

Barrier Islands 101

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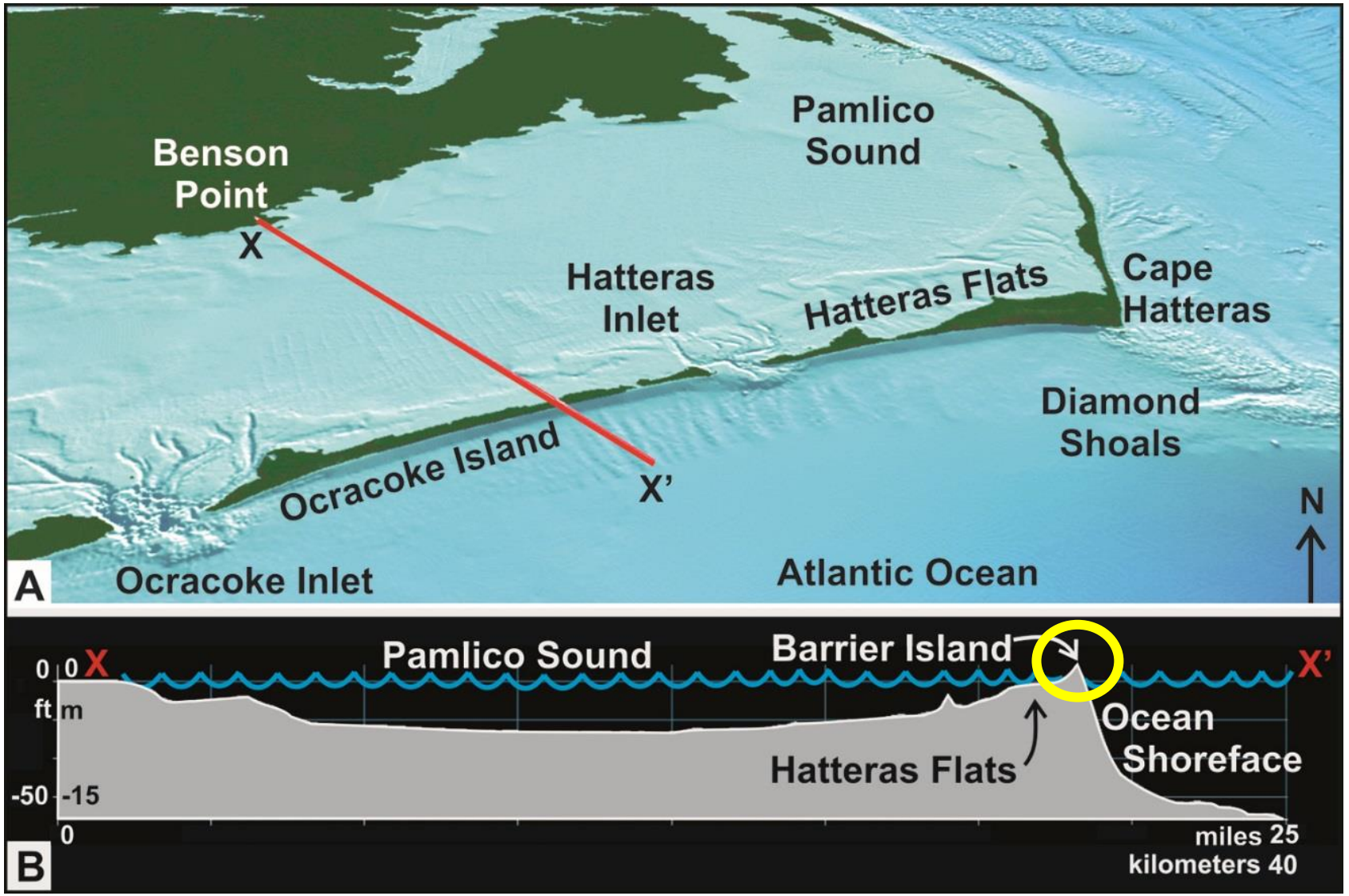
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Barrier Island – "A relatively long, narrow body of (usually) sand, bound by tidal inlets, backed by sound/bay and/or marsh."

Barriers serve as buffers to storms for mainland shores



After Riggs et al., 2020

Barrier islands are constructed by storms

- Waves sweep sand toward shore
- Strong storms pile sand landward of the beach = Overwash or ‘Washover’



Barrier islands are constructed by storms

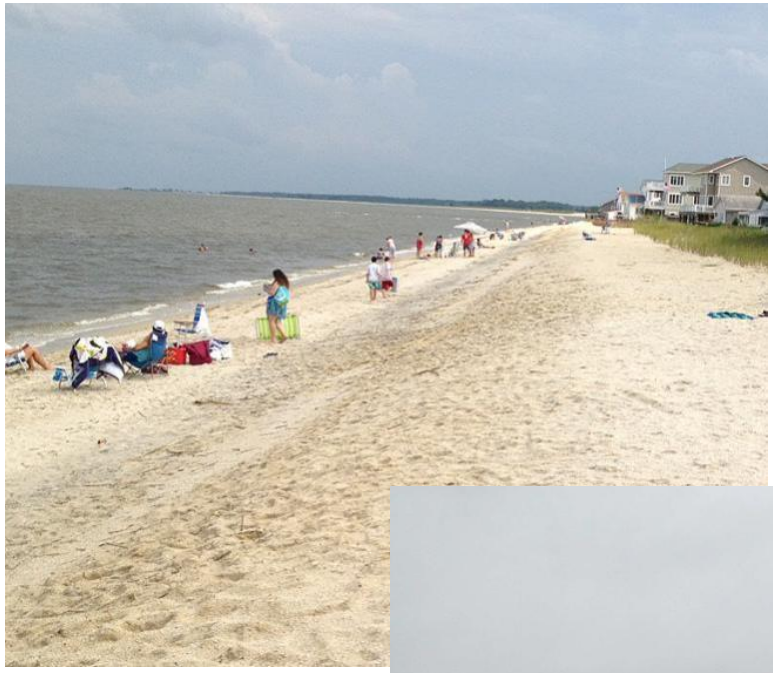
- Waves sweep sand toward shore
- Strong storms pile sand landward of the beach = Overwash or ‘Washover’

- Height (excluding dune) is set by highest storm surge *(and also by dune changes…)*

- Width of sandy part of island is set by landward limit of overwash.



For some storms, effects are limited to the beach and sand tends to return later.





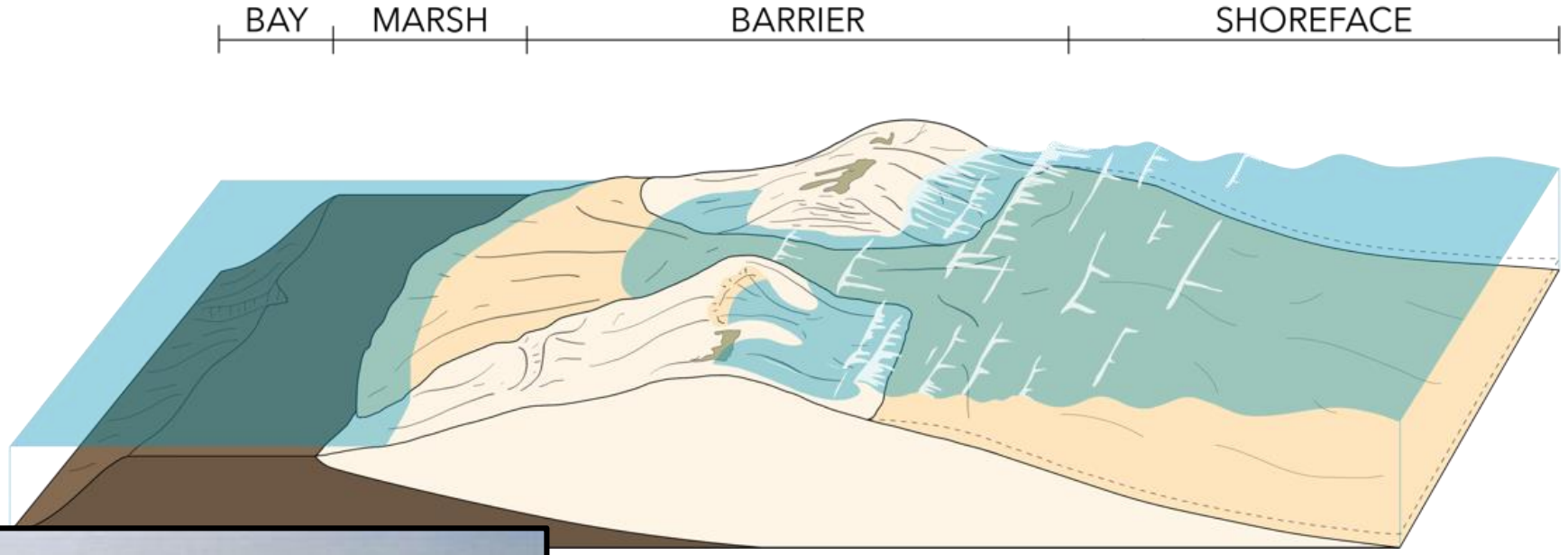
Before and after Sandy
Bowers Beach, DL

Overwash removes sand from the beach system, contributing to long-term erosion.



Washover from Superstorm Sandy, NC12

On natural barrier islands overwash maintains elevation relative to sea level

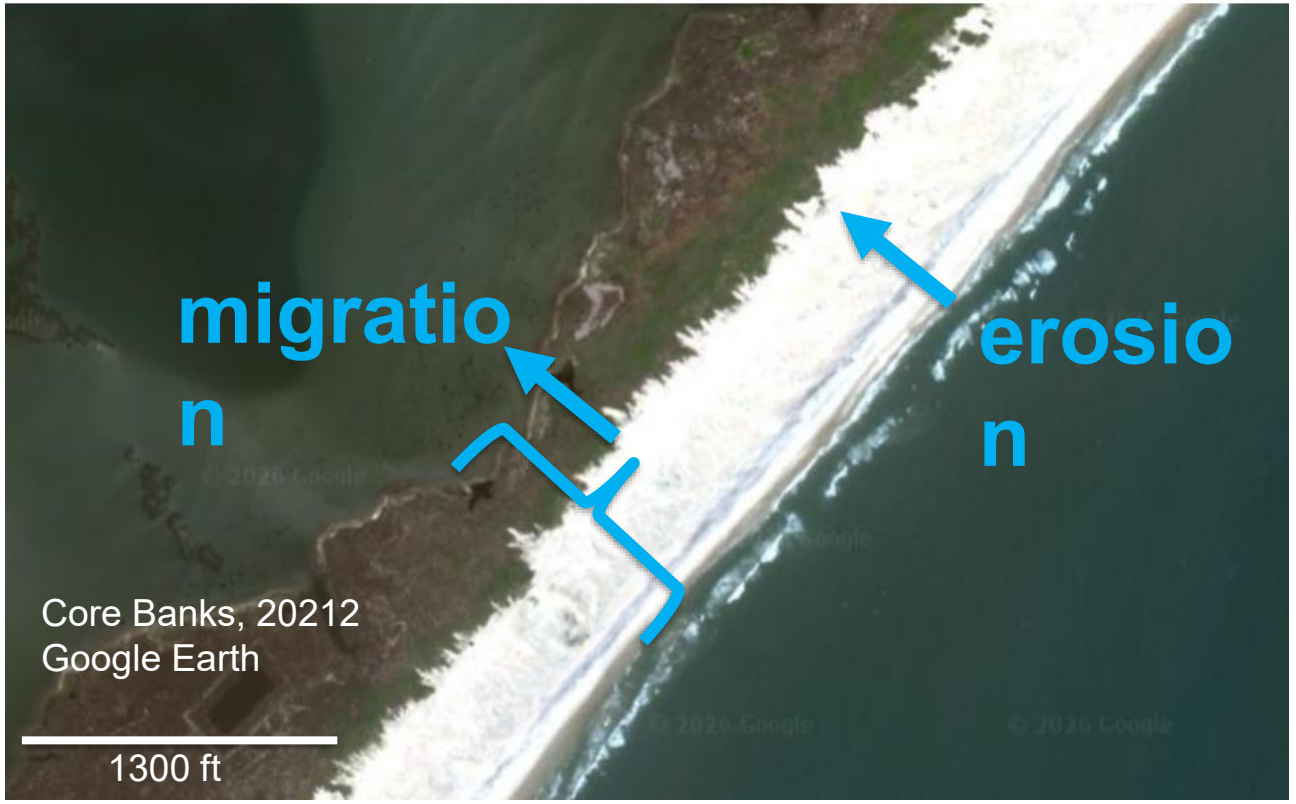




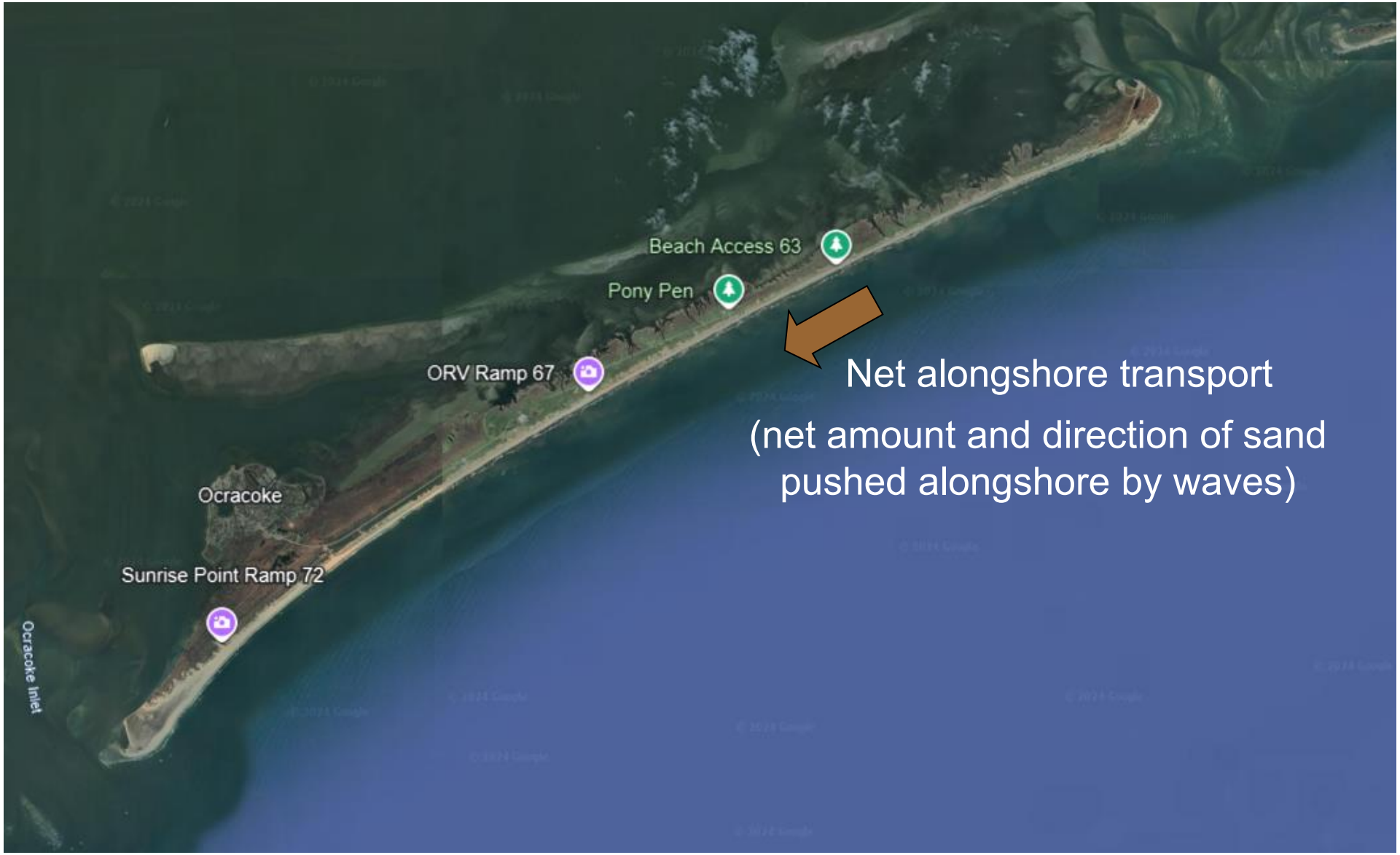
Overwash also drives landward migration of narrow islands

- Sea level rise + storms leads to episodic overwash; **height maintained** relative to sea level
- Overwash leads to shoreline **erosion**; faster sea-level rise = **faster erosion**
- Overwash maintains width
- Barrier migrates **upward** and **landward**

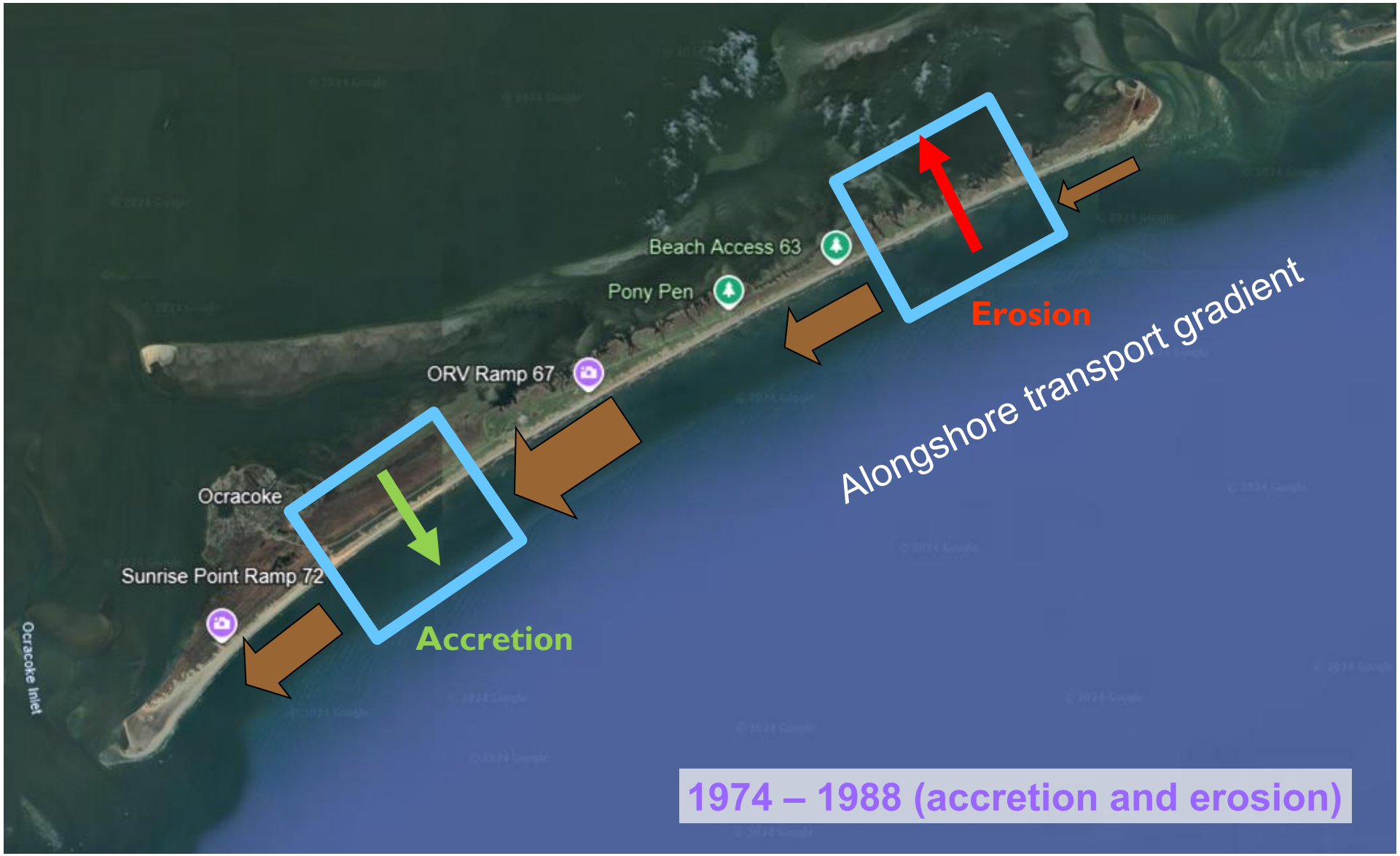
(* some barriers become too wide or high to migrate; more later…)



Overwash contributes to shoreline erosion, but, currently, shoreline change is primarily driven by alongshore wave processes



Shoreline change is primarily driven by alongshore *differences* in net amount of sand pushed alongshore by waves (i.e., gradients)

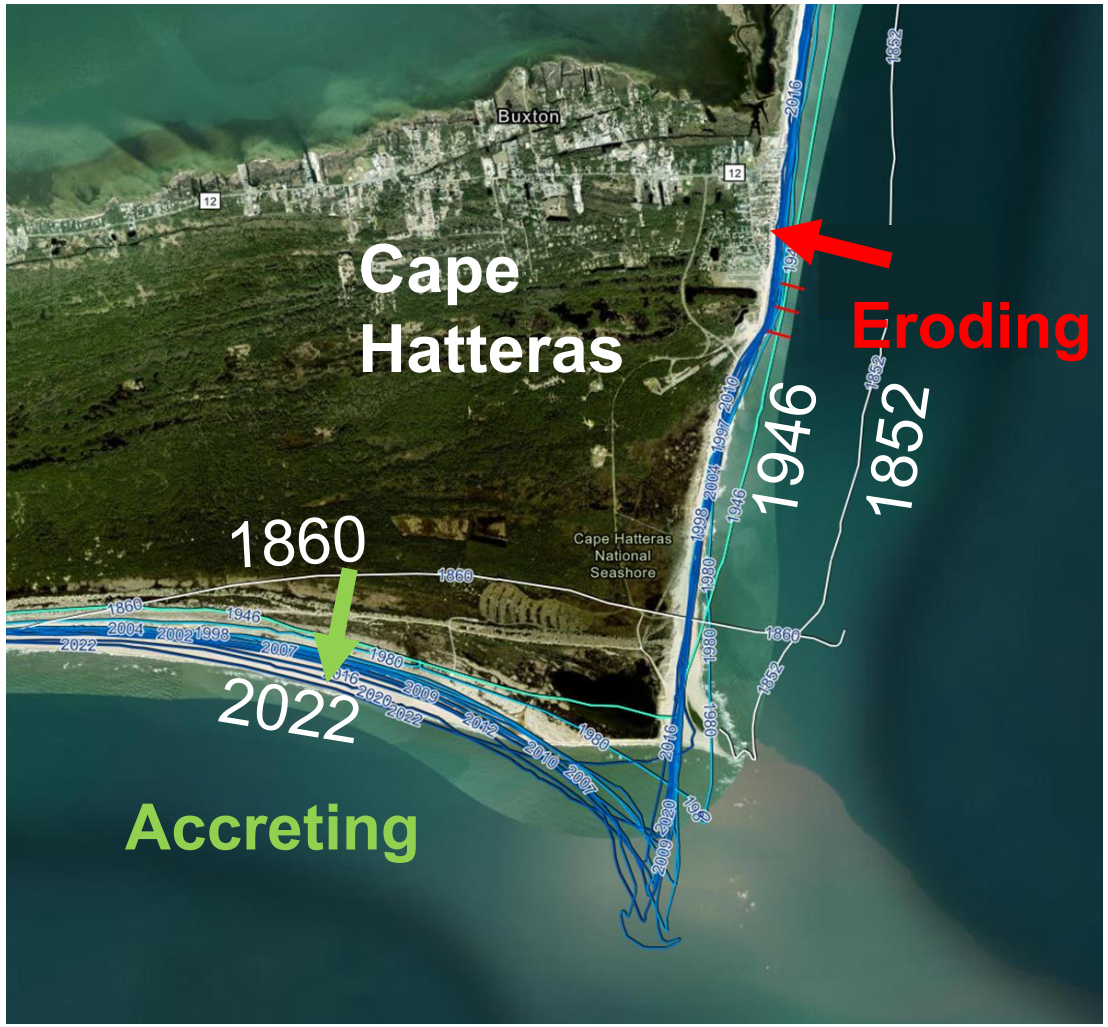


Gradients in alongshore transport lead to erosion hot spots

For example:

- North of Cape Hatteras
- Northern end of Ocracoke Island

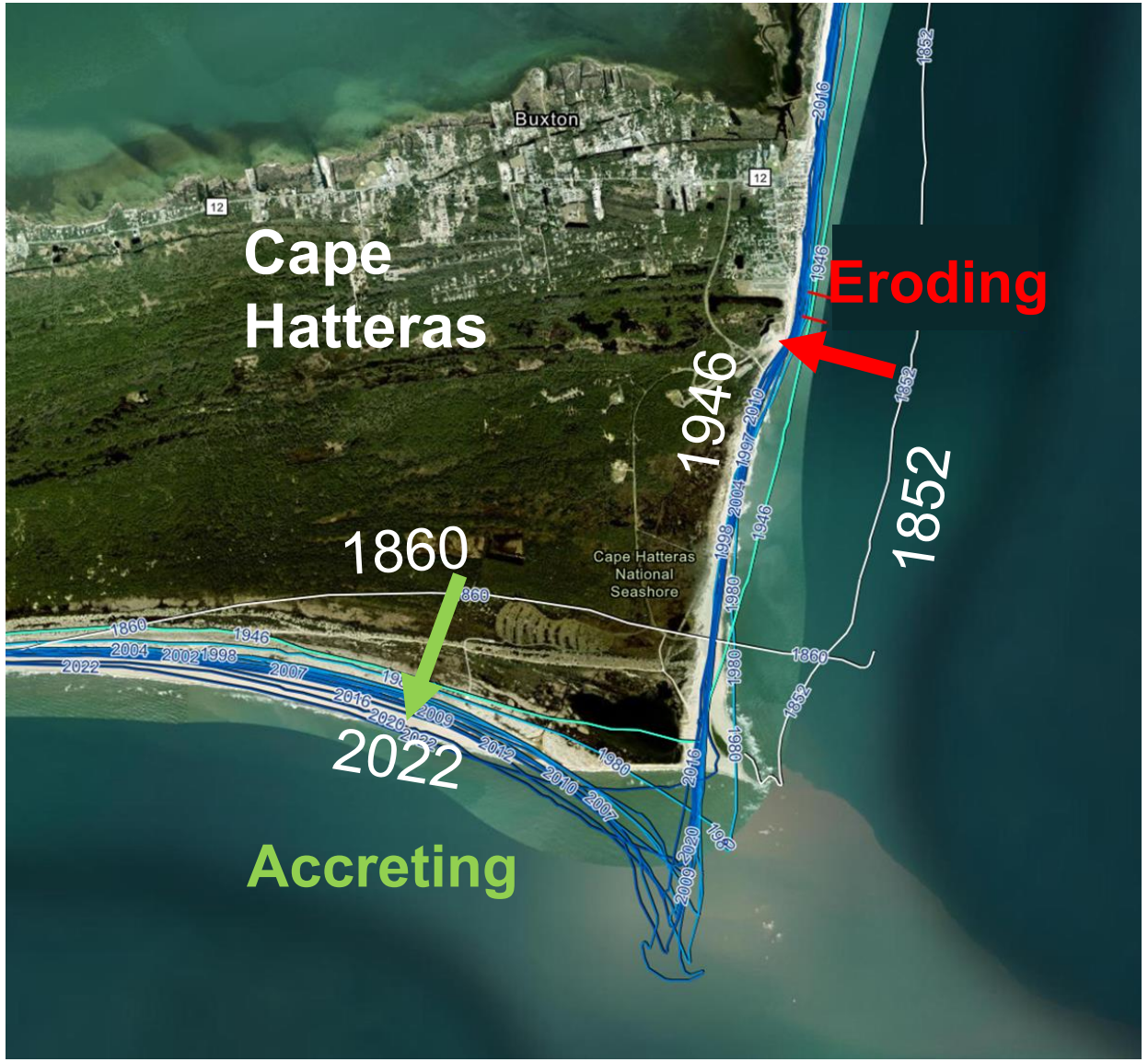




Gradients in alongshore transport can lead to wider islands

For example:

- **West side of Cape Hatteras**



Gradients in alongshore transport can lead to wider islands

For example:

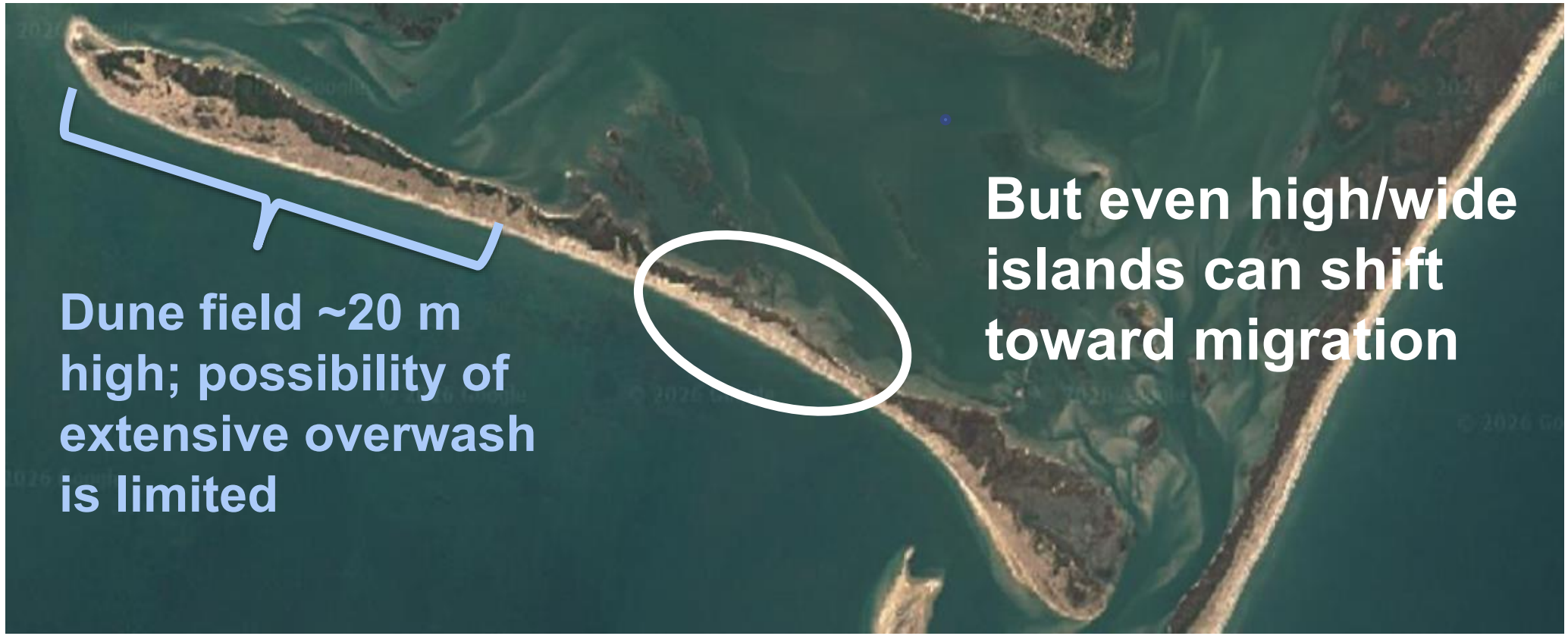
- West side of Cape Hatteras
- **Parts of Bogue Banks (e.g., Pine Knoll Shores)**



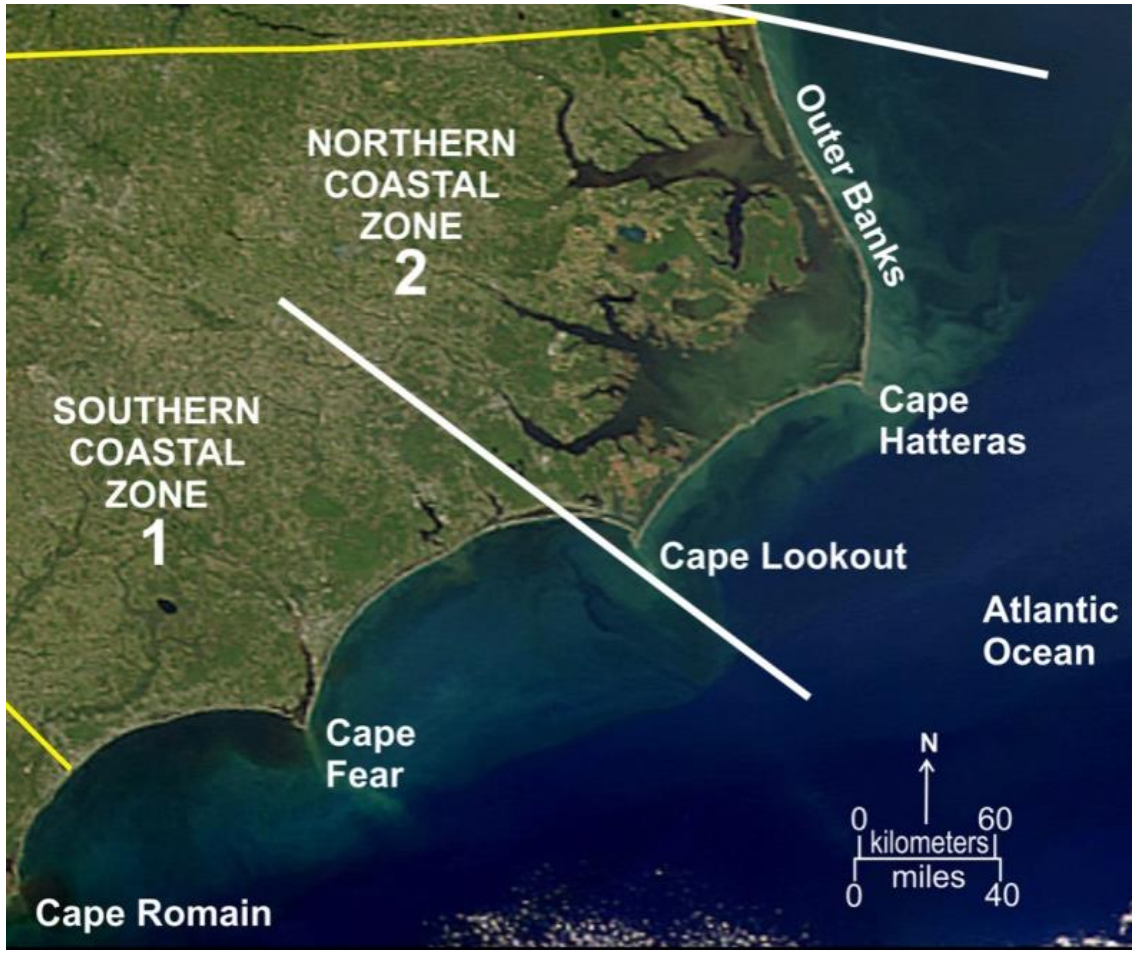
A wide barrier can also become higher with time and wind…

For example:

- West side of Cape Hatteras
- Parts of Bogue Banks (e.g., Pine Knoll Shores)
- **Parts of Shackleford Banks**



NC barrier islands more dominated by wave processes in the north and more dominated by tides in the south



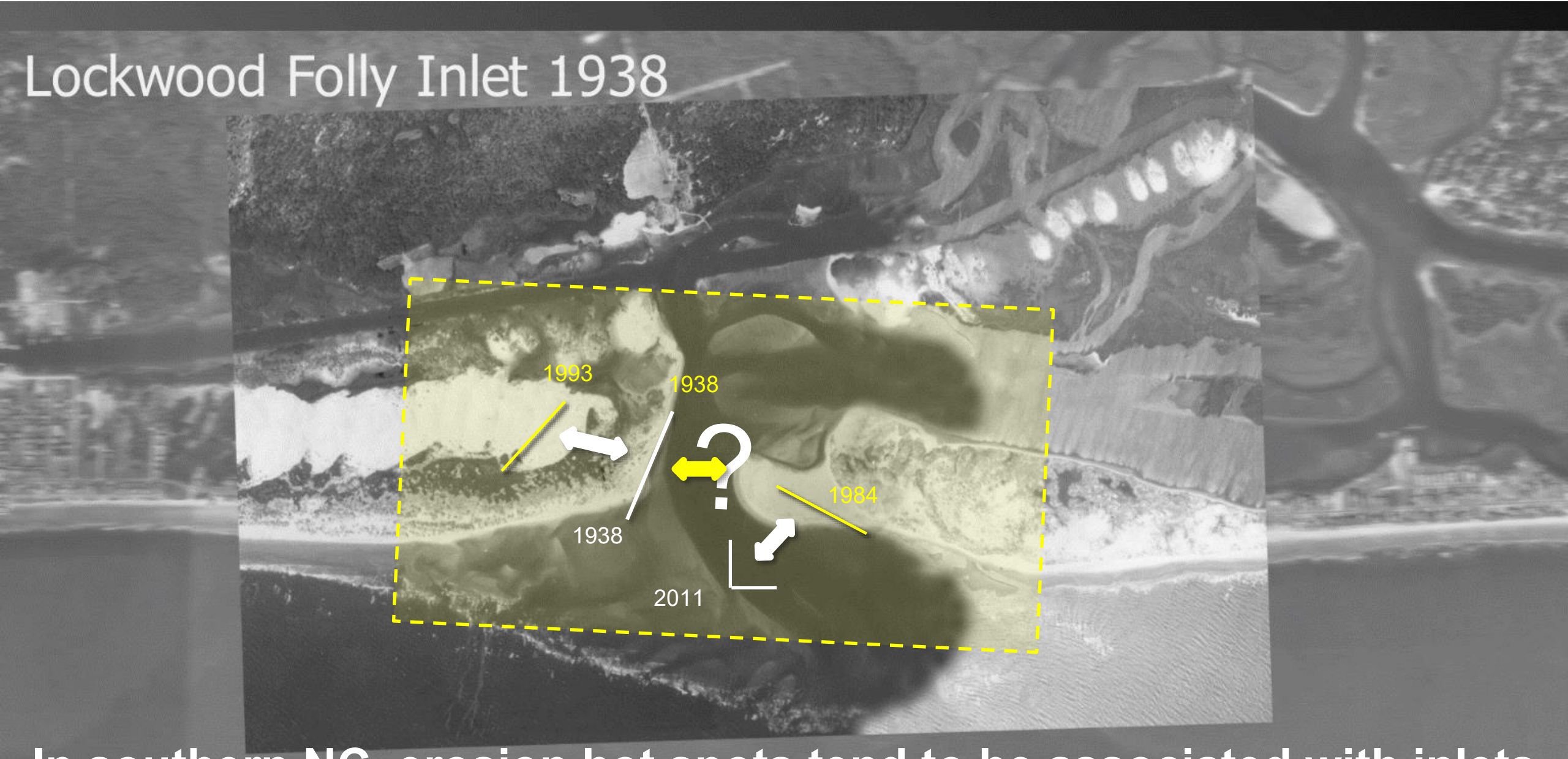
Northern NC

- low slope land surface
- elongate, thin barrier islands ***(wave effects most dominant)***
- 3 major inlets, tendency to migrate
- wide back-barrier estuaries

Southern NC

- more steeply sloping land surface
- shorter barrier islands ***(incr. relative influence of tides)***
- 18 inlets, inlet channels migrate, not the inlets themselves
- narrow back-barrier estuaries

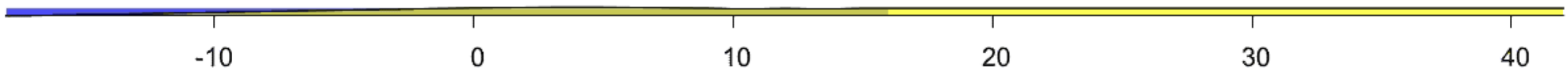
Lockwood Folly Inlet 1938



In southern NC, erosion hot spots tend to be associated with inlets

On narrow islands, dunes affect when and where washover occurs

Blue = high water events/storms at the elevation of occurrence



- Dunes naturally tend to come and go
- When dunes are low, they tend to stay low; washover occurs during even minor storms
- When dunes are high, they tend to stay high; washover only during major storms





Artificially tall dunes prevent or reduce washover

- Prior to construction of CCC dunes along in the 1930s, islands stuck in a low state.
- Construction of dunes kept overwash at bay
  - development



When dunes are taller than natural:

- Island gets lower relative to sea level
- Increases vulnerability to strong storms
- Increases vulnerability to soundside flooding



Magliocca et al,. 2011; Anarde et al, 2024a, 2024b , Eisemann et al., 2025

On developed islands, management actions and infrastructure affect island processes…



Image: Greg Kahn, Audubon

dune construction reduces overwash
overwash removal =lost elevation gain
Nordstrom 1994, 2004

Homes filter overwash



Rogers et al., 2015
Lazarus et al., 2021

sandbag seawalls block overwash



Washover is building elevation where NC-12 was re-routed on Pea Isand









As sea level rises more rapidly into the future…

- Increases in washover will increase erosion rates island narrowing and migration.
- Washover (where it remains) will maintain island elevation relative to sea level, at least for a time.* Where washover is removed, islands will get lower.
- Lower islands will be more susceptible to storm impacts and soundside flooding.
- Many barrier islands and barrier stretches (except for highest areas) will look very different in the coming decades/centuries.

**Long-term there may not be sufficient sand supply offshore (erosion of shoreface may not be fast enough) for barriers to maintain elevation*

The last time sea level rise rates were as high as projected for the end of this century, barrier islands were rare

With implications for mainland shores…

