Erosional Impacts of Modified Inlets on the East Coast of Florida (Beach Encroachment and Nourishment) Jim Houston and Bob Dean



Erosional Impacts of Modified Inlets

Well recognized

- Modification anything impeding littoral sand flow or removing sand from the littoral system
- It has been estimated that modified inlets produce 80 - 85% of the erosion on the Florida east coast (Dean, Pilkey, and Houston, 1988)



19 Modified Inlets



Historical Shoreline Change

 Analyzed historical shoreline change measured relative to 2000 monuments



Data Source – Florida DEP

ftp://ftp.dep.state.fl.us/pub/water/beaches/HSSD/MHWfiles/ mhw2779/

Historical shoreline positions for all 2000 monuments

	Shoreline													
			Year					Pos	ition					
	R-	35	1858		2194844.007	374291.869	95	528.49	MHW	2194797.25	374818.282	10000	U.S.C. &	G.S.
	R-	35	1924		2194844.007	374291.869	95	339.67	MHW	2194813.75	374630.188	20000	U.S.C. &	G.S .
	R-	35	1933		2194844.007	374291.869	95	231.73	MHW	2194822.75	374522.625	20000	U.S.C. &	G.S.
	R-	35	1943-1948		2194844.007	374291.869	95	194.96	MHW	2194826	374486.001	24000	U.S.G.S.	
	R-	35	1958		2194844.007	374291.869	95	177.06	MHW	2194827.5	374468.156	10000	U.S.C. &	G.S.
	R-	35	1973-1975		2194844.007	374291.869	95	189.01	MHW	2194826.75	374480.094	20000	N.O.S.	
	R-	35	1974	3	2194844.007	374291.869	95	181.01	MHW	2194828.231	374472.19	EL2.9	DNR, B&S	
С	R-	35	1974	3	2194844.007	374291.869	95	337.63	NGVD	2194814.581	374628.214		DNR, B&S	
	R-	35	1979-1980		2194844.007	374291.869	95	182.78	MHW	2194827.5	374473.906	20000	N.O.S.	
С	R-	35	1990	4	2194843	374289.5	95	394.86	MHW	2194808.586	374682.857	EL2.9	DNR, B&S	
С	R-	35	1990	-4	2194843	374289.5	95	515.43	NGVD	2194798.077	374802.969		DNR, B&S	
	R-	35	1990	-4	2194844.007	374291.869	95	392.59	MHW	2194809.79	374682.965	EL2.9	DNR, B&S	
С	R-	35	1990	4	2194844.007	374291.869	95	513.16	NGVD	2194799.282	374803.076	SR001	DNR, B&S	
С	R-	35	1999	1	2194843	374289.5	95	357.35	MHW	2194811.855	374645.49	EL2.9	DNR, B&S	
С	R-	35	1999	1	2194843	374289.5	95	468.5	NGVD	2194802.168	374756.217		DNR, B&S	
	R-	35	1999	1	2194844.007	374291.869	95	355.08	MHW	2194813.06	374645.598	EL2.9	DNR, B&S	
С	R-	35	1999	1	2194844.007	374291.869	95	466.23	NGVD	2194803.372	374756.325	SR 1	DNR, B&S	
С	R-	35	2003	6	2194843	374289.5	95	401.61	MHW	2194807.997	374689.582	EL2.9	DNR, B&S	
С	R-	35	2003	6	2194843	374289.5	95	520.89	NGVD	2194797.601	374808.408		DNR, B&S	
	R-	35	2003	6	2194844.007	374291.869	95	399.34	MHW	2194809.202	374689.689	EL2.9	DNR, B&S	
С	R-	35	2003	6	2194844.007	374291.869	95	518.62	NGVD	2194798.806	374808.515	SR 1	DNR, B&S	



Inlet Analysis

- Started when an inlet was modified
- Ended before widespread beach nourishment began mitigating and masking recession (early 1970s)



Example – St Lucie Inlet



 $\frac{dy}{dt} \Delta x \Delta t$ $\Delta A =$ n=1dy= Shoreline change rate dtfrom least squares Δx = Monument cell width Δt = Time period *N* = Number monuments **Conservative** – **Bodge (1994,1999) showed** armoring often moved recession further downdrift than we considered

Modified Inlets Causing Recession

• 16 modified inlets causing net downdrift shoreline recession



St Mary's Entrance



St Augustine Inlet



South Lake Worth Inlet



Erosion Caused by 16 Modified Inlets

Inlet	Year	Recession Area			
		10 ⁶ m ²			
St Johns	1858 - 1970	- 1.01 ± 0.17			
Matanzas	1923 - 1972	- 0.15 ± 0.05			
Ponce de Leon	1928 - 1969	- 0.39 ± 0.02			
Port Canaveral	1951 - 1969	- 0.17 ± 0.03			
Sebastian	1880 - 1970	- 0.23 ± 0.17			
Fort Pierce	1883 - 1971	- 1.39 ± 0.36			
St Lucie	1892 - 1971	- 4.30 ± 0.34			
Jupiter	1883 - 1971	- 0.41 ± 0.14			
Lake Worth	1883 - 1971	- 1.14 ± 0.38			
Boca Raton	1884 - 1971	- 0.24 ± 0.04			
Hillsboro	1927 - 1972	- 0.12 ± 0.07			
Port Everglades	1883 - 1972	- 0.56 ± 0.11			
Bakers Haulover	1919 - 1972	- 0.03 ± 0.01			
Government Cut	1867 - 1972	- 0.04 ± 0.03			
Norris Cut	1851 - 1972	- 0.59 ± 0.09			
Bear Cut	1851 - 1972	- 0.20 ± 0.08			
TOTAL	- 11.0 ± 0.7	Million m ²			

Average recession of 250 ft for all shorelines impacted by modified inlets



Recession by County



Black = Recession caused by modified inlets White = Recession not caused by modified inlets

Recession Caused by Modified Inlets



Beach Nourishment

- Beach nourishment was Florida's response to mitigate shoreline recession
- Over 130 million yd³ of sand was placed from 1971 - 2008
- How well has it worked?



Florida Designation of Critically Eroding Shorelines

1985	1993	2008	2014
20%	35%	56%	57% (+7% eroding)

- Has beach nourishment been a failure??
- We analyzed measured shoreline change, and the 360-mile shoreline advanced on average + 82 ft from 1971 - 2008



Measured shoreline change

Definition was the same in 1985. Eroding meant eroding.

Definition Has Changed - "Critically Eroding" Does Not Mean Eroding

Florida Designation of Critically Eroding

1985	1993	2008	2014
20%—	→ 35% —	→ 56%	57% (+7% eroding)

- Esteves and Finkl (1998) show these increases are due to "anthropogenic" factors in designation, not actual erosion
- Shorelines with authorized or active nourishment projects were designated in 1992 as critically eroding regardless of the actual state of shoreline change
 - Later, shorelines were designated as critically eroding if development was threatened by a 25-year storm

Daytona Beach Area Currently Designated as Critically Eroding



Encroachment Has Masked Accretion Making Beaches Appear Erosional

Designated as

critically eroding

Soogle-earth

Mean High Water

Houses built 1980, R100 prior to setback line

Monument R100 Location

South Indian

River County

02015 Google

Shoreline Change, 1882 - Aug 2006



Encroachment – Portion Miami Beach



Miami Beach

 In 1950s hotels received permission to build up to 75 feet seaward of MHW to have swimming pools with ocean views



Shoreline Change, Miami Beach 1867-2005



Average shoreline change at Miami Beach over about 10 miles

Shoreline Change, Miami Beach



Has Recession Been Eliminated Downdrift of Modified Inlets?

- Sufficient beach nourishment was placed to have eliminated recession caused by modified inlets
 - However, only half of the recession was eliminated because half of the nourishment was placed on stable and accreting rather than eroding beaches



Modified Inlets Dominate Shoreline Change







It Is Time to Manage Inlets

- Florida Statues call for Inlet Management Plans to mitigate beach erosion caused by modified inlets
- Fewer than half of Florida's managed inlets have Plans
- Most Plans are 10 25 years old



St. Augustine Port, Waterway & Beach District

St. Augustine Inlet 2013 draft Inlet Management Plan

March 19, 2013



Conclusions

- Modified inlets cause most of the erosion on the Florida east coast
- Beach nourishment has been very successful, advancing the shoreline 82 ft, but only about half was placed on eroding beaches
 - Inlet management plans are needed to restore the balance required to have sustainable shorelines

"Reinstate the natural flow. Sand went around inlets before the channels were dredged and the jetties were built" - Bob Dean





The End