ESTIMATES OF THE IMPACT OF NEARSHORE NOURISHMENTS ON DIRECT BEACH NOURISHMENT LIFESPAN

INLET GEOMORPHIC EVOLUTION

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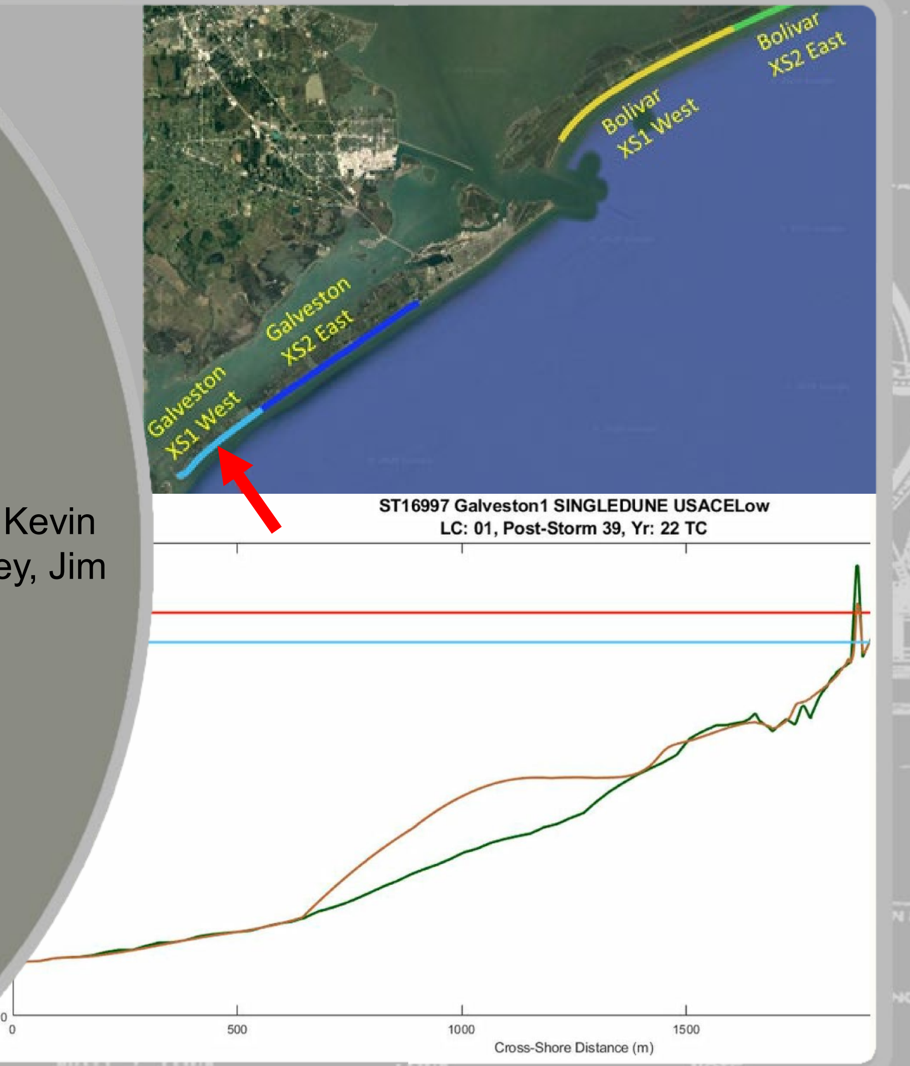

COASTAL INLETS RESEARCH PROGRAM

FY21 RESEARCH UPDATE

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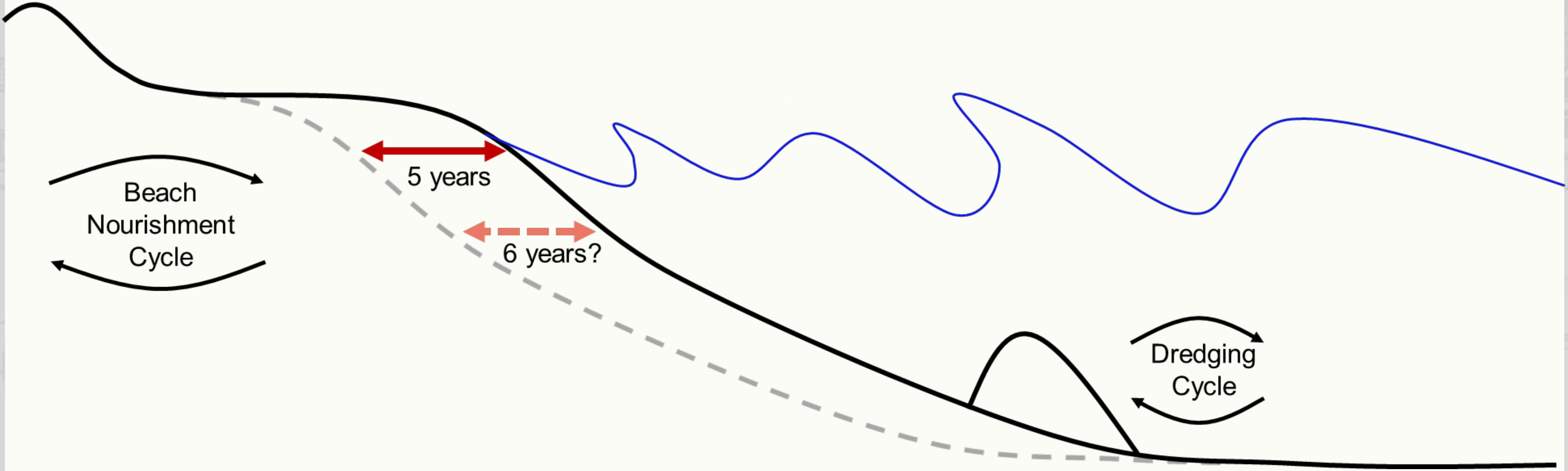
Co-Located Beach & Nearshore Nourishments

Objective:

To what extent can nearshore nourishments extend the life of sub-aerial beach fills?

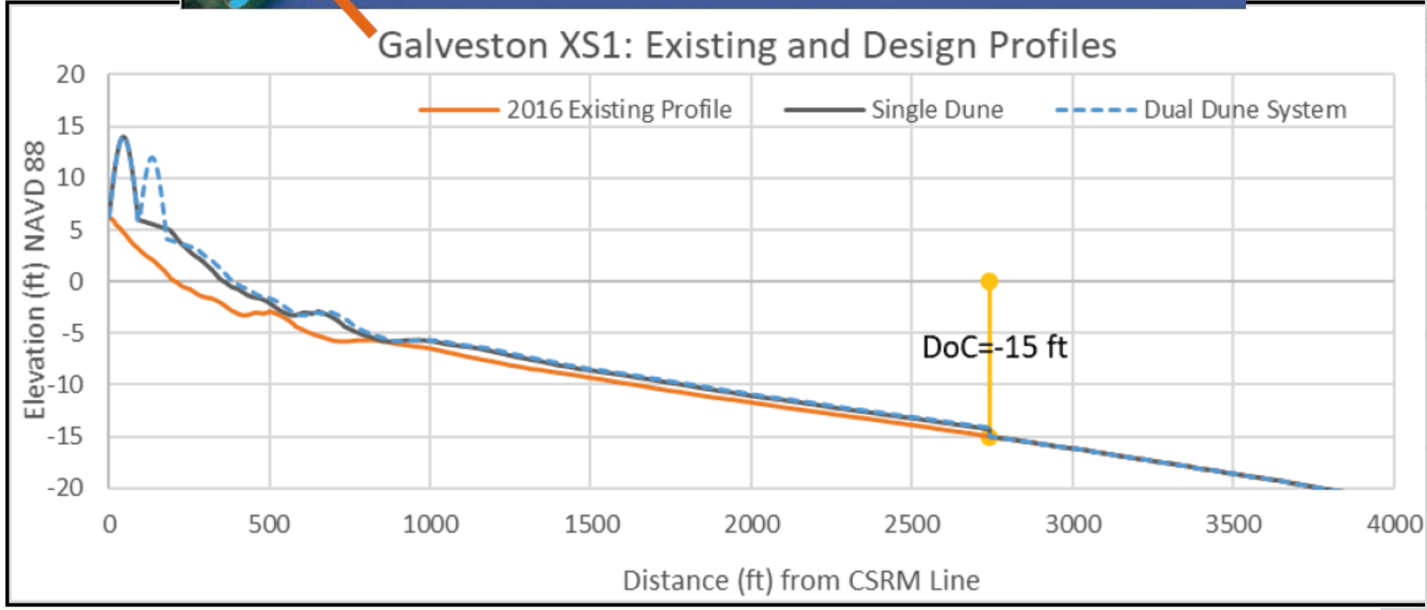
- Break waves farther from shore, dissipating energy over a wider surf zone
- Supply sediment to the beach profile



Background

Building off of the Recent Coastal Texas Protection and Restoration Feasibility Study CSRM:

- Several CSRM alternatives evaluated in StormSim
  - 50 year Monte Carlo life-cycle simulations
  - Randomly sampled storms applied to representative profiles in CSHORE
  - ~30 CSTORM synthetic Tropical Storms
  - ~46 measured/hindcast Non-Tropical Storms
- This task modifies a subset of these simulations:
  - Single dune alternative
  - Galveston XS1 West
  - Add recurring nearshore nourishments



Site map & initial elevation plot for Galveston XS1 from Melby et al. (2021)

Simulating Beach Nourishment Lifespan

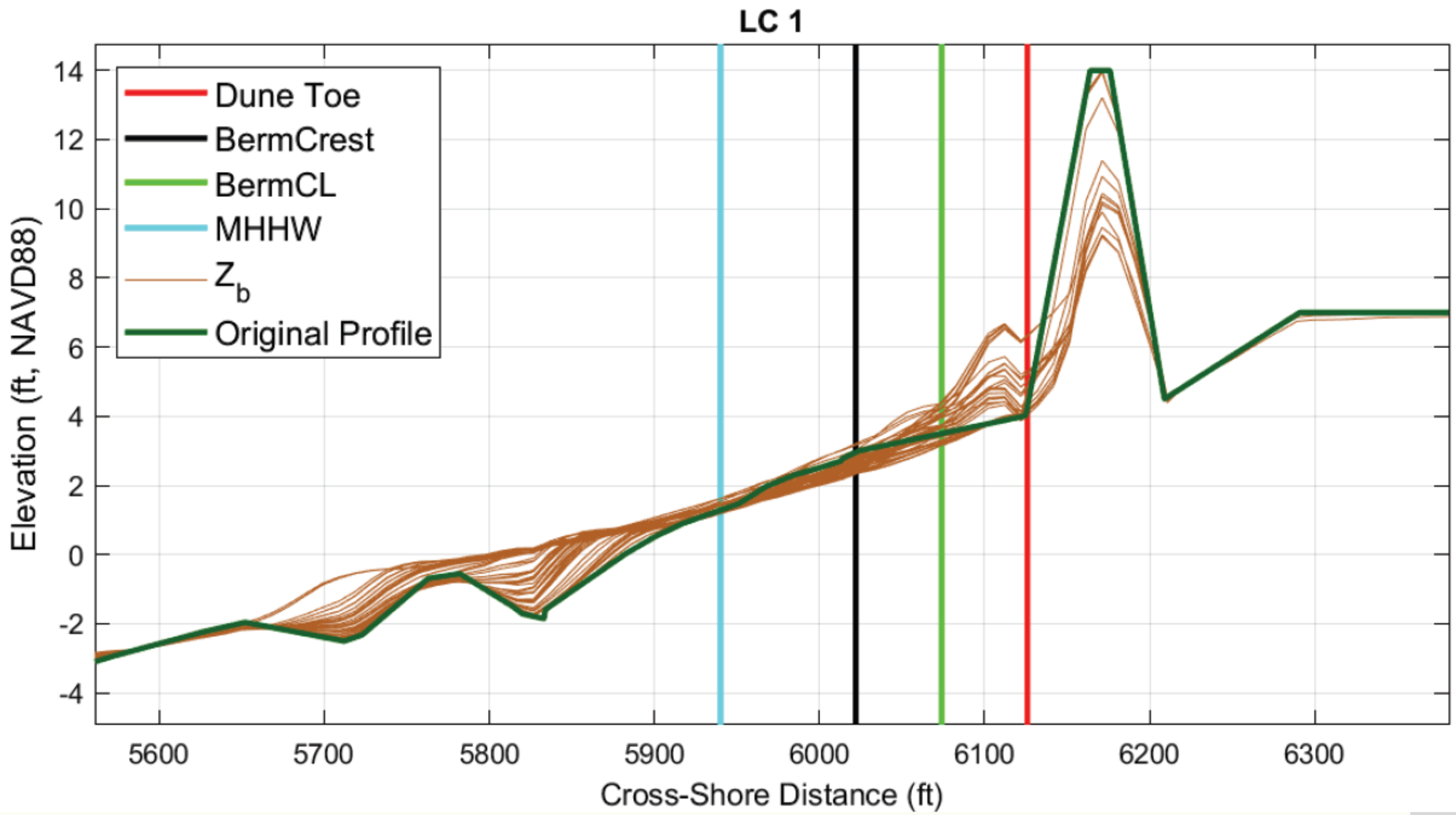
Beach re-nourishment condition

- Profile elevations are reset to the initial values when the dune crest is reduced to 50 % of the initial height
- The interval between profile rebuilding is interpreted as the beach nourishment lifespan

Morphology Change Pattern

- Morphology change from storm forcing is characterized by dune erosion and accretion at the landward and seaward edges of the dry beach
- Can nearshore nourishments shelter the beach and dune and reduce wave energy that reaches the dune by breaking waves farther offshore?

Example Morphology Change Predictions:



Plot of example profile elevations over one life cycle simulation for Galveston XS1 from Melby et al. (2021).

Adding Recurring Nearshore Nourishments

Adding Nearshore Nourishments:

- Nearshore nourishments are defined Gaussian mounds
- The shape parameter (*r*) is set to match the best fit to data from the 2009 Ft. Myer's Beach nearshore berm
- Parameters are varied iteratively until:
  - a specific volume is achieved,
  - near a specific depth,
  - without going above a vertical limit

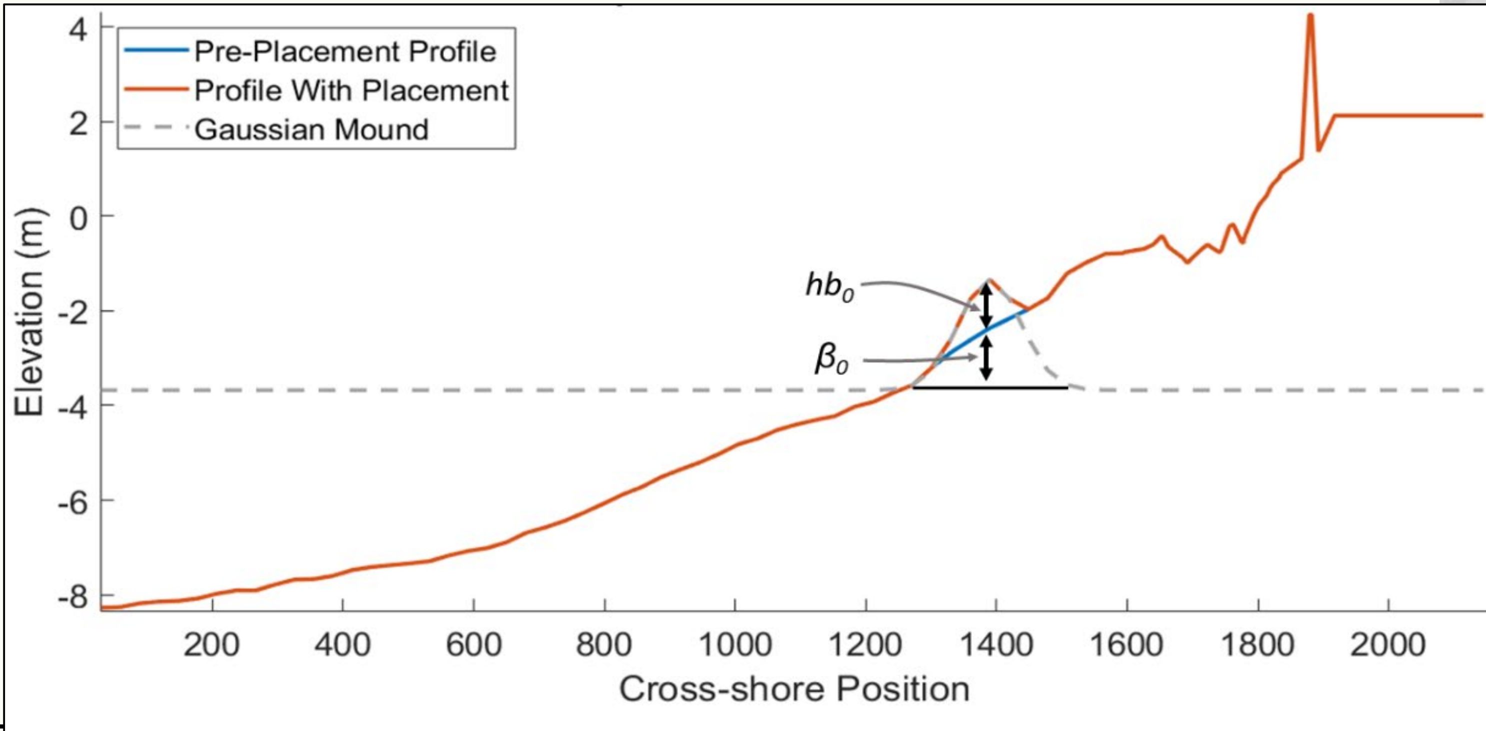
Nearshore Nourishment Characteristics:

- Adding 91 yd^3/yd of shoreline annually
- Placement depths: 8, 10, & 12 ft
- Minimum crest depths: 4, 6, & 8 ft

$$z(x) = \alpha \cdot e^{-\frac{(x-\mu)^2}{2\sigma^2}} - z_{offset}$$

$$\alpha = hb_0 + \beta_0 \qquad \sigma = \frac{\alpha}{r} \qquad z_{offset} = h_{nn} - \beta_0$$

Representative with Example Nearshore Nourishment:



Morphology Results

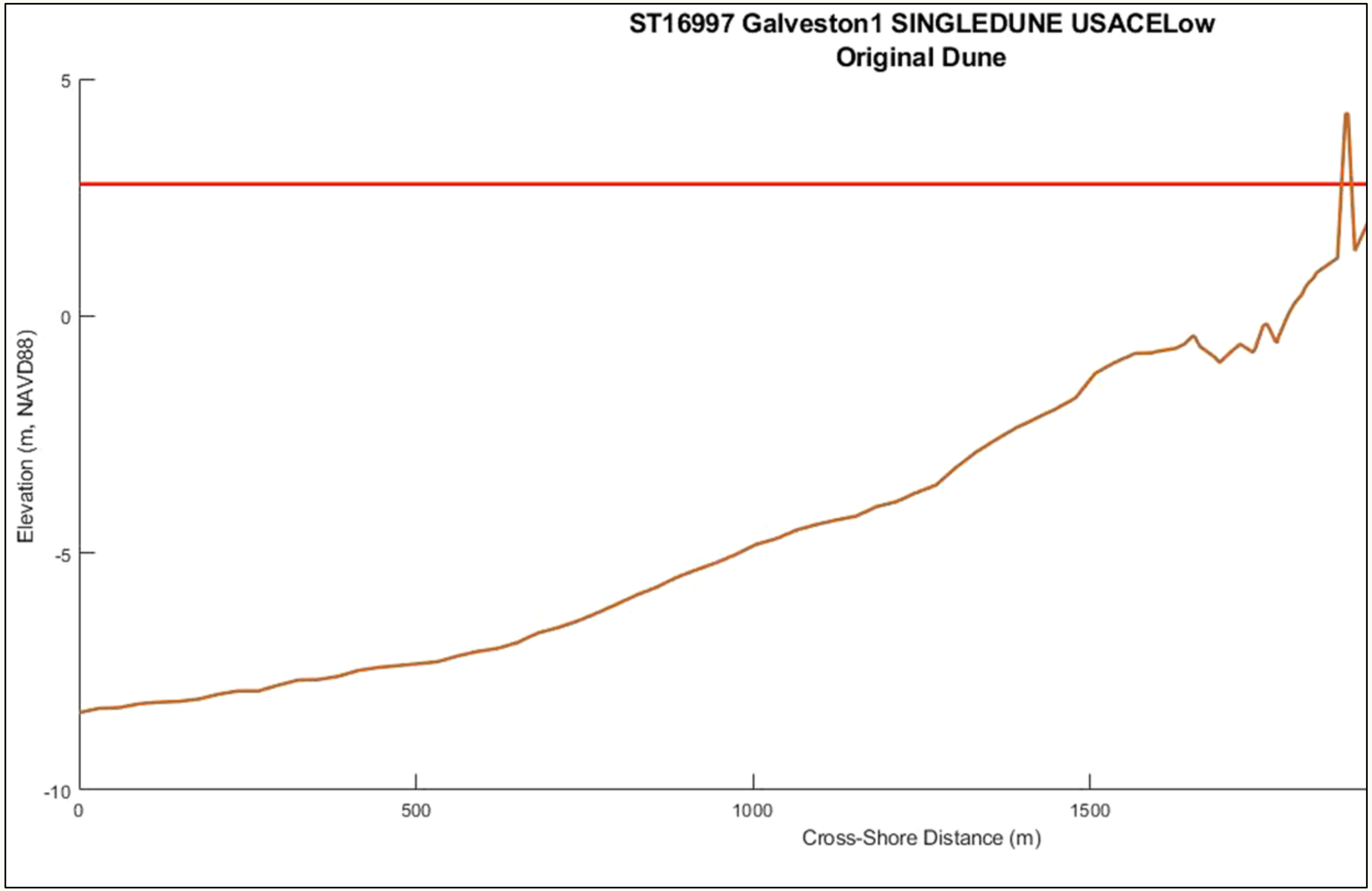
Morphologic Response:

- Large storms erode the dune
- Sediment from the dune may limit shoreline erosion

Beach Nourishment Lifespan:

- Beach nourishment lifespans did not change
- Nearshore nourishments did not impact dry beach or dune morphology
- Features placed within DoC generally migrate onshore, with shoreline accretion not uncommon

Added Nearshore Nourishments & Morphology Change:



Nearshore Berm Morphodynamics

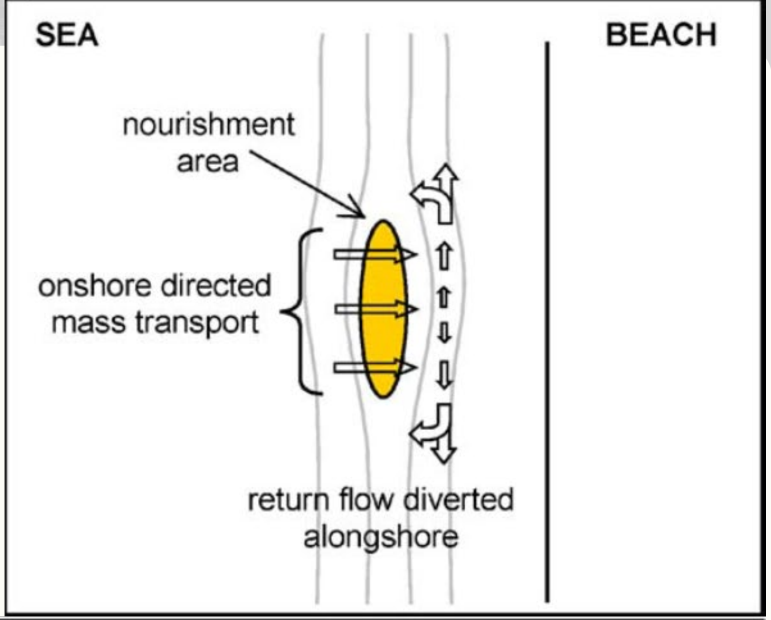
Sediment Transport at Nearshore Berms (van Duin et al. 2004):

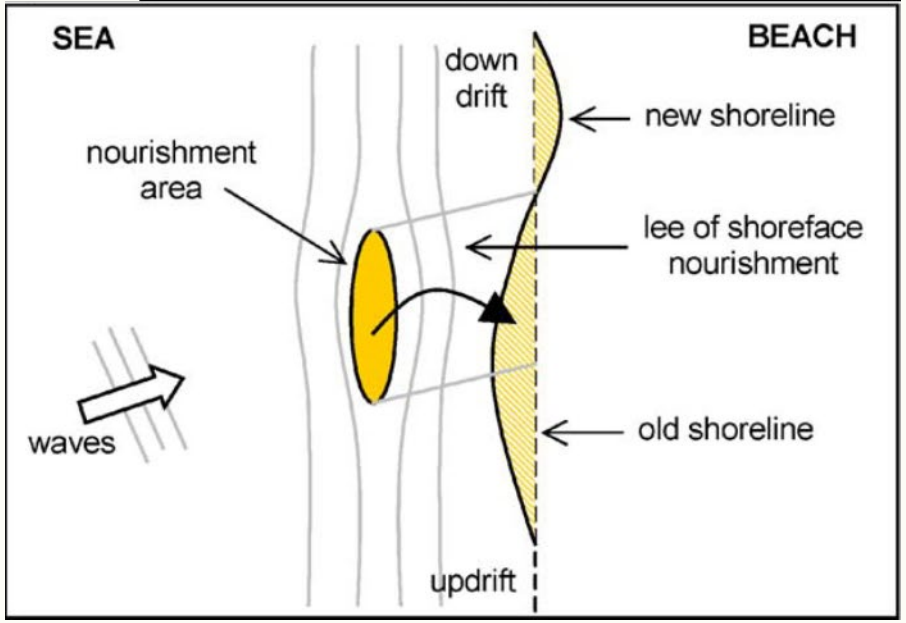
Cross-shore Processes (Potentially resolved well)

- Wave energy dissipation by breaking
- Berm introduces wave asymmetry and transports sediment onshore (resolved during storms, lower intensity events omitted)
- Return flow reduces, so offshore sediment transport decreases

Alongshore Processes (Unable to resolve)

- Less alongshore transport in a region of wave sheltering
- Alongshore transport trapping in the lee of the nearshore berm
  - Onshore and updrift sedimentation
  - Some downdrift erosion



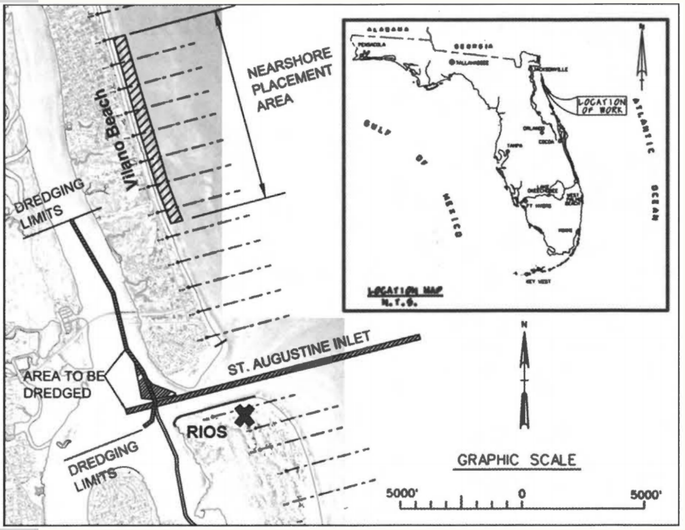


Graphic of sediment transport processes around nearshore berms from van Duin et al. (2004)

Example of Observed Shoreline Response

2015 Vilano Beach Nearshore Nourishments (Brutsché et al. 2017 and McFall et al. 2017):

- 115 kcm of dredged sediment was placed at a depth of 3 m, forming two 300 m long nearshore nourishments
- Imagery data showed that waves broke over the nearshore nourishments
- Salient formed in the lee of the two nearshore nourishments

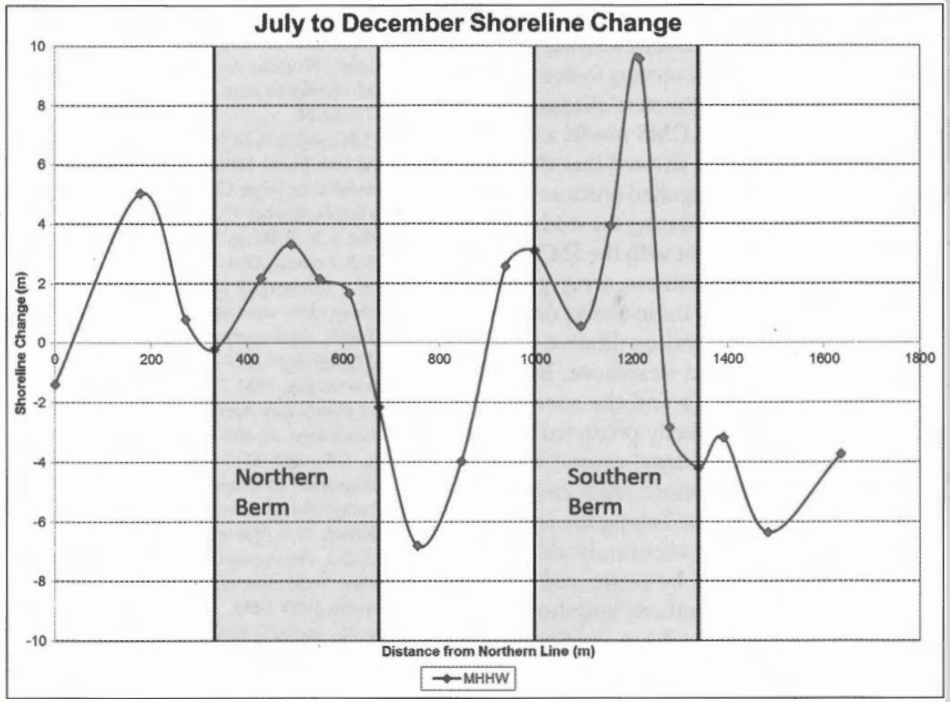


Location of placement area at Vilano Beach, FL (Brutsché et al. 2017)

Nearshore nourishment placement locations (McFall et al. 2017)

Shoreline response to nearshore nourishments at Vilano Beach (Brutsché et al. 2017)

Shoreline Change at Vilano Beach:



Possible Causes of Unanticipated Results

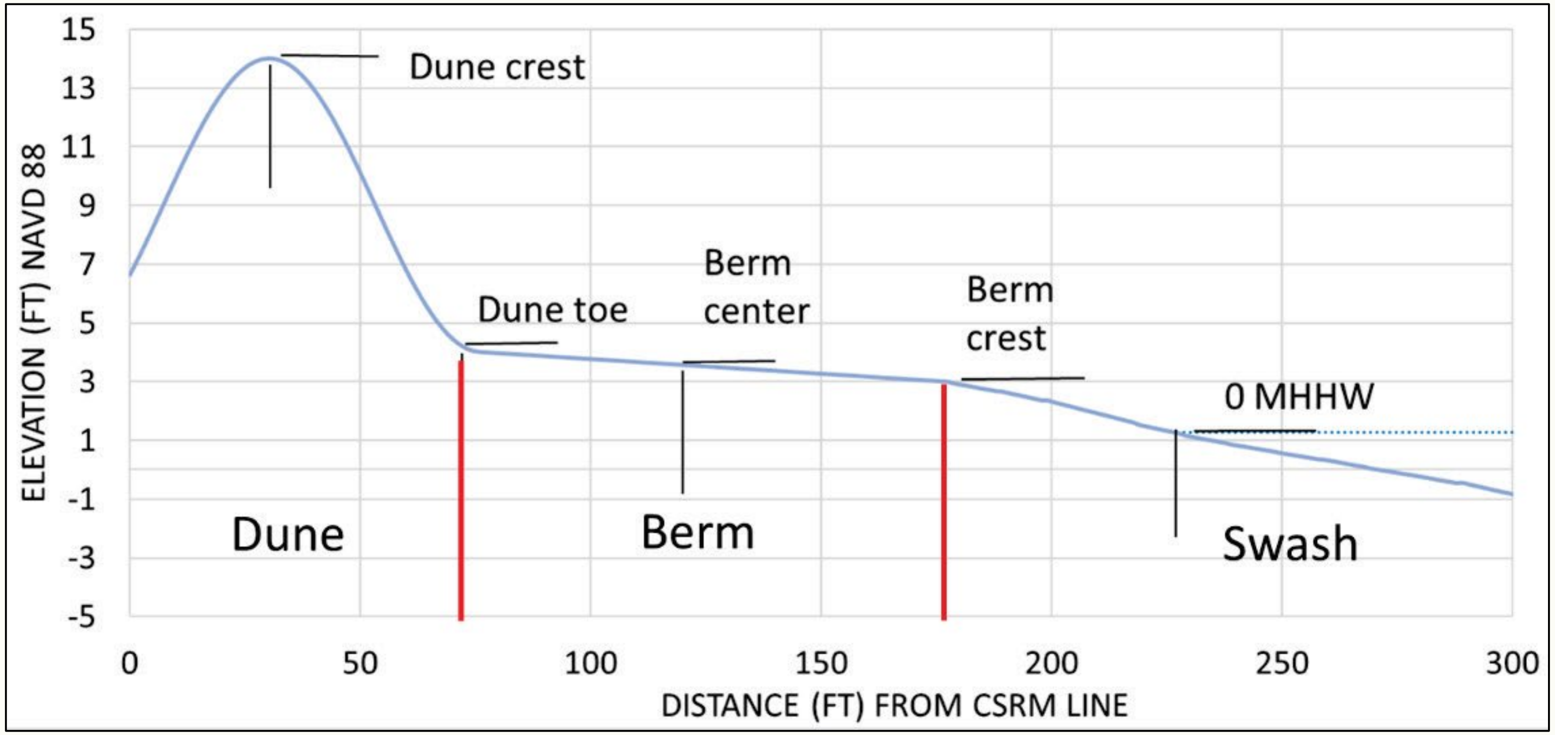
Unexpected Results:

- Large shallow nearshore nourishments often influence nearby morphology
- No impact on wave energy reaching the dry beach
- Dry beach morphology change also not impacted

Contributing Factors:

- Wave Energy Dissipation
- Alongshore Sediment Transport
- Accretionary Waves

Beach Elevation Tracking Locations:



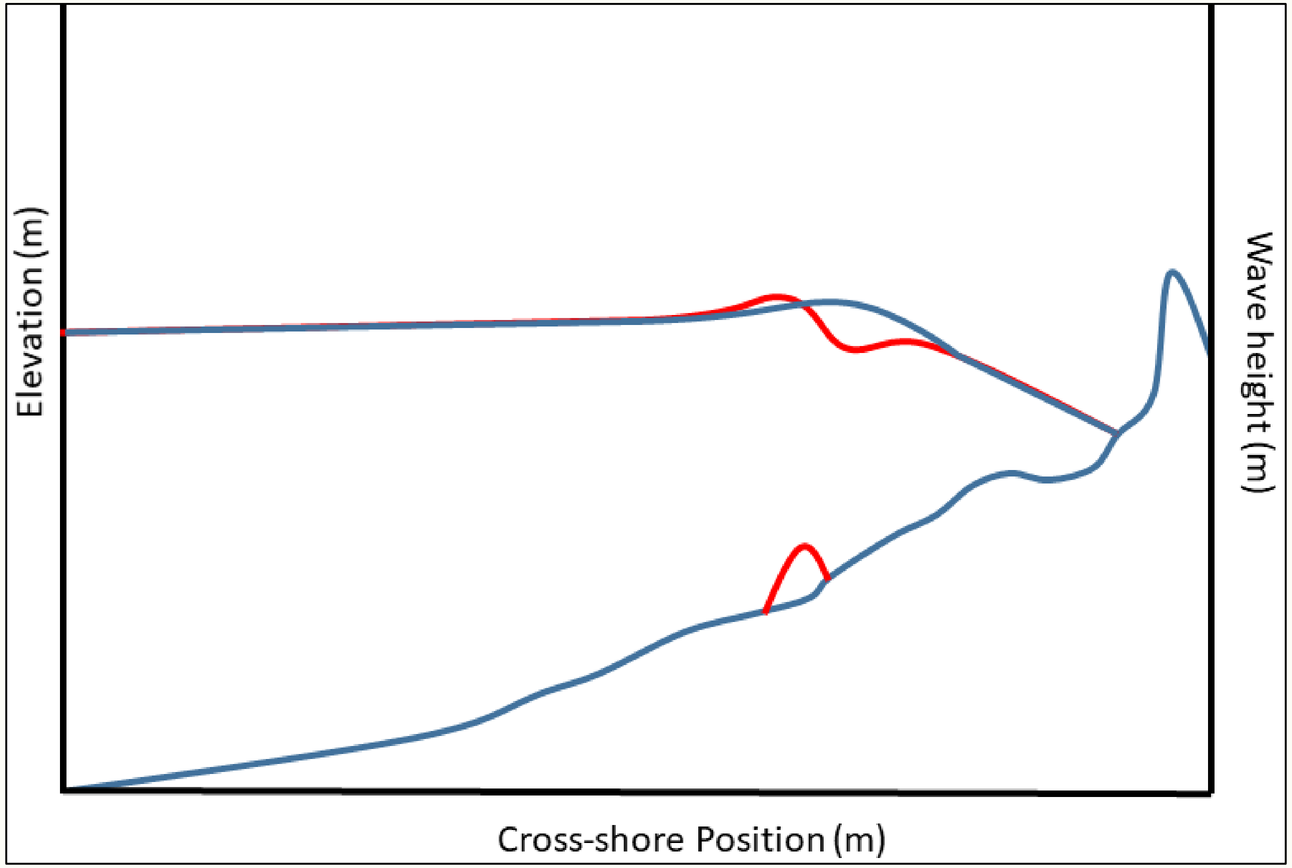
Graphic of additional locations on the beach where elevations are tracked from Melby et al. (2021). Elevations did not vary at any tracked location with any number of nearshore nourishments.

Wave Sheltering & Surf Zone Saturation

Wave Energy & Surf Saturation:

- Wave breaking assumed to be saturated, limited impacts at depths shallower than the berm crest
- Region of wave sheltering, similar waves near the shoreline
- Observations indicate that some combination of processes often results in shoreline accretion and in the lee of similar nearshore nourishments
- The role of wave energy dissipation in that outcome is unclear

Wave Height Predictions & Nearshore Berms:



Graphic demonstrating potentially limited region of wave sheltering induced by a nearshore nourishment.

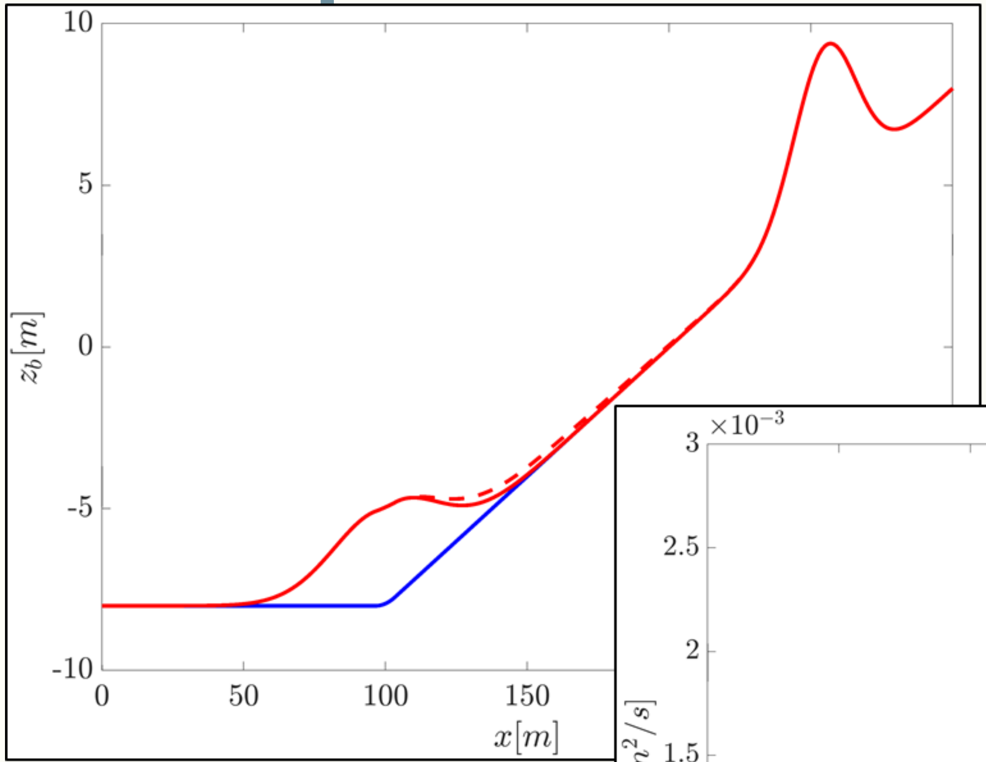
Alongshore Sediment Transport

Alongshore Transport Gradients:

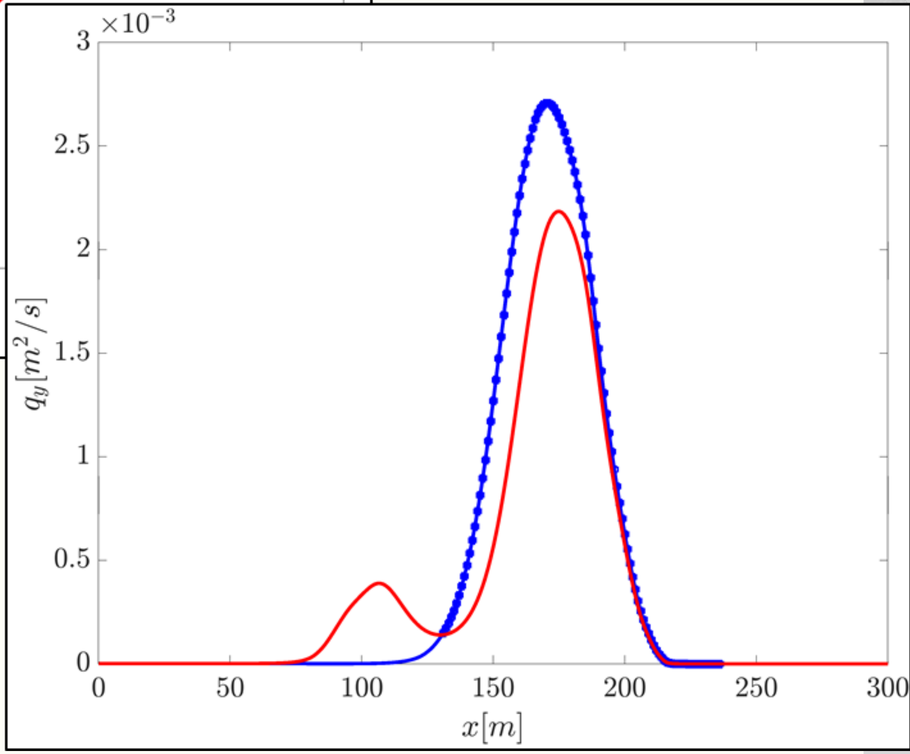
- Breaking waves over a wider surf zone results in more alongshore transport at the nearshore berm, & less in the region of wave sheltering
- This pattern likely removes sediment from the nourishment & temporarily traps alongshore transport in the region of wave sheltering

Approximating Alongshore Sediment Trapping and Deflation

- Track differences in alongshore transport from the nearshore berm
- Add transport volumes where the nearshore berm decreases transport & vice versa in 1.5D approach



Addition of Alongshore Transport:



1.5D alongshore transport implementation on an example elevation profile and associated alongshore sediment transport rates (q_y).

Cross-shore Transport & Accretionary Waves

Accretionary Wave Events:

- This study only investigated morphology response to storm waves
- Observations have both high and low energy events
- Lower intensity accretionary wave events may play a large role in the morphology change around nearshore nourishments

Cross-shore Sediment Transport:

- Reporting the material transported in the cross-shore from the placement area during storms
- Cross-shore transport during lower intensity, more accretionary events may also strongly influence morphology change at nearshore nourishments
- Greater values of the bedload parameter (0.001 vs. 0.003) have matched some observations of onshore transport more closely

Conclusions

Conclusions:

- Alongshore processes may be key elements of the observed morphodynamics around nearshore berms
  - Placed sediment moving onshore vs. temporarily trapped alongshore transport
- The cumulative effect of lower intensity accretionary wave events may drive the influence of nearshore nourishments during storms
  - Accretion over a wider section of the profile vs. energy dissipation from large waves

Questions & Discussion

Thank you for attending!

Please let me know if I can answer any questions.

If you have comments or suggestions later please email me at:
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