



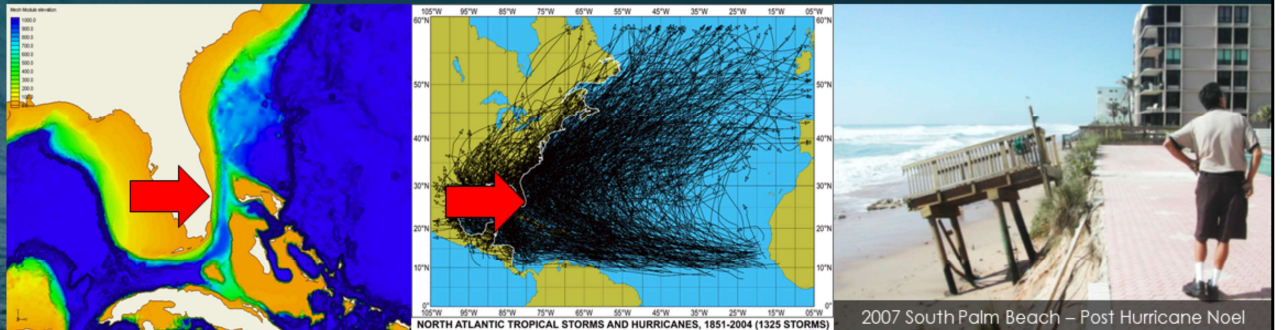
- Titled: Balancing Act, and we couldn't have a better cover photo to illustrate the challenges PBC and the SE Fla region face in maintaining a resilient coast
- Pre-storm mapping photo of South Palm Beach snapped by our friendly drone in September 2018
 - Depicts extensive nearshore hardbottom and a historically developed, fully armored shoreline



Location, Location, Location

Palm Beach County's Unique Coastline and Associated Challenges

- 47 miles of Atlantic coastline
- 33 miles designated critically eroded by the FDEP
- 4 regularly maintained inlets
- Limited protection from deep Atlantic swell due to adjacent depths
- Extensive nearshore hardbottom resources Countywide



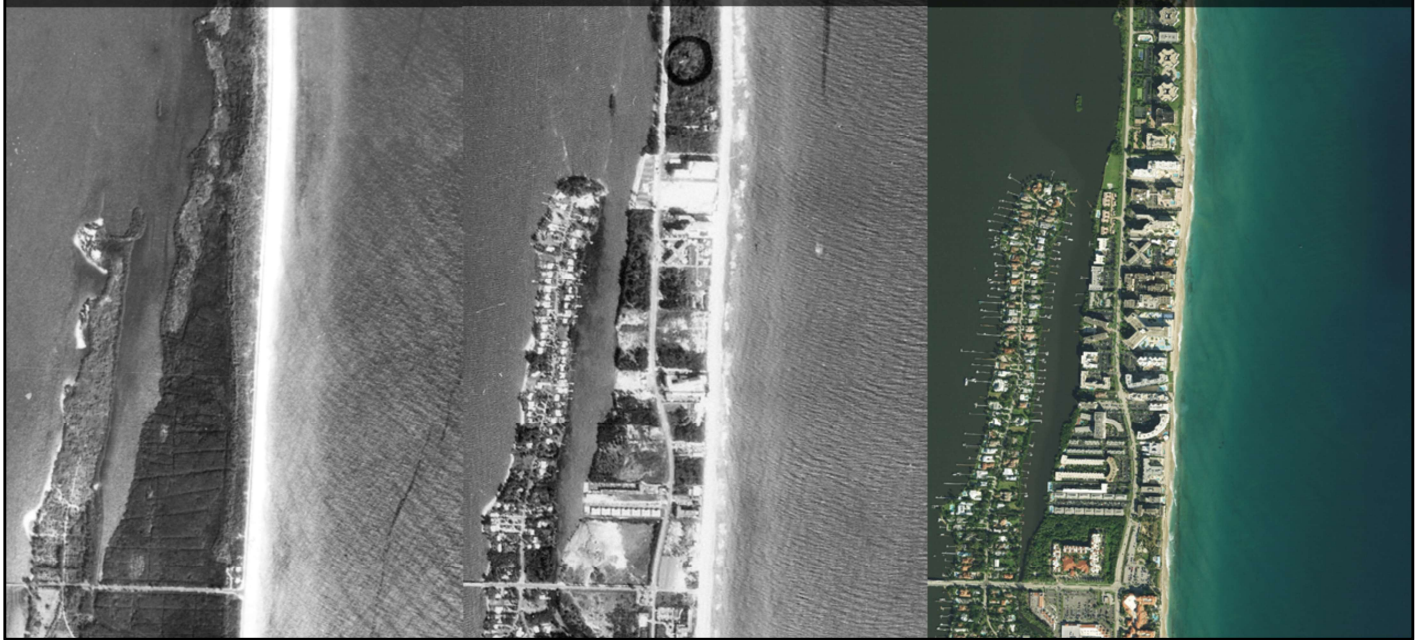
- Monitor/maintain 47 miles of Florida's easternmost coastline
 - Strong partnerships with municipalities, State, and Federal partners
- 70% of our coast, or 33 miles, is designated as critically eroded by the FDEP
- 4 regularly maintained inlets including 1 port facility
- Deep waters and currents of Gulf Stream make their closest approach to Florida in Palm Beach County
- Limited protection from deep Atlantic swell due to proximity of deep waters and limited footprint of Bahamas Shoal
- Nearshore hardbottom that is critical to our fisheries and tourism-driven economy
- Entirety of PBC coast is critical habitat for Loggerhead turtles along with a number of other species



History of Development

(80+ Years of Impact to the Coastal System)

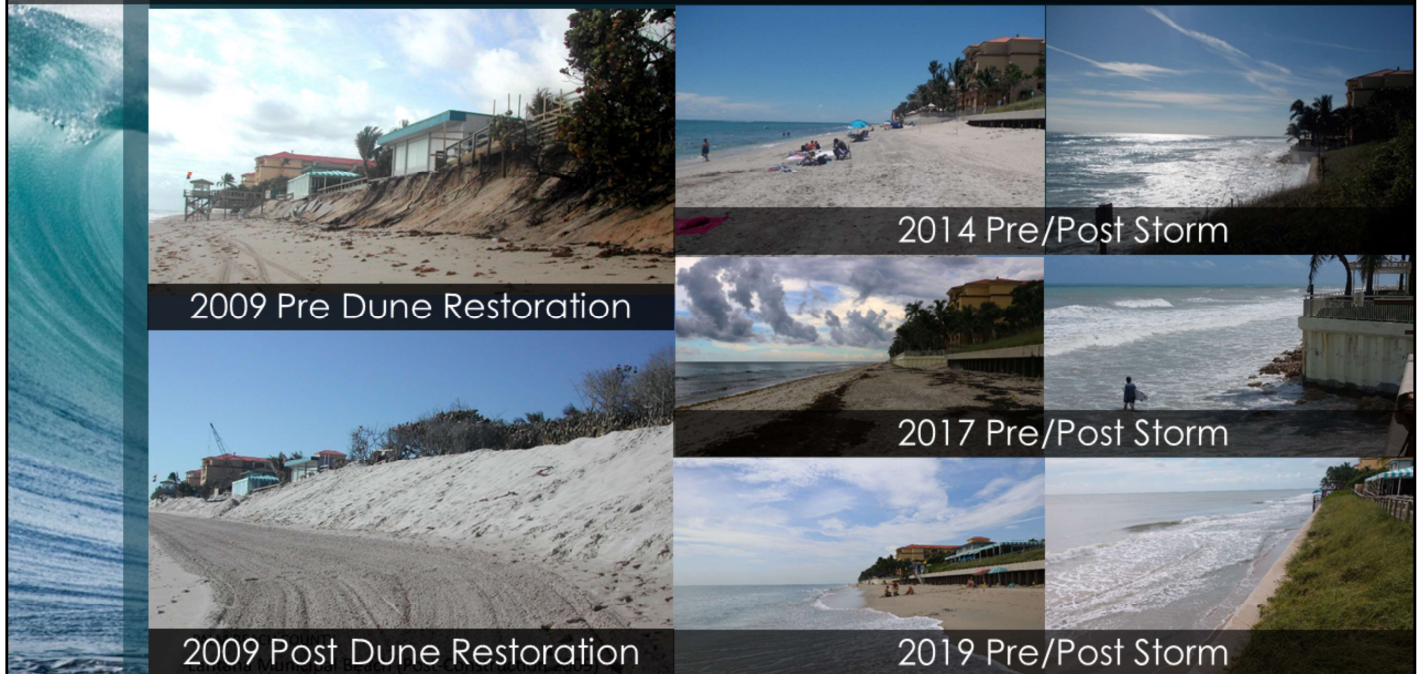
1940 – Southern Palm Beach 1970 – Southern Palm Beach 2019 – Southern Palm Beach



- Southern Palm Beach Island is a case study that defines several generations of change and development along the coast of Southeast Florida
- Over 80 years of development and impacts to the coastal system have irreparably transformed the native beach and dune system
- The eastern edge of this barrier island was formerly composed of coastal strand and maritime hammock, which are today some of the rarest of habitat types in Southeast Florida
- The US FWS noted in its Multi-Species Recovery Plan for South Florida that the 75 miles of coastline north of MacArthur Beach State Park, located in north central Palm Beach County, contains 32 sites in natural vegetation comprising 2,800 acres, while the 85 miles of coastline south of MacArthur Beach State Park contains only 15 sites totaling 500 acres.
- This data could use an update, but the trend is clear: Palm Beach County is a breaking point for historic coastal development and its associated impacts, and this trend has only continued with extensive coastal armoring of existing development up and down our coast.



Southern Palm Beach Island Comprehensive Shoreline Stabilization Project (Genesis and Observed Impacts)



- The Southern Palm Beach Island Comprehensive Shoreline Stabilization Project.
 - That's a bit of a word salad isn't it?
 - Had to reduce the title font just to get it to fit
- Brief history of our efforts to protect this 2/3 mile stretch of shoreline
- Problem identification- in this case it's pretty apparent
 - Severe storms, even regularly occurring coldfronts can quickly erode remaining beach berm
- This presentation isn't all doom and gloom- this is about finding a path forward. How can we protect a persistently and critically eroded area of our coast while also attempting to approximate a native beach and dune system where one no longer exists?
- The County made a half dozen attempts to restore the dunes between 2003 and 2009, but with nothing to hold them in place and a near-completely armored shoreline, we began looking for a more long-term solution...



Southern Palm Beach Island Comprehensive Shoreline Stabilization Project (A Long-term Solution)

7 Shore-perpendicular Low Profile Groins with Beach/Dune Fill



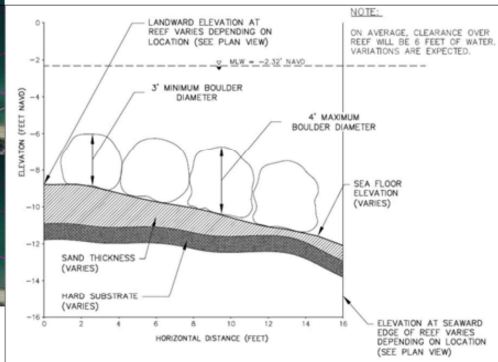
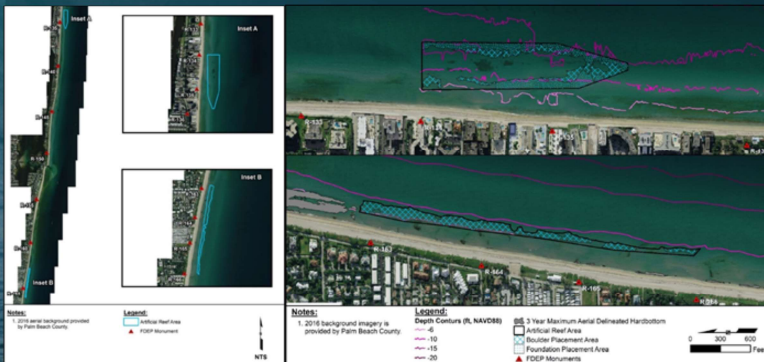
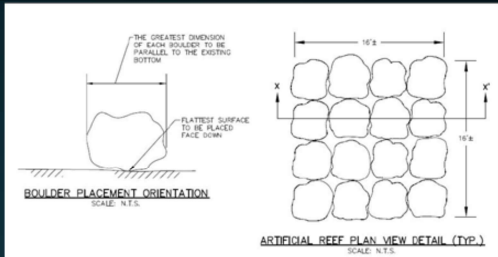
- Feasibility study and extensive engineering analysis indicates a series of 7 low profile groins
 - Beach/dune fill component, much more stable and less frequent placement
- ETOF +50m buffer indicate extensive impacts to persistently exposed nearshore hardbottom
 - 50m buffer included to prevent perpetual study and potential for additional mitigation requirements
- Conceptual photo isn't perfectly accurate, but what great pieces of art really are?
 - Main point- a stabilized beach and dune system, or as close of an approximation to this critical component of the coastal system as possible



Southern Palm Beach Island Comprehensive Shoreline Stabilization Project (Financial Infeasibility)

Hardbottom Impacts and Mitigation Design

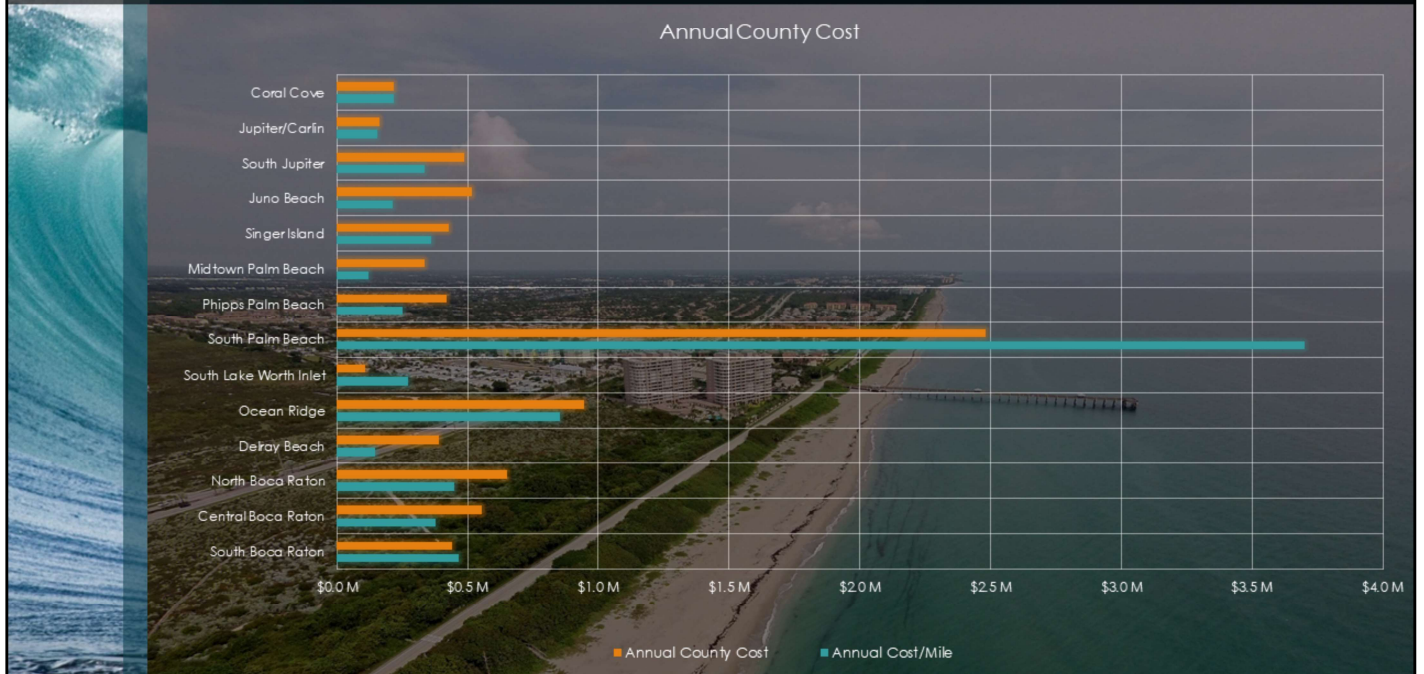
- 5.5ac impacts in ETOF +50m buffer
- 7.6ac mitigation requirement
- 10.9ac area assuming 70:30 sand/gap ratio
- Design requires diver-verified placement and special construction techniques
- Feasibility cost estimate: \$10M Total Project
- 2018 cost: \$30M Total Project, \$25M Mitigation



- 5.5ac direct impact yields a net 7.6ac mitigation requirement, or 10.9ac with a 70:30 sand/gap ratio
- Designed to mimic adjacent natural hardbottom
 - Flat top, largely contiguous
 - Moderate to low relief
- Construction requires diver-verified placement and marine mattress due to unique geomorphology
- Limited available placement area and construction techniques drive costs out of reach for County and Town budgets
 - \$25M mitigation estimate based on current contracts
 - \$30M includes groin, beach, dune construction with open-ended commitment for further placement



Project Cost Comparison



- Quick slide depicting countywide beach and dune projects managed by PBC or it's partners
- Annual cost, and particularly annual cost per mile would compromise PBC's ability to manage the other 98.6% of our coast
- Guess who we're coming to with requests for funding assistance?
 - Budgetary implications extend directly to State funding program
 - Harbinger for regional attempts to consider stabilization projects with similar resource concerns



Analysis of Historical Aerials

(Study Area and Process)

Study Area

- R-132 to R-138 includes entire Town of South Palm Beach and Lantana Municipal Beach Park
 - Initially selected based on available imagery and core SPBICSPP area
- Further analysis included R-134 to R-140 to match SPBICSPP ETOF mitigation area

Image Rectification and Analysis

- 1940, 1970, and 2019 digital orthophotos
- 1940 – 5 common points achieved RMS error of 5.6ft
- 1970 – 6 common points achieved RMS error of 2.6ft
- High water line and vegetation edge digitized based on apparent color difference or hardened structures
- Hardbottom exposure based on 2018 Countywide coverage



1940 Image Rectification

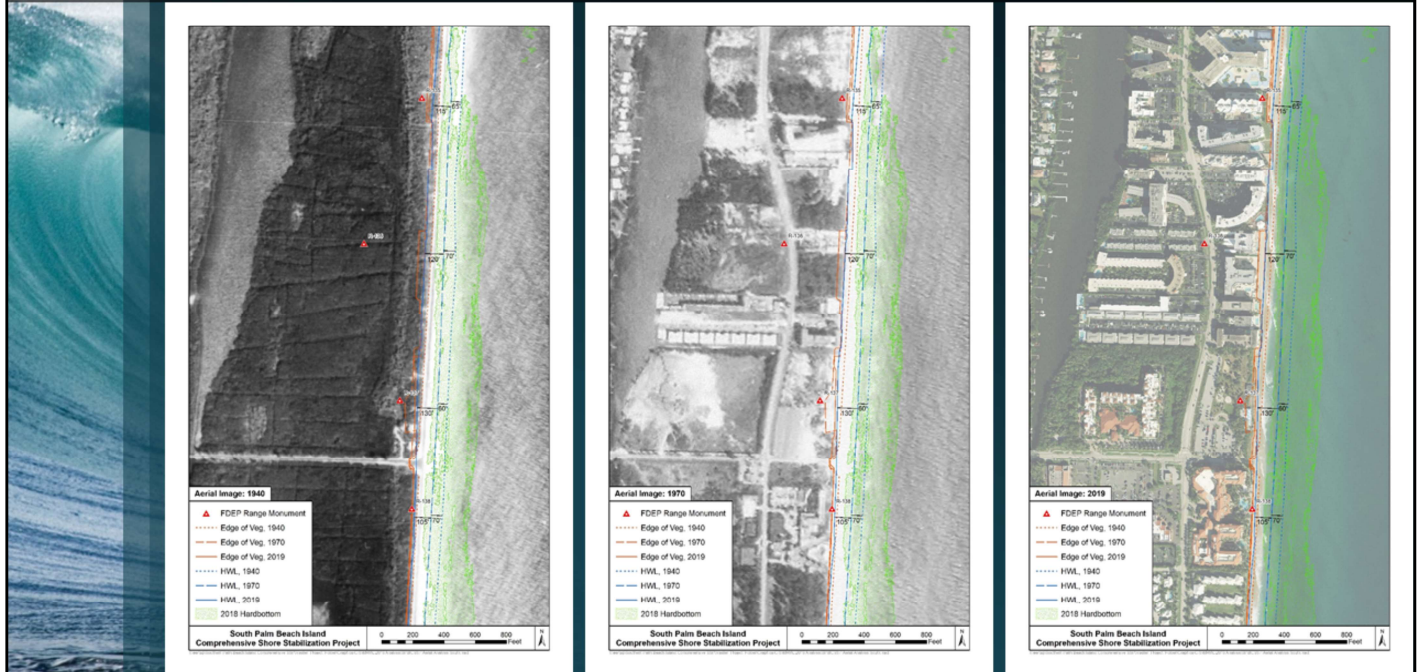


1970 Image Rectification

- Began with core project area sited for placement of structures
 - R-132 to R-138
 - Available historical images limited in scope- missing patches Countywide
- Study area refined to SPBICSPP ETOF +50m buffer area to directly compare estimated reef exposure over time
- Digital orthophotos previously rectified by County GIS staff were rectified a second time
 - 1940 5 good points with RMS error of 5.6ft
 - 1970 6 good points with RMS error of 2.6ft
- Image analysis hinged on image processing and apparent differences in color to determine high water line, veg line, or hardened structures
 - Not just a random line drawn on a map- Chris and I have spent more hours than we each care to recall digitizing Countywide hardbottom and coastal features
- Hardbottom location based on countywide 2018 digitization
- Potential for error? Of course... but the trends are clear.
 - Unless you have a time-machine that can transport us back to the date and location, analysis of historical aerials is as good as it gets



Analysis of Historical Aerials (Shoreline Recession Results)



- R-134 to R-138 Shoreline recession
 - Maximum of 235ft at R-132
 - Minimum of 175ft at R-138
 - Average of approximately 198ft
- 1940 image – already evidence of extensive development including roads and mosquito ditches
 - Lake Worth Inlet first opened in 1866
 - Regularly maintained, deepened, widened beginning in 1918
- Shoreline Recession further evidenced by elevation of adjacent development, located on historic primary and back dune areas



Analysis of Historical Aerials (Increase in Hardbottom Exposure)

Estimated Hardbottom Exposure (R-132 to R-138)

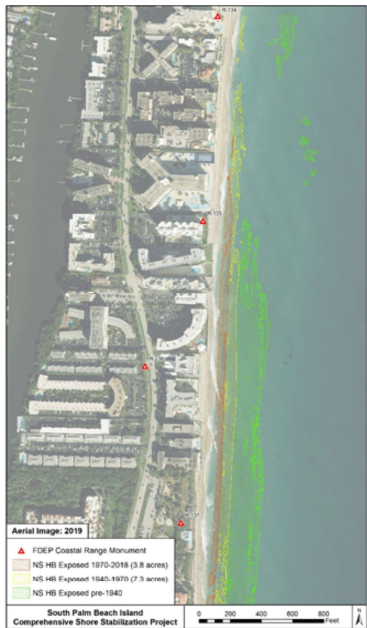
- 1940 – 1970: +9.1ac
- 1970 – 2018: +2.5ac
- 1940 – 2018: +11.6ac



- Analysis indicates complete coverage of present hardbottom exposure west of historic high water lines
- Original study area- R-132 to R-138
- 1940-1970: +9.1ac
- 1970-2018: +2.5ac
- 1940-2018: +11.6ac



Analysis of Historical Aerials (Comparison with SPBICSPP Mitigation Requirements)

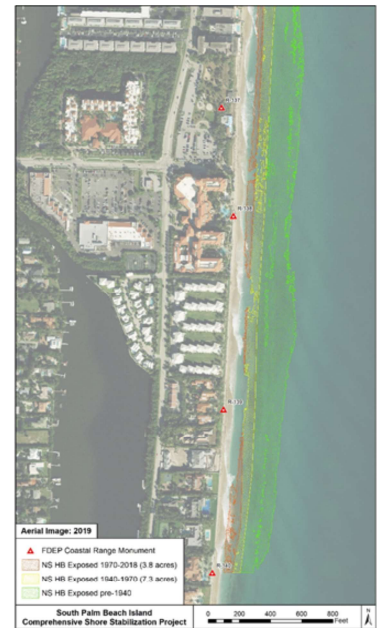


SPBICSPP ETOF +50m R-134 to R-140

- Estimated Impact: 5.5ac
- Net Mitigation Req: 7.6ac
- Gross Mitigation Req: 10.6ac

Historical Analysis R-134 to R-140

- 1940 – 1970: +7.3ac
- 1970 – 2018: +3.8ac
- 1940 – 2018: +11.1ac

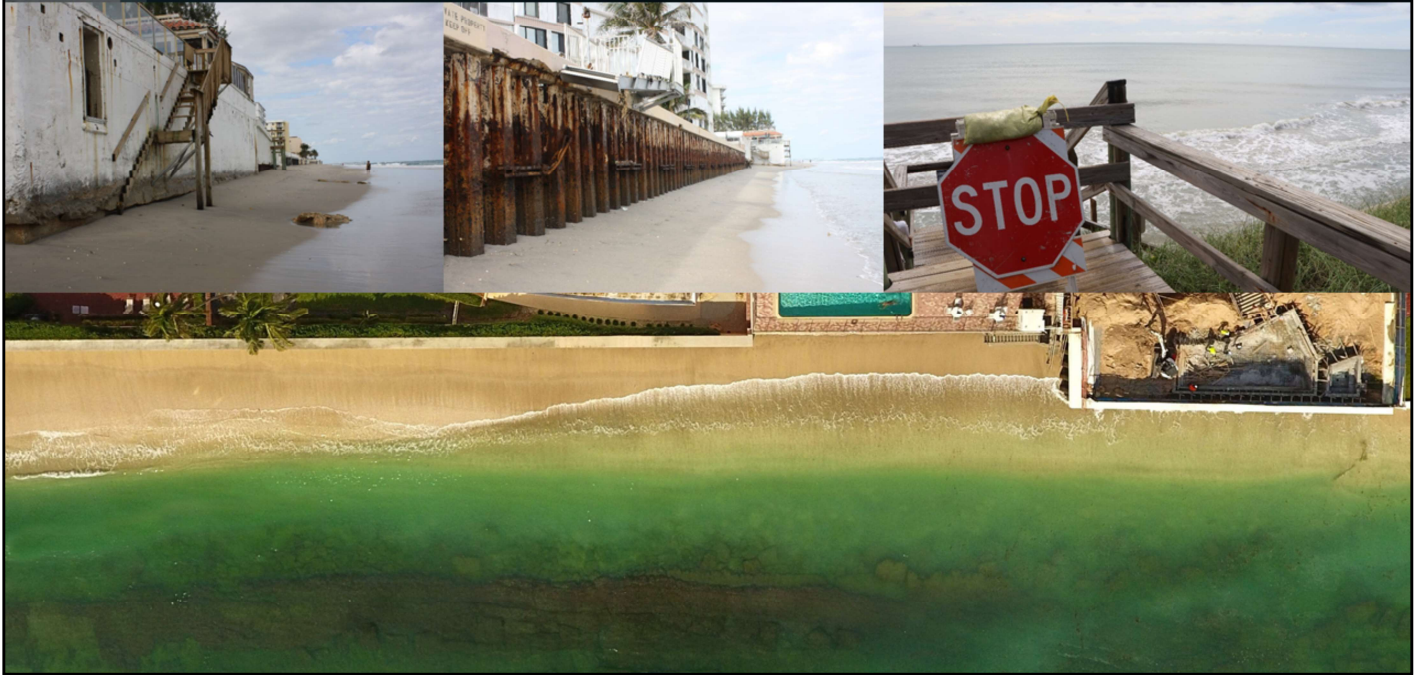


- Refined study area to directly compare analysis with SPBICSPP ETOF +50m mitigation requirements
 - R-134 to R-140
- Estimated project impact: 5.5ac
- Net mitigation requirement: 7.6ac
- Gross mitigation requirement: 10.6ac
- Historical Analysis
 - 1940-1970: +7.3ac
 - 1970-2018: +3.8ac
 - 1940-2018: +11.1ac
- Possibility of error? Of course, but the trends are clear and the analysis relatively conservative
 - High water line indicates complete coverage- hardbottom exposure likely further reduced in historic nearshore area due to additional sand in native system



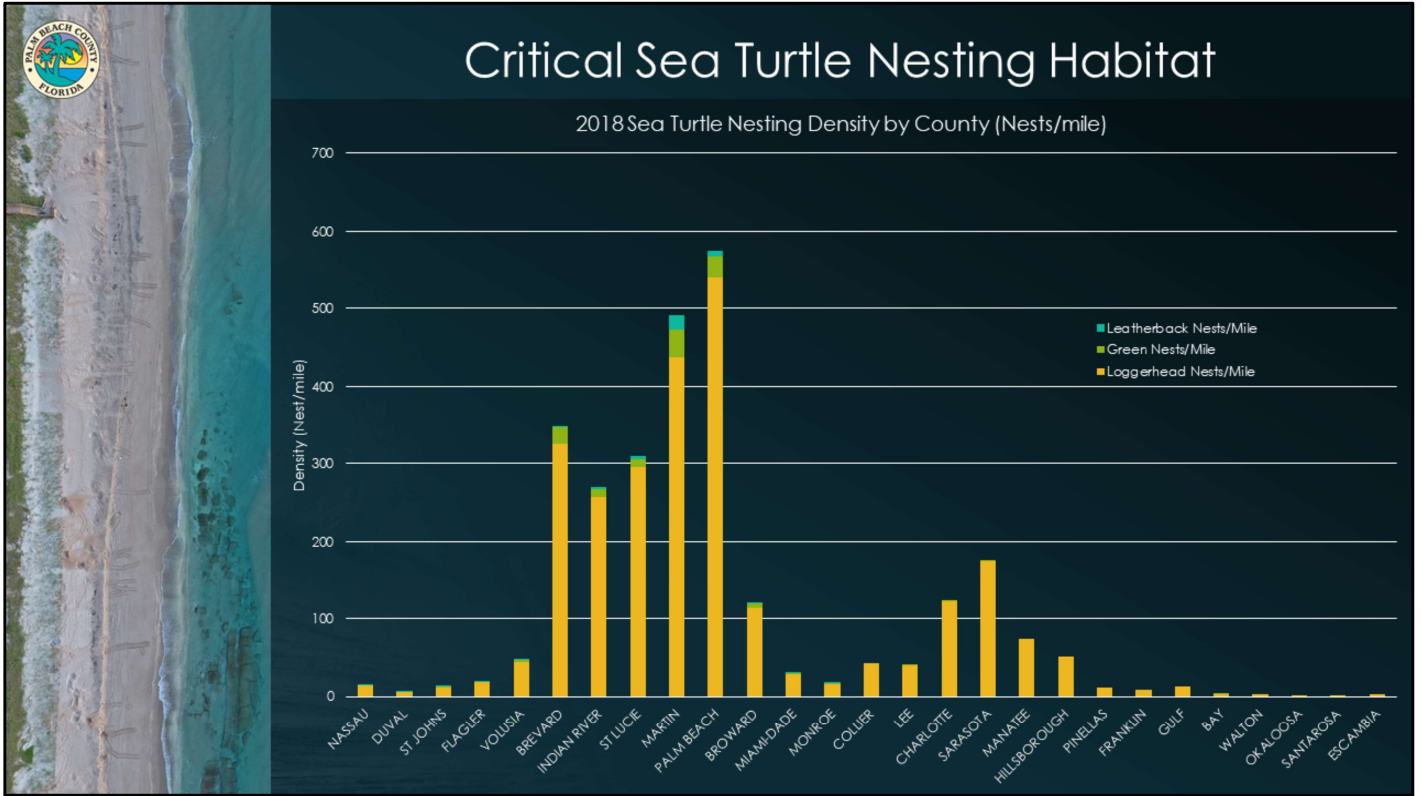
The No-Action Alternative

(80+ Years of Impact to the Coastal System)

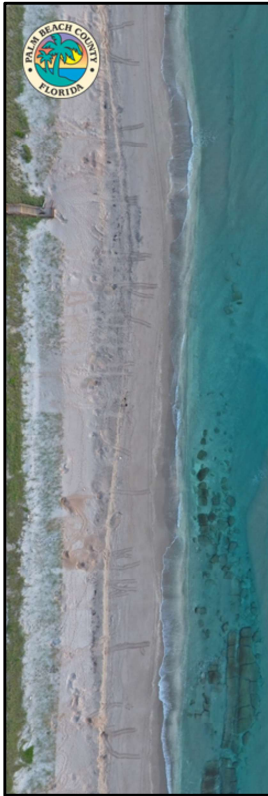


- So where does this leave us?
- We've identified the problem
 - Persistent and critical erosion
 - Vulnerability to storm impacts- both to infrastructure and now-temporary beach habitat
 - Historic loss of native beach and dune habitat
- The solution is cost prohibitive under the current rules and regulations- which are diligently and appropriately applied
 - We can engineer the hell out of a seawall to withstand a Cat 5 storm, but wait... we have those here.
 - We can entertain endless dune fill projects to provide some semblance of short-term habitat and storm protection
 - Here today gone tomorrow with extensive coastal armoring already in place
- The fact is- the focus on singular resources can be detrimental to the coastal system as a whole
 - Fear of consequences or impacts to such resources promotes the No-Action alternative in the face of significant challenges
- The No-Action alternative isn't really no-action, it is the perpetuation of a systemic change in the coastal system
 - In this case- a historic transformation from a native system dominated by a perched beach and ephemeral nearshore hardbottom, to a system defined by persistent hardbottom

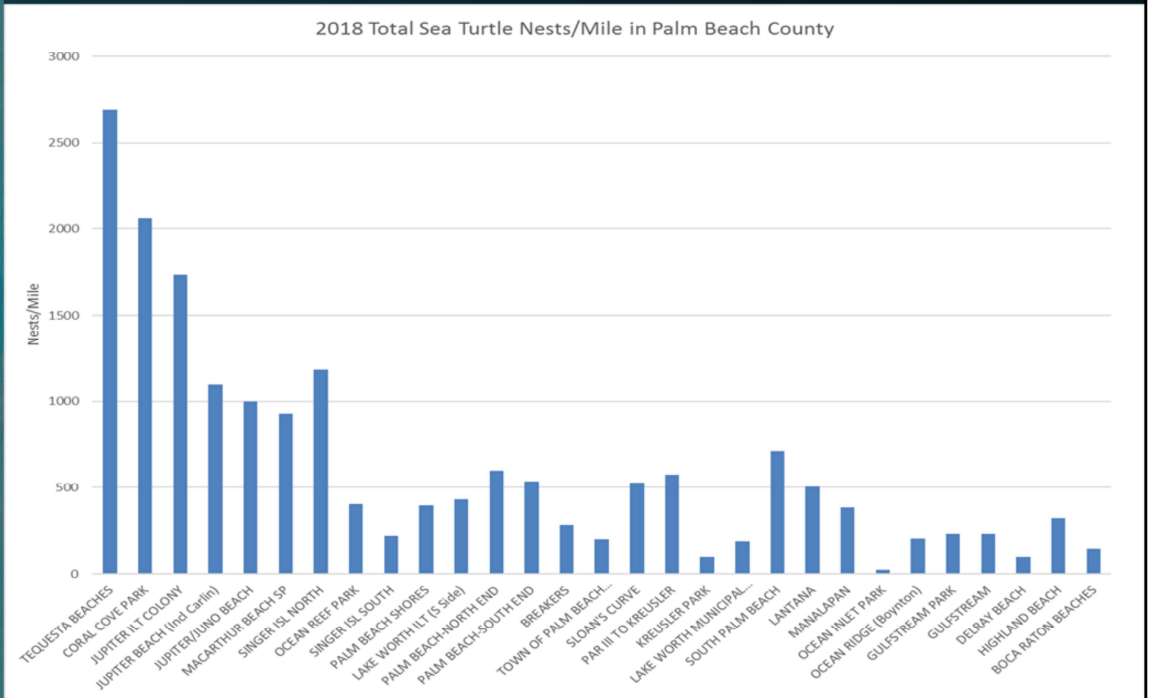
exposure and an ephemeral beach.



- But what about the resources we've already lost and are attempting to recreate some semblance of?
- In 2018, Palm Beach County had the most densely nested beaches in Florida
- In total, there were 575 nests per mile in the county which equates to a nest every 9 feet
- There were 26,458 total nests in 2018
- Palm Beach County has the highest density of loggerhead nesting in the state (540 nests/mile) and the second highest leatherback (7 nests/mile) and green turtle (28 nests/mile) nesting density (Based on 2018 numbers only)



Critical Sea Turtle Nesting Habitat



- Here's the kicker- recall the coastal inflection point for natural vegetation sites in northern PBC- MacArthur Beach State Park
- Historic development is greatly increased south of this point
- Evidence of a dramatic difference in the coastal system is apparent

Achieving a Balance

(Equitable Impacts within a Complex Coastal System)



Andy Studt and Chris Carstens

Palm Beach County Environmental Resources Management

- How do we strike a balance between
 - storm protection
 - recreational space
 - restoration of historically impacted habitat
- How do we build and maintain coastal resiliency in a system that is increasingly dominated by singular critical resources?
- The results of this brief analysis have clear implications for critically eroded areas of Palm Beach County's coastline with similar adjacent resources
- Singer Island Dune Project area, pictured here, has gone from 50 to over 80% seawall coverage in the past 10 years
 - With Southern Palm Beach Island as a guide, we may be observing another loss of beach and dune habitat without the ability to strike a balance of equitable impacts to critical resources within the coastal system on Singer Island and throughout the region.