2025 Inlet Hazard Area (IHA) Update

CRC's Science Panel on Coastal Hazards

August 28, 2025

NORTH CAROLINA
Department of Environmental Quality

Why Inlet Hazard Areas?

CRC's Charge to the Science Panel

01

Perform 5-year re-evaluation of IHA methods and boundaries, incorporating data collected since the 2019 study.

02

Evaluate end-point and linear regression methods, and consider alternative methods, for calculating oceanfront shoreline change rates.

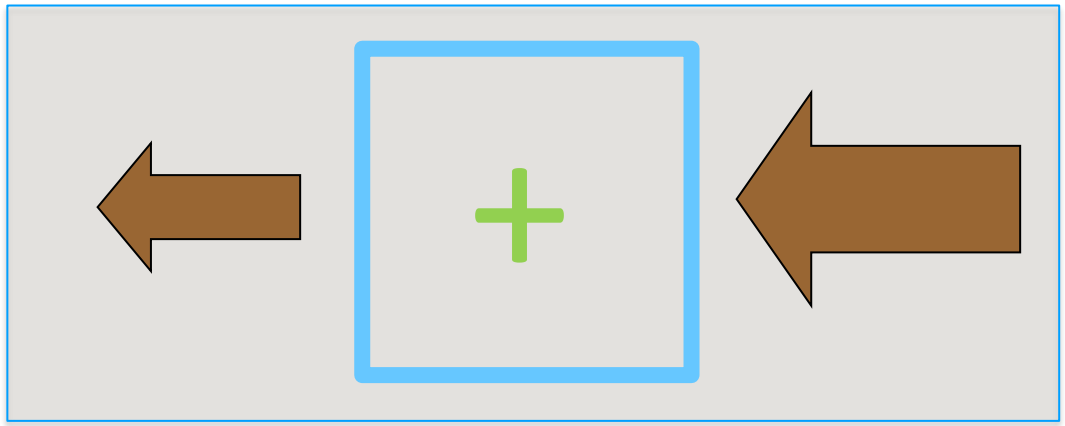
03

Present results at CRC meeting.

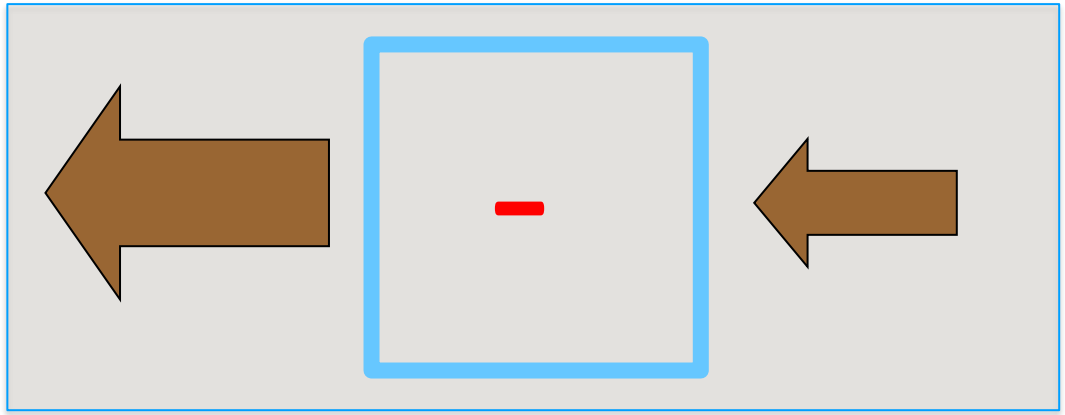
Outline:

- Review of Coastline and Inlet Processes
- The Inlet Hazard Area Method (IHAM)
- Applying the IHAM
- Summary & Recommendations

Change in shoreline position determined by a balance between losses and gains of sand



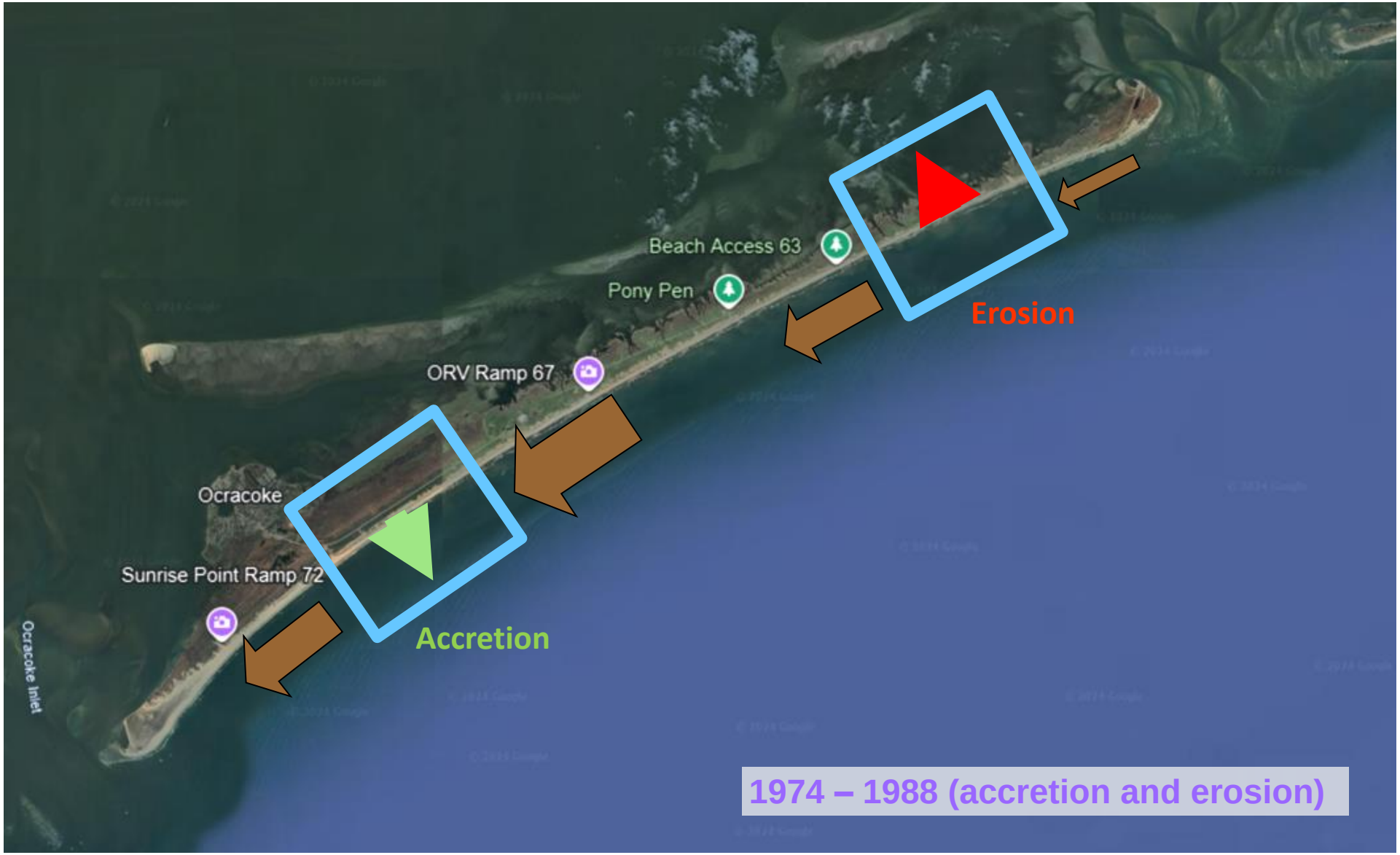
Positive Balance = **Accretion**



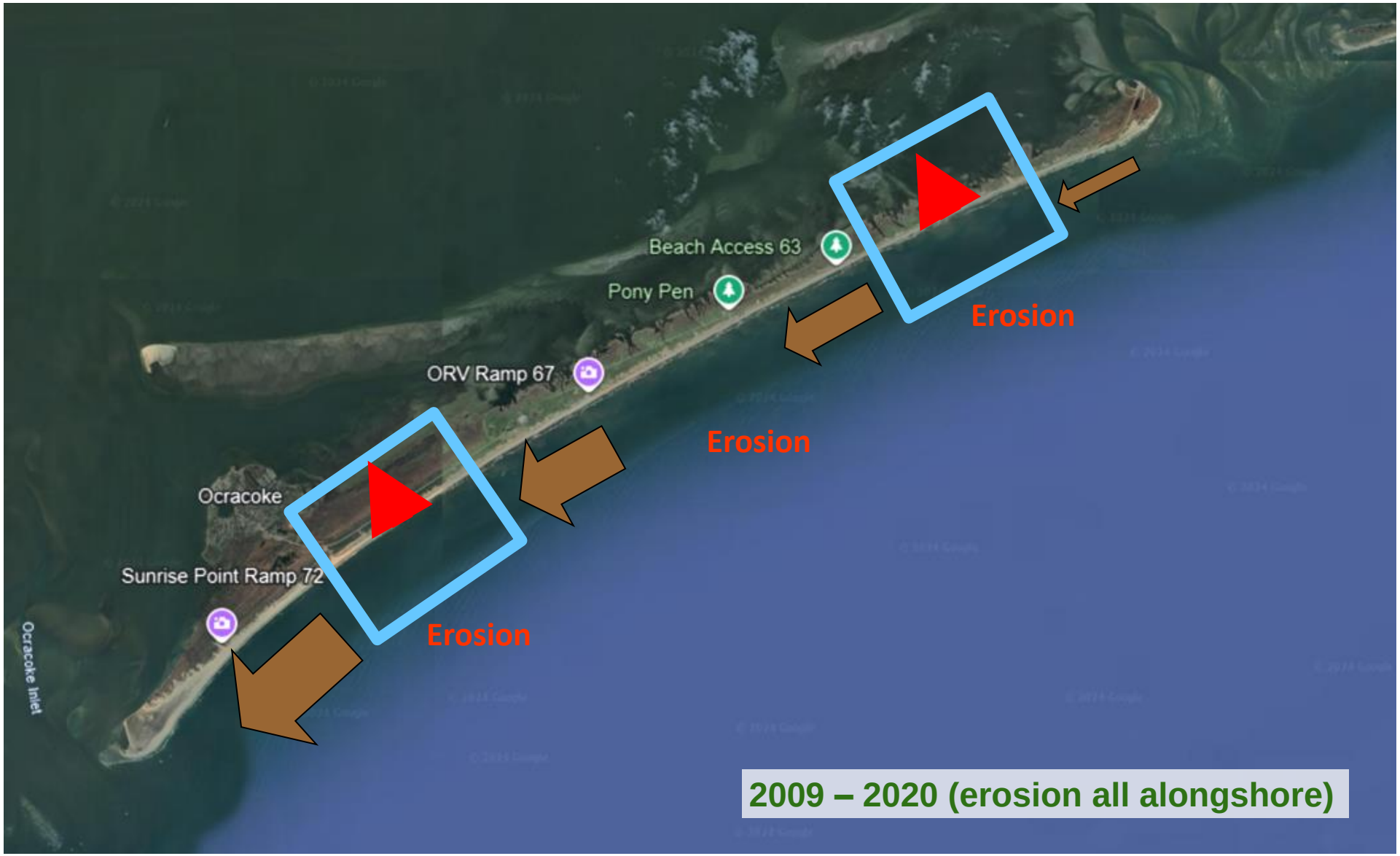
Negative Balance = **Erosion**

Both alongshore balance and cross-shore balance matter

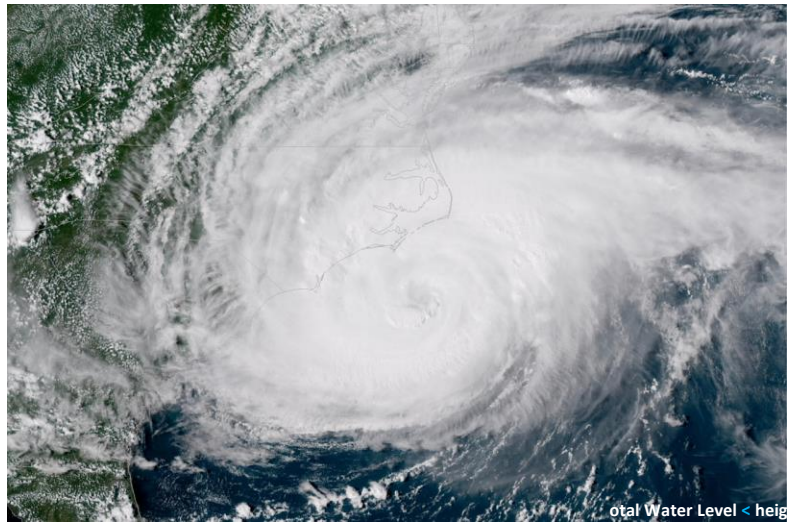
Chronic Shoreline Erosion - *alongshore balance*



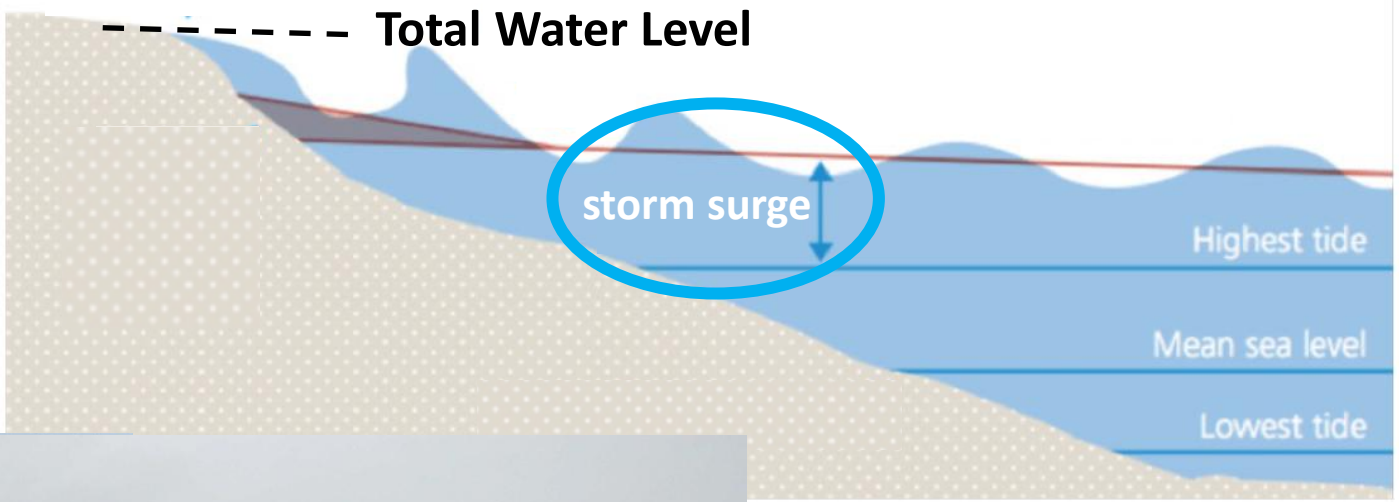
Chronic Shoreline Erosion - *alongshore balance*



Chronic Shoreline Erosion – *cross-shore balance*

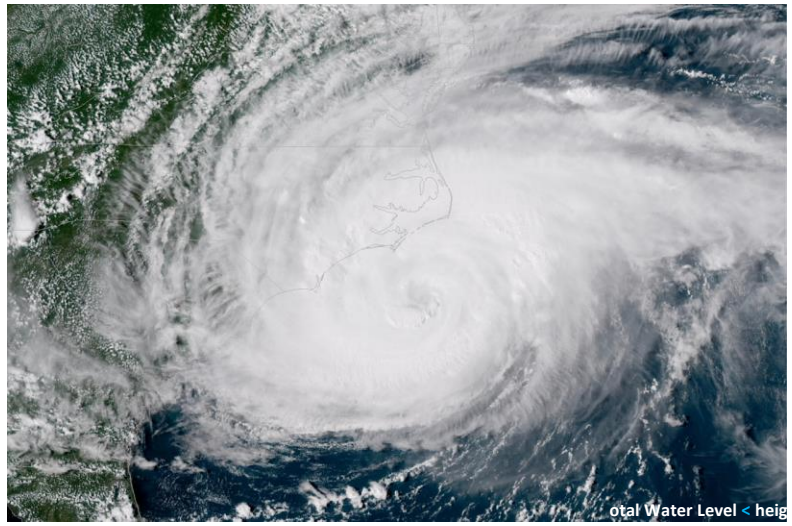


Storm surge + waves elevate Total Water Level

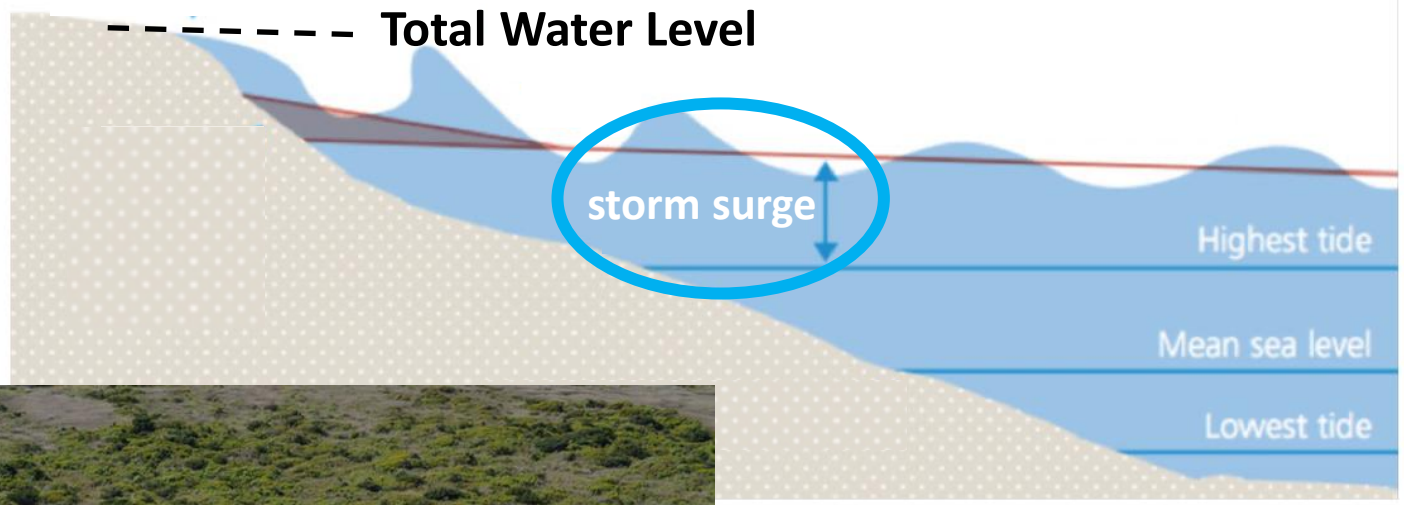


Total Water Level below dune/back-beach = sand moved offshore; returns in fair weather

Chronic Shoreline Erosion – *cross-shore balance*



Storm surge + waves elevate Total Water Level



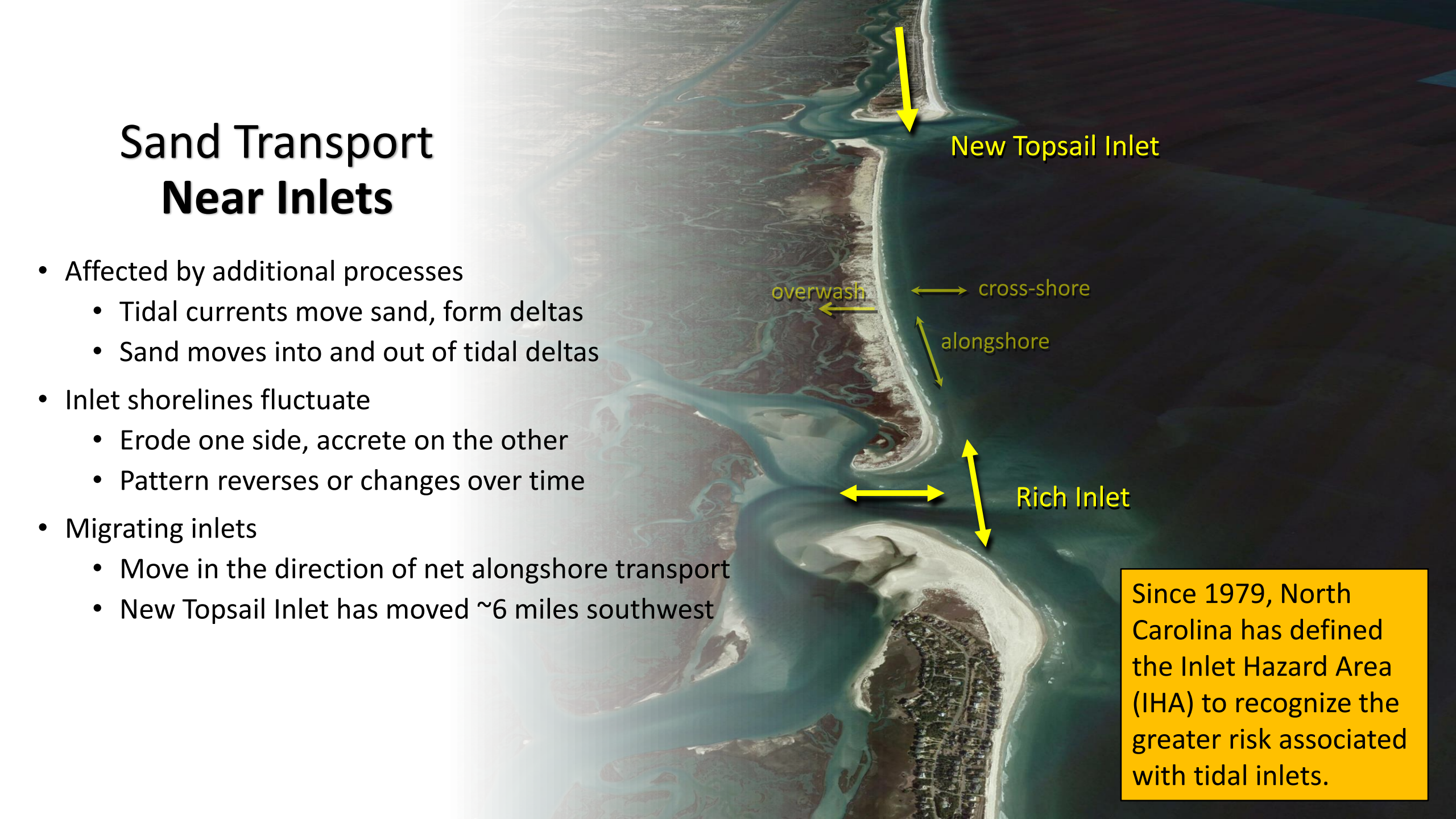
Total Water Level
above dune/back-beach
= sand moves onshore
= shoreline erosion

Sand Transport on **Open Coast**

- **Accretion vs. Erosion determined by**
  - Balance in alongshore sand transport
  - Balance in cross-shore sand transport
- **Uninterrupted by inlets and structures**
  - Shoreline change is similar alongshore
  - Fairly predictable
  - Typical of Ocean Erodible Areas (OEA)

Sand Transport **Near Inlets**

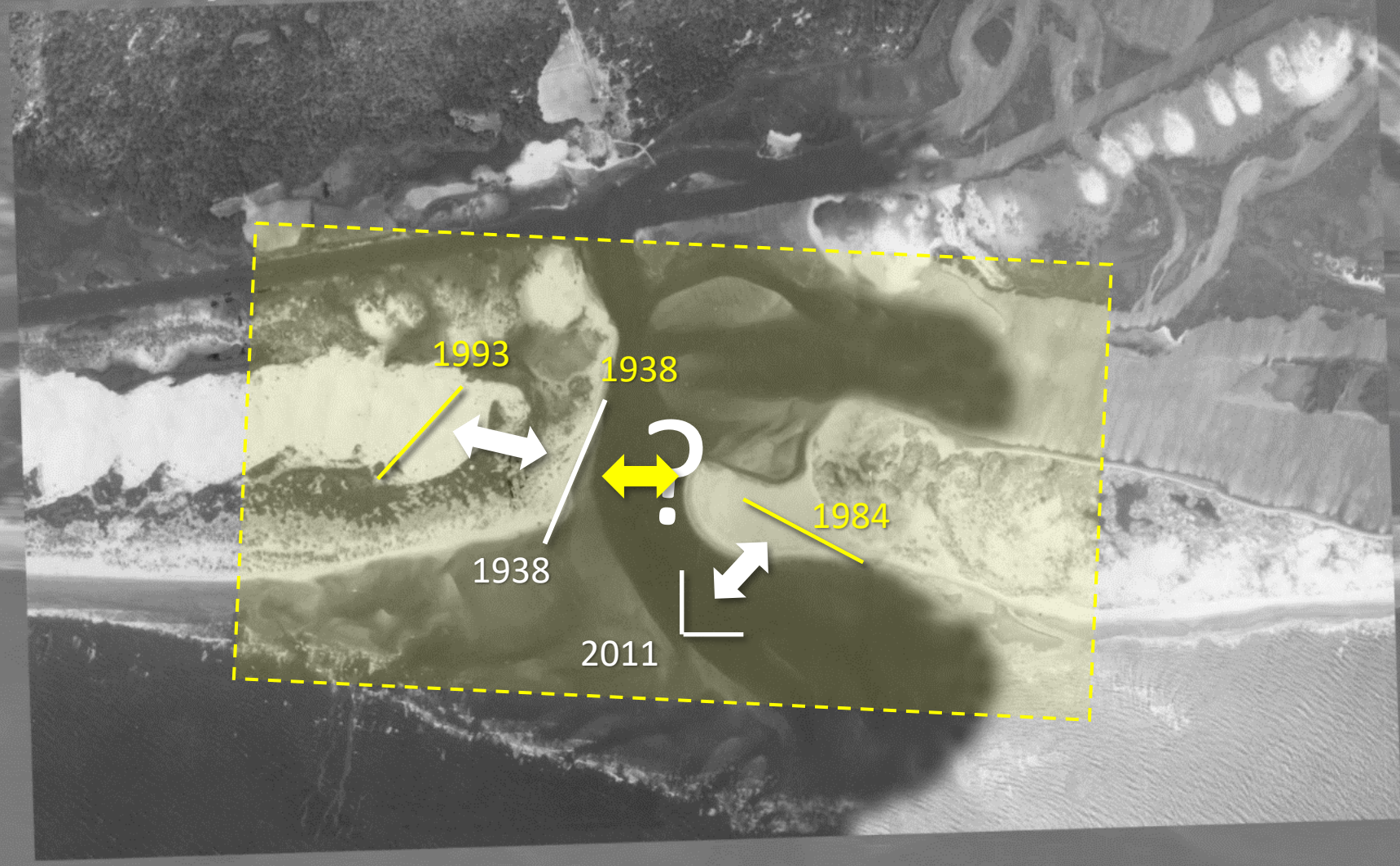
- Affected by additional processes
  - Tidal currents move sand, form deltas
  - Sand moves into and out of tidal deltas
- Inlet shorelines fluctuate
  - Erode one side, accrete on the other
  - Pattern reverses or changes over time
- Migrating inlets
  - Move in the direction of net alongshore transport
  - New Topsail Inlet has moved ~6 miles southwest



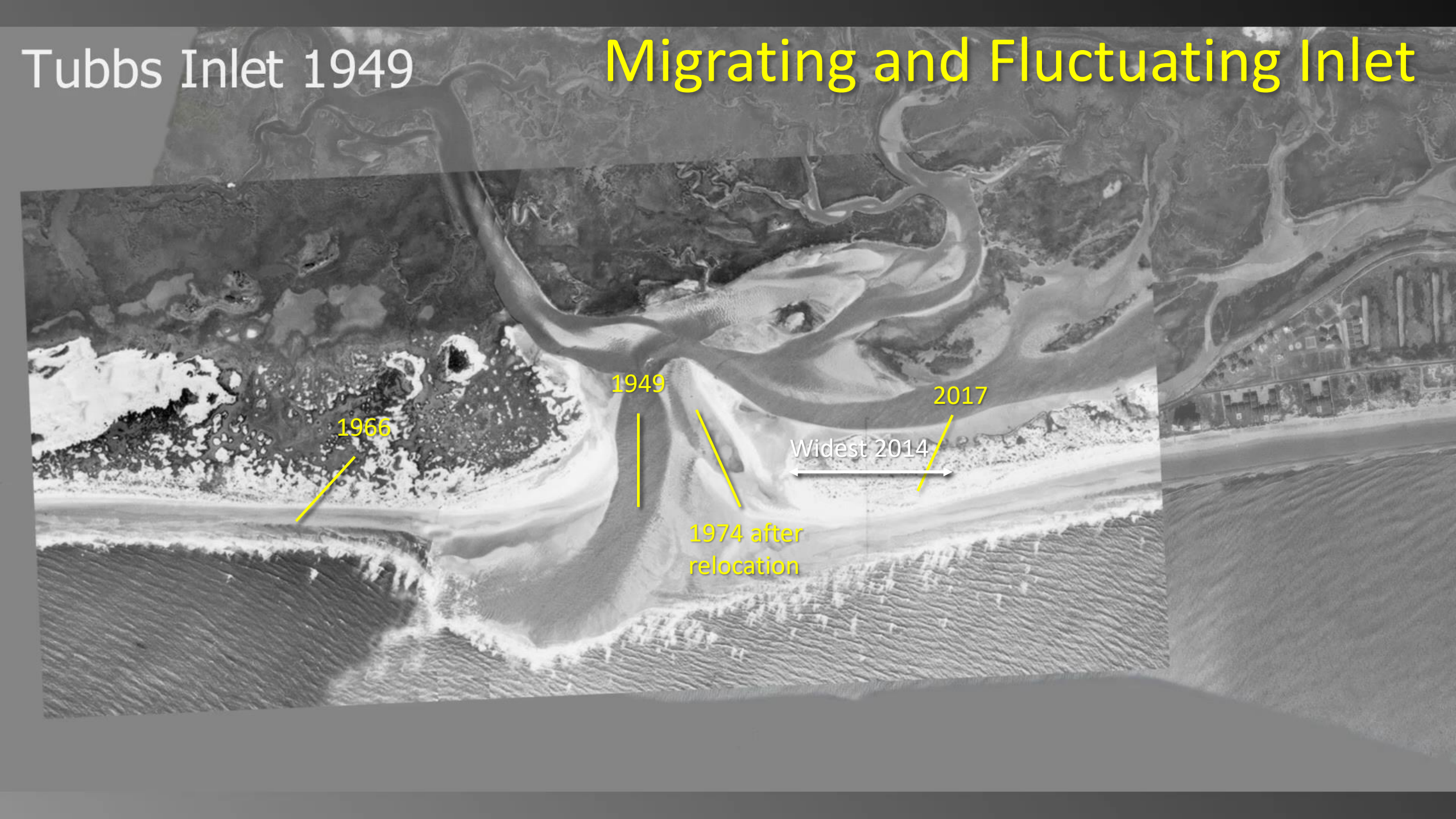
Since 1979, North Carolina has defined the Inlet Hazard Area (IHA) to recognize the greater risk associated with tidal inlets.

Lockwood Folly Inlet 1938

Fluctuating Inlet



Migrating and Fluctuating Inlet



Update the IHA for these 10 Inlets

- Tubbs Inlet
- Shallotte Inlet
- Lockwood Folly Inlet
- Carolina Beach Inlet
- Masonboro Inlet
- Mason Inlet
- Rich Inlet
- New Topsail Inlet
- New River Inlet
- Bogue Inlet

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Review of Ocean Erodible Area (OEA) Setback Calculation Process:

1. Map shorelines

2. Calculate long-term erosion rates (LRR)

3. Identify **existing** vegetation line

4. Measure Setbacks & OEA:

(min. Setback = 30 x ER) (max Setback & OEA = 90 x erosion rate)

The Inlet Hazard Area Mapping (IHAM) Process

1. Map shorelines

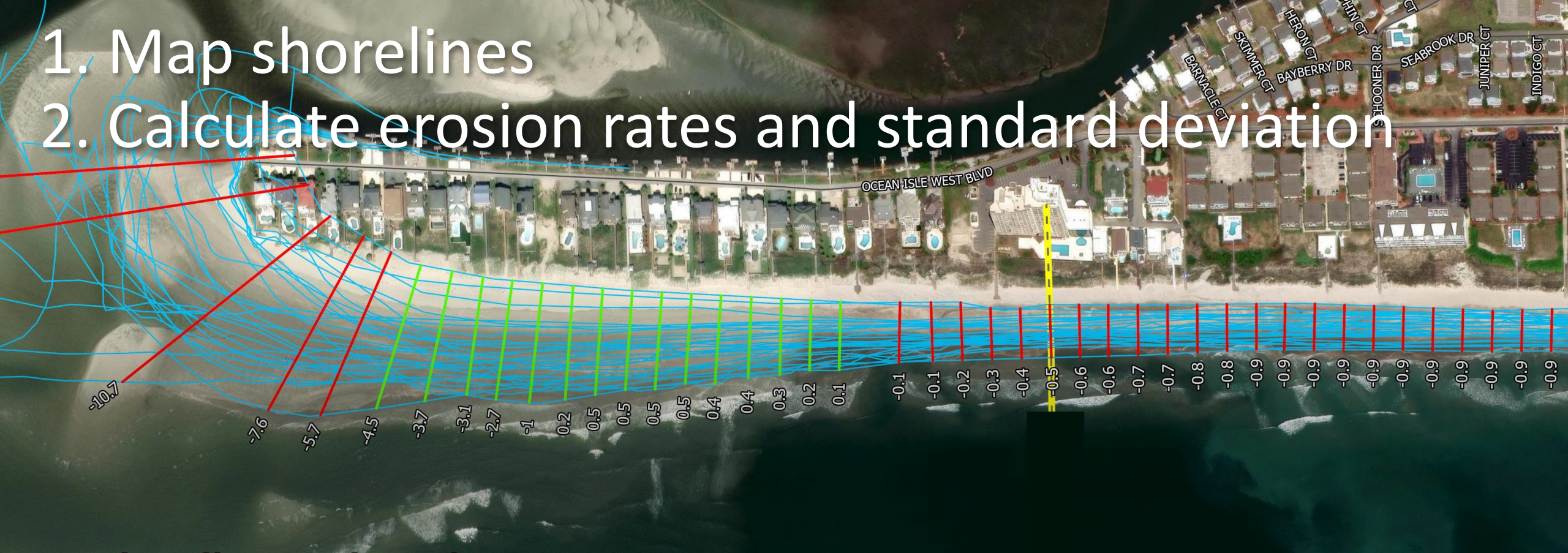
2. Calculate long-term erosion rates **(LRR)** & **standard deviation**

3. Determine alongshore IHA boundary

4. Identify **hybrid-vegetation** line (HVL)

5. Determine landward IHA boundary (90 x erosion rate, measured from HVL)

1. Map shorelines
2. Calculate erosion rates and standard deviation



IHA Shorelines and Erosion Rates (1970-2022)

Ocean Isle at Tubbs Inlet

Legend

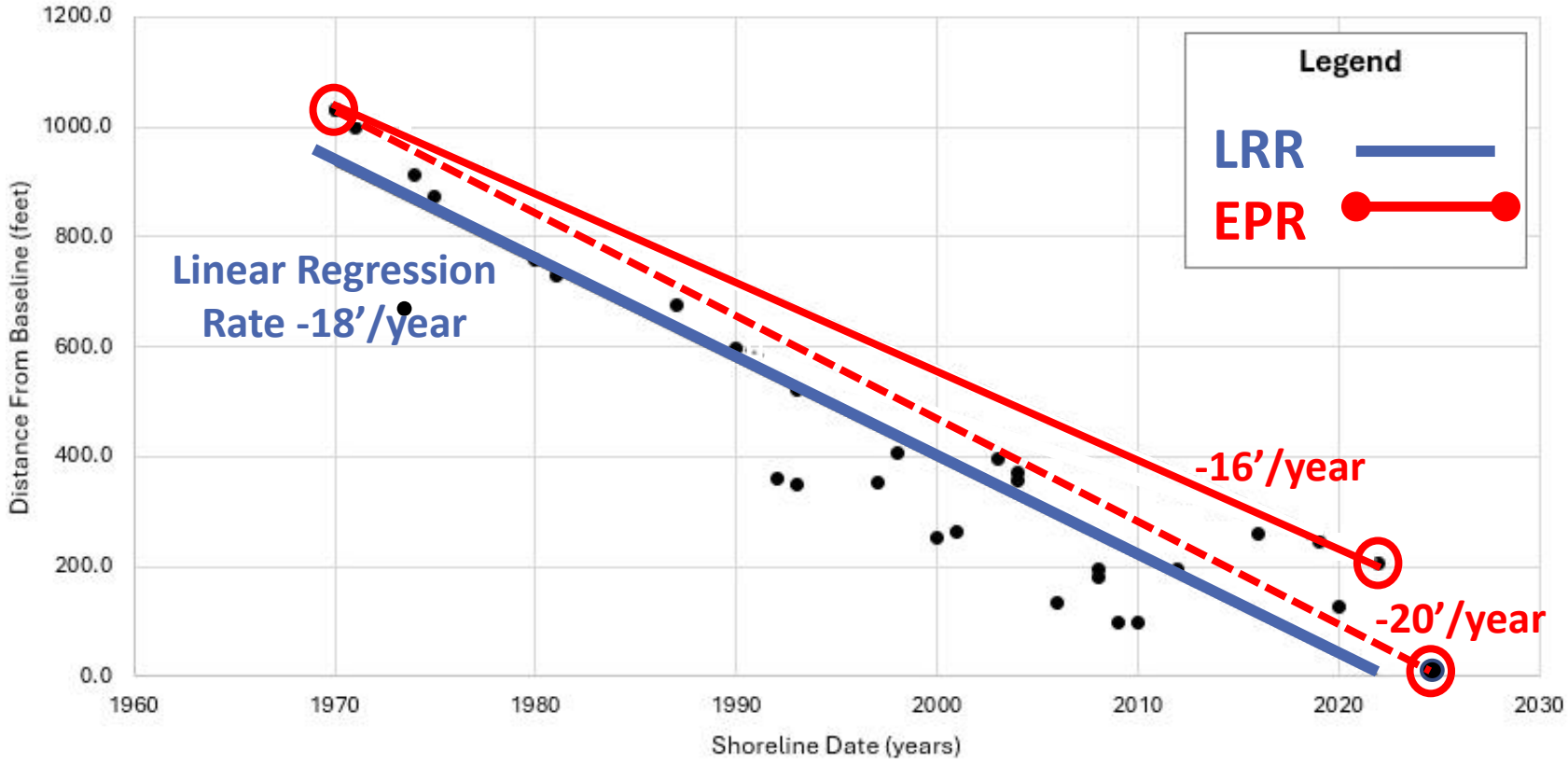
- Transect - Measured Accretion (ft/yr)
- Transect - Measured Erosion (ft/yr)
- Shorelines
- 2023 Imagery

N

0 500 1,000 2,000 US Feet

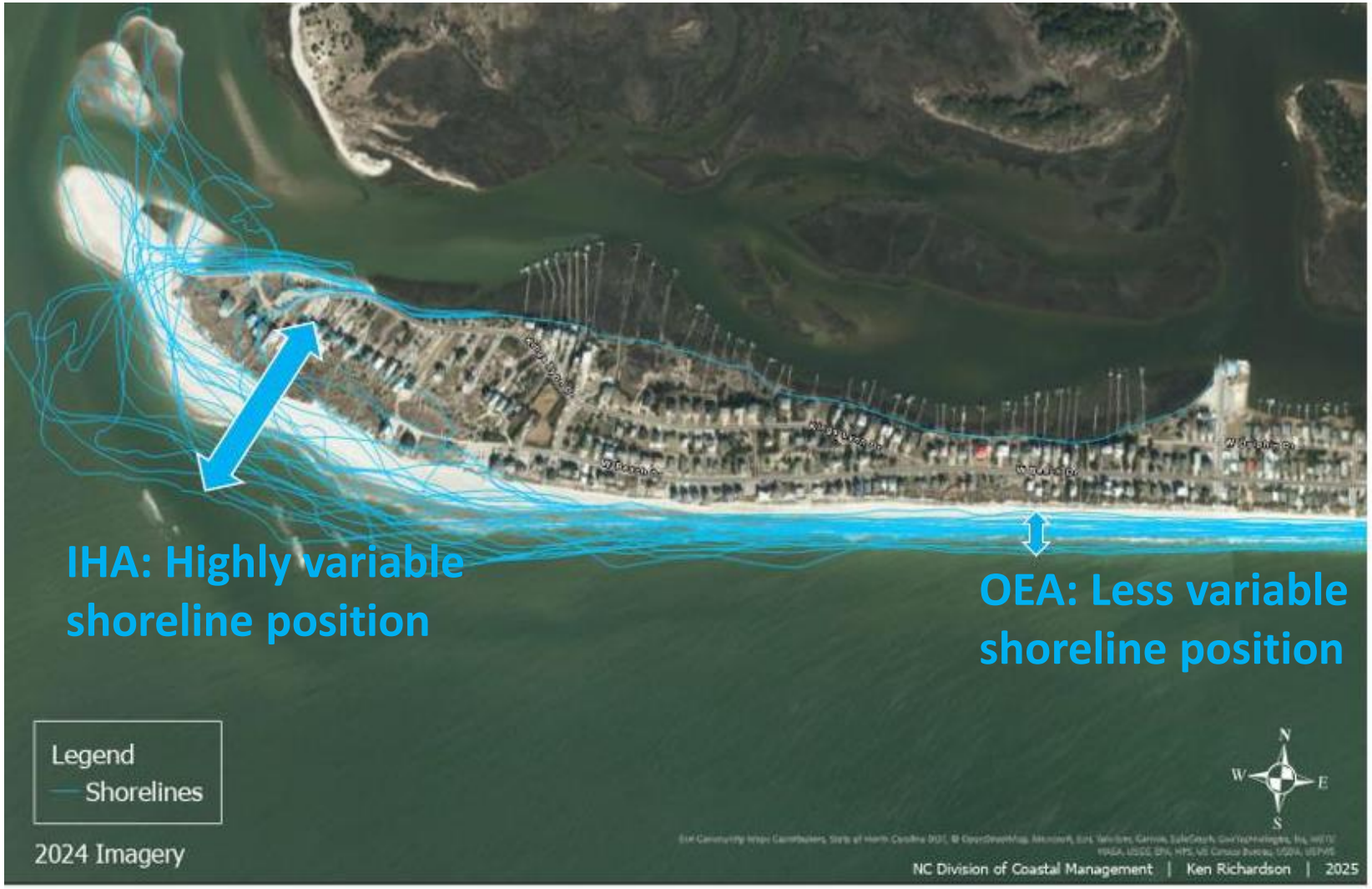
Why Linear Regression Rate (LRR) instead of End-point rate (EPR)?

LRR is the gold standard for measuring long-term trends because it uses all data & is not sensitive to start and end values.



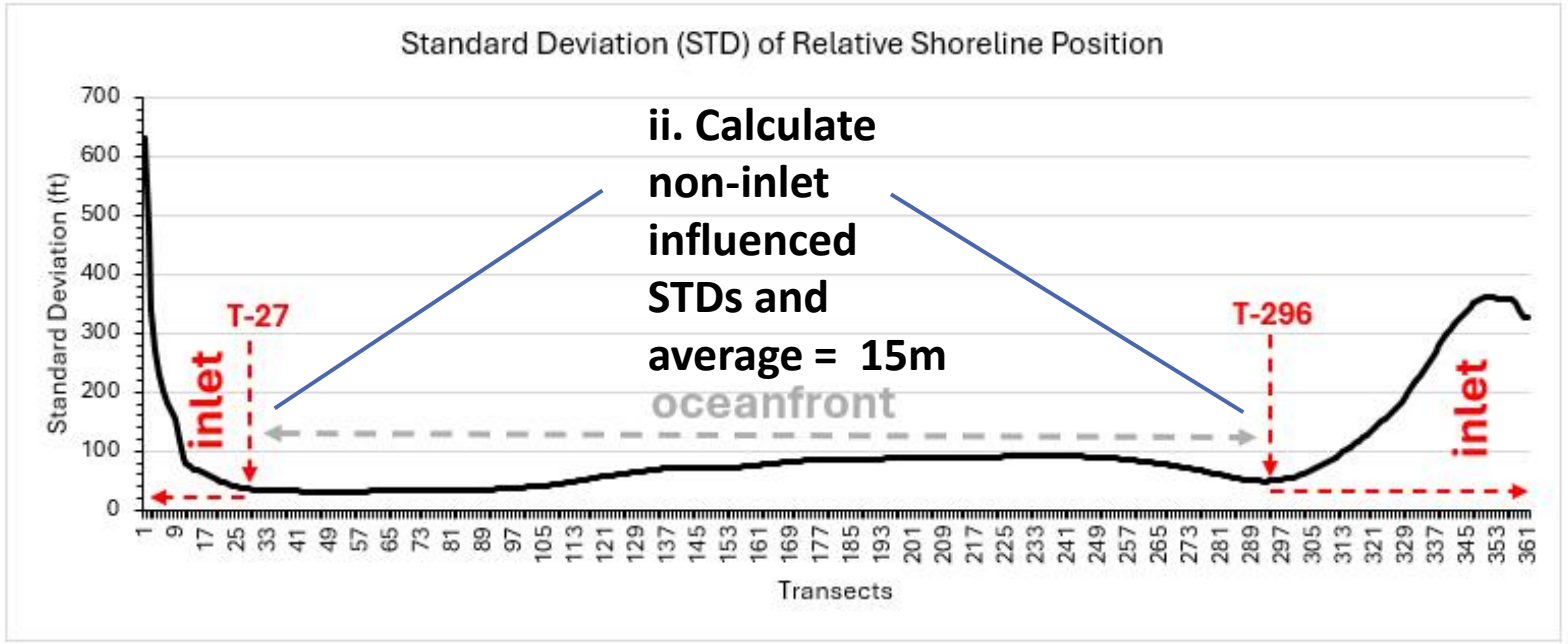
The standard deviation (STD)

Provides a measure of differences from the mean, which are greater near inlets.



Using the standard deviation (STD) to determine alongshore IHA boundaries

i. Identify where the STD starts to increase.



iii. Moving toward inlet, identify where STD > 15 m (49.2 ft).

Transect ID	STD
204	12.78
205	12.66
206	12.55
207	12.52
208	12.86
209	12.91
210	13.31
211	13.27
212	13.28
213	13.78
214	14.21
215	14.59
216	**15.05**
217	15.35
218	16.07
219	16.63
220	17.46

Oceanfront → Inlet

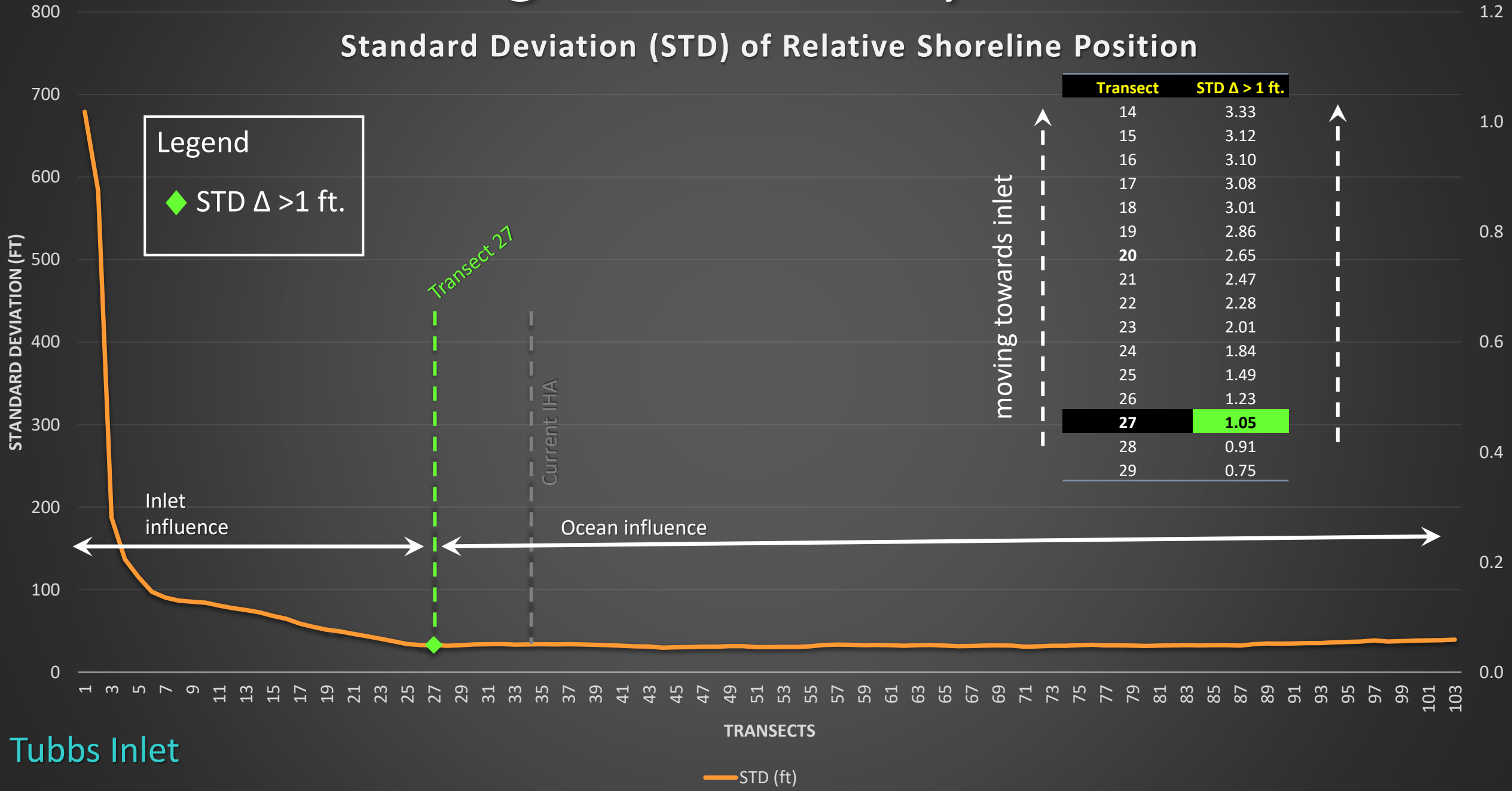
iv. Moving toward inlet, identify the transect where the change in STD is > 1 ft .

Used for all inlets except Lockwood Folly

Transect ID	STD	STD Δ
289	50.51	-0.59
290	49.92	-0.43
291	49.49	-0.27
292	49.22	-0.02
293	49.20	0.28
294	49.48	0.52
295	50.00	0.78
296	50.78	**1.03**
297	51.82	1.23
298	53.05	1.42
299	54.46	1.60
300	56.06	1.78
301	57.84	1.98
302	59.82	2.19
303	62.01	2.43
304	64.44	2.78
305	67.22	3.06
306	70.28	3.30
307	73.58	3.58
308	77.16	3.84
309	81.01	4.00

Oceanfront → Inlet

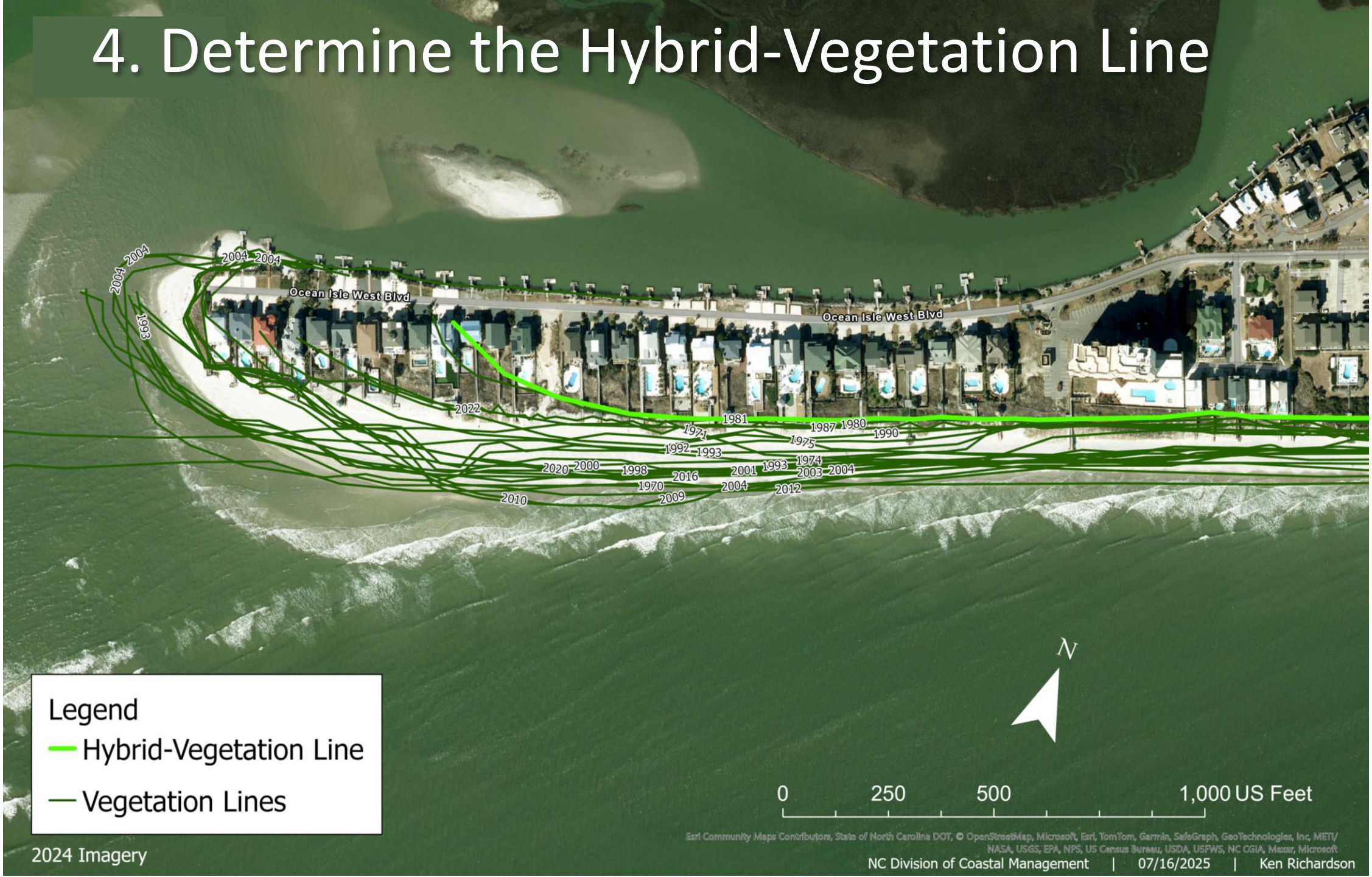
3. Determine Alongshore Boundary as STD Δ > 1ft.



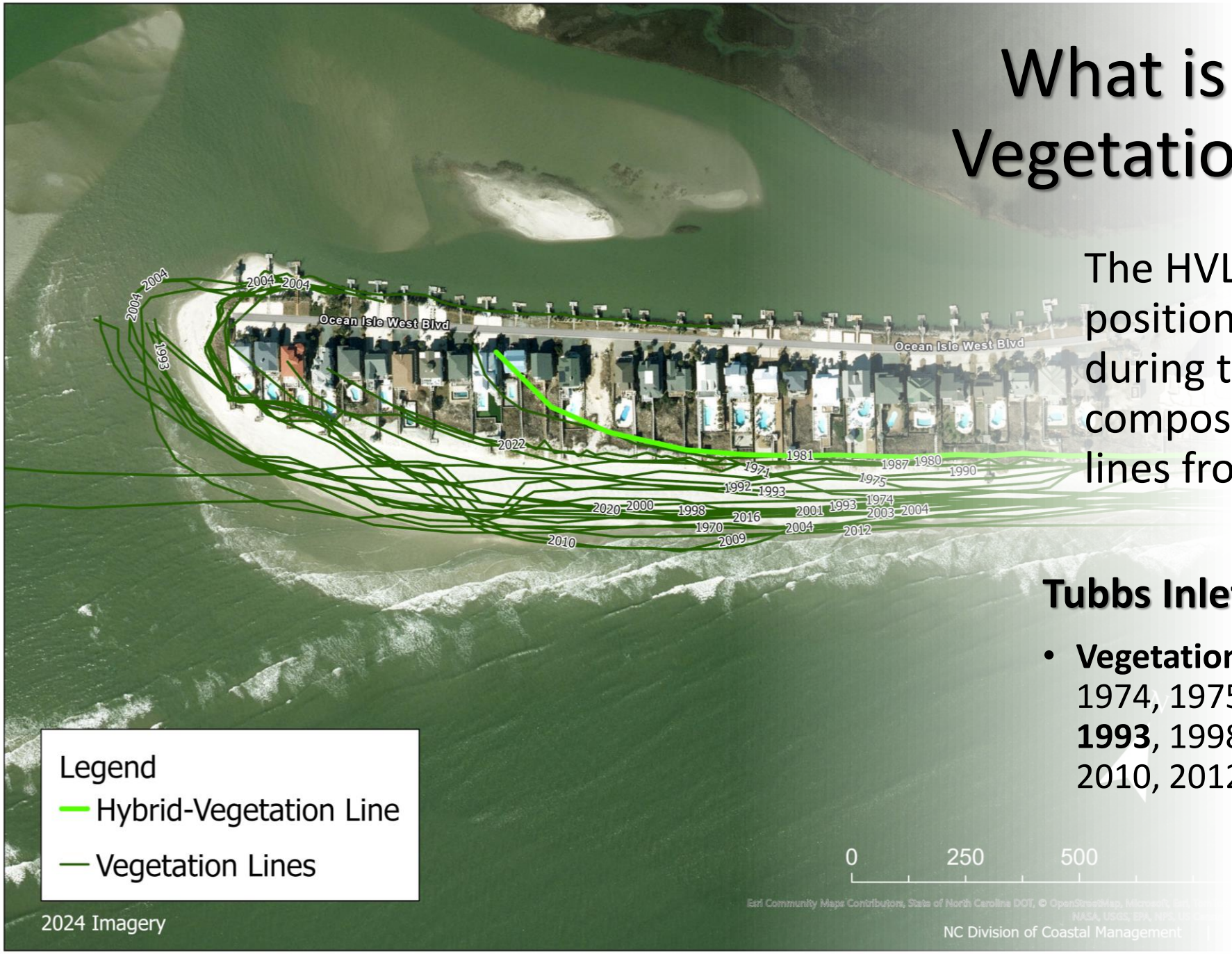
Transect	STD Δ > 1 ft.
14	3.33
15	3.12
16	3.10
17	3.08
18	3.01
19	2.86
20	2.65
21	2.47
22	2.28
23	2.01
24	1.84
25	1.49
26	1.23
27	**1.05**
28	0.91
29	0.75

Tubbs Inlet

4. Determine the Hybrid-Vegetation Line



What is the Hybrid-Vegetation Line (HVL)?



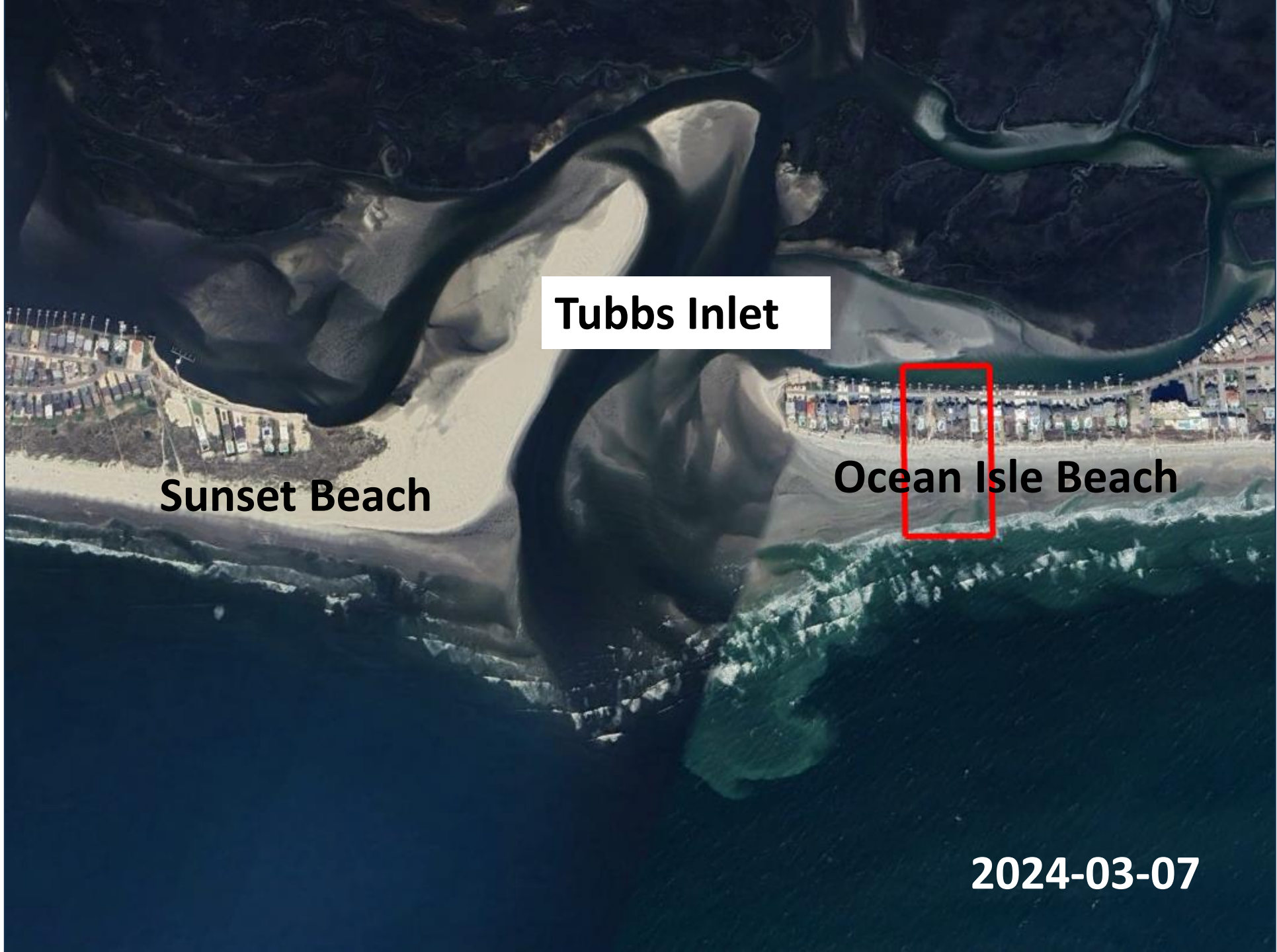
The HVL is the landward-most position of all vegetation lines during the study period. It is a composite, including vegetation lines from more than one date.

Tubbs Inlet – Ocean Isle

- **Vegetation lines mapped:** 1970, 1971, 1974, 1975, **1980**, **1981**, 1987, 1990, 1992, **1993**, 1998, 2000, 2001, 2003, 2004, 2009, 2010, 2012, 2016, 2020, 2022

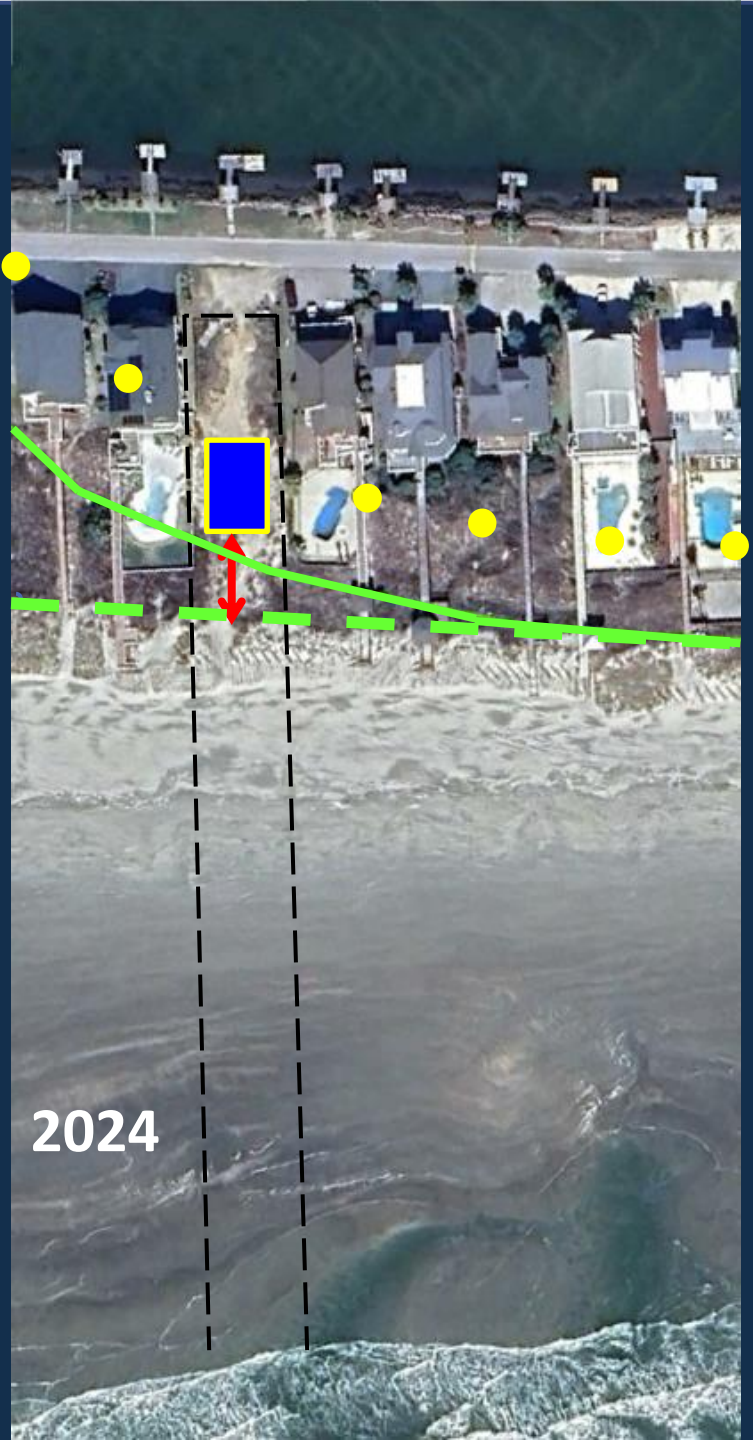
Why the Hybrid-Vegetation Line (HVL)?

Ocean Isle Example



Why the Hybrid-Vegetation Line (HVL)?

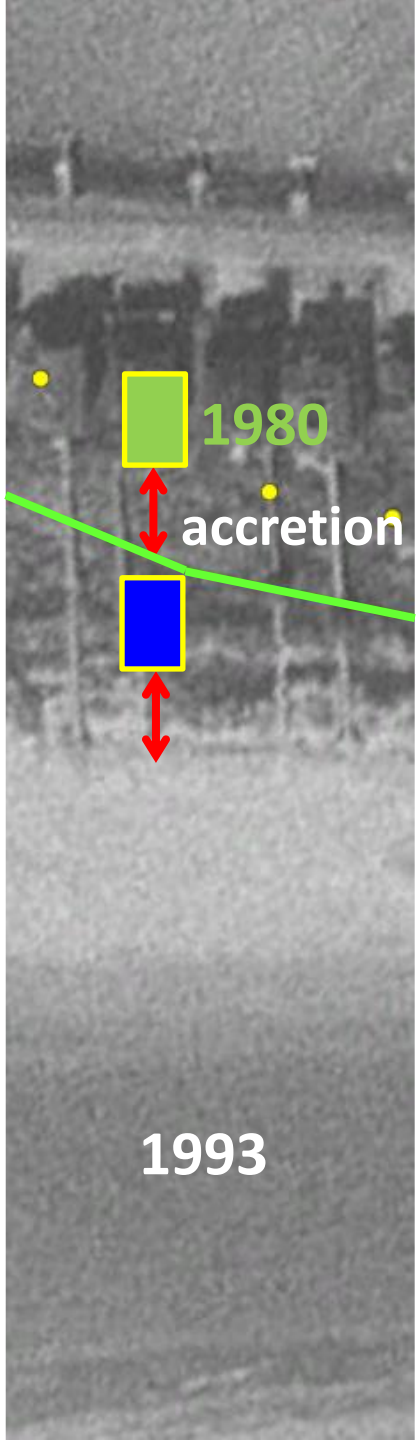
Ocean Isle Example



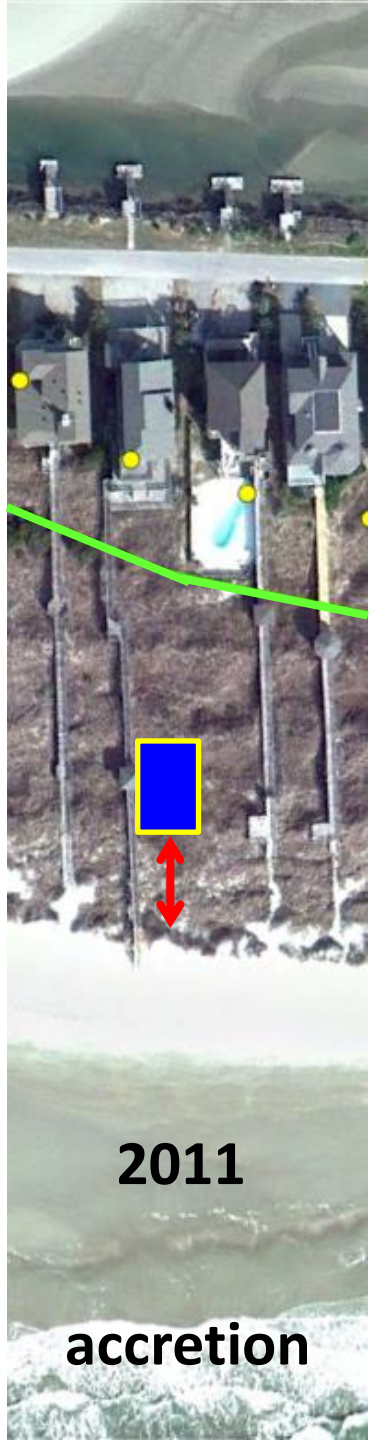
Single Family House
2-Story, 5000 sf
Setback Factor = -2’/yr (erosion)
Erosion Rate = +1.3’/yr accretion

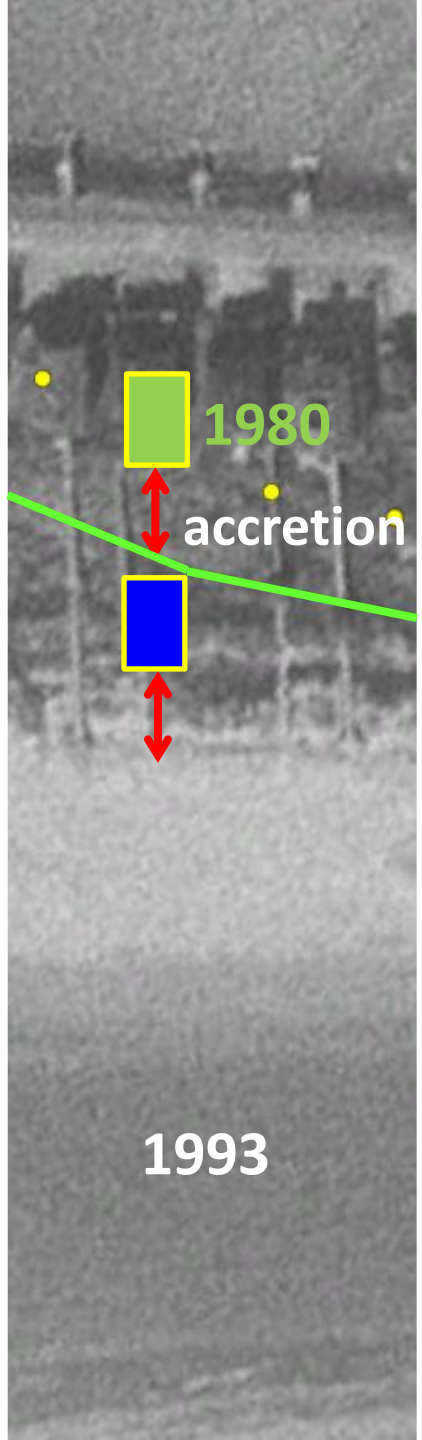
- Existing vegetation Line
- 60’ setback
- Hybrid-Vegetation Line (HVL)
- 30-Year Risk Line

Ocean Isle HVL Example

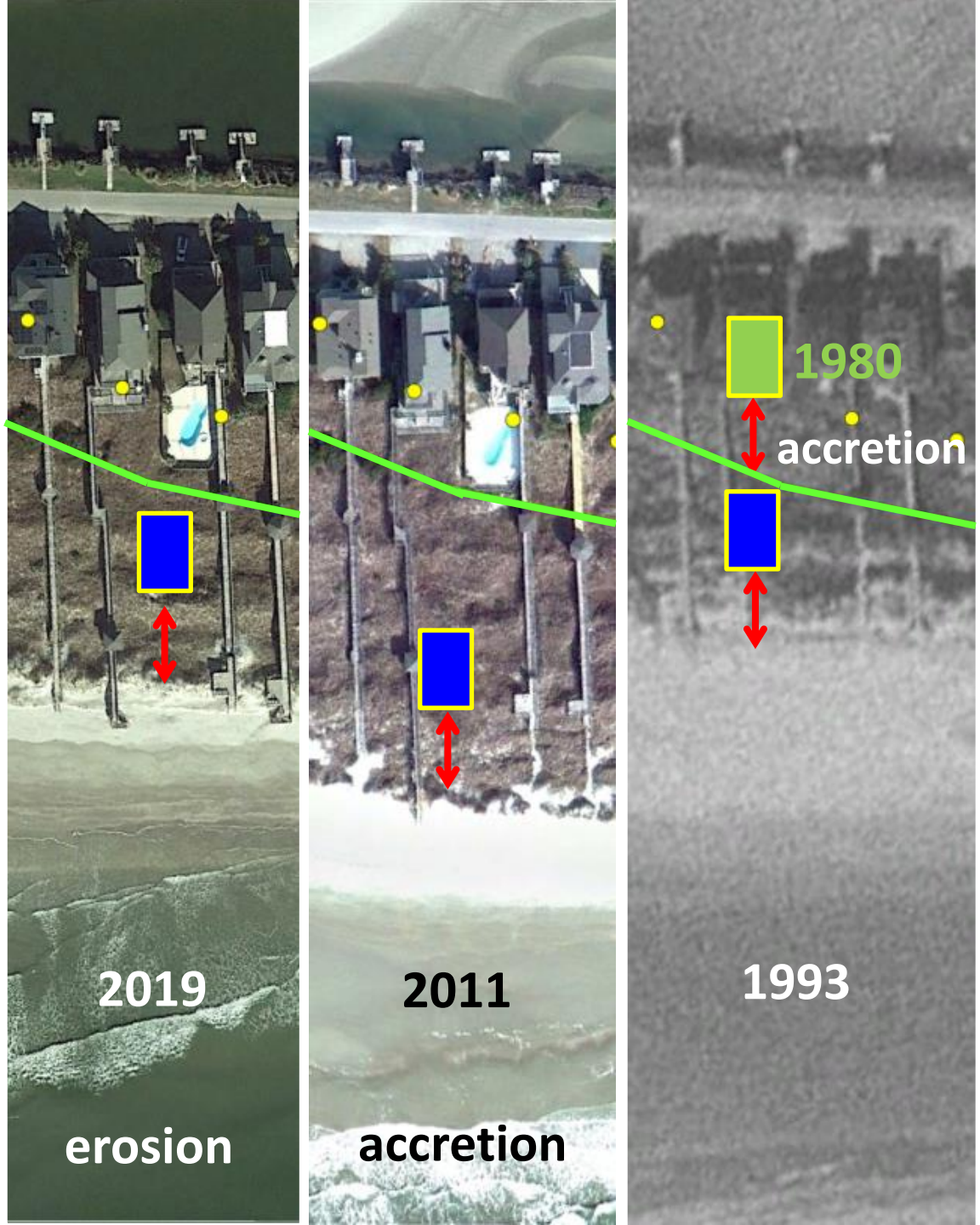


Ocean Isle HVL Example

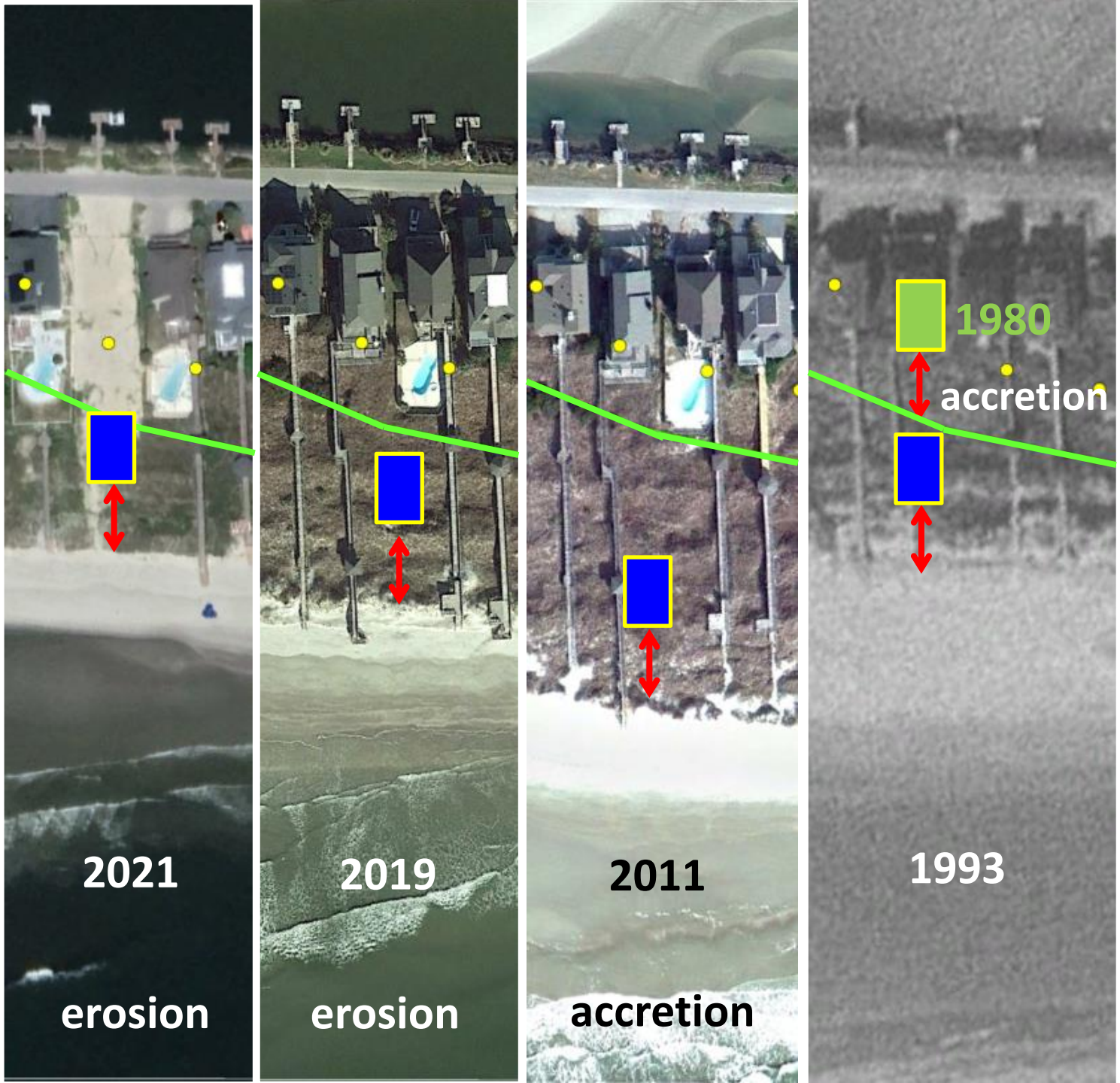




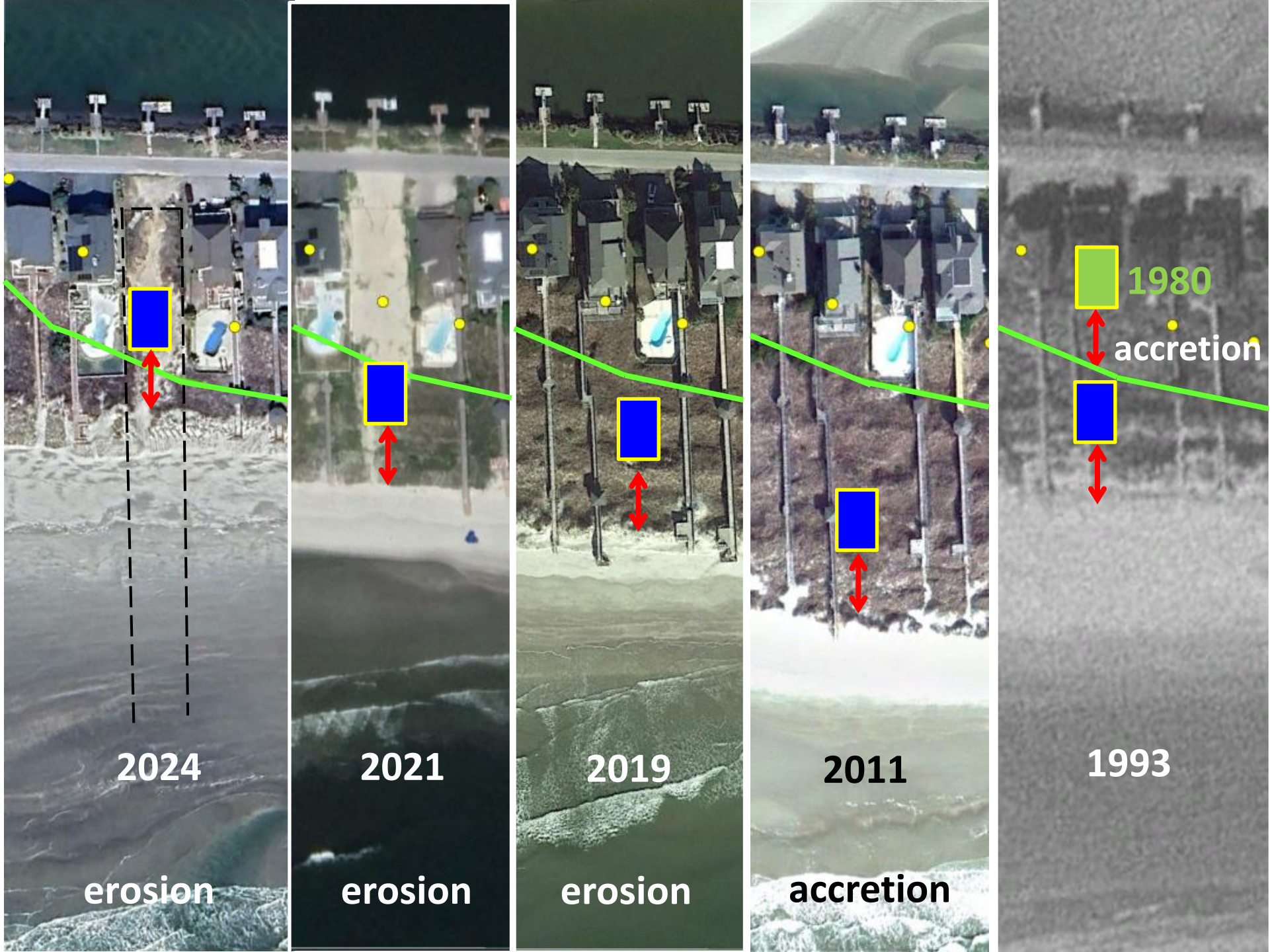
Ocean Isle HVL Example



Ocean Isle HVL Example

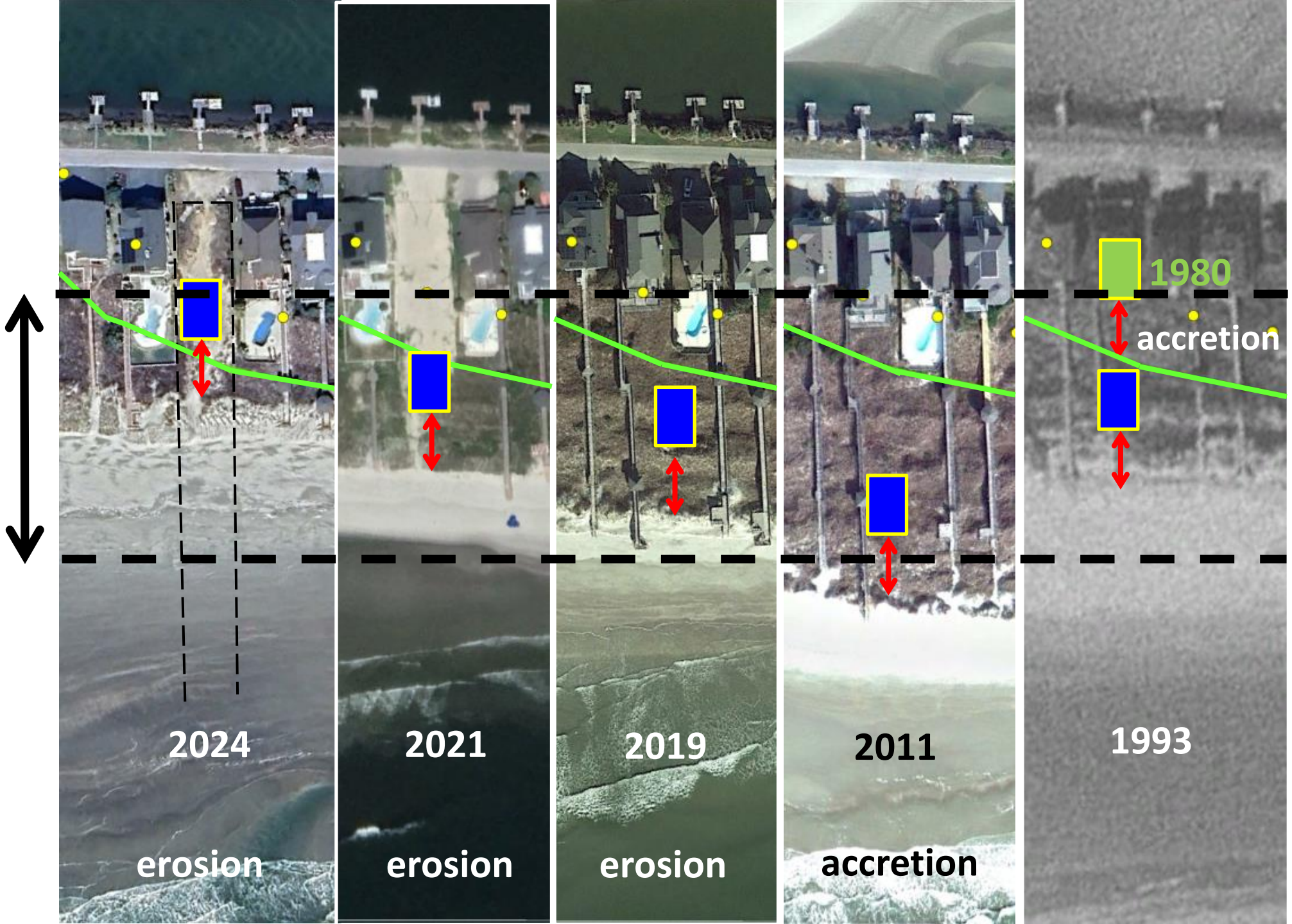


Ocean Isle HVL Example



Ocean Isle HVL Example

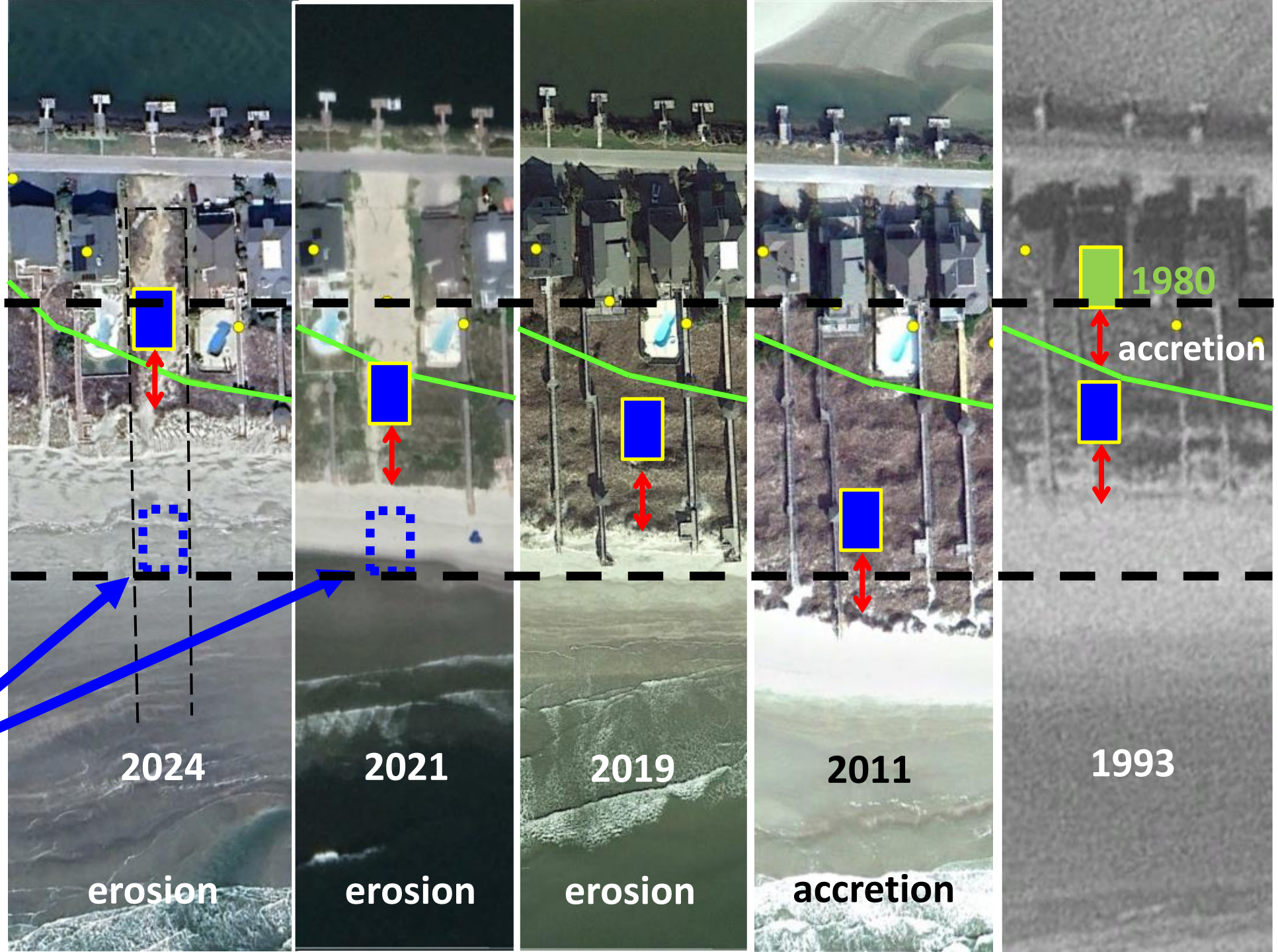
1980 – 2024 Setback variability = ~250’



Ocean Isle HVL Example

1980 – 2024 Setback variability = ~250’

If built in 2011 with existing vegetation line setback, home would have been here…

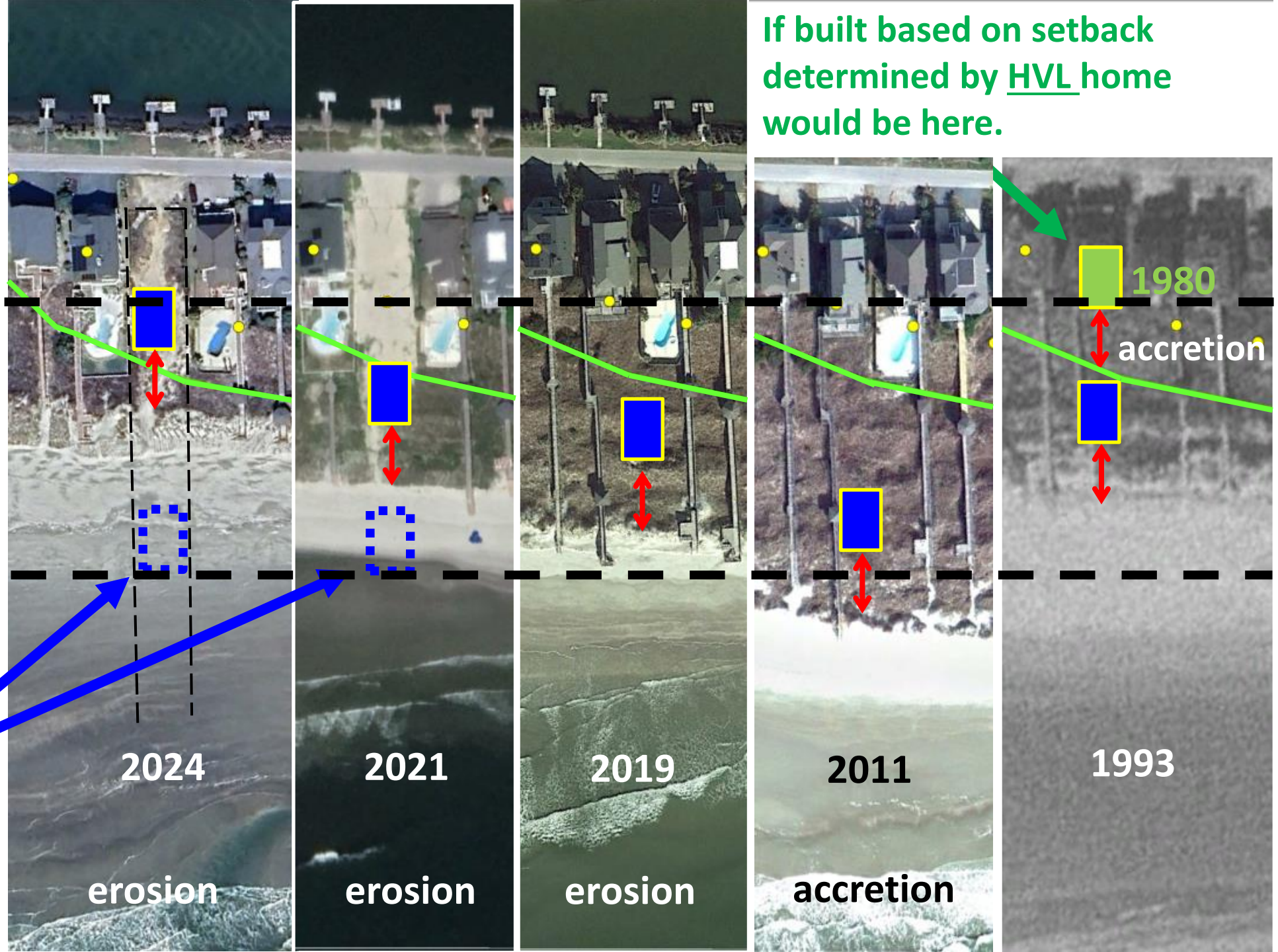


Ocean Isle HVL Example

1980 – 2024 Setback variability = ~250’

If built in 2011 with existing vegetation line setback, home would have been here…

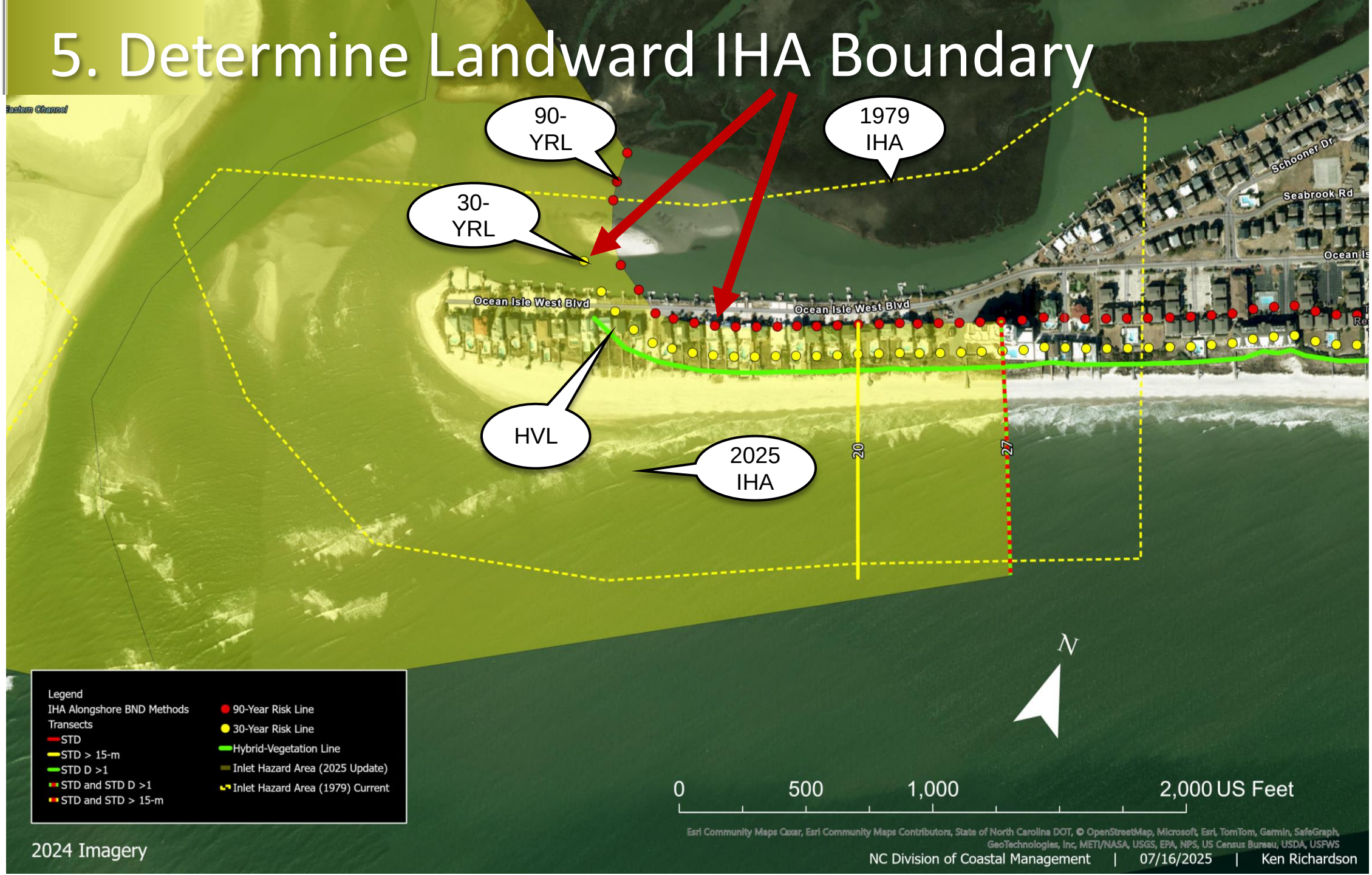
If built based on setback determined by HVL home would be here.



Why the Hybrid-Vegetation Line (HVL)?

Because the existing vegetation line fluctuates quickly in IHAs (with the shoreline), the HVL is a more reliable reference for measuring risk.

5. Determine Landward IHA Boundary



Multiply LRR erosion rate (or 2) x 30 and 90

Mapping 30- & 90-Year Risk Lines

- Applied conceptual basis of the Ocean Erodible Area & Setbacks
- Measured landward from the **hybrid-vegetation line**

Where the shoreline is eroding

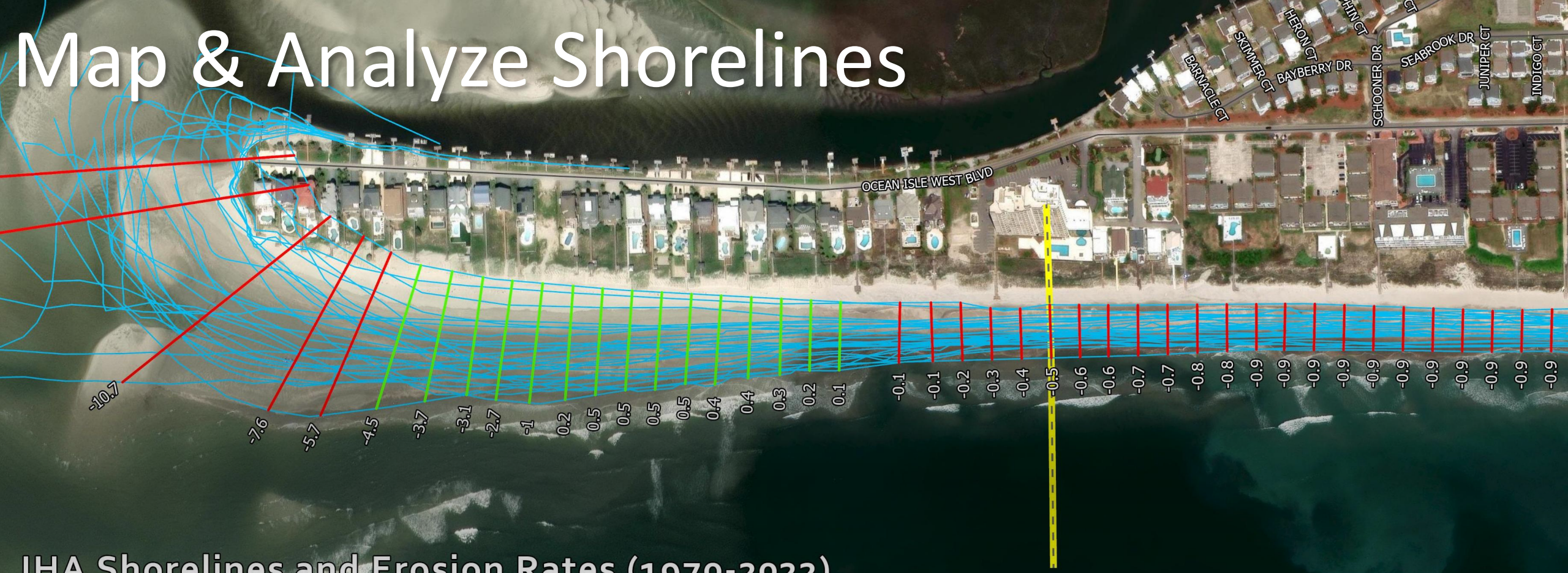
- 30-Year Risk Line = RL_{30} = 30 × Erosion Rate (or x 2, if <2'/year)
- 90-Year Risk Line = RL_{90} = 90 × Erosion Rate (or x 2, if <2'/year)

Where the shoreline is accreting

- 30-Year Risk Line = RL_{30} = 30 × 2
- 90-Year Risk Line = RL_{90} = 90 × 2

90-year risk line= <u>Landward IHA Boundary</u>

Map & Analyze Shorelines



IHA Shorelines and Erosion Rates (1970-2022)

Ocean Isle at Tubbs Inlet

Legend

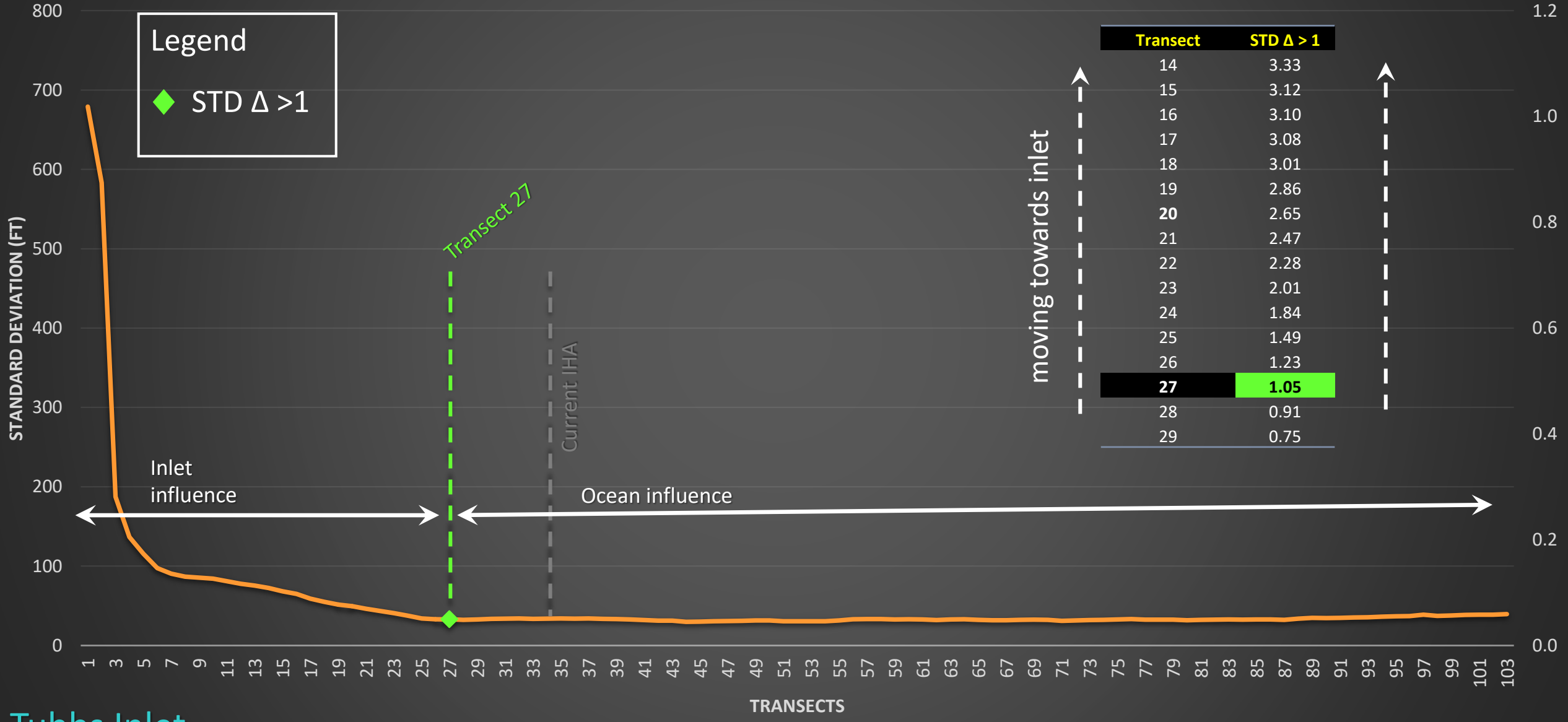
- Transect - Measured Accretion (ft/yr)
- Transect - Measured Erosion (ft/yr)
- 2025 IHA Shoreline Boundary
- Shorelines

2023 Imagery

N

0 500 1,000 2,000 US Feet

Standard Deviation (STD) of Relative Shoreline Position
Tubbs Inlet at Ocean Isle



Transect	STD Δ > 1
14	3.33
15	3.12
16	3.10
17	3.08
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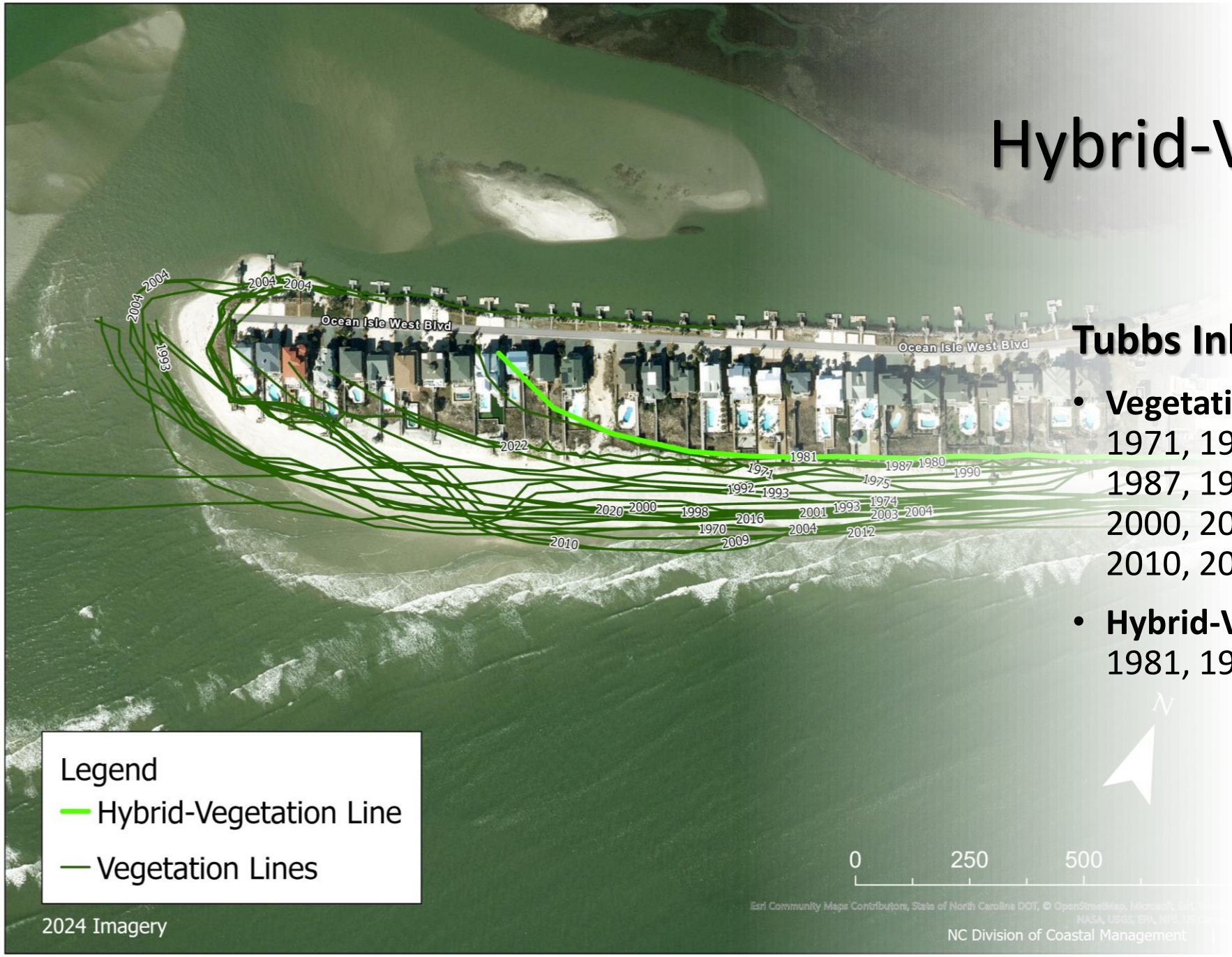
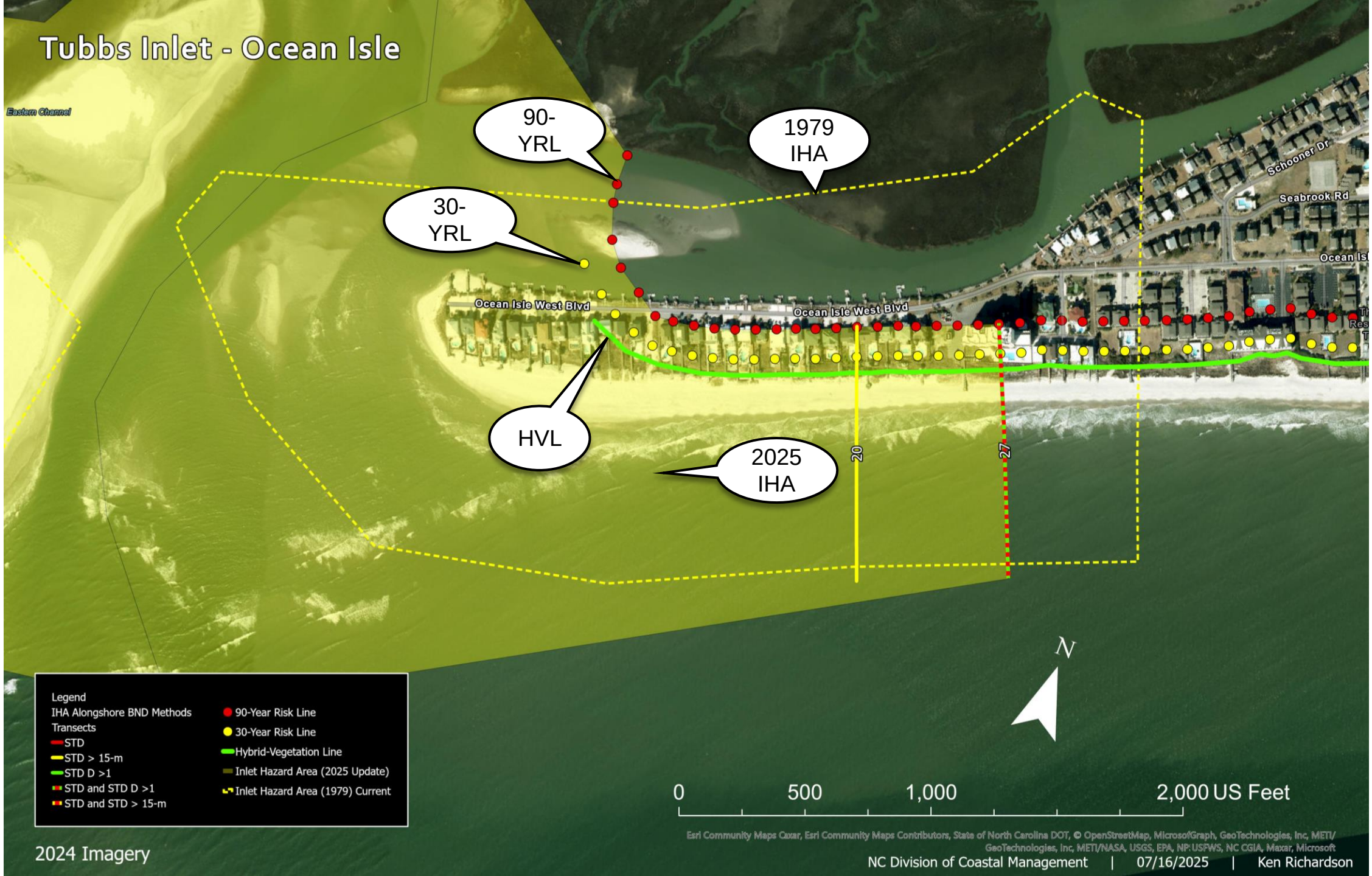
Tubbs Inlet

Hybrid-Vegetation Line



Tubbs Inlet – Ocean Isle

- **Vegetation lines mapped:** 1970, 1971, 1974, 1975, **1980**, **1981**, 1987, 1990, 1992, **1993**, 1998, 2000, 2001, 2003, 2004, 2009, 2010, 2012, 2016, 2020, 2022
- **Hybrid-Vegetation Line:** 1980, 1981, 1993


Tubbs Inlet - Ocean Isle
Eastern Channel
90-YRL
30-YRL
HVL
1979 IHA
2025 IHA
Ocean Isle West Blvd
Ocean Isle West Blvd
Schooner Dr
Seabrook Rd
20
27
Legend
IHA Alongshore BND Methods
Transects
STD
STD > 15-m
STD D >1
STD and STD D >1
STD and STD > 15-m
90-Year Risk Line
30-Year Risk Line
Hybrid-Vegetation Line
Inlet Hazard Area (2025 Update)
Inlet Hazard Area (1979) Current
N
0
500
1,000
2,000 US Feet
2024 Imagery
Esri Community Maps Contr, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, MicrosoftGraph, GeoTechnologies, Inc, METI/
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Special Cases Involving Structures


Masonboro Inlet - Wrightsville Beach
2025 Proposed Inlet Hazard Area
USCG
Water St
Schloss St
S Lumina Ave
Waynick Blvd
South End Surf Shop
The Surf Suites
Oceanic Restaurant
Legend
90-Year Risk Line
30-Year Risk Line
Hybrid-Vegetation Line
2025 Proposed IHA Alongshore BND
Inlet Hazard Area (2025 Update)
Inlet Hazard Area (1979) Current
2024 Imagery
North jetty constructed in 1966; shoreline relatively stable since 1970; jetty proposed as IHA boundary
N
0
0.13
0.25
0.5 Miles
Esri Community Maps Contr, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, MicrosoftGraph, GeoTechnologies, Inc, METI/ GeoTechnologies, Inc, METI/NASA, USGS, EPA, NP:USFWS, NC CGIA, Maxar, Microsoft
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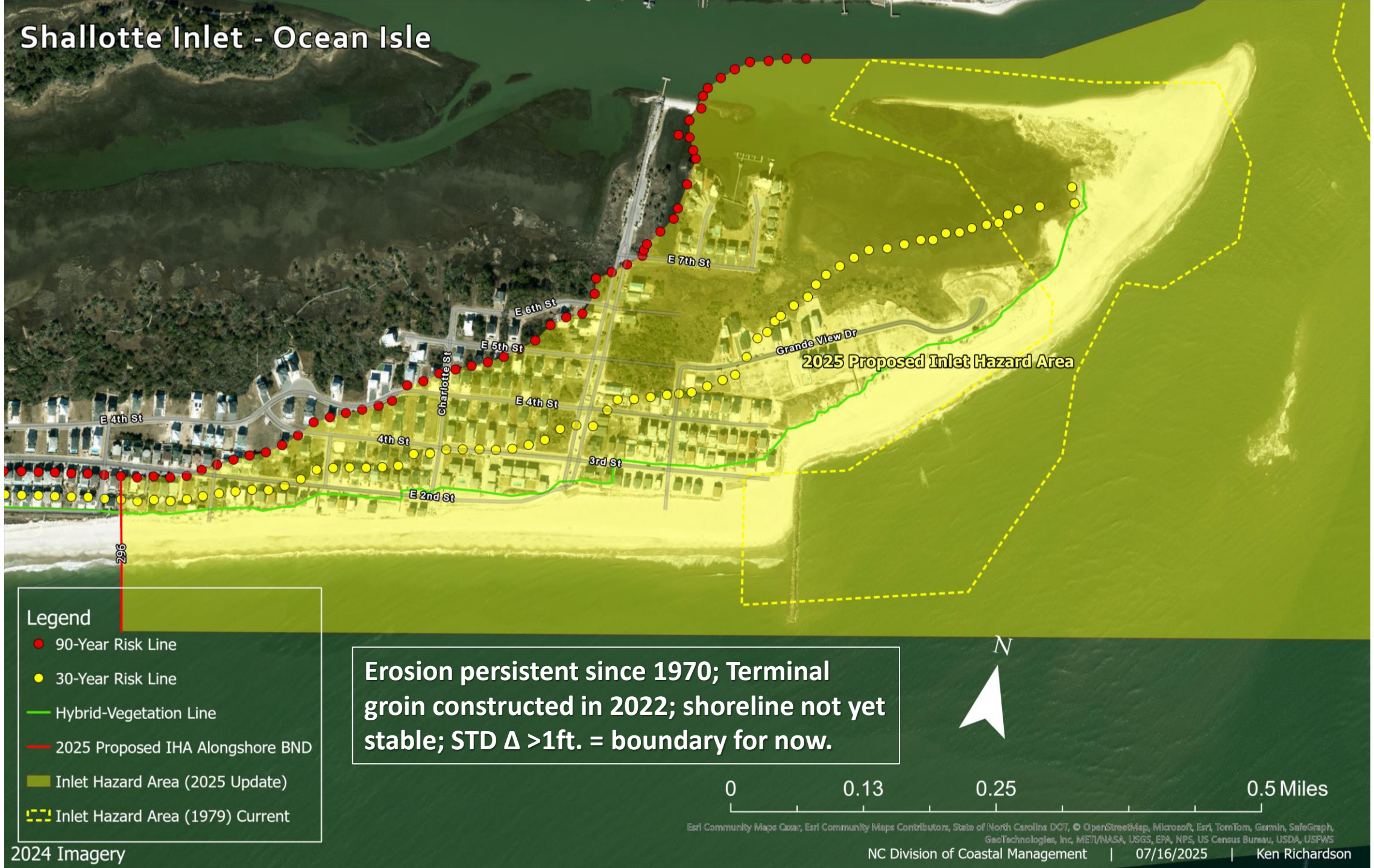
Shallotte Inlet - Ocean Isle
E 7th St
E 6th St
E 5th St
Charlotte St
Grande View Dr
2025 Proposed Inlet Hazard Area
E 4th St
E 4th St
4th St
3rd St
E 2nd St
296
Legend
90-Year Risk Line
30-Year Risk Line
Hybrid-Vegetation Line
2025 Proposed IHA Alongshore BND
Inlet Hazard Area (2025 Update)
Inlet Hazard Area (1979) Current
2024 Imagery
Erosion persistent since 1970; Terminal groin constructed in 2022; shoreline not yet stable; STD Δ >1ft. = boundary for now.
N
0
0.13
0.25
0.5 Miles
Esri Community Maps Contr, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
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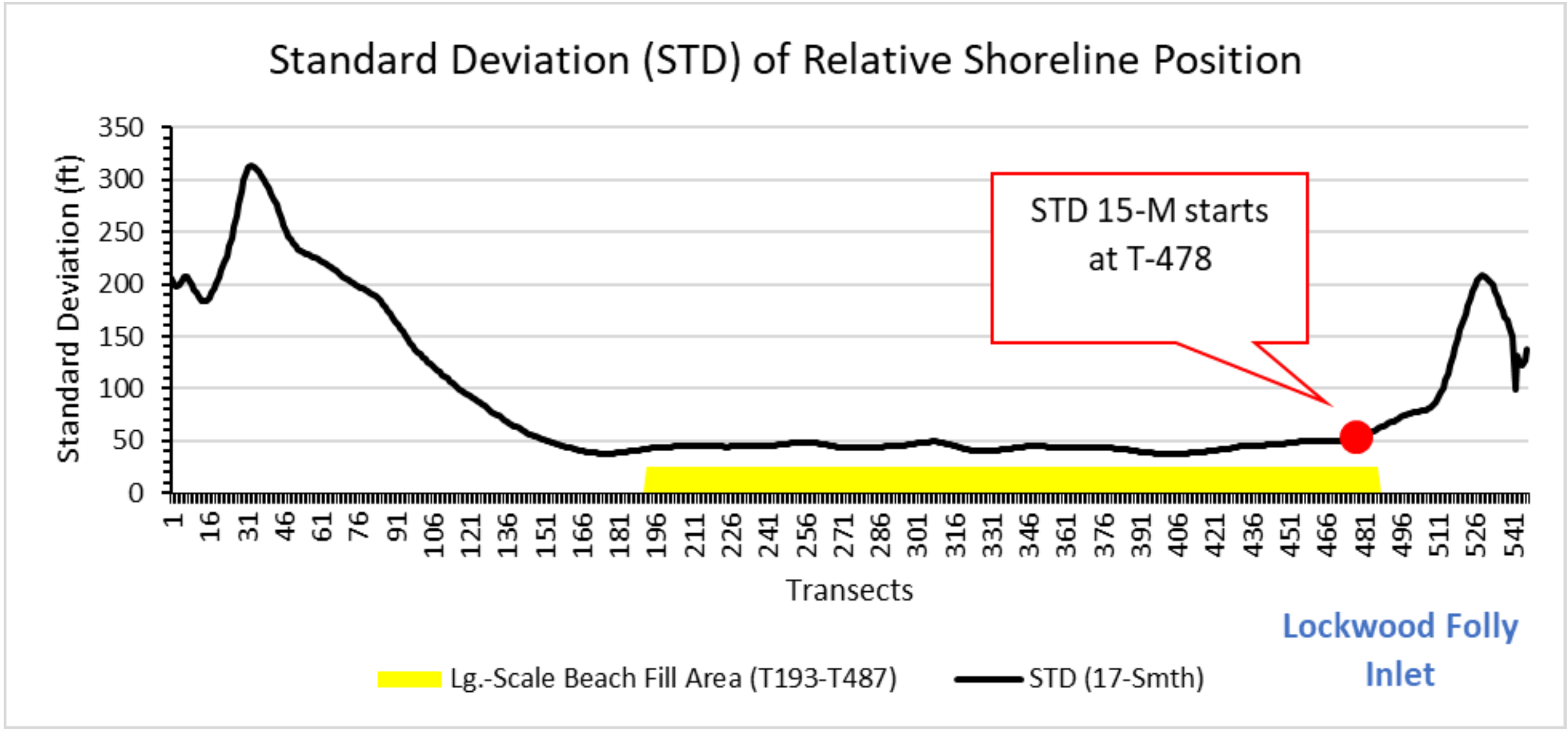
Summary & Recommendations

- Inlet shorelines are more variable than OEA shorelines, with the potential for rapid shifts from accretion to erosion and v.v.
- We defined IHAs following steps similar to those used in OEAs.
- We determined alongshore IHA boundaries based on STD thresholds, which identify where inlet influence dominates and shoreline position is highly variable.
- **We recommend using LRRs to measure OEA and IHA setbacks because they reflect all historic shoreline positions used.**
- **We recommend measuring setbacks in IHAs from the HVL because it is the most reliable reference line where shoreline position fluctuates.**
- Using LRRs and measuring from the HVL we determined the 30-year and 90-year risk lines. The 90-year risk line = the landward IHA boundary.
- **We recommend updating the IHAs every 5 years to coincide with OEA & erosion rate updates**

Questions?


Standard Deviation (STD) of Relative Shoreline Position
Standard Deviation (ft)
350
300
250
200
150
100
50
0
1
16
31
46
61
76
91
106
121
136
151
166
181
196
211
226
241
256
271
286
301
316
331
346
361
376
391
406
421
436
451
466
481
496
511
526
541
Transects
STD 15-M starts at T-478
Lockwood Folly Inlet
Lg.-Scale Beach Fill Area (T193-T487)
STD (17-Smth)