How beach nourishment has impacted the surf breaks of Cape Canaveral and Cocoa Beach, Florida

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with assistance from
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AUTHOR'S FORWARD

The purpose of this paper is to disseminate the knowledge acquired during my research to a wider audience in the hope that it may be used to help preserve the beach environment and surfing wave conditions in Cape Canaveral and Cocoa Beach, Florida.

This paper contains a great deal of technical data. References have been provided where necessary to support the data and arguments presented. Every effort was made to present the data in a clear and concise manner to improve readability, increase understanding, and provide value to the general public.

It is also my hope that residents of beach communities around the world can learn from what is happening here in Brevard County and make more informed decisions regarding the management of their beaches and surf breaks.

DEFINITION OF COASTAL ENGINEERING TERMS

To properly explain the impacts of beach nourishment it will be necessary to define some coastal engineering terms. Sandy beaches are primarily made up of sand grains and shell fragments collectively described as sediment. A typical beach will have a wide distribution of various sized sediment grains which make up the beach. The sediment grains tend to be larger on the dune and berm (dry parts of the beach) and smaller below the waterline and offshore.

The *sediment grain size distribution* is a measure of the various sediment grain size diameters which make up the beach. Typically, the sediment grain size is given as the composite mean (average) or median (midpoint of the distribution) grain size of all the particles in the shoreline profile from the dune out to around 20 feet deep.

The *dimensionless sediment fall velocity* (**Ω**), also known as the *Dean Number* (after the Coastal Engineer who defined the term), is a measure of how quickly the sediment grains fall out of suspension and return to the sea bed when churned up in the surf zone. Larger sand grain sizes typically fall out of suspension quicker than smaller sand grains.

The *modal beach state* uses the *dimensionless sediment fall velocity* to describe the characteristics of a sandy beach. The primary modal beach states were classified by Wright and Short (1984) and are calculated as a function of the mean sediment grain size, modal (typical) wave breaking height, and modal (typical) wave period. The primary modal beach states are illustrated in Figure 1. Benedet et al. (2004 & 2007) determined that the effects of beach nourishment on the shoreline could be predicted by comparing the modal state of the native beach to the post fill beach using the composite mean grain sizes of the native and borrow site sediment and the modal breaking wave conditions. They suggested that the analysis of modal beach state beach could be used to predict and quantify the impact of beach nourishment on the surfing wave environment of sandy beaches.

Natural sorting is the process which describes how wave and current action will transform the *sediment grain size distribution* and *modal state* of a sandy beach from its post fill state back to its natural state. When larger storm waves impact a sandy beach, they will pull sand from the beach and foreshore and deposit that sand further offshore creating the deep troughs and sand bars that are typically present after a hurricane or big northeaster storm. When the waves return to their more typical calmer state, the smaller waves will transport some of the smaller grain size sand back to shore but are not powerful enough to move the larger grain sizes. Over the course of time a nourished beach will return to its pre-nourished state if left undisturbed. Previous research has determined that this natural sorting process can take over 5 years to occur after beach nourishments in Cape Canaveral and Cocoa Beach (Hearin, 2012 & 2014).

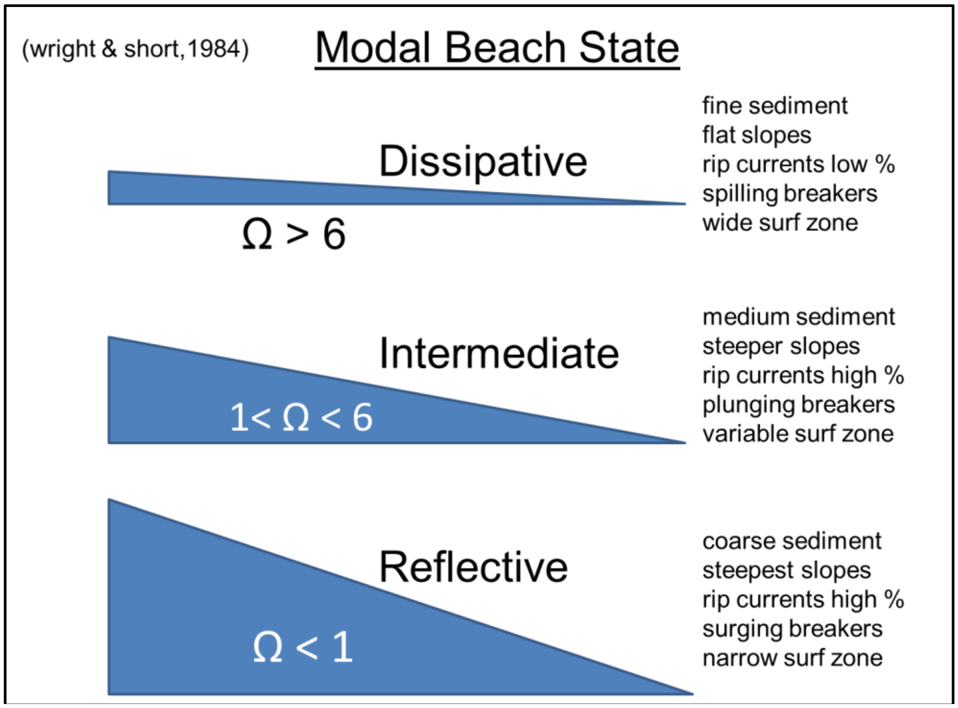

Figure 1. Description of primary modal beach states. The modal beach state describes the nature of a sandy beach based on the composite mean grain size of the sediment and the typical wave height and period.

Coarser sediment = steeper beach slope
Finer sediment = flatter beach slope

INTRODUCTION

The nature of a sandy beach is primarily dependent upon the characteristics of its sediment (primarily made up of sand and shell). If a beach is nourished with fill sediment that does not match its natural sediment, the fill may have impacts on such parameters as the seabed slope, sandbar formation, rip current formation, surf zone width, and predominant wave breaker type (Wright & Short, 1984). Variations in these parameters may have an impact on the surfing wave environment of sandy beaches (Benedet, Finkl, Campbell, & Klein, 2004) (Benedet, Pierro, & Henriquez, 2007). The purpose of this paper is to describe the impact that the 2014 beach nourishment project has had on the surf breaks of Cape Canaveral and Cocoa Beach, Florida.

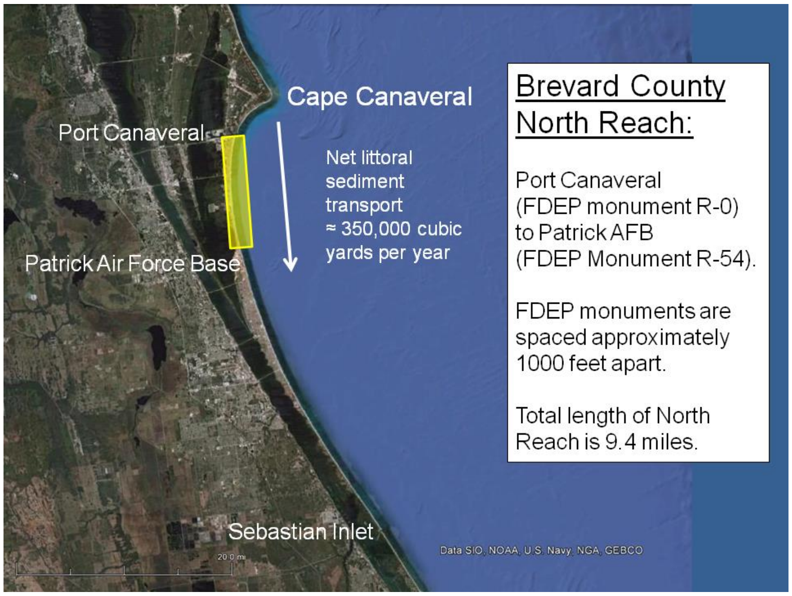

Figure 2. North Reach of Brevard County, Florida which includes the beaches of Cape Canaveral and Cocoa Beach.
(Brevard County NRMO, 2013) (Google Earth, 2012)

HISTORICAL BACKGROUND

The North Reach of Brevard County extends 9.4 miles from the south jetty of Port Canaveral to the northern border of Patrick Air Force Base and includes the beaches of Cape Canaveral and Cocoa Beach (Figure 2). The North Reach is delineated by Florida Department of Environmental Protection (FDEP) survey monuments, which are spaced approximately 1000 feet apart, starting with R-0 at the jetty and ending with R-54 at the Air Force Base (AFB). The prevailing waves and currents create a net longshore sediment flow from north to south of approximately 350,000 cubic yards per year (Chiu, 1986).

The North Reach is partially sheltered from northerly waves by Cape Canaveral and the Canaveral Shoals offshore of the cape (Surfbreak Engineering, 2008). The sheltering is most pronounced at the Port Canaveral jetty and diminishes as you move south towards Patrick AFB. As a result of this wave sheltering, the North Reach has a lower energy wave climate, smaller grain size distributions, and flatter sea bed profiles than the more southerly beaches of Brevard County (Olsen, 1989).

The construction of Port Canaveral and the entrance jetties was completed in 1954. Since its construction, the port has reduced the net southerly flow of sediment along the coastline resulting in higher rates of beach erosion in the North Reach as shown in Figure 3 (USACE, 1987). An Independent Coastal Expert (ICE) study, completed in 2002, determined that the coastal erosion impact of Port Canaveral Harbor extends 10 to 15 miles south of the harbor and encompasses the entire North Reach of Brevard County (Kriebel, Weggel, & Dalrymple, 2002). The ICE study concluded that the beaches in the North Reach would have widened significantly between 1951 and present without the presence of Port Canaveral. An updated Inlet Management Plan, completed in 2012, determined that the reduction in southerly sediment flow caused by Port Canaveral is responsible for increased erosion rates in the North Reach (Olsen, 2012A).

In 1993 the U.S. Army Corps of Engineers (USACE) authorized the Canaveral Harbor Sand Bypass Project to address the erosion impact of the port. That project calls for the bypassing of 636,000 cubic yards of sediment around the port every six years (equivalent to 106,000 cubic yards per year) by means of conventional dredge and fill operations (USACE, 1993). In 2000 the USACE initiated the North Reach Shore Protection Project to address additional beach erosion concerns (Brevard County NRMO, 2013). That project authorizes the periodic nourishment of the North Reach for a term of 50 years to maintain the beach and protect coastal infrastructure (USACE, 1996).

The North Reach of Brevard County has been the subject of 14 beach fill projects between 1972 and 2010. A total of 10,279,600 cubic yards of sediment was placed on the North Reach beaches during that 38-year period. The borrow site locations (highlighted in red) and fill placement locations (highlighted in yellow) for the most recent nourishment projects are shown in Figures 4 and 5.

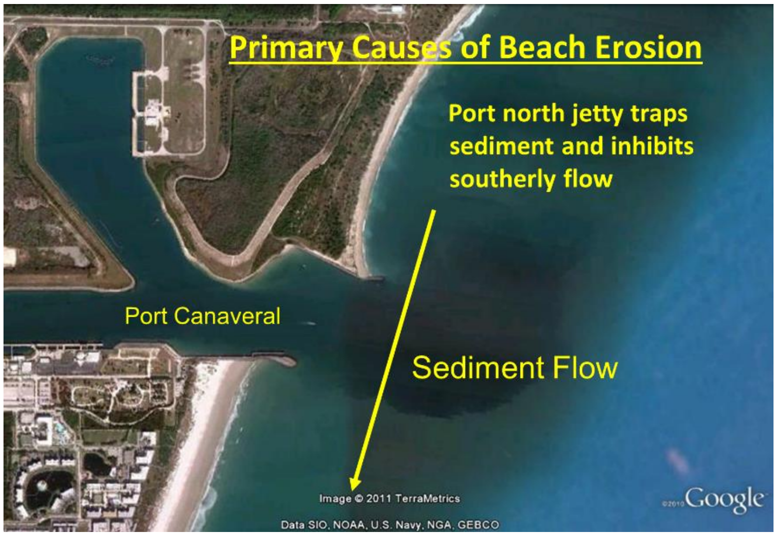

Figure 3. Port Canaveral, Florida. The trapping of sediment by the north jetty is evident from the easterly offset of the shoreline north of the port. (Google Earth, 2012)

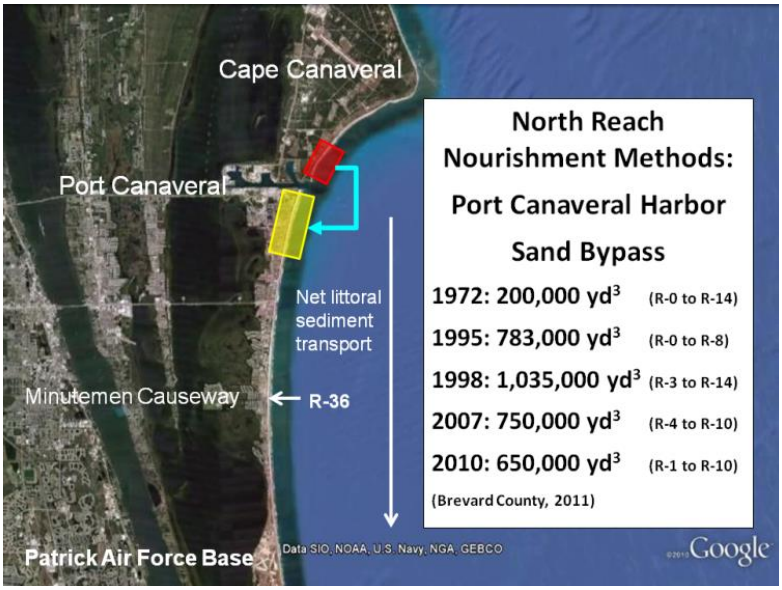

Figure 4. Port Canaveral Harbor sand bypass project overview.
The fill is dredged from the beach north of the port and placed
on the beaches in the City of Cape Canaveral.
(Brevard County NRMO, 2013) (Google Earth, 2012)

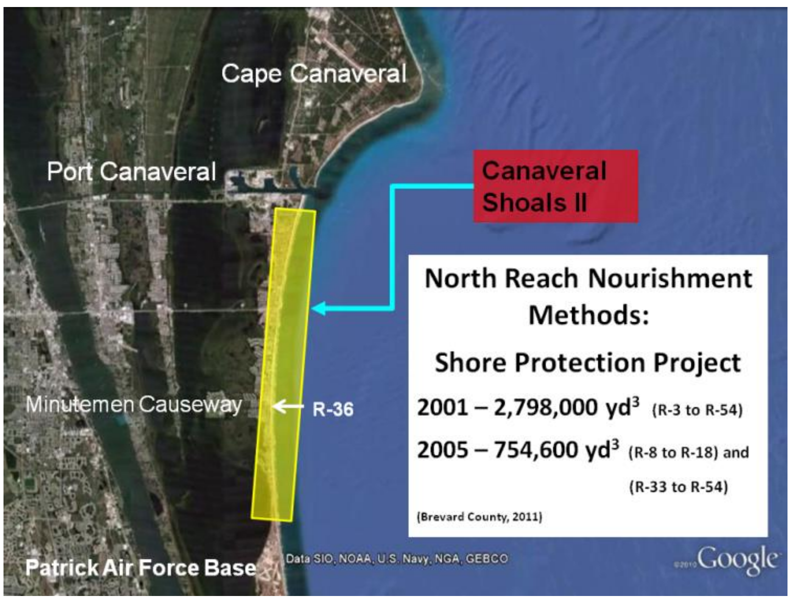

Figure 5. Brevard County Shore Protection Project. The fill is dredged
from the Canaveral Shoals, offshore of Cape Canaveral, and placed on the
beaches in the cities of Cape Canaveral and Cocoa Beach.
(Brevard County NRMO, 2013) (Google Earth, 2012)

PREVIOUS BEACH NOURISHMENT RESEARCH

The impact of the 2001 and 2005 Shore Protection Projects on the surfing wave environment in the North Reach was first studied by Klug (2010). That research was expanded to include the impacts of all nourishment projects up to and including the 2010 Sand Bypass project by Hearin (2012 & 2014). The major conclusions from that research were as follows.

The natural modal beach state of the North Reach is dissipative. Dissipative beaches are characterized as flat wide beaches with gentle slopes and fine grain sediment. The typical surfing wave environment for a dissipative beach is low intensity spilling breakers which break consistently over a wide surf zone at all tides. The fill projects conducted between 1972 and 1998 did not significantly modify the sediment grain size distribution or modal beach state of the North Reach beaches. Consequently, the surfing wave environment was not impacted in any measurable way by those beach nourishment projects (Hearin, 2012 & 2014).

The 2001 and 2005 Shore Protection Projects used fill sediment from the Canaveral Shoals II borrow site. As stated in the post project report prepared by Olsen Associates, *"The in-place beach fill material along the North Reach and Patrick AFB is slightly coarser than the native berm and significantly coarser than the native (beach) profile"* (Olsen, 2002). The coarser (larger) fill sediment changed the modal beach state of the entire North Reach from dissipative to intermediate-reflective. This change in modal beach state resulted in steeper seabed profiles and variable bar formations which transformed the surfing wave environment in the North Reach to a tidally dependent beach break which broke very differently over the normal tide range. At low tide, the beach break retained its character as a spilling breaker with a reasonably wide surf zone but at higher tides, the waves would plunge much closer to shore (shore pound) and in some cases, shut down altogether (Hearin, 2012 & 2014).

The 2007 and 2010 Sand Bypass projects used fill from the Cape Canaveral Air Force Station borrow site (beach north of the jetty). This fill was finer (smaller) than the Canaveral Shoals, and a much better match for the native beach sediment. In fact, this is the sediment that would have flowed south into the North Reach naturally if the Port Canaveral jetty did not trap it.

The analysis of survey and sediment data collected in 2011 – 2012 indicated that natural sorting and the addition of finer sediment from the Cape Canaveral Air Force Station borrow site had begun the process of returning the North Reach its natural character. The available data suggests that this transition could take at least five years after each fill project (Hearin, 2012 & 2014). The data also shows that the overall modal beach state has been trending towards intermediate/reflective (steeper beach slopes) due to the continued nourishments using fill from the Canaveral Shoals.

DESCRIPTION OF 2014 NORTH REACH SHORE PROTECTION PROJECT

The North Reach was divided into 3 zones for the 2014 Shore Protection Project. The zones are described in Table 1. Fill placement began on January 28, 2014 and all work was completed prior to May 1, 2014. 972,410 cubic yards of sediment was deposited in the north and south sections using standard dredge and fill operations. The central zone was not nourished as that part of the beach had remained relatively stable. The fill sediment was dredged from the Canaveral Shoals offshore borrow site, located approximately 6 miles east of Cape Canaveral.

Zone	Location	Monuments	Description
North	Cherie Down Park to Surf Road	R-7 to R-24	Fill
Central	Surf Road to 3rd Street North	R-24 to R-33	No Fill
South	3rd Street North to Patrick AFB	R-33 to R- 53	Fill

Table 1. 2014 North Reach Shore Protection Project.
(Brevard County NRMO, 2017)

RESEARCH METHODS USED FOR THE 2014 SHORE PROTECTION PROJECT

Analysis of the Beach Sediment Characteristics

Sediment samples for selected locations in the North Reach were collected and analyzed before the fill project in April 2013 by Scientific Environmental Applications, Inc. (SEA). Sediment samples were also collected and analyzed at those same locations after the fill project in May and August of 2014. The results from those sample analyses were compared to previous sediment data and used to calculate the modal beach states before and after the 2014 fill project.

Analysis of Beach Profile Surveys

Data from five bathymetric surveys performed in the North Reach between May 2012 and May 2015 were obtained from the Florida Department of Environmental Protection (FDEP, 2017). The survey data was plotted in profile view and analyzed to determine the sea bed slopes and profile variations before and after the 2014 fill project.

Littoral Environment Observations (Surfing Wave Observations)

The Littoral Environment Observation Program (LEO) was instituted by the Coastal Engineering Research Center of the USACE in 1968 to provide low-cost data on waves, currents, and sand movements along beaches. It has been shown that LEO data could provide useful data in areas where instrumentation is not available (Smith & Wagner, 1991). Mesa (2006) also confirmed that visual observations were a valid method for obtaining wave data in the surf zone.

Presently no instrumentation exists to accurately measure surfing wave quality. To analyze the impact the beach nourishment project may have had on surfing wave quality, daily observations of the waves were conducted in all three zones (north fill, central no fill, south fill) by members of the Cocoa Beach Chapter of Surfrider Foundation and other volunteers with significant experience in analyzing surfing wave parameters.

The volunteers utilized a modified version of the USACE LEO data sheet to record their observations of tide, wind direction, wave surface condition, wave direction, wave breaker height, wave breaker type, wave peel angle, wave reflection, rip currents, surf zone width, average surfing ride duration, overall wave quality, and number of surfers present. The information from these observations was entered into an online database for further analysis. These visual assessments were used to draw qualitative comparisons between the nourished and non-nourished sections of the beach.

RESEARCH RESULTS FOR THE 2014 SHORE PROTECTION PROJECT

Beach and Fill Sediment Data Analysis

A summary of the composite mean grain size statistics for the fill sediment used between 1989 and 2015 is shown in Figure 6. The data shows that the fill sediment taken from the Cape Canaveral AFS beach (north of the jetty) is a much better match for the native beach (1989 data) than the fill taken from the Canaveral Shoals. The composite mean grain size of the Canaveral Shoals fill is more than twice as large as the native beach profile. This observation was confirmed by the post project monitoring report prepared by Olsen and Associates, "The As-Built (2014 fill) sediment is coarser than the overall native profile sediments (from dune to about -20 feet depth), but is nearly identical to the native berm sediments" (Olsen, 2014). While the Canaveral Shoals fill may match the native berm, which is the coarsest sand in the profile, the fill placement was not limited to the berm. A large proportion of that fill flowed offshore into the surf zone.

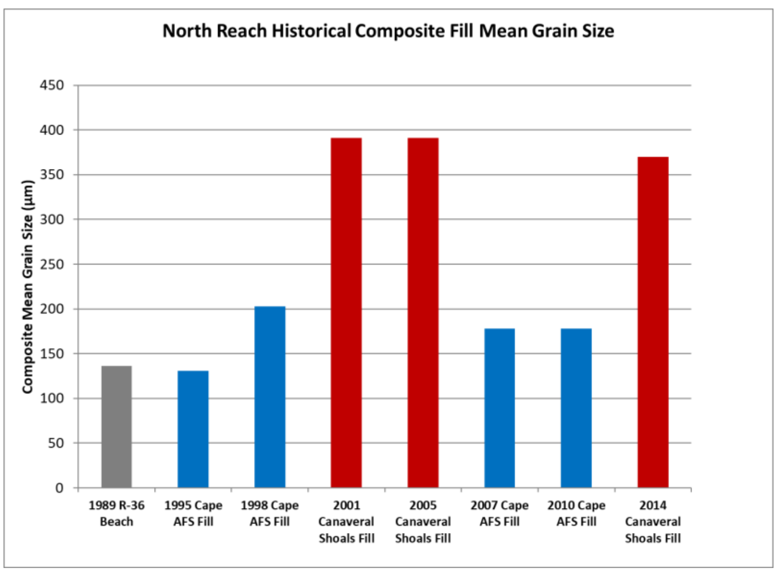

Figure 6. Summary of North Reach fill composite sediment grain size distribution statistics.
(Olsen, 1989) (FDEP, 1995) (Hearin, 2005) (USACE, 2006) (USACE, 2003) (Olsen, 2008) (SEA Inc., 2013) (SEA Inc., 2014) (Olsen, 2014)

A summary of the composite mean grain size statistics for the beach profile sediment data collected between 1989 and 2014 is shown in Figure 7Figure . The data shows that the Canaveral Shoals fill placements in 2001, 2004, and 2014 enlarged the composite beach profile sediment grain size of the nourished beaches in the North Reach. The cumulative effect of the Canaveral Shoals fill projects is that the composite beach profile mean grain size has nearly doubled since 1989.

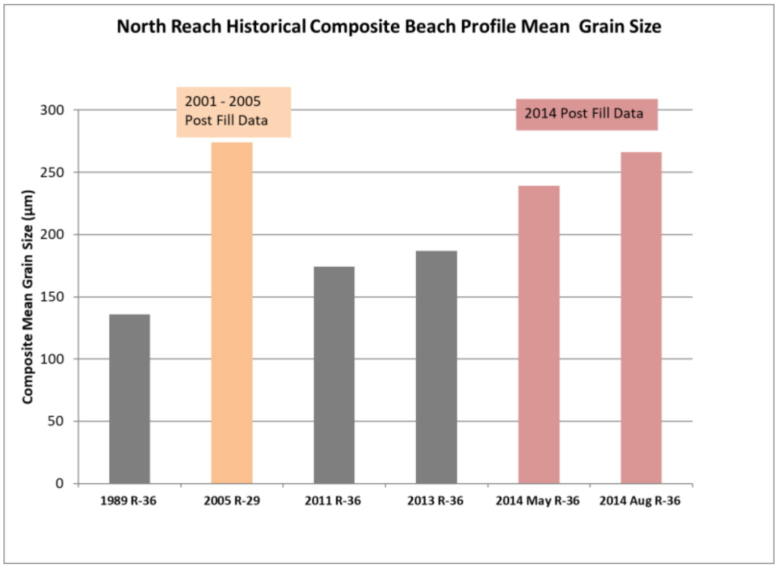

Figure 7. Summary of North Reach beach profile composite sediment grain size distribution statistics. (Olsen, 1989) (Hearin, 2005) (Hearin, 2012) (SEA Inc., 2013) (SEA Inc., 2014)

Morphological Modal Beach State Calculations

The calculated modal beach states for the North Reach composite beach profiles between 1989 and 2014 are presented in Figure 8. The native beach modal state was very dissipative in 1989. The North Reach was transformed into an intermediate beach after the Canaveral Shoals fill projects in 2001 and 2004. The beach had returned to a dissipative state by 2011 and 2013 but the filled zones were again transformed into intermediate beaches after the Canaveral Shoals fill projects in 2014. The same cumulative trend towards a less dissipative beach is also apparent in the data.

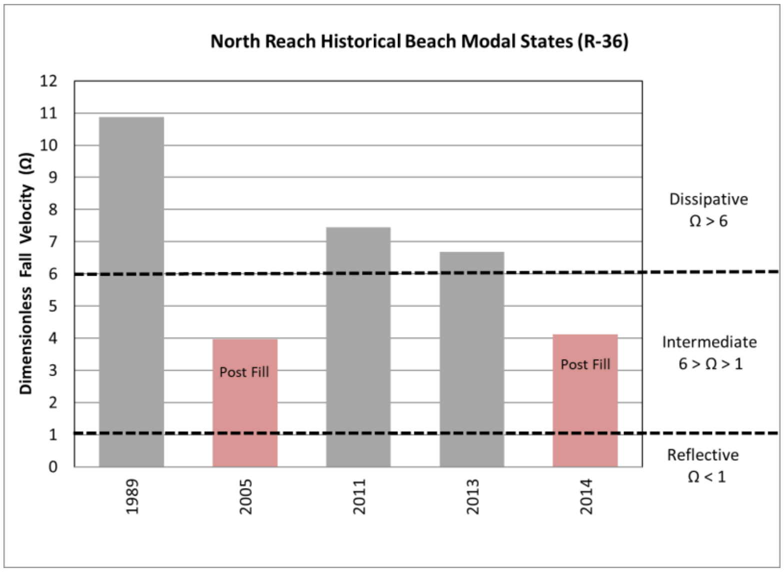

Figure 8. Summary of North Reach modal beach states.
(Olsen, 1989) (Hearin, 2005) (Hearin, 2012) (SEA Inc., 2013) (SEA Inc., 2014)

Analysis of Bathymetric Profiles

An analysis of the beach surf zone slopes for all the surveys taken between 2012 and 2015 is presented in Figure 9. Another survey was conducted in 2016, but unfortunately the survey profiles only extended down to the water line and were of no use for the surf zone slope analysis. It is evident from the data that in all cases the filled zone slopes were steeper after the 2014 Canaveral Shoals fill and remained steeper through May 2015. The non-filled central zone showed a slight increase in steepness in the May 2015 survey but was still much flatter than the filled zones.

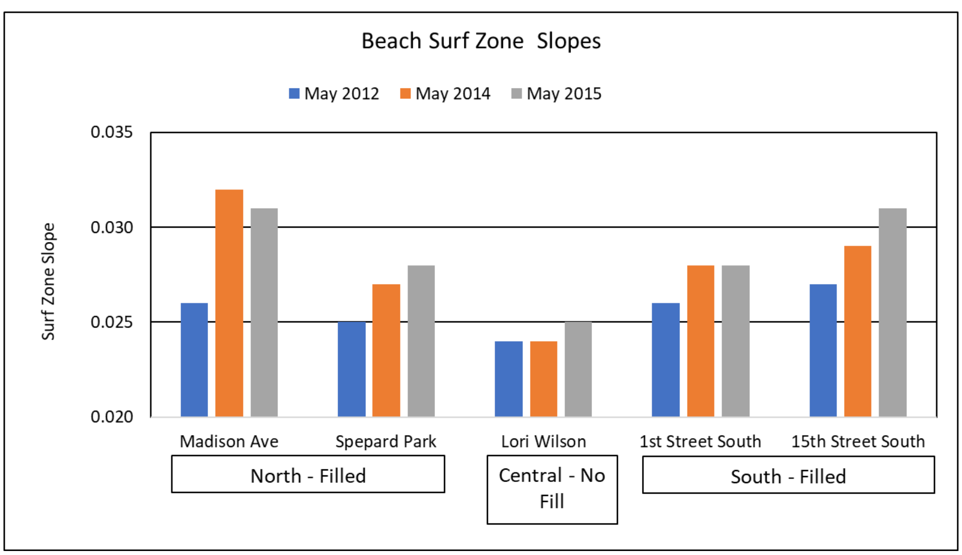

Figure 9. Beach surf zone slopes for the North Reach pre and post fill. (FDEP, 2017)

Analysis of Littoral Environment Observations (Surfing Wave Observations)

A total of 372 independent wave observations were recorded post fill between May and December of 2014. Observations were taken at the filled and un-filled zones at the same time, during the same wave conditions, to draw comparisons between the nourished and non-nourished zones.

To have confidence in any scientific observations, it is necessary to perform statistical tests of the results to determine if the results are statistically significant. Observation results are considered statistically significant if the confidence level of the test is greater the 95%. This means that there is a greater than 95% probability that the results of the observations are due to actual differences in the data and not a function of random chance. A Mann-Whitney Rank Sum test was performed on all the observation results presented in this paper. All the results were confirmed to be statistically significant.

The distribution of the Wave Breaker Height observations taken post fill is presented in Figure 10. The statistical analysis of this data determined that there was no statistically significant difference between the distribution of wave heights observed in the filled zones (north and south) and the un-filled zone (central). This indicates that the post fill observed wave heights were statistically the same in all zones and that the beach nourishment did not have any observable impact on the breaking wave heights.

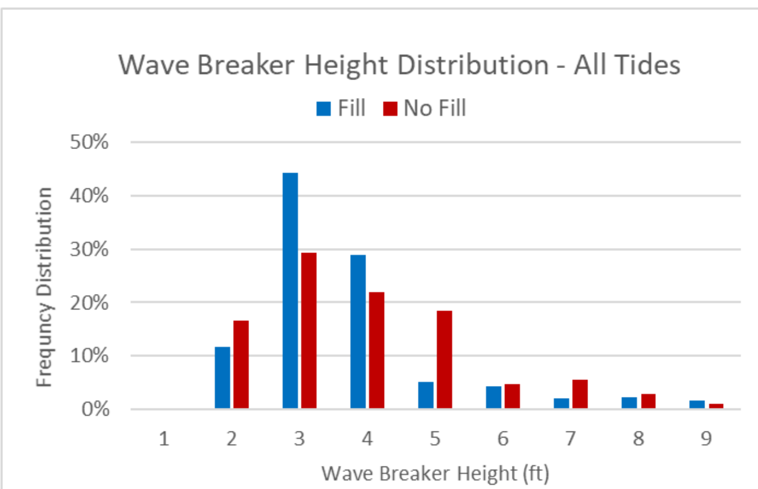

Figure 10. Wave Breaker height distributions.

The median values for the post fill observed surf zone widths are presented in Figure 11. The data show that median surf zone width in the filled zones was 100 feet narrower than the un-filled zone over all tide ranges. A narrower surf zone width means that the waves were breaking closer to shore which allows less space and time to ride the waves.

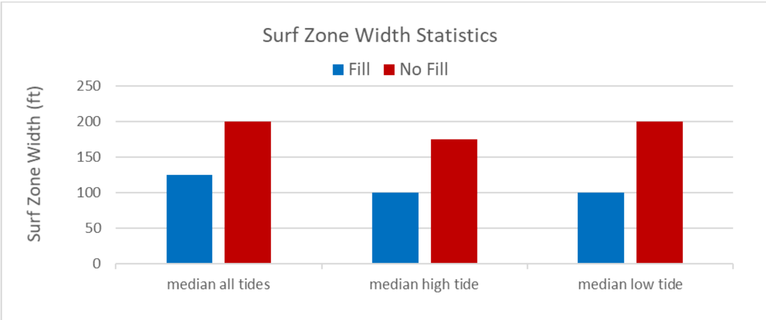

Figure 11. Surf Zone Width median values - post fill.

The median values for the post fill observed average ride duration are presented in Figure 12. The data show that the median ride duration in the filled zones was 5 to 10 seconds shorter than the un-filled zone over all tide ranges. As expected, the ride durations at low tide were the longest as the waves tend to break further from shore at low tide. A shorter ride duration means that surfers have less time to perform maneuvers and spend less time riding the waves.

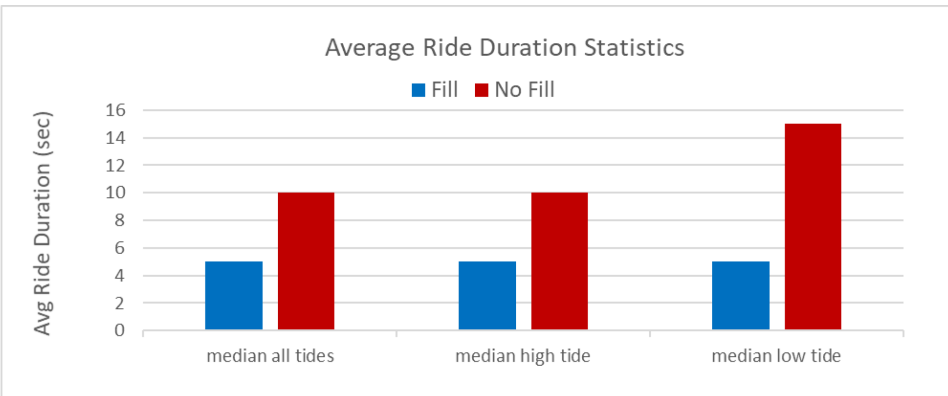

Figure 12. Average Ride Duration median values.

The median values for the post fill observed overall surf quality are presented in Figure 13. The data show that the median surf quality in the filled zones was a full point lower than the un-filled zone over all tide ranges.

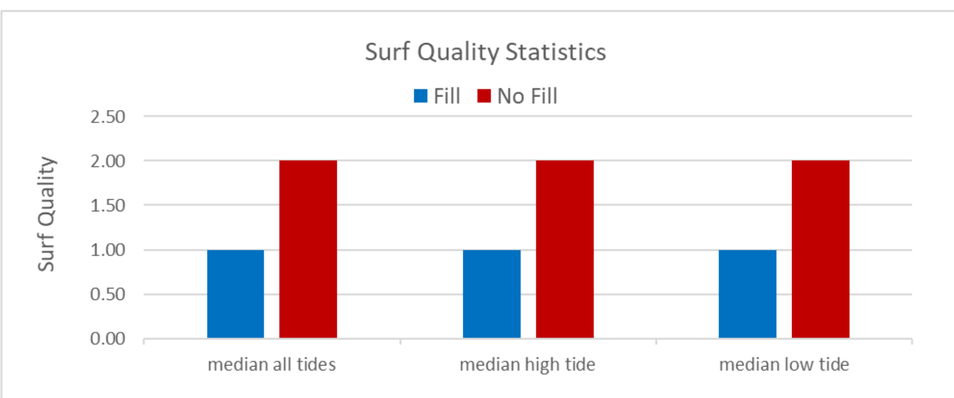

Figure 13. Overall Surf Quality median values.

2014 NOURISHMENT PROJECT RESEARCH CONCLUSIONS

The results of the 2014 North Reach beach nourishment study clearly demonstrate that the fill sediment from the Canaveral Shoals II borrow site is much coarser than the native beach profile sediment in the North Reach. The coarser fill sediment changed the modal beach state of the filled zones from dissipative to intermediate. This change in modal beach state resulted in steeper seabed slopes which impacted the surfing wave environment in the filled zones. Littoral Wave Observations conducted by experienced surfers confirmed that the surf zone widths were narrower, that average ride durations were 5 to 10 seconds shorter, and that the overall surf quality was lower in the filled northern and southern zones when compared to the central zone, which was not filled.

Previous research suggests that the adverse impacts to the surfing wave environment of the Canaveral Shoals fill will continue for at least 5 years after the project was completed. If left undisturbed, the entire North Reach could return to a dissipative modal beach state through the process of natural sorting and the addition of finer fill sediment from the beaches of the Cape Canaveral Air Force Station. However, if nourishments from the Canaveral Shoals borrow site continue to occur, the beach modal state will continue to trend more intermediate/reflective and at some point, the beach may not be able to recover to its natural dissipative state.

RECOMMENDATIONS

Based on the reports from Brevard County, the combined effects of the North Reach Shore Protection Projects and Canaveral Harbor Sand Bypass Projects have increased the total shoreline volume of the North Reach by over 2 million cubic yards and advanced the shoreline position 90 to 120 feet seaward of the pre-fill values in 2000. Therefore, the North Reach beach nourishment projects must be considered a success from a coastal protection point of view. The beaches in the North Reach are much wider and boast a much healthier dune system than before the fill projects began in 2001. It is the author's opinion that the North Reach beaches could be maintained and protected without degrading the surfing wave environment. The following recommendations are offered as a way forward.

Improve Beach Nourishment Fill Compatibility

Based on the available sediment data, the fill projects conducted in the North Reach of Brevard County using the Canaveral Shoals II borrow site did not comply with the Florida Department of Environmental Protection's rules for beach fill compatibility. The fill was much coarser than the native beach profile and did not maintain the general character of the sediment occurring in the natural coastal system. The results have been a nourished beach with a very different character than the natural beach.

The available data suggests that the Cape Canaveral AFS borrow site is a much better match for the natural beach profile sediment of the North Reach. This is not surprising since the sediment trapped north of the Port Canaveral jetty, which includes the borrow site, is the sand that would flow naturally into the North Reach if the Port did not trap it. Utilizing the Cape Canaveral AFS borrow site for all future nourishment projects in the North Reach would help restore the natural character of the beaches and preclude negative impacts to the surfing wave environment.

Improve the Post Nourishment Physical Monitoring Program

The current post nourishment physical monitoring program focusses on the sediment located on the berm and its impacts on sea turtle nesting. Prior to the 2014 fill project, beach surveys were only conducted annually and no post fill sediment samples were collected. To their credit, Brevard County did conduct 4 beach profile surveys and 3 sediment sample collections during the first 12 months after the 2014 fill project. However, a more robust, long term, physical monitoring program is needed to capture the sediment equilibration process, assess the impact on the modal beach state, and assess the impact of the beach nourishment projects on recreational activities such as surfing, swimming, diving, and fishing.

A Fixed Sand Bypass System for Port Canaveral Harbor

A fixed sand bypass system for Port Canaveral Harbor was initially considered in 1962 (USACE, 1987). The most recent study conducted by the USACE was completed in 1993 (USACE, 1993). In that study three alternatives were evaluated: (1) a fixed bypass system, (2) a moveable bypass system, and (3) a conventional dredging bypass system. Alternatives 1 and 2 called for pumping a sand slurry from the shoreline north of the harbor, through a pipeline underneath the inlet channel, to a discharge port located 6,500 feet south of the jetty near Madison Avenue (monument R-7). Alternative 3 called for the conventional dredging of the shoreline north of the harbor and filling the beach south of the harbor between monuments R-1 and R-14 at six year intervals. The results of that evaluation are summarized in Table 2.

Bypass System Alternative	Avg. Annual Benefit	Avg. Annual Cost	Benefit to Cost Ratio
1. Fixed System	$1,610,500	$1,167,000	1.4
2. Moveable System	$1,610,500	$1,233,800	1.3
3. Conventional Dredging	$2,015,800	$1,213,800	1.7

Table 2. Evaluation of sand bypass systems for Port Canaveral. (USACE, 1993)

The unit cost for the four Port Canaveral Harbor sand bypass operations is shown in Table 3. The data indicate that the actual cost for the traditional dredge and fill projects has doubled since the first bypass was completed in 1995. Adjusting for inflation, based on the Consumer Price Index (USGPO, 2012), the unit cost for the traditional dredging projects has risen over 39% since 1995.

Year	Total Volume Placed (yd^3)	Final Payment ($ millions)	Unit Cost ($ / yd^3)	Unit Cost adjusted for inflation ($ 2012 / yd^3)
1995	783,000	4.82	6.16	9.17
1998	1,035,000	NA	NA	NA
2007	750,000	7.90	10.53	11.62
2010	650,000	7.92	12.18	12.80

Table 3. Unit cost of Port Canaveral Harbor sand bypass projects adjusted for inflation. (Brevard County NRMO, 2013) (USACE, 2013) (USGPO, 2012)

The 1993 sand bypass study only considered the erosion impacts of Port Canaveral Harbor for the 2.4 miles of coastline immediately south of the harbor. An Independent Coastal Expert (ICE) study determined that the coastal erosion impact of Port Canaveral Harbor extends 10 to 15 miles south of the harbor and encompasses the entire North Reach, Patrick Air Force Base (AFB), and parts of the Mid Reach of Brevard County (Kriebel, Weggel, & Dalrymple, 2002). The ICE study concluded that 100% of the fill placed by the North Reach Shore Protection Project (USACE, 1996) should be considered mitigation for erosion caused by the harbor. An updated Inlet Management Plan determined that Port Canaveral is primarily responsible for beach erosion from Cape Canaveral to the south end of Patrick Air Force Base (Olsen, 2012A). In fact, the beach at Patrick AFB has been nourished four times since 1998 (Brevard County NRMO, 2013). A total of 1,094,843 cubic yards of sediment has been place on the beach at Patrick AFB as mitigation for erosion caused by Port Canaveral Harbor (Olsen, 2012B).

Since the ICE study (2002) and Inlet Management Plan (2012) have both determined that Port Canaveral Harbor is a primary cause of beach erosion for the North Reach and Patrick AFB, then the cost for the entire North Reach Shore Protection Projects and the Patrick AFB nourishment projects should be considered when performing a benefit to cost analysis for a sand bypass system at Port Canaveral Harbor.

Since the 1993 sand bypass study was completed, the actual unit cost for traditional dredging operations has doubled, while the technology for fixed bypassing stations, such as Tweed River in Australia (Dyson, Victory, & Connor, 2001) and Lake Worth Inlet in Florida (FDEP, 2008), has improved.

Considering these facts, it would prove beneficial to all stakeholders to re-evaluate the possibility of adopting a fixed sand bypass system at Port Canaveral. A fixed bypass system would promote a more natural flow of compatible sediment around the harbor and reduce the need for disruptive dredge and fill or truck haul projects.

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