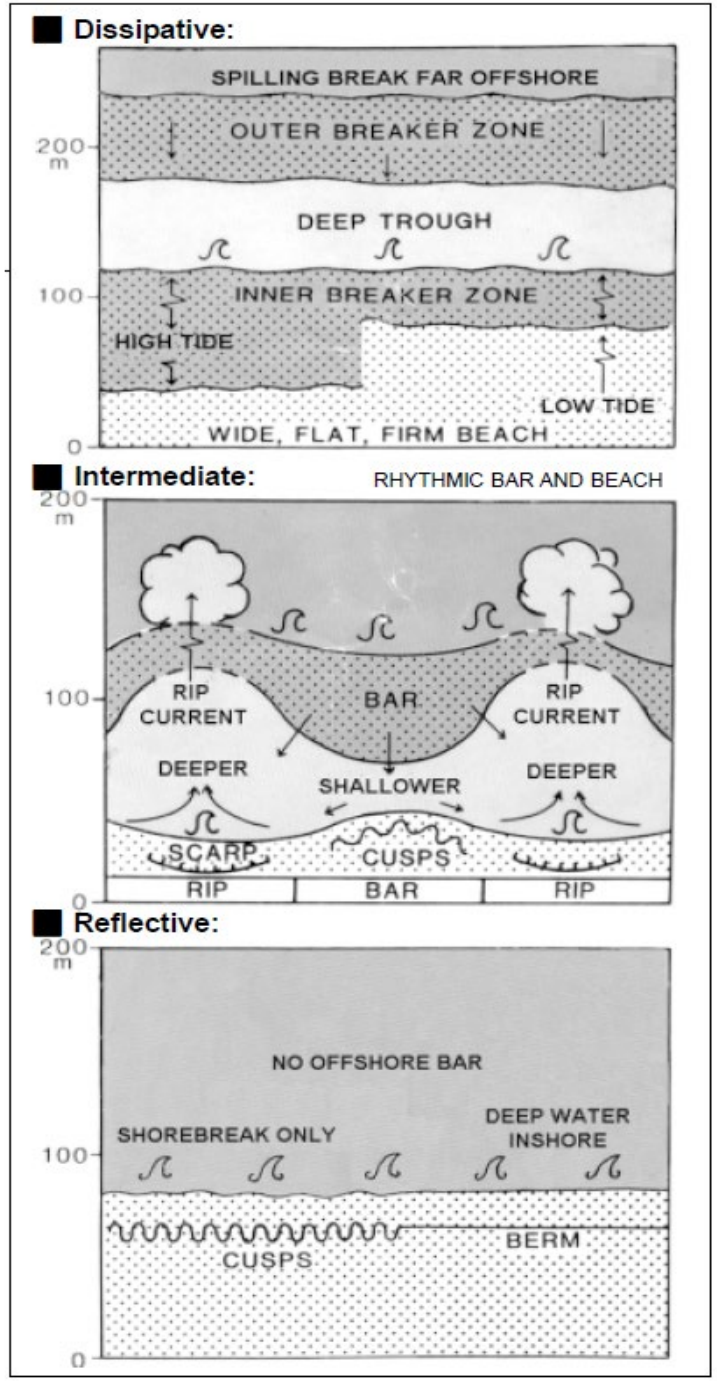
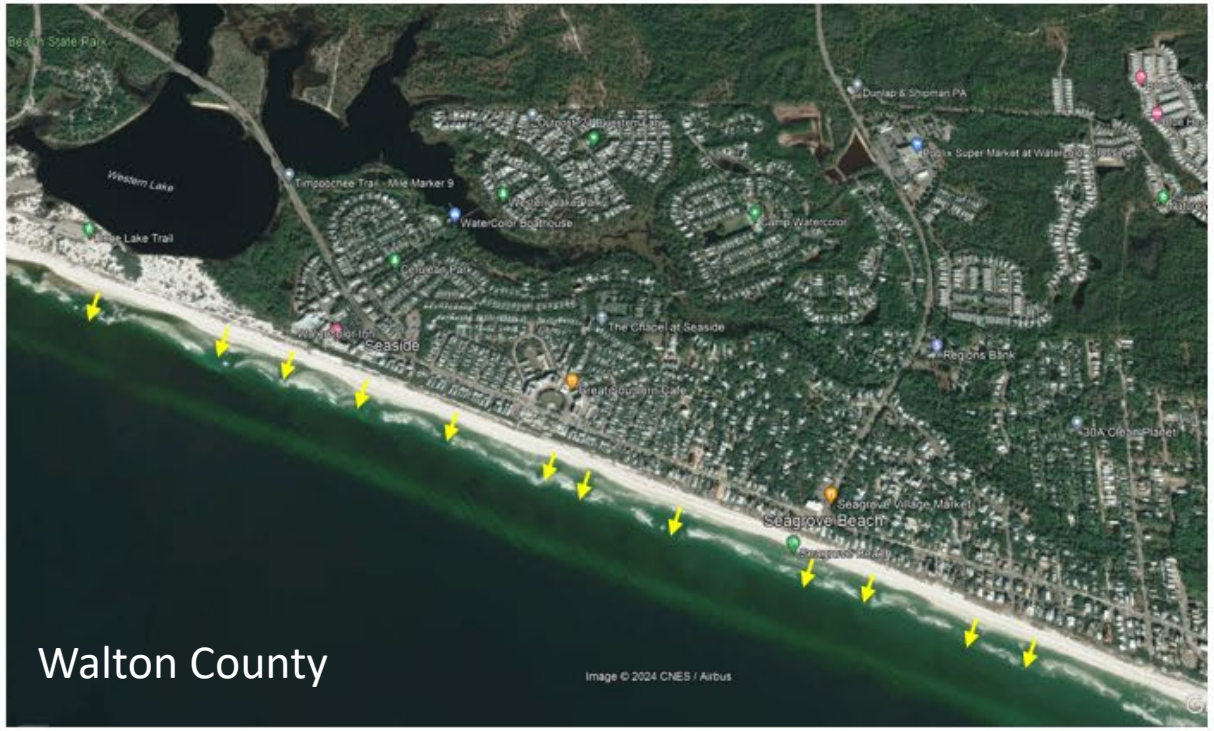




Beach type did not change due to fill placement

RIP CURRENTS AT NEIGHBORING BEACHES

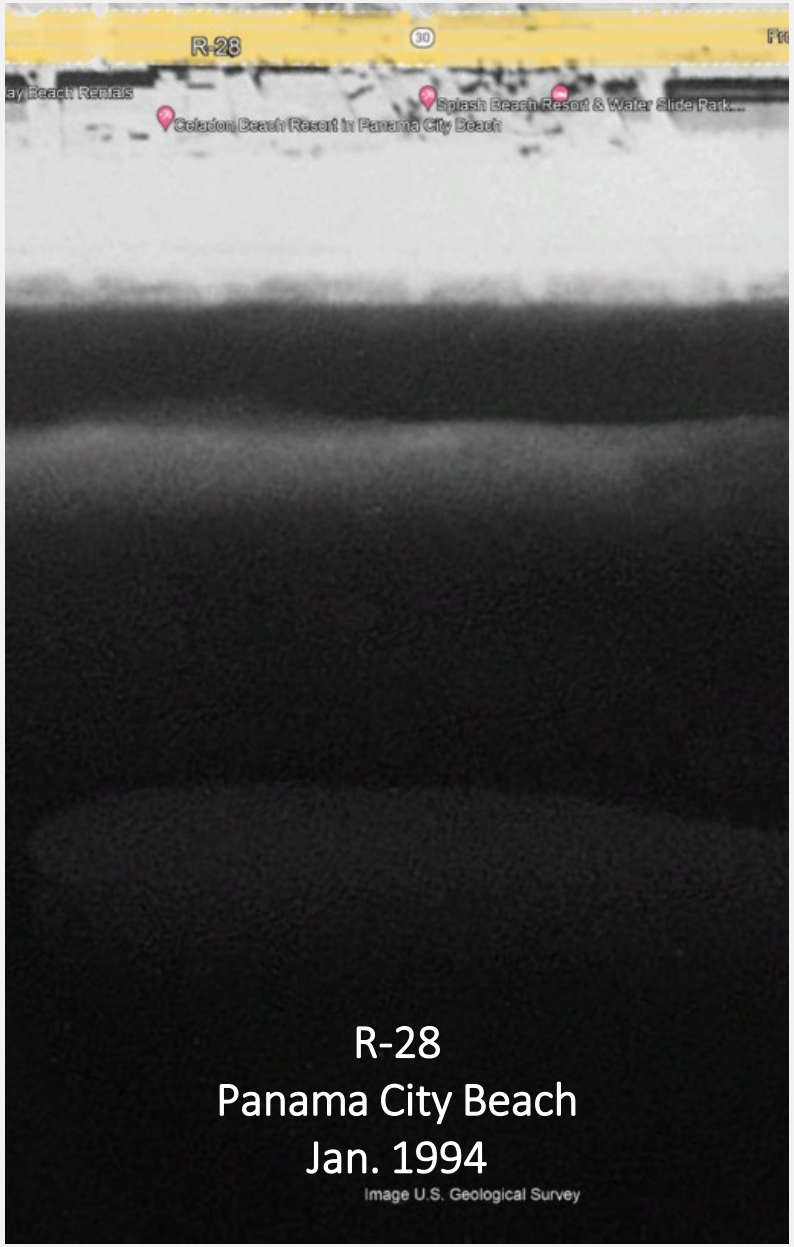
- Widely occurring process in the region …



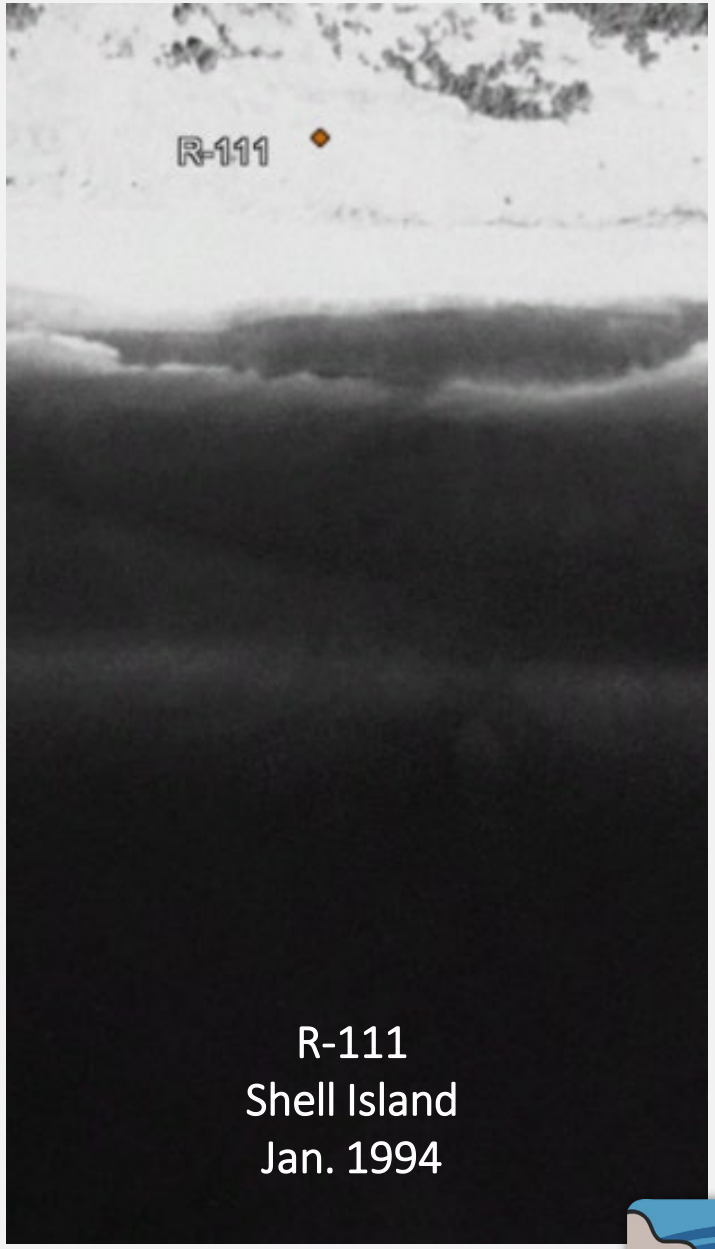
Walton County

Shell Island

R-117
Alys Beach, Walton County
Jan. 1994



R-28
Panama City Beach
Jan. 1994



R-111
Shell Island
Jan. 1994

Pre-Nourishment – Double Bar System

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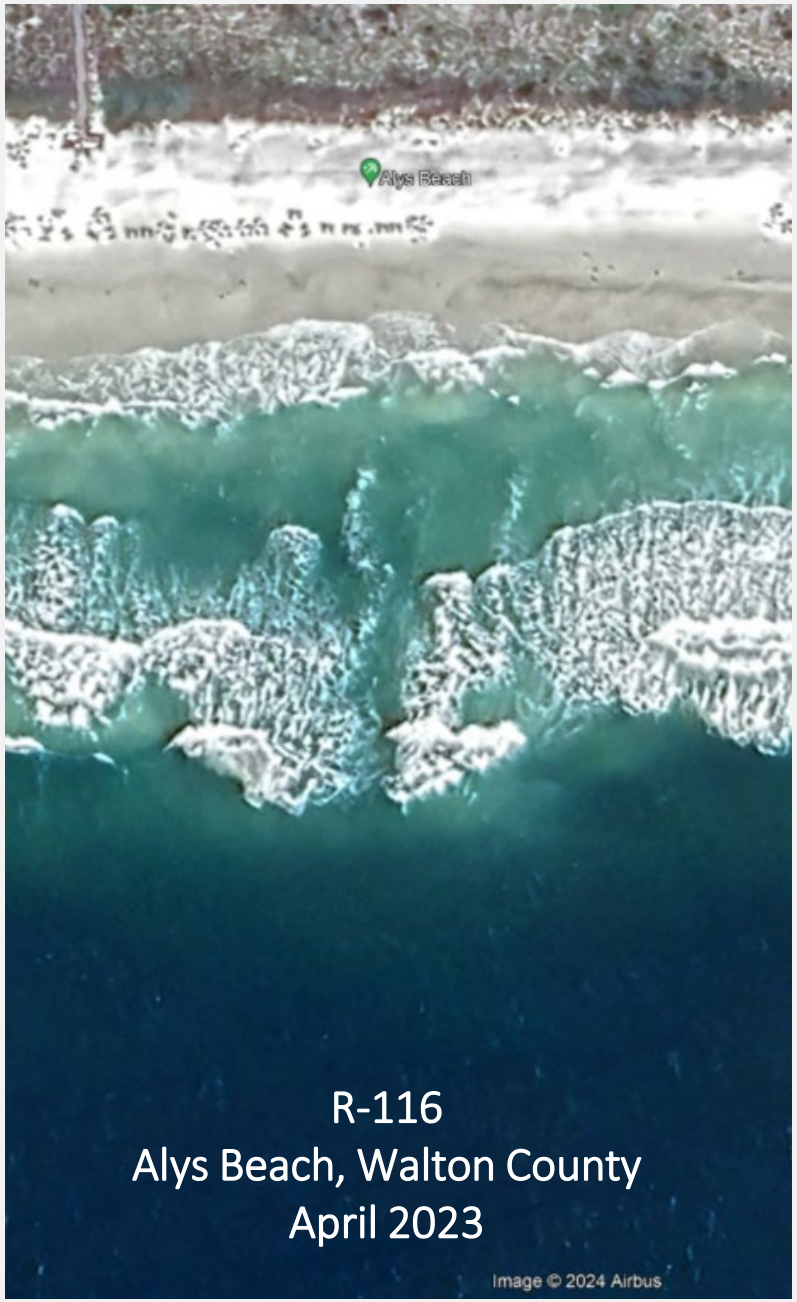
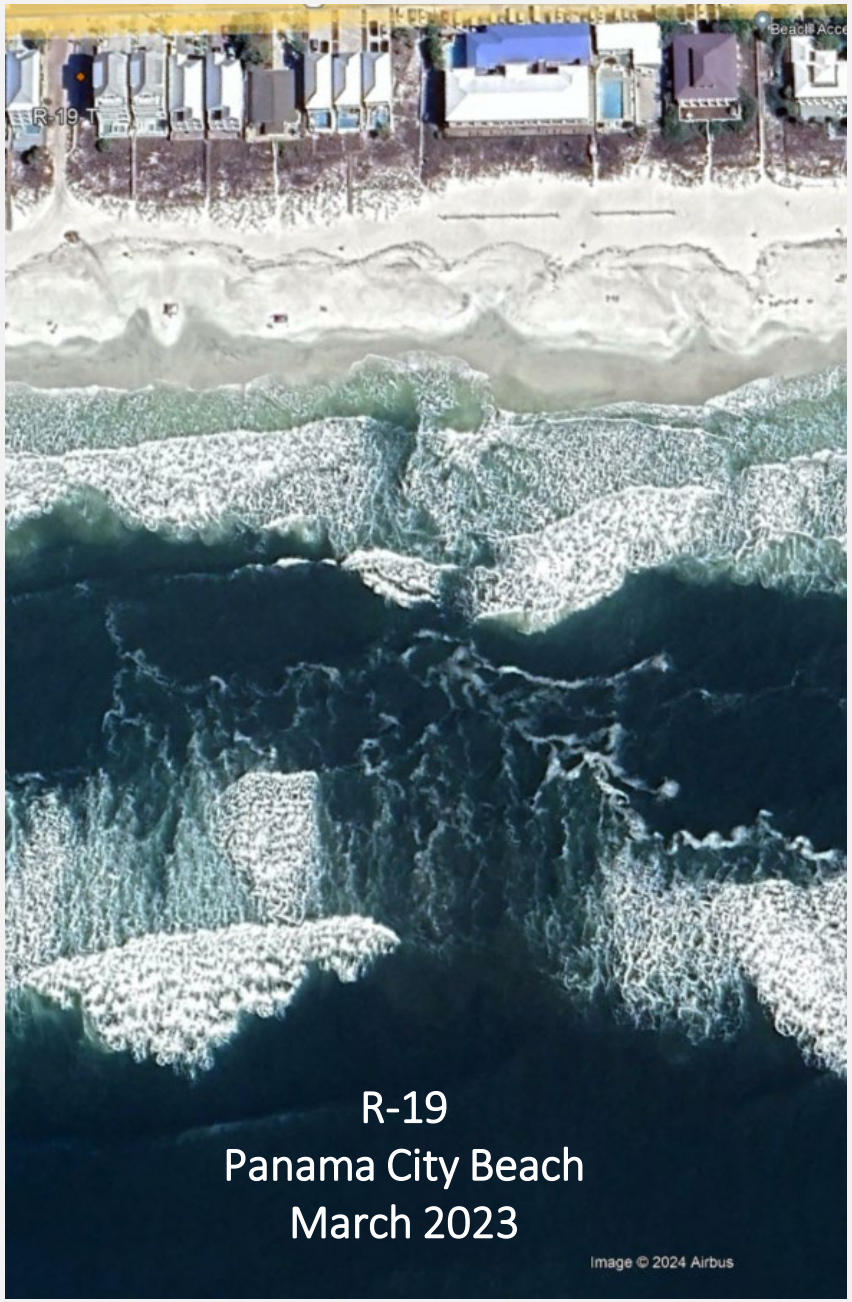
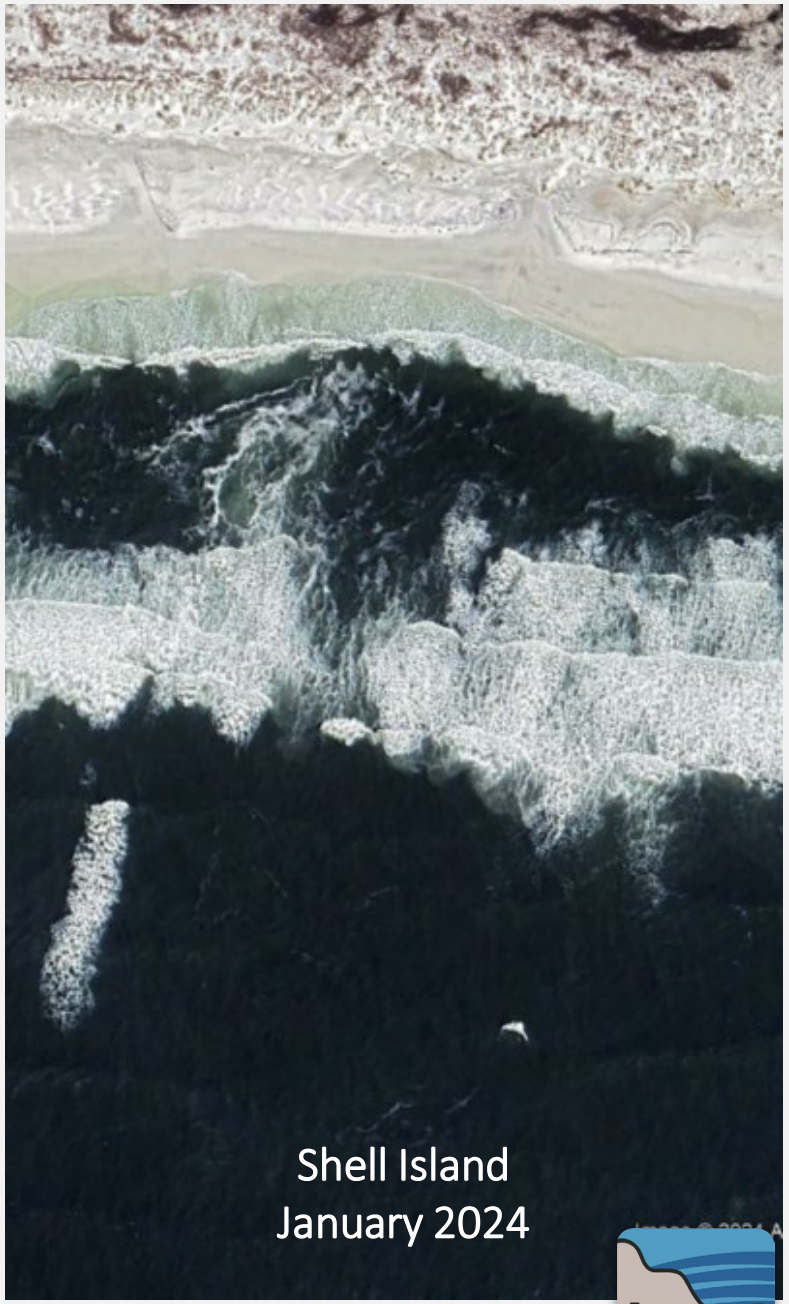


R-116
Alys Beach, Walton County
April 2023



R-19
Panama City Beach
March 2023



Shell Island
January 2024

Rip Currents during High Wave Conditions

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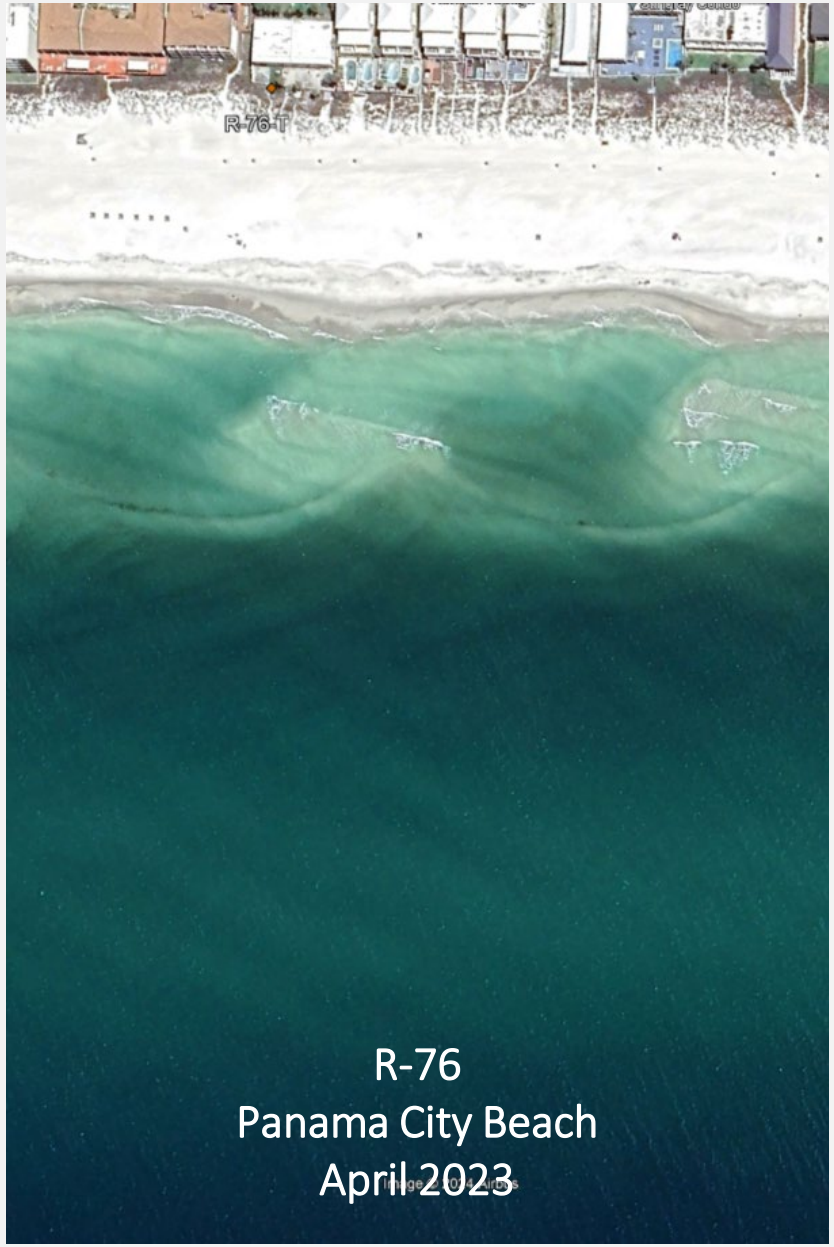
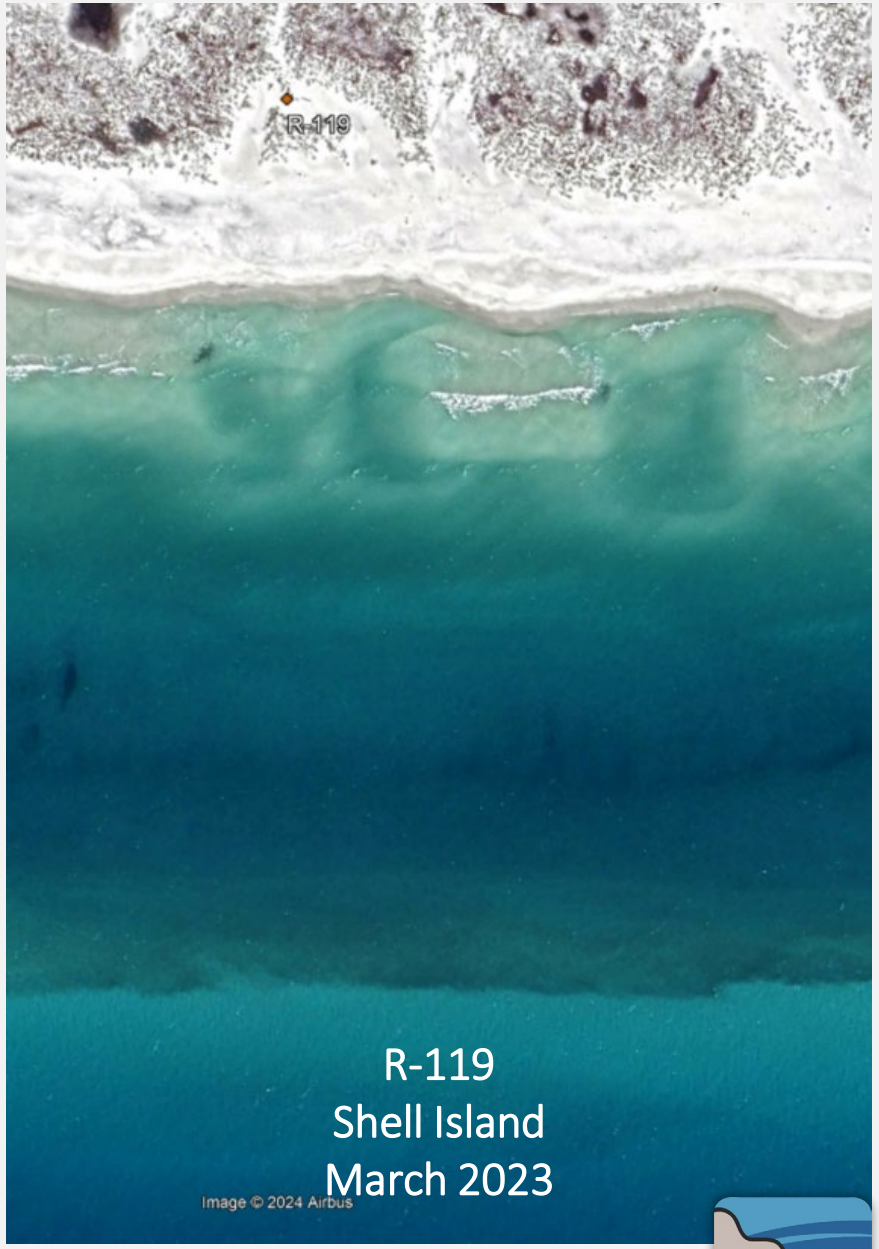
R-117
Alys Beach, Walton County
Oct. 2018



R-76
Panama City Beach
April 2023



R-119
Shell Island
March 2023

Alongshore Variability and Rip Channels

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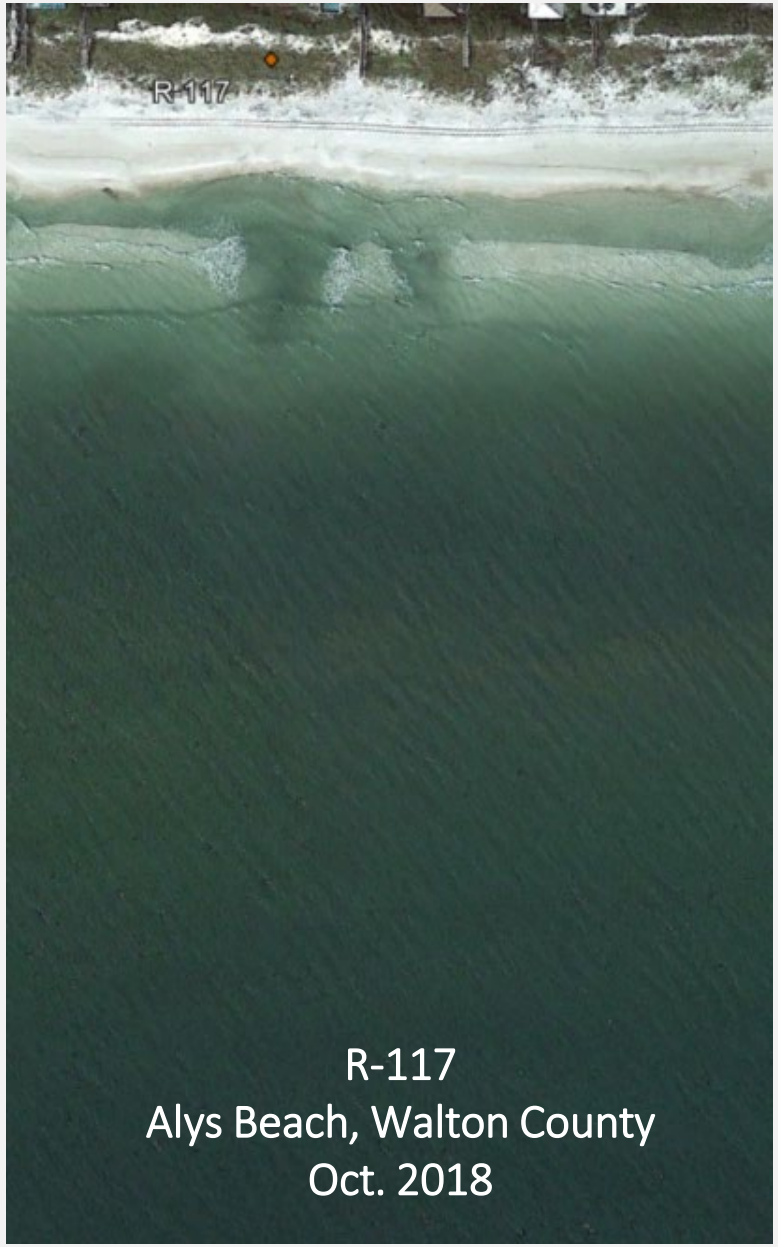
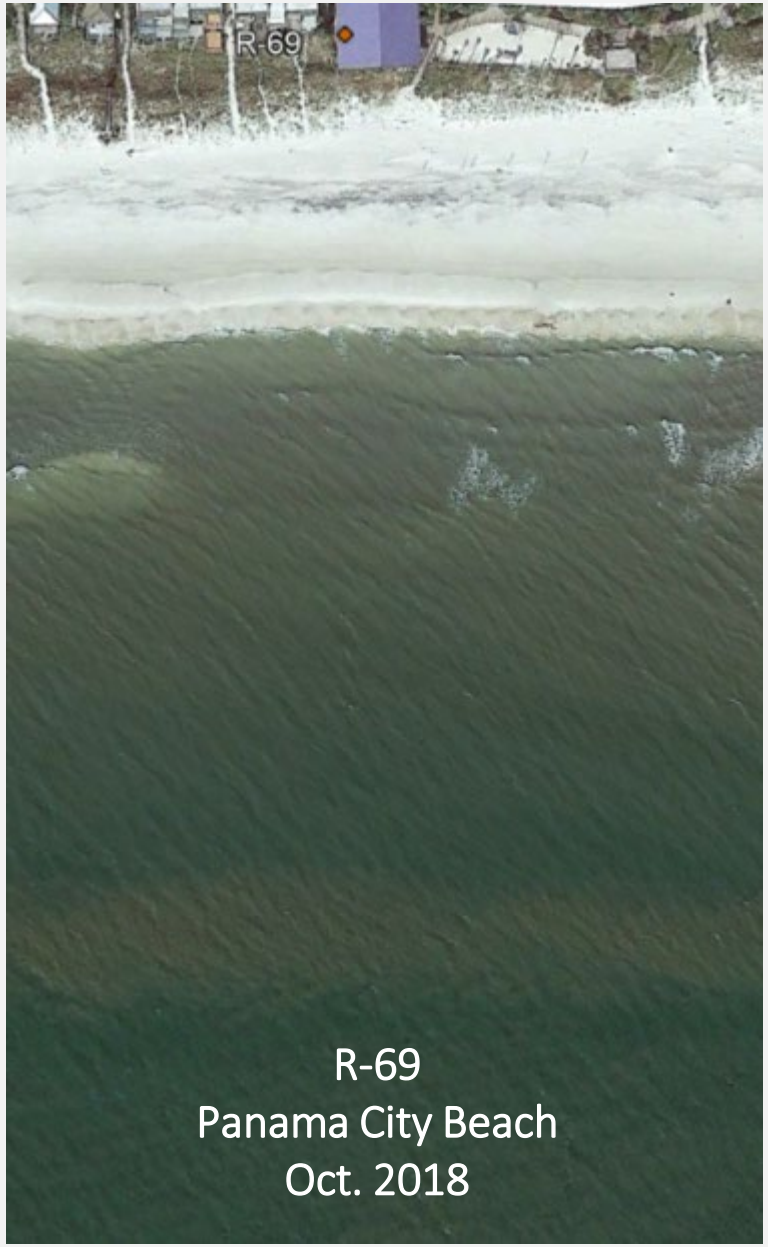


R-117
Alys Beach, Walton County
Oct. 2018



R-69
Panama City Beach
Oct. 2018

R-110
Shell Island
Oct. 2018

Oct 2018 - Post-Hurricane Michael

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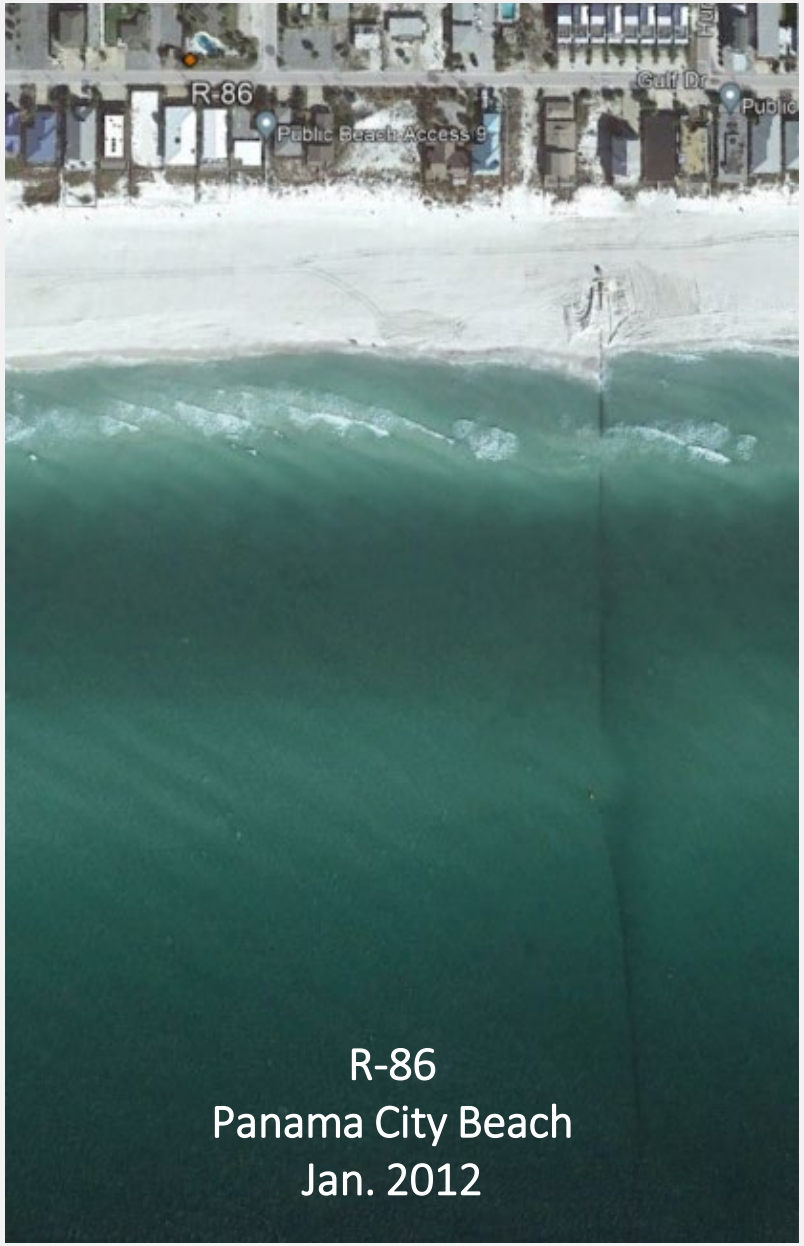
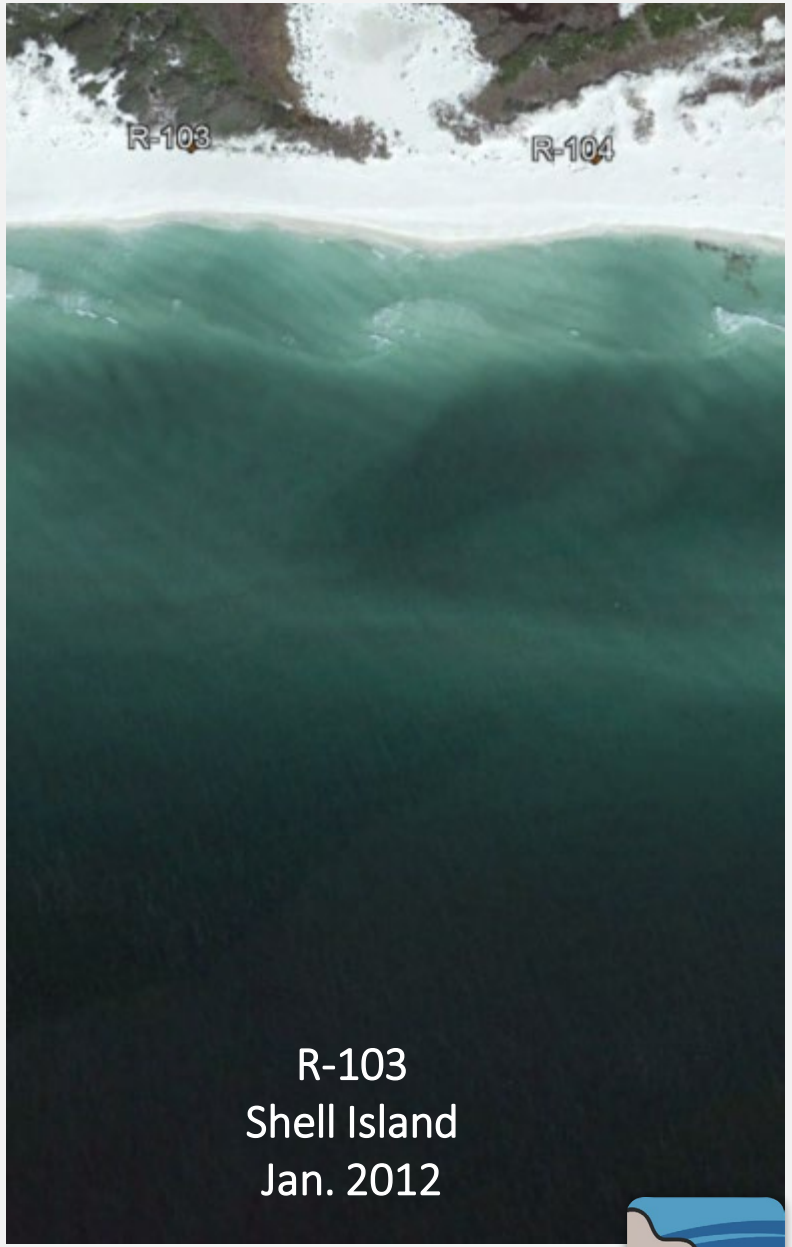
R-117
Alys Beach, Walton County
Jan. 2012



R-86
Panama City Beach
Jan. 2012



R-103
Shell Island
Jan. 2012

Jan 2012 – Post Renourishment Project

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STUDY CONCLUSIONS

- Rip currents are a worldwide natural phenomenon.
- Entirely an “in-water” circulation process that returns water from the nearshore back to the sea in a concentrated flow.
- Formed under certain combinations of wave conditions, sand bar morphology, alongshore variability, tides, structures, etc.
- Beach nourishment would not affect the frequency and magnitude of rip currents unless the dominant beach type (morphology) changes.
- The beach/bar/profile shape in the project area has not changed significantly over time to have affected these processes.
- Rip currents are not unique to nourished beaches, or Panama City Beach; similar wave events cause rip currents in neighboring beaches.

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OVERALL FINDING

There is no evidence in the literature or data reviewed to suggest the beach nourishment program has resulted in an abnormal increase in rip currents along Panama City Beach.

THANK YOU!

FLORIDA SHORE & BEACH
PRESERVATION ASSOCIATION
A League of Cities and Counties on Beach and Coastal Issues

38th Annual National Conference on
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February 2025, Panama City Beach

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Panama City Beach Convention & Visitors Bureau (CVB)
Bay County and the Panama City Beach Tourist Development Council (TDC)
The CPE-APTIM Project Team