

Analysis of predicted dune erosion along North Carolina barrier island shorelines



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March 29th, 2019



INSTITUTE OF
MARINE SCIENCES

Research Applied to Managing the Coast Symposium

North Carolina Dune Erosion



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Home News

Florence accelerates Bogue Banks beach erosion



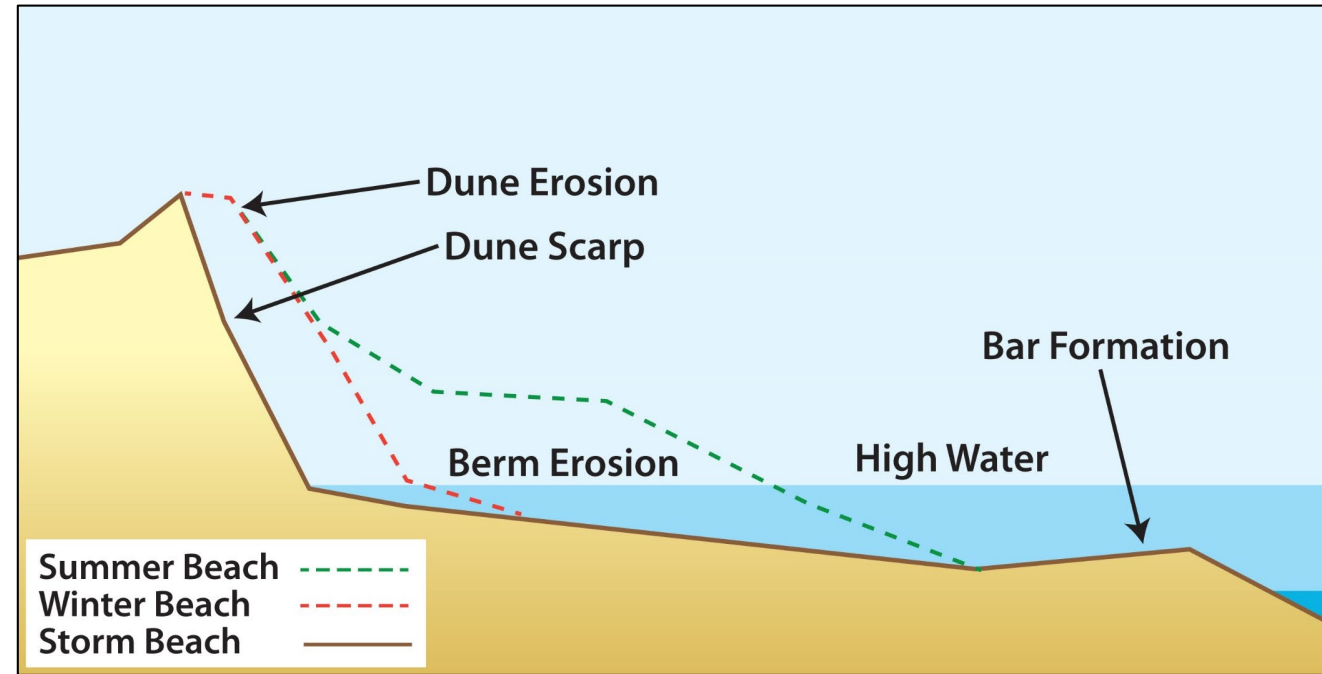
Dunes & Human Development

- Natural first line of defense from coastal winds, waves, and flooding
- Communities commonly expend resources to restore and stabilize dunes
- Increases in risky coastal development patterns
- Clear need for accurate forecasts of coastal dune erosion



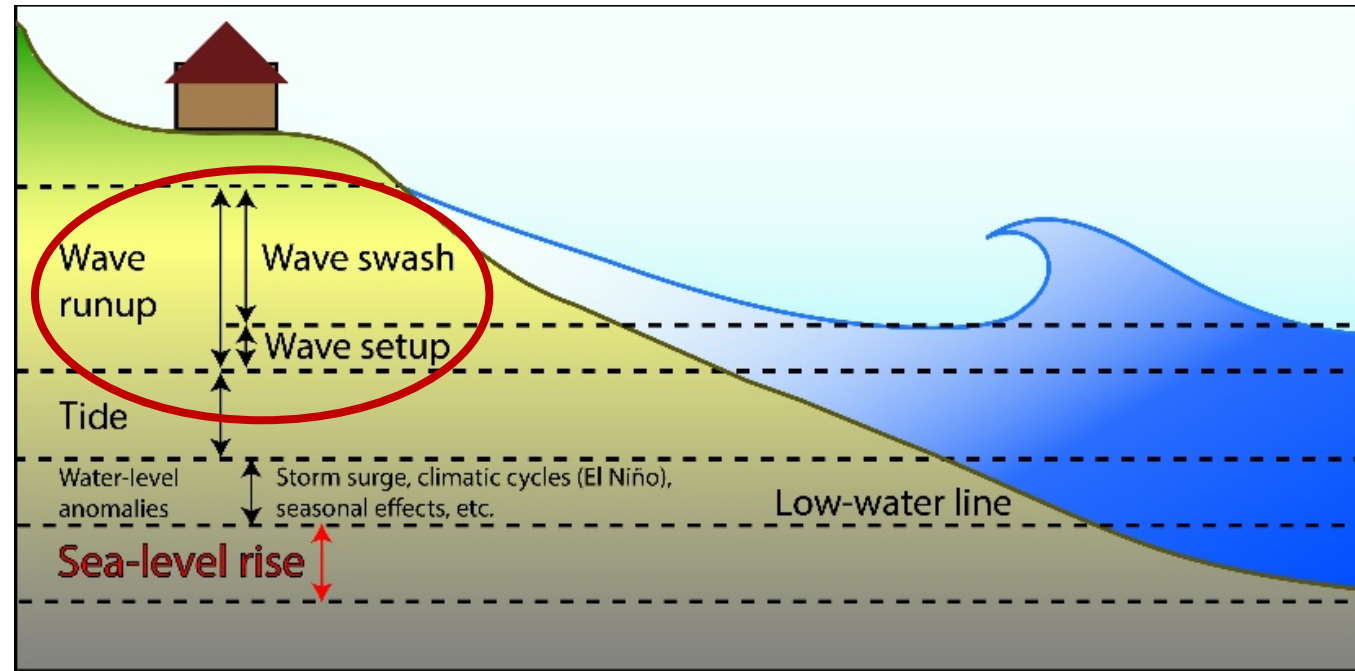
Coastal Dune Erosion

- Dunes constantly change in shape, width, height
- Erosion types
 - *Seasonal fluctuations*
 - *Storm-induced*
 - *Long-term*
- Dune recovery controlled by SLR, changes in storm frequency, duration, vegetation growth



Components of Coastal Water Levels

- *Mean Sea level*
- *Tide*
- *Storm surge*
- *Wave runup*: elevation of water on beach face = setup + swash
 - Wave setup*: Time averaged elevated water level due to wave action
 - Wave swash*: Movement of water up the shore due to breaking waves
- *Total Water Level*: Tide + surge + wave runup



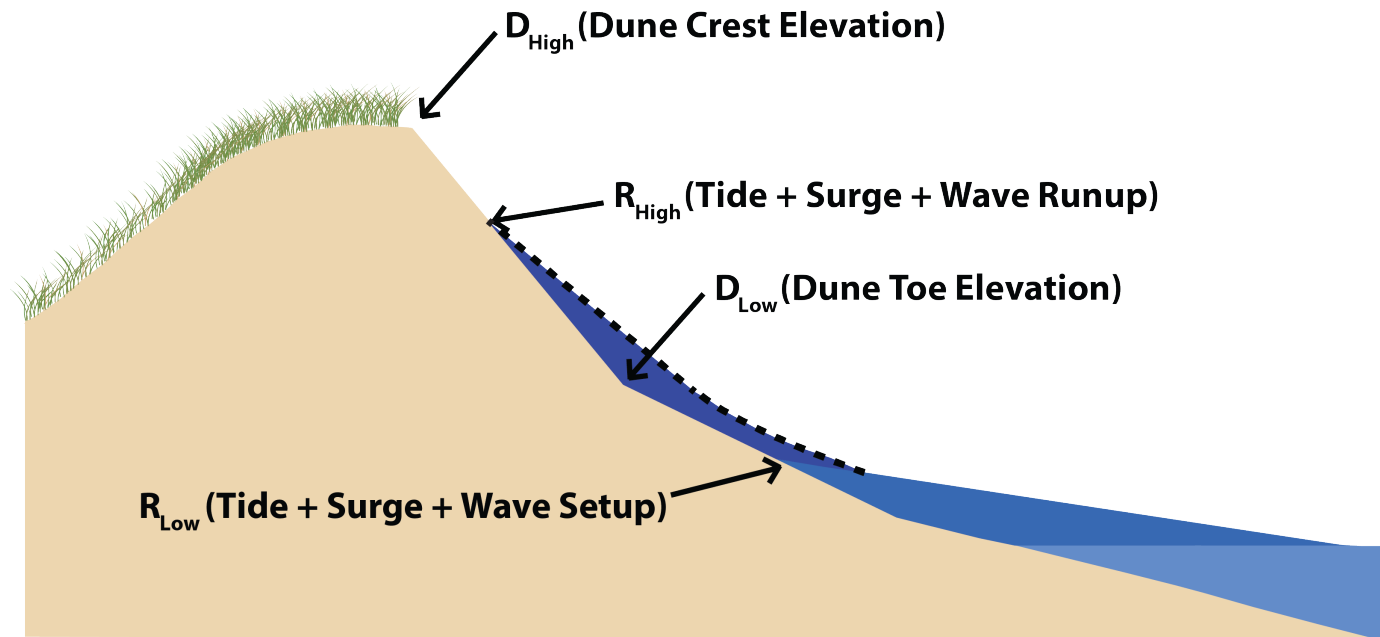
Dune Response: Storm Scaling Model

- *Swash*
 - Water level seaward of dune toe
- *Collision*
 - **Water reaches base of dune: erosion of front of dune**
- *Overwash*
 - Waves transport sand landward
- *Inundation*
 - Beach system completely submerged



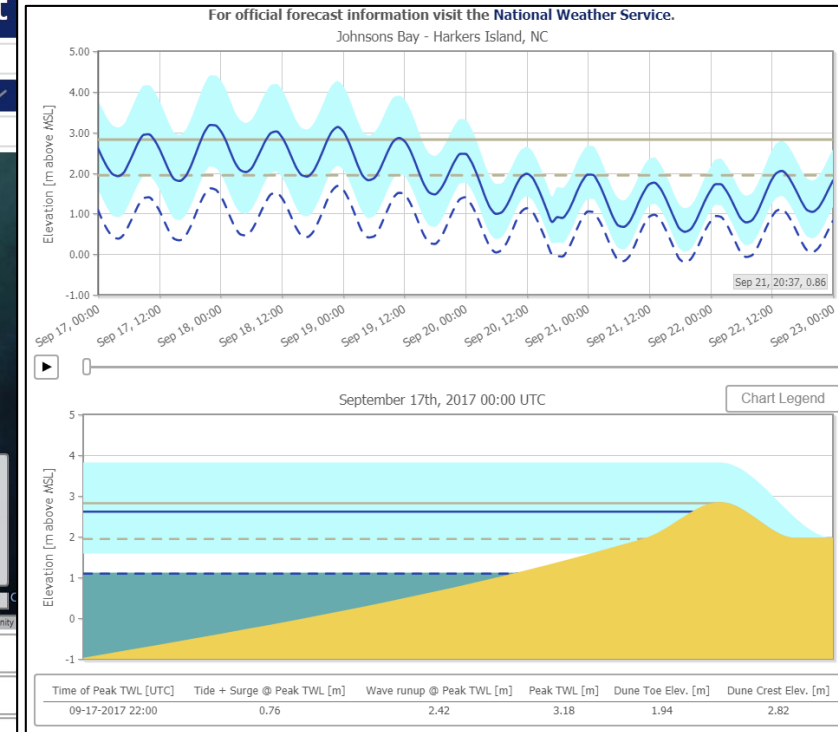
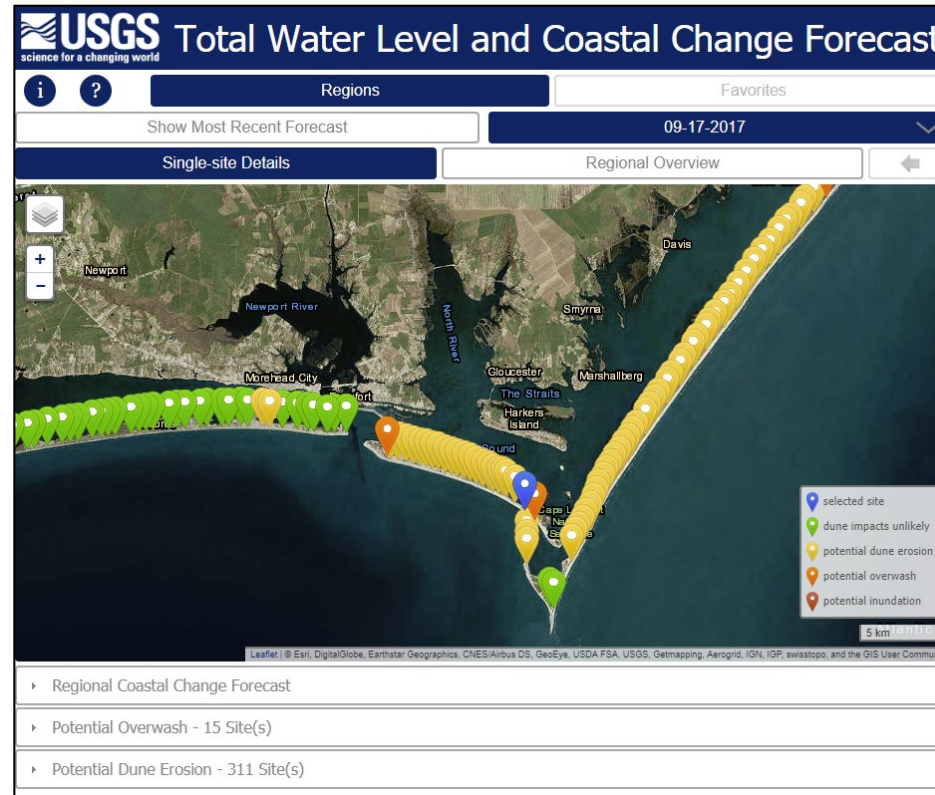
Dune Response: Collision Regime

- Total water level exceeds dune toe, but not dune crest
- Erosion of seaward dune face
- Beach can recover to pre-storm conditions in weeks to years



Current Models: USGS Storm Impact Assessment

- Probability of collision, overwash, and inundation from TWL and dune measurements
- Models parametrized with buoy data and SLOSH and SWAN models
- Not representing accurate wave runup and dune erosion



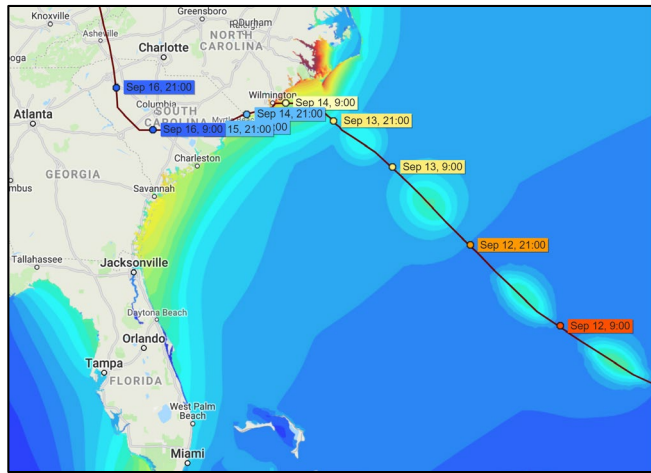
Research Question: How often do we need to updated beach topography data to have accurate predictions of dune erosion?

Region: MHX (Morehead, NC)
Site ID: 2313
Location Near: Johnsons Bay, Harkers Island, NC
Forecast Begins: 09-17-2017 00:00 UTC
Dune Measured In: January 2014
Forecasted Dune Impact Regime: Collision

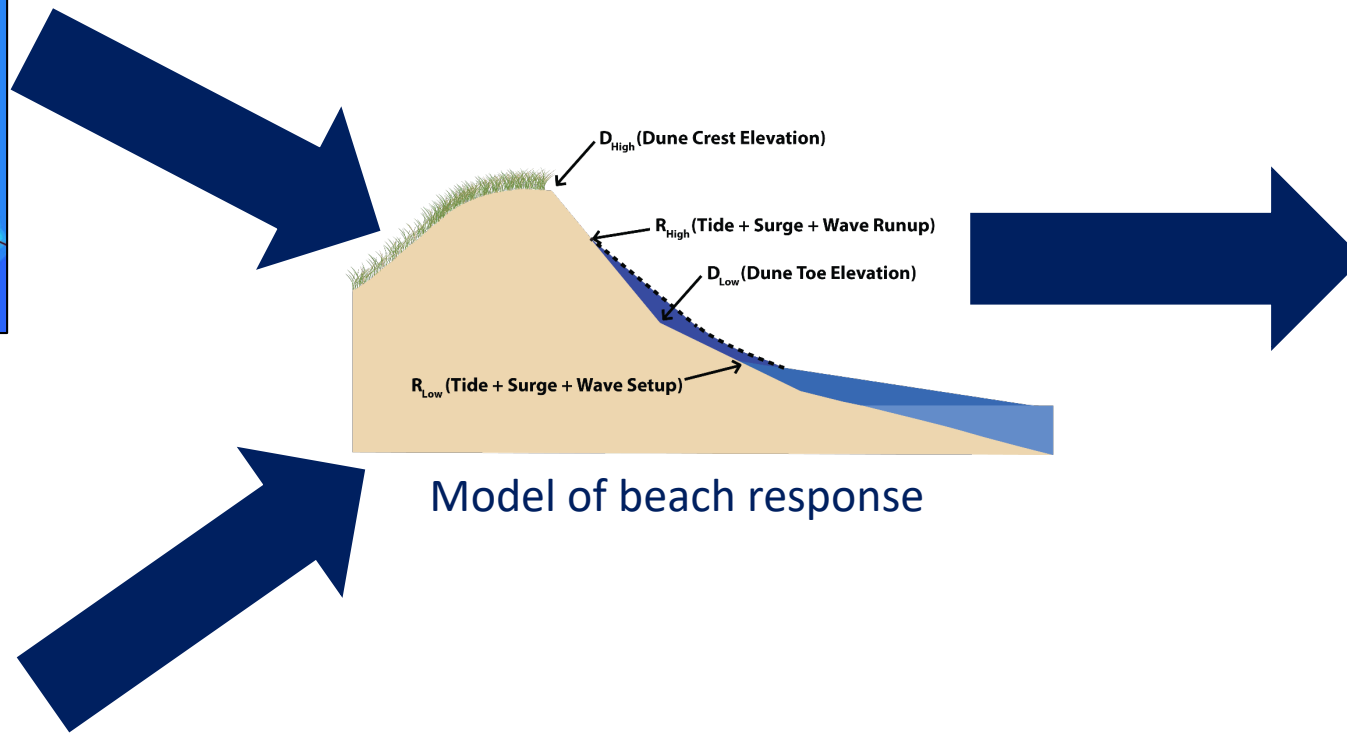
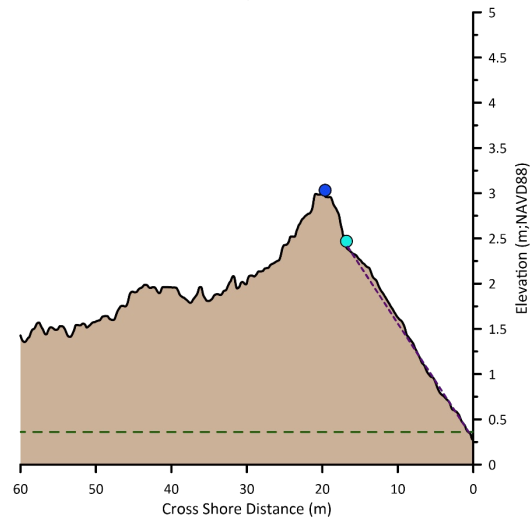
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Predictions of Coastal Change During Storms

Model of approaching storm: ADCIRC+SWAN (waves, surge, water level)



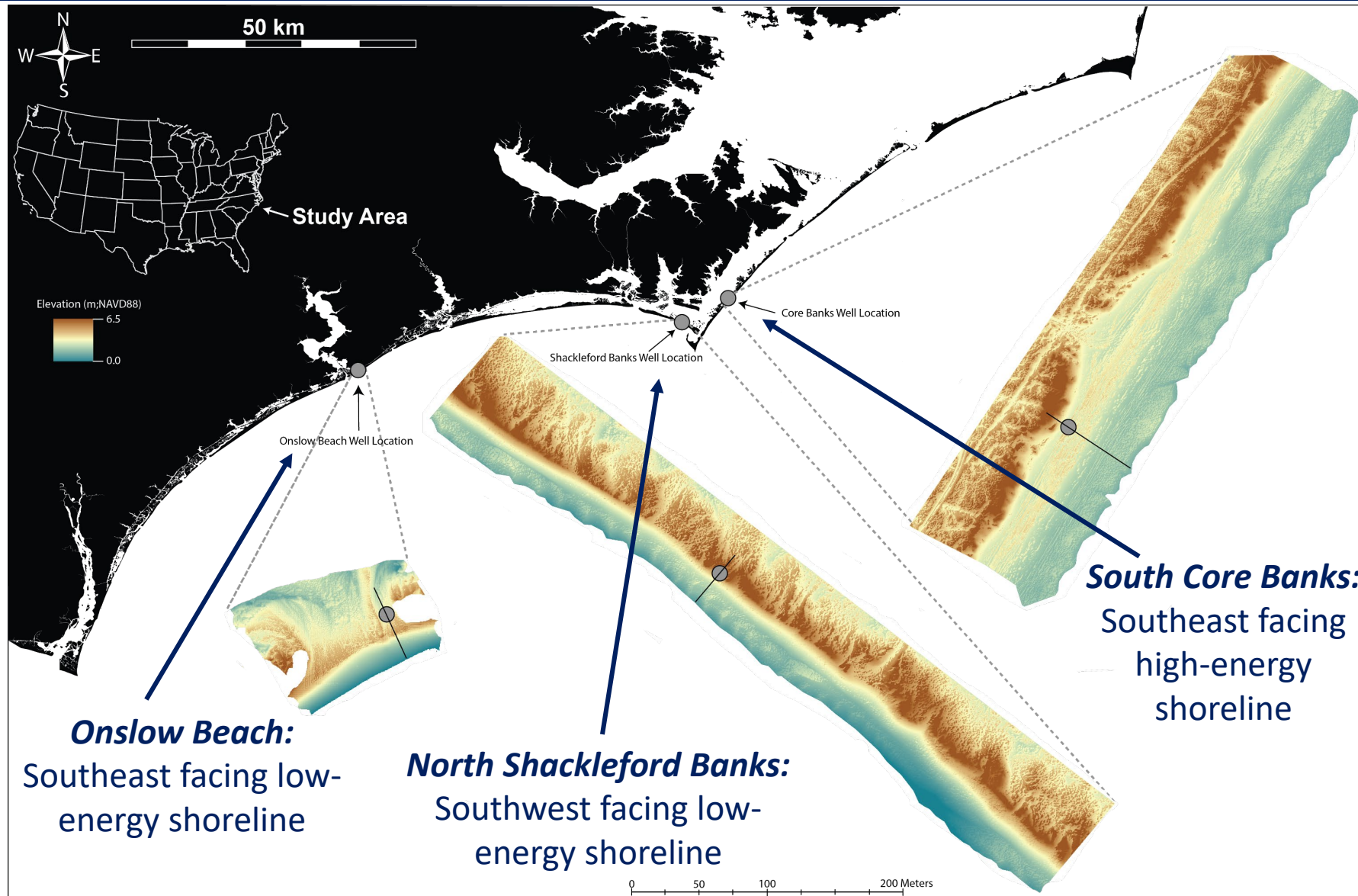
Shackleford Banks September 2017 Beach Profile



Coastal change (collision, overwash, inundation)

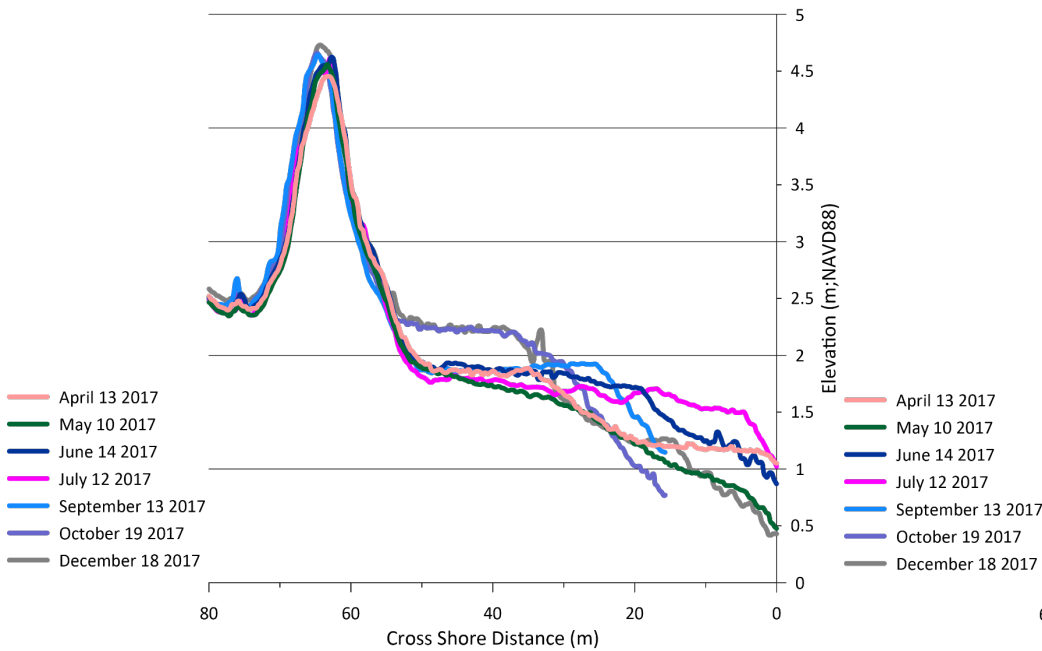
Initial beach morphology: beach slope, dune toe and crest elevations

Study Sites

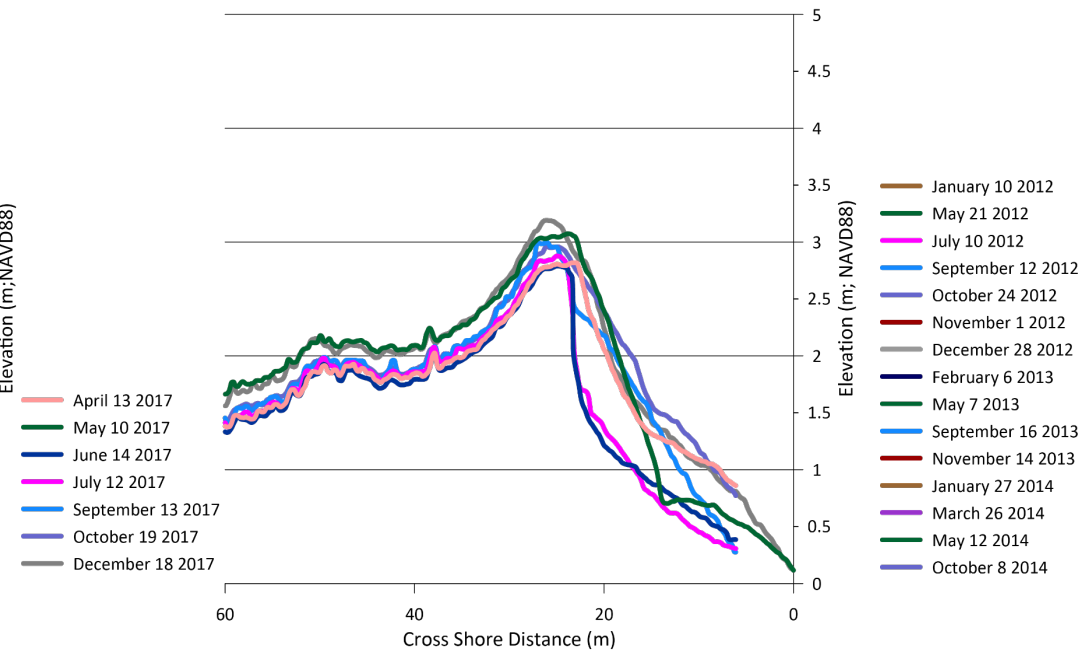


Comparing Beach Slope & Profile Changes Between Sites

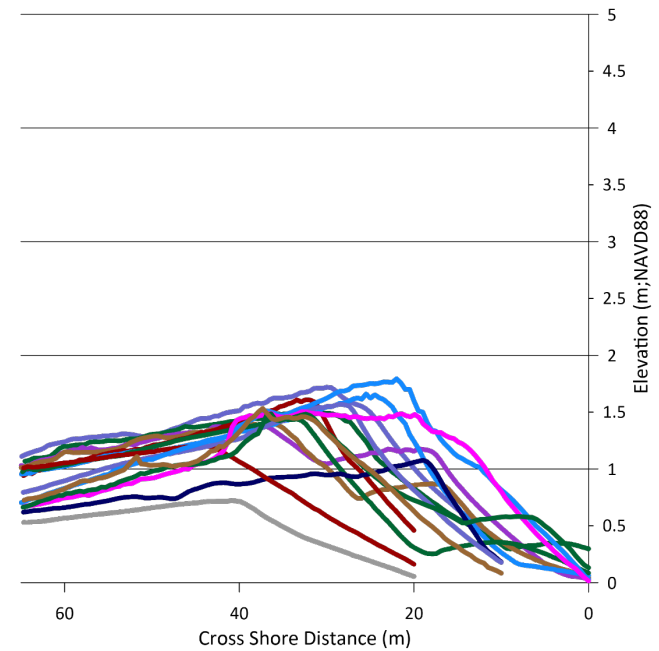
Core Banks Beach Transects



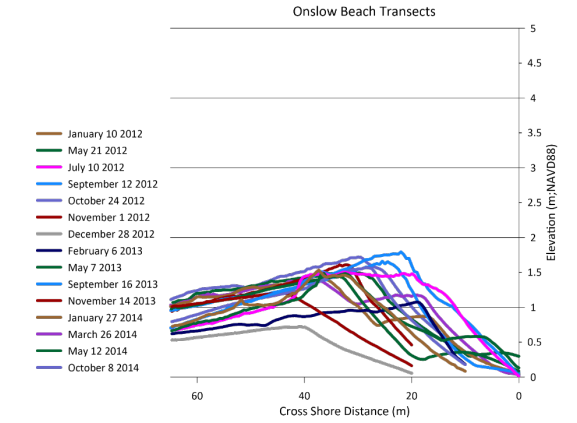
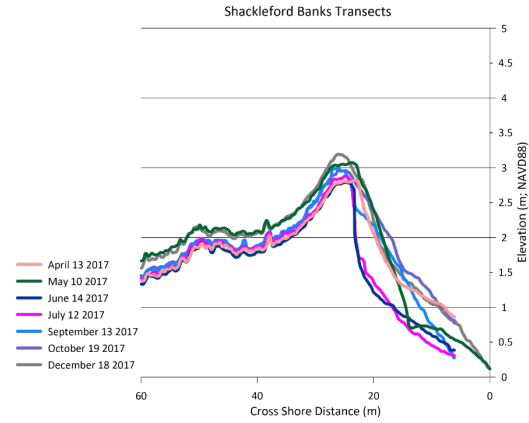
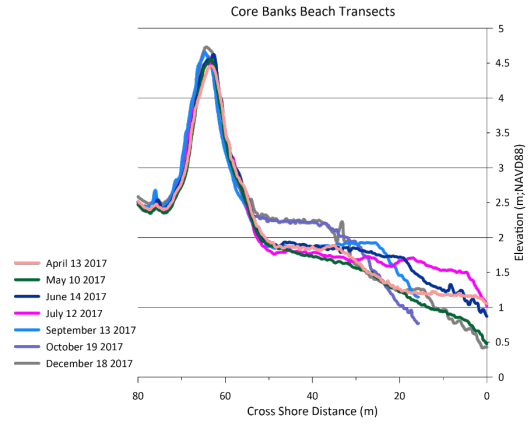
Shackleford Banks Transects



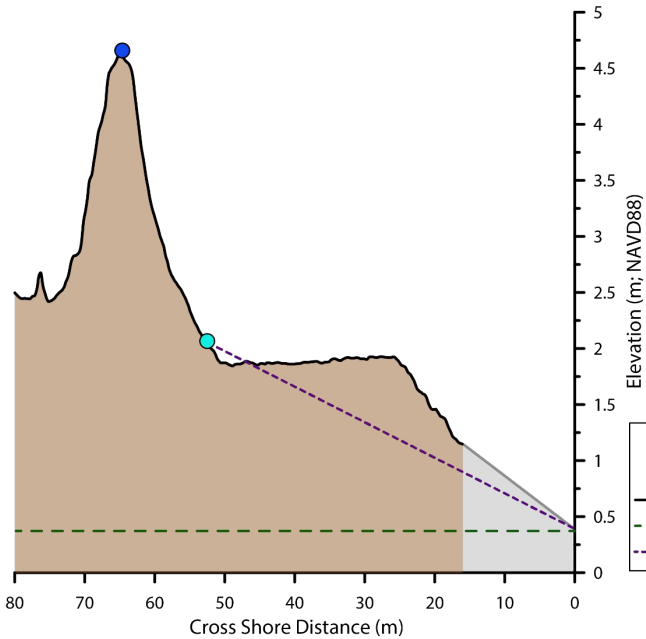
Onslow Beach Transects



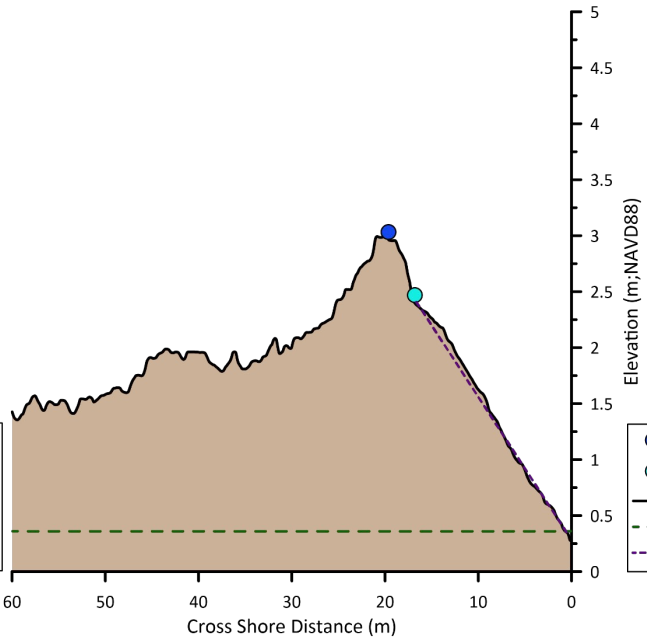
Comparing Beach Slope & Profile Changes Between Sites



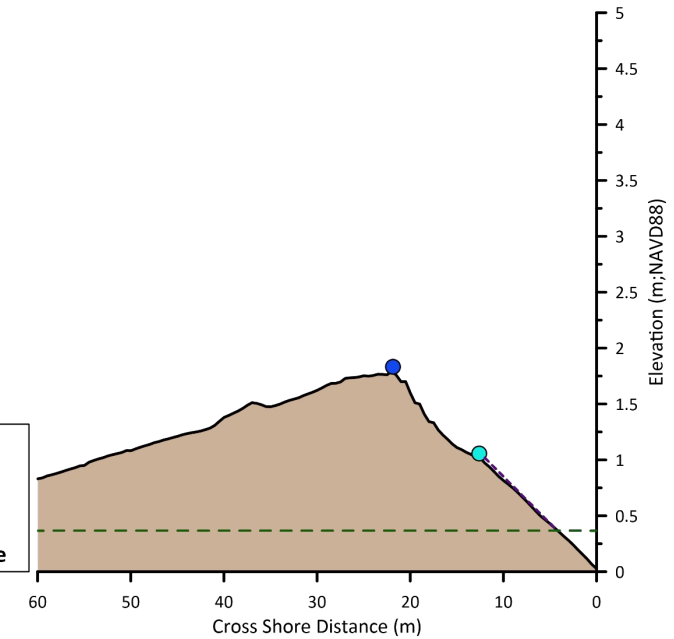
Core Banks September 2017 Beach Profile



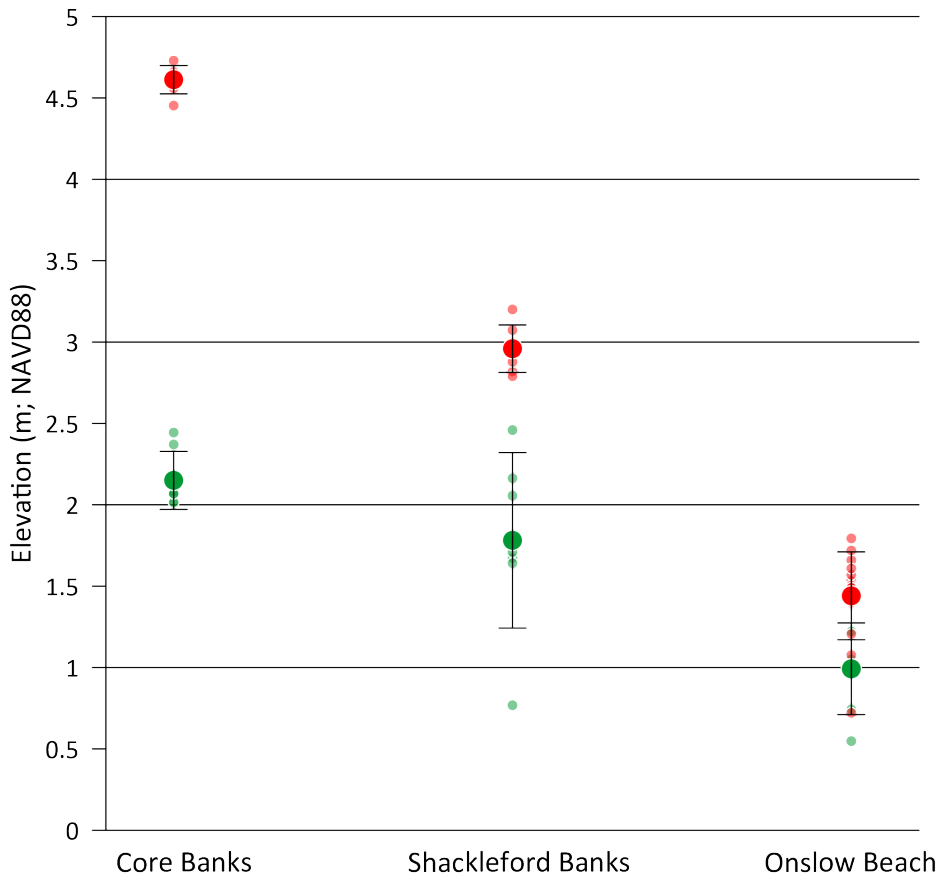
Shackleford Banks September 2017 Beach Profile



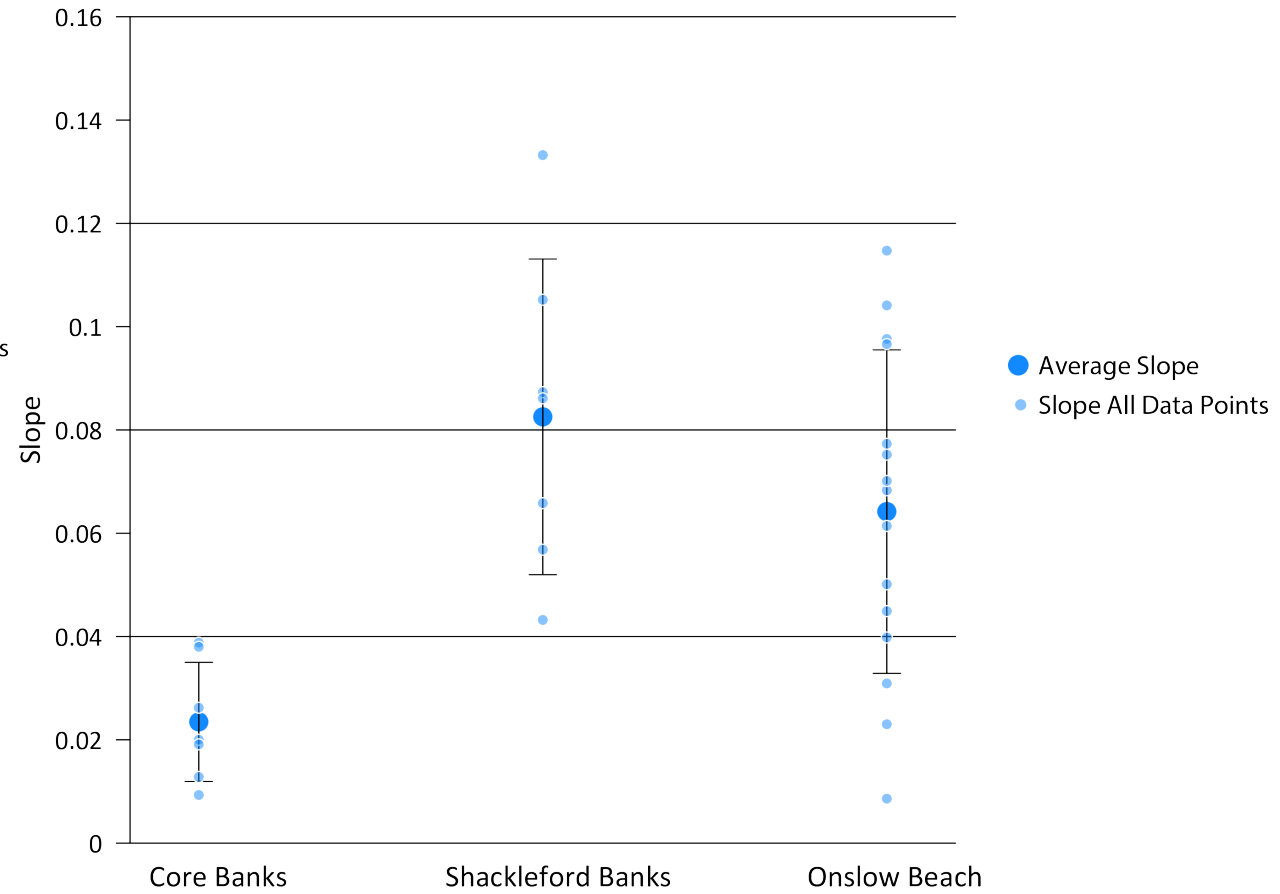
Onslow Beach September 2012 Beach Profile



Dune Elevation & Beach Slope Differences Between Sites

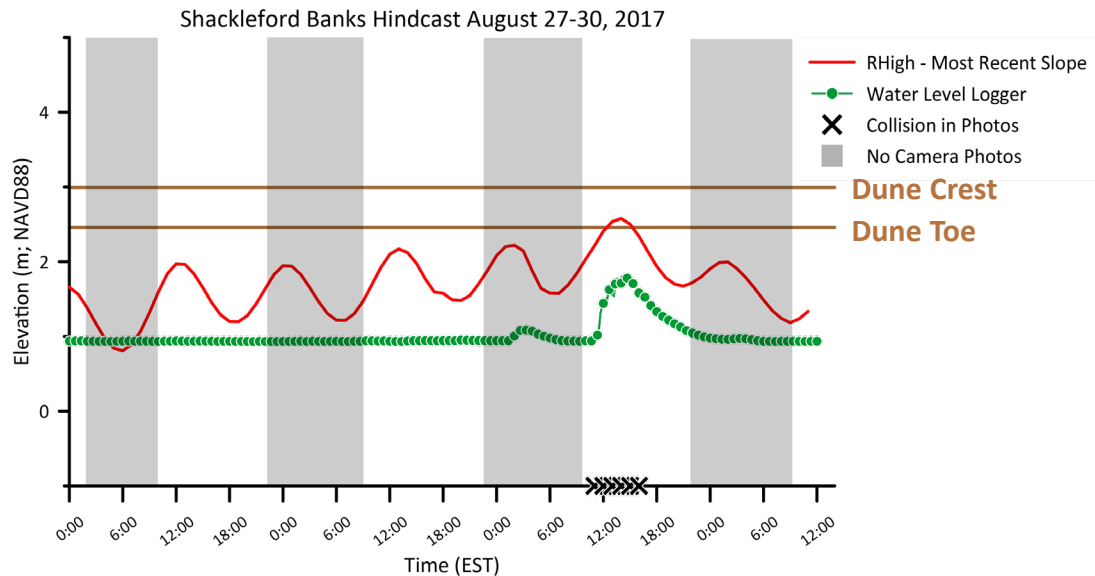
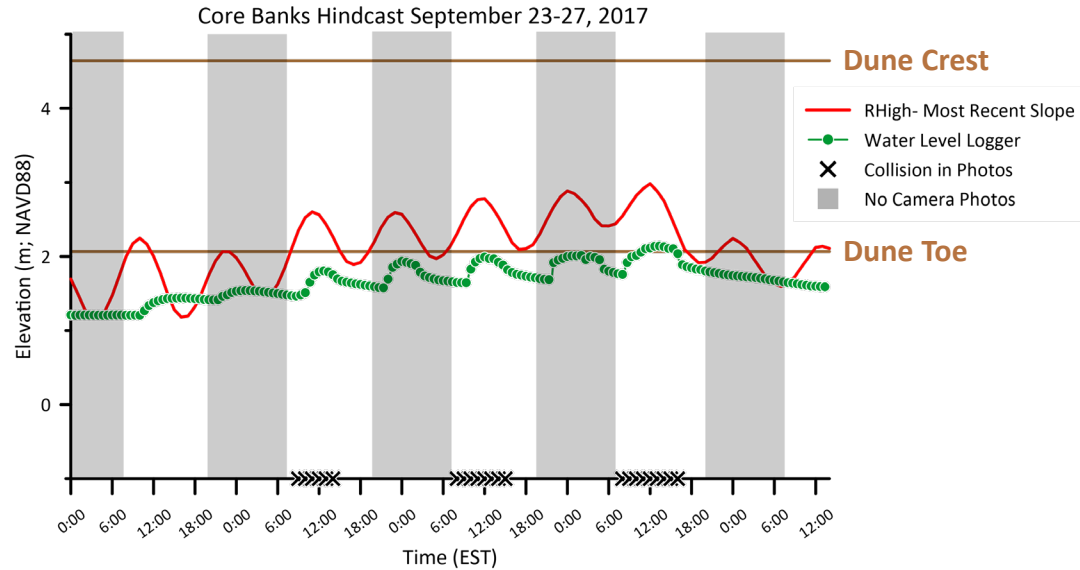


- Average Dune Crest
- Average Dune Toe
- Dune Crest All Data Points
- Dune Toe All Data Points



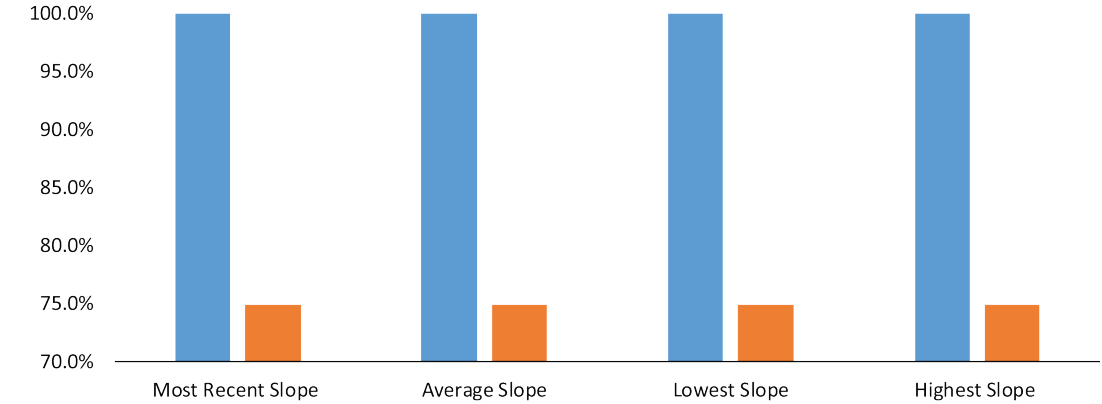
- Average Slope
- Slope All Data Points

Core & Shackelford Banks Dune Erosion Example



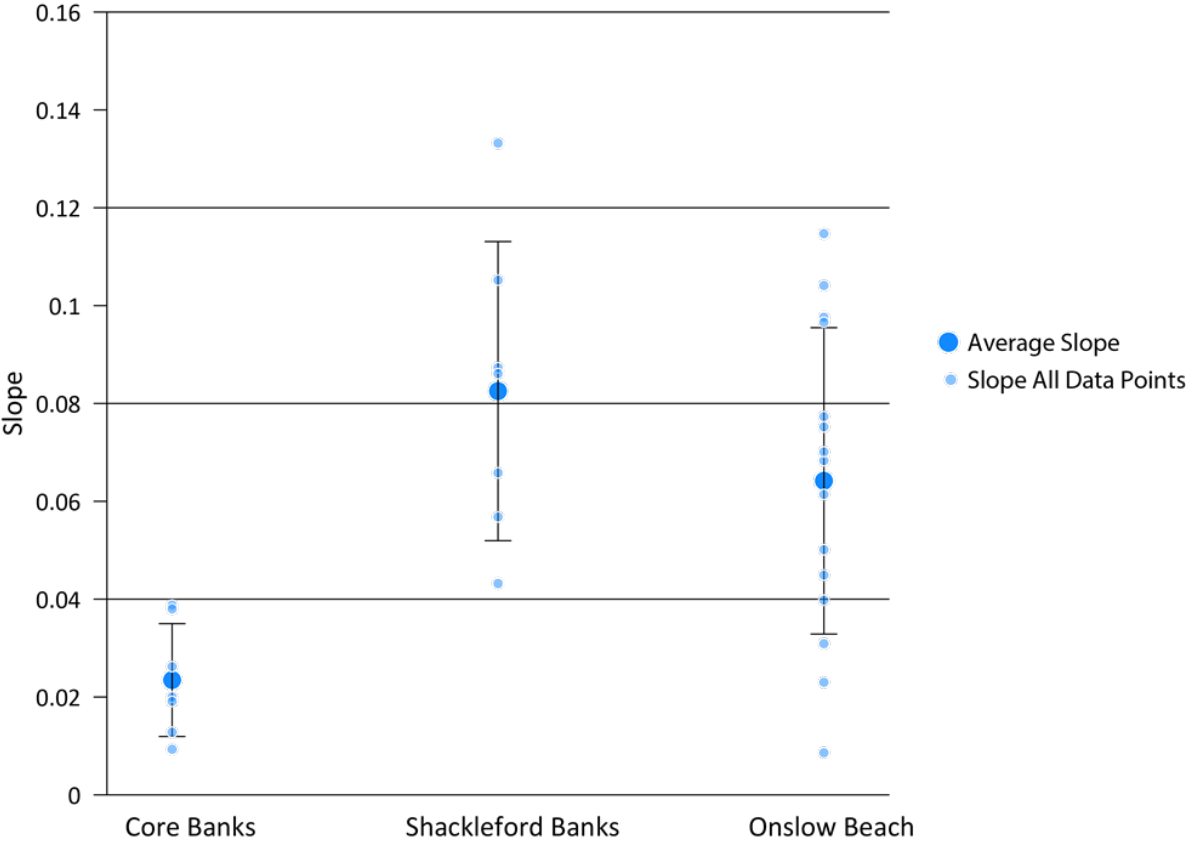
Collision Prediction Accuracy with Varying Beach Slopes

Core Banks Collision Predictions with Varying Beach Slopes



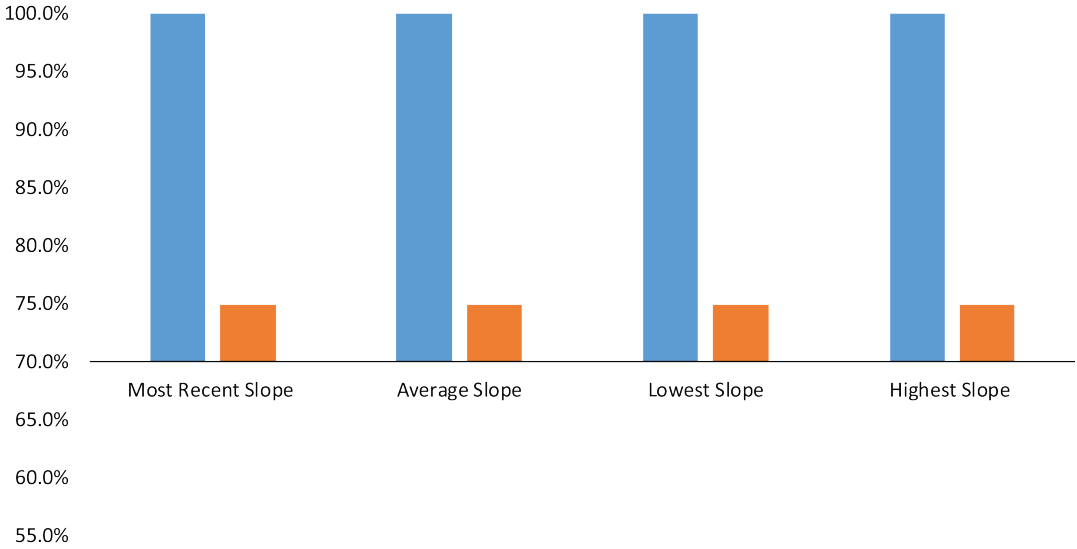
Sensitivity: $\frac{\text{\# of days collision predicted}}{\text{\# of days collision observed}}$

Predictive Power: $\frac{\text{\# of correct days collision predicted}}{\text{\# of days collision predicted}}$

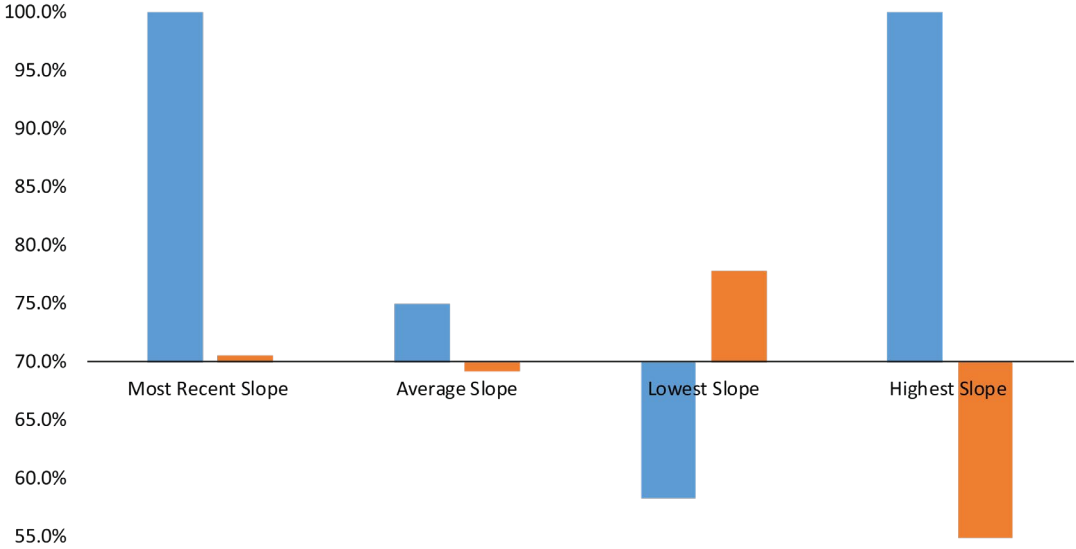


Collision Prediction Accuracy with Varying Beach Slopes

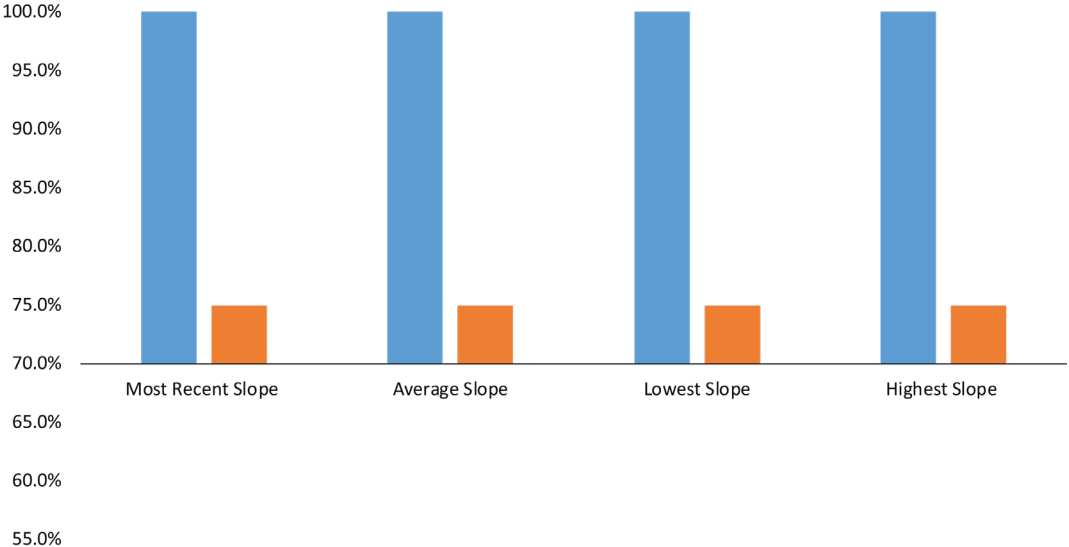
Core Banks Collision Predictions with Varying Beach Slopes



Shackleford Banks Collision Predictions with Varying Beach Slopes



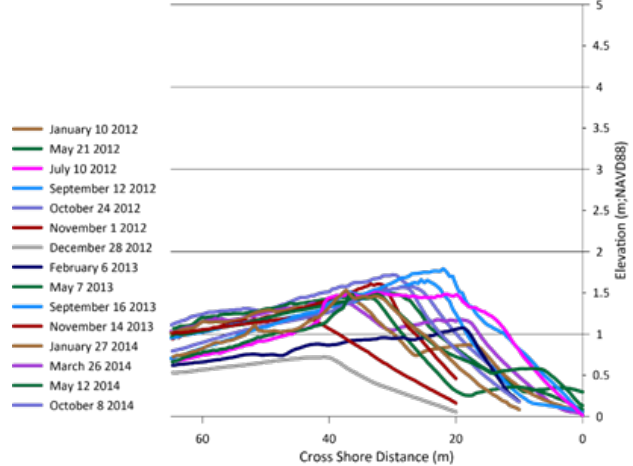
Onslow Beach Collision Predictions with Varying Beach Slopes



Sensitivity: $\frac{\text{\# of days collision predicted}}{\text{\# of days collision observed}}$

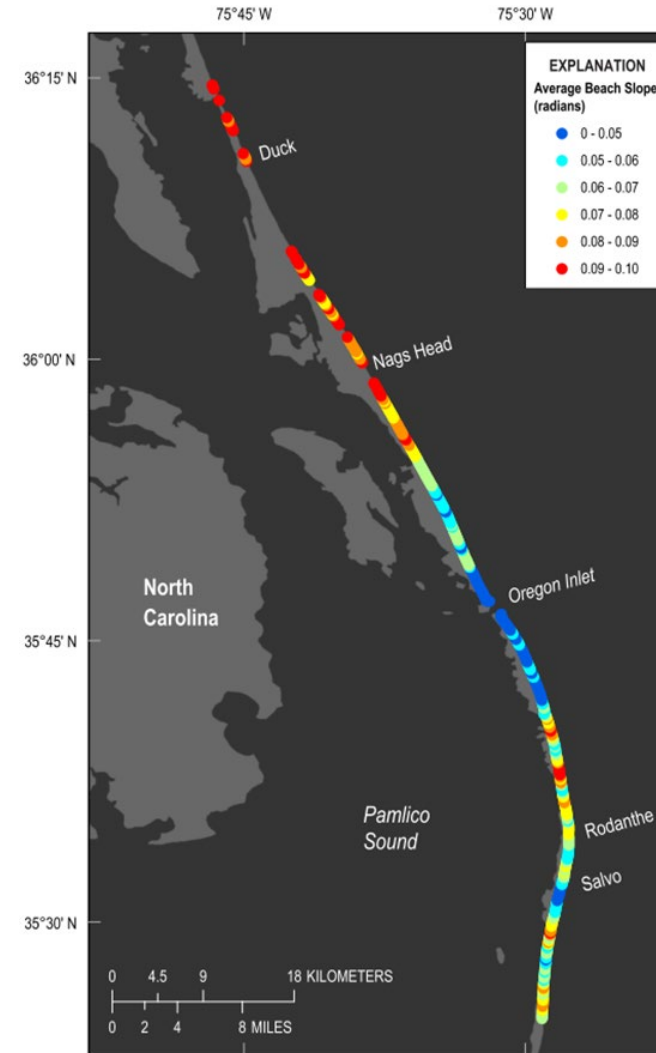
Predictive Power: $\frac{\text{\# of correct days collision predicted}}{\text{\# of days collision predicted}}$

Onslow Beach Transects



Take Home Messages

- Up to date beach slope is important in wave runup and dune erosion prediction accuracy
- ADCIRC + SWAN can be used to accurately predict water levels along the coast
- **Reflective beaches**
 - Steeper more variable slopes
 - Wave runup occurs more frequently
 - Need updated topography data
- **Dissipative beaches**
 - More gradual and less variable slopes
 - Update topography data less often



Acknowledgments

Carson Miller, Molly Bost, Michael Itzkin
Tony Rodriguez, Rick Luettich, Laura Moore
Duke Marine Robotics & Remote Sensing Lab



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Questions

