ERDC
Engineer Research and Development Center

Advancing Nearshore Berm Research, Guidance, Tool Development: Sediment Mobility Tool

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Nearshore Placement

- Sediment placed in the nearshore in either an elongate (bar-like) feature or a mound
  - Stable berms- remain stationary for years
  - Active/Feeder berms- sediment dispersed by waves and currents
- Typically consist of dredged sediment from navigation projects that is incompatible with natural beach sediment
- Goals:
  - Reduce O&M cost
  - Nourish adjacent beaches
  - Selectively move fine sediment offshore, while beach quality material moves onshore
  - Efficiently and beneficially utilize greater volumes of dredged material

Nearshore Placement

- Nearshore placement is increasingly utilized for beneficial use of dredged material
  - ► Less costly than beach nourishment, fewer restrictions, fewer environmental concerns
- Need a better understanding of sediment migration after placement
  - ► Stakeholder and regulatory agency questions
- Several programs at USACE ERDC are researching nearshore placement
  - ► CIRP, RSM, DOER, EWN

Important Questions

- Will sediment move once it is placed in the nearshore?
- Where will the sediment move?
- How much sediment will move?
- How long will it take for the sediment to move?

Sediment Mobility Tool

- Objective:
  - Determine frequency of sediment mobility and general transport direction without running a full numerical model
- Ideal for:
  - Preliminary Siting of a Nearshore Placement
  - Small Projects That Don't Warrant a Full Numerical Model
- Currently Being Developed into a Web App

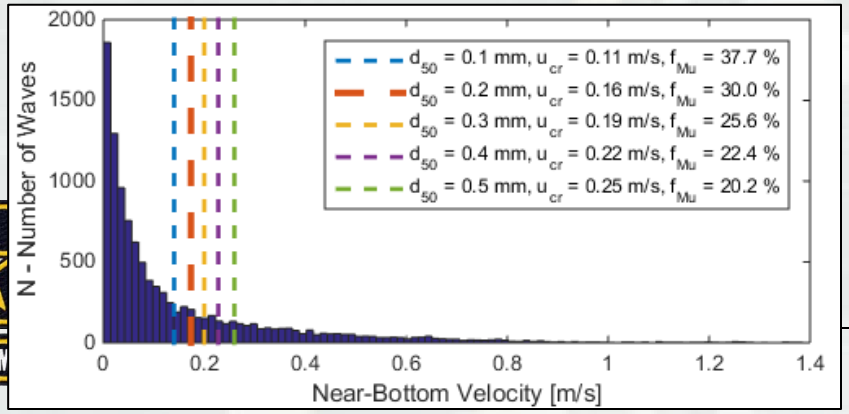
User Input

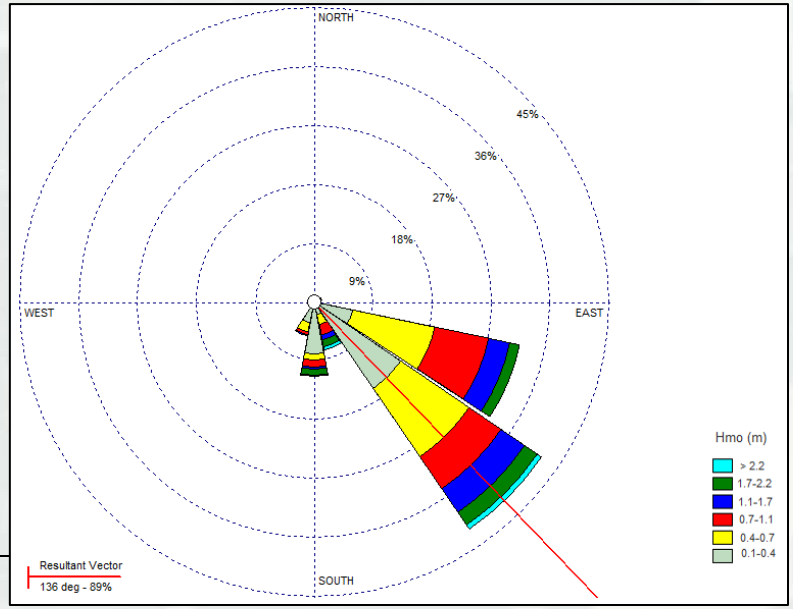
- Data Source
- Offshore Water Depth of Data Source
- Shoreline Orientation
- Median Grain Size
- Current Velocity 1 m above the Bed

Tool Output

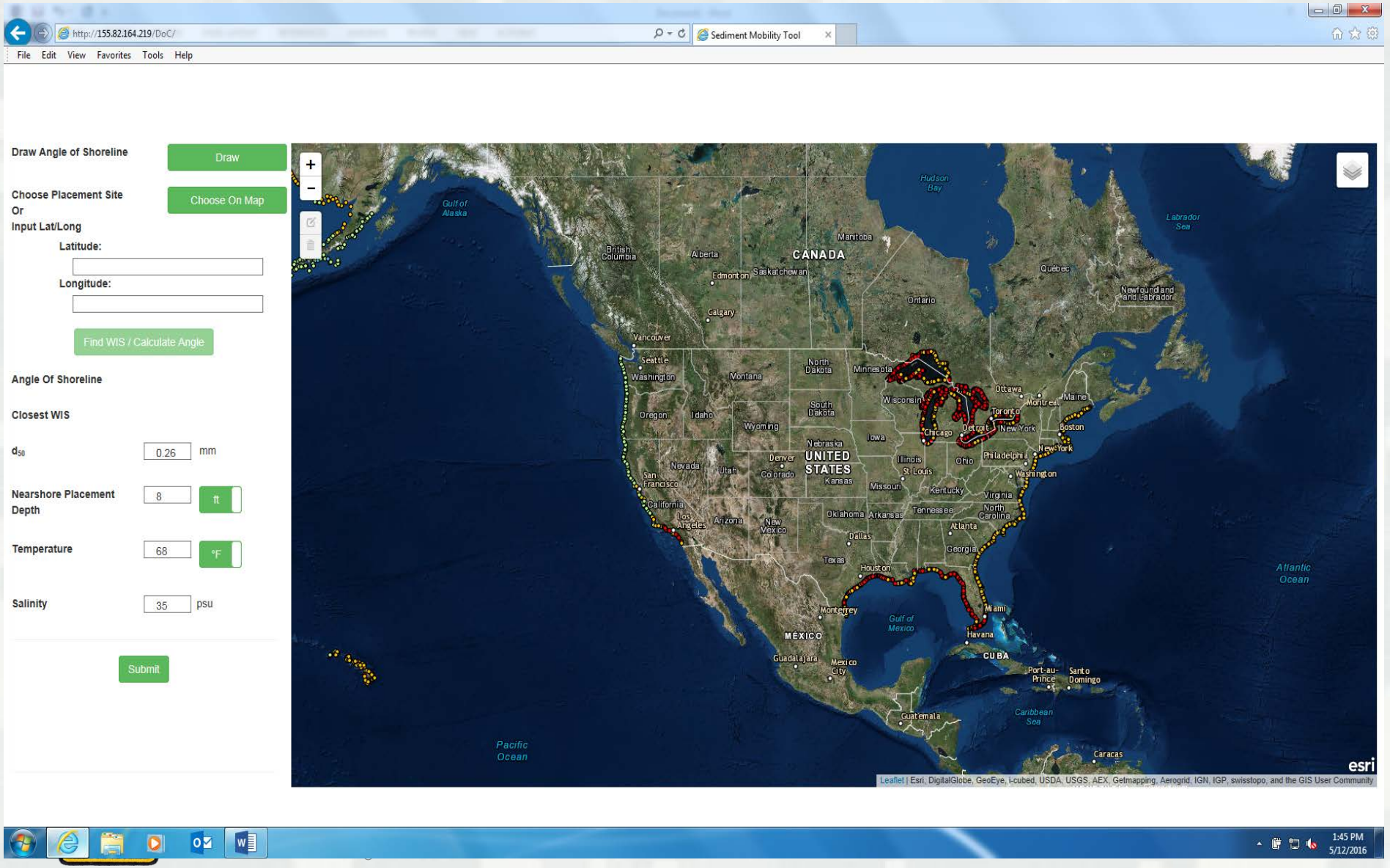
- Frequency of sediment mobility using linear and non-linear wave theories
- On/Offshore migration direction
- Dominant axis of wave direction to estimate alongshore migration

d_{50} (mm)	Frequency of Mobilization	Predicted Sediment Migration
0.1	16 – 38%	83% Offshore
0.2	14 – 30%	60% Onshore
0.3	12 – 26%	84% Onshore





SMT


http://155.82.164.219/DoC/
Sediment Mobility Tool
File Edit View Favorites Tools Help
Draw Angle of Shoreline
Draw
Choose Placement Site
Or
Input Lat/Long
Choose On Map
Latitude:
Longitude:
Find WIS / Calculate Angle
Angle Of Shoreline
Closest WIS
d50
0.26
mm
Nearshore Placement Depth
8
ft
Temperature
68
°F
Salinity
35
psu
Submit
CANADA
UNITED STATES
MÉXICO
CUBA
Gulf of Alaska
Hudson Bay
Labrador Sea
Atlantic Ocean
Gulf of Mexico
Pacific Ocean
Caribbean Sea
British Columbia
Alberta
Saskatchewan
Manitoba
Ontario
Québec
Newfoundland and Labrador
Vancouver
Seattle
Washington
Montana
North Dakota
Minnesota
Oregon
Idaho
Wyoming
South Dakota
Wisconsin
Michigan
Chicago
Detroit
Toronto
Ottawa
Montreal
Maine
Boston
New York
Philadelphia
Nebraska
Iowa
Illinois
Ohio
Nevada
Utah
Colorado
Kansas
Missouri
Kentucky
Virginia
San Francisco
California
Los Angeles
Arizona
New Mexico
Oklahoma
Arkansas
Tennessee
North Carolina
Atlanta
Dallas
Texas
Georgia
Houston
Miami
Monterrey
Havana
Guadalajara
Mexico City
Port-au-Prince
Santo Domingo
Guatemala
Caracas
Leaflet | Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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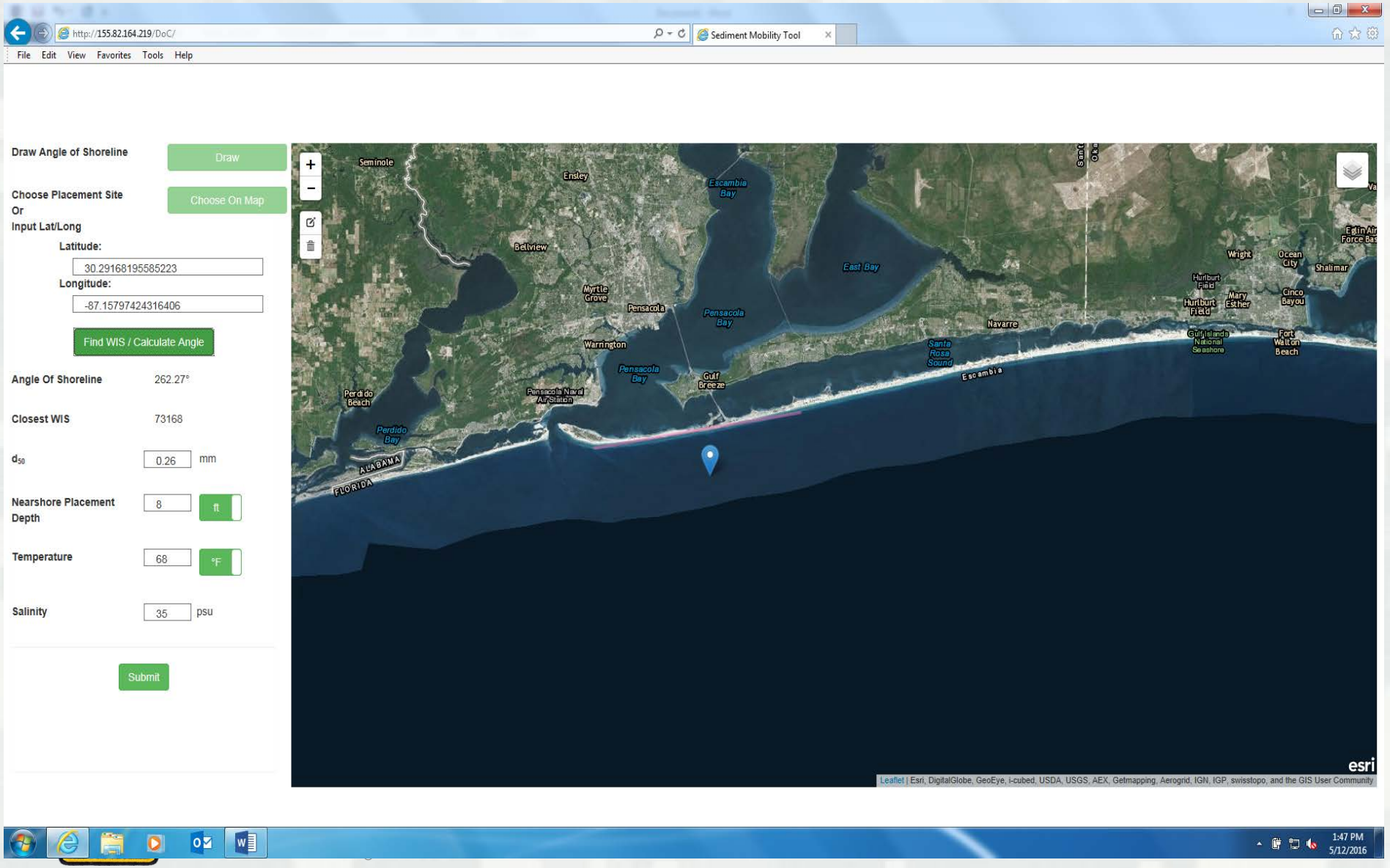
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Sediment Mobility Tool
File Edit View Favorites Tools Help
Draw Angle of Shoreline
Draw
Choose Placement Site
Or
Input Lat/Long
Choose On Map
Latitude:
30.29168195585223
Longitude:
-87.15797424316406
Find WIS / Calculate Angle
Angle Of Shoreline 262.27°
Closest WIS 73168
d50 0.26 mm
Nearshore Placement Depth 8 ft
Temperature 68 °F
Salinity 35 psu
Submit
Seminole
Ensley
Escambia Bay
Bellview
East Bay
Myrtle Grove
Pensacola
Pensacola Bay
Warrington
Navarre
Santa Rosa Sound
Gulf Breeze
Pensacola Naval Air Station
Perdido Beach
Perdido Bay
ALABAMA
FLORIDA
Escambia
Wright
Ocean City
Shalimar
Hurlburt Field
Mary Esther
Cinco Bayou
Gulf Islands National Seashore
Fort Walton Beach
esri
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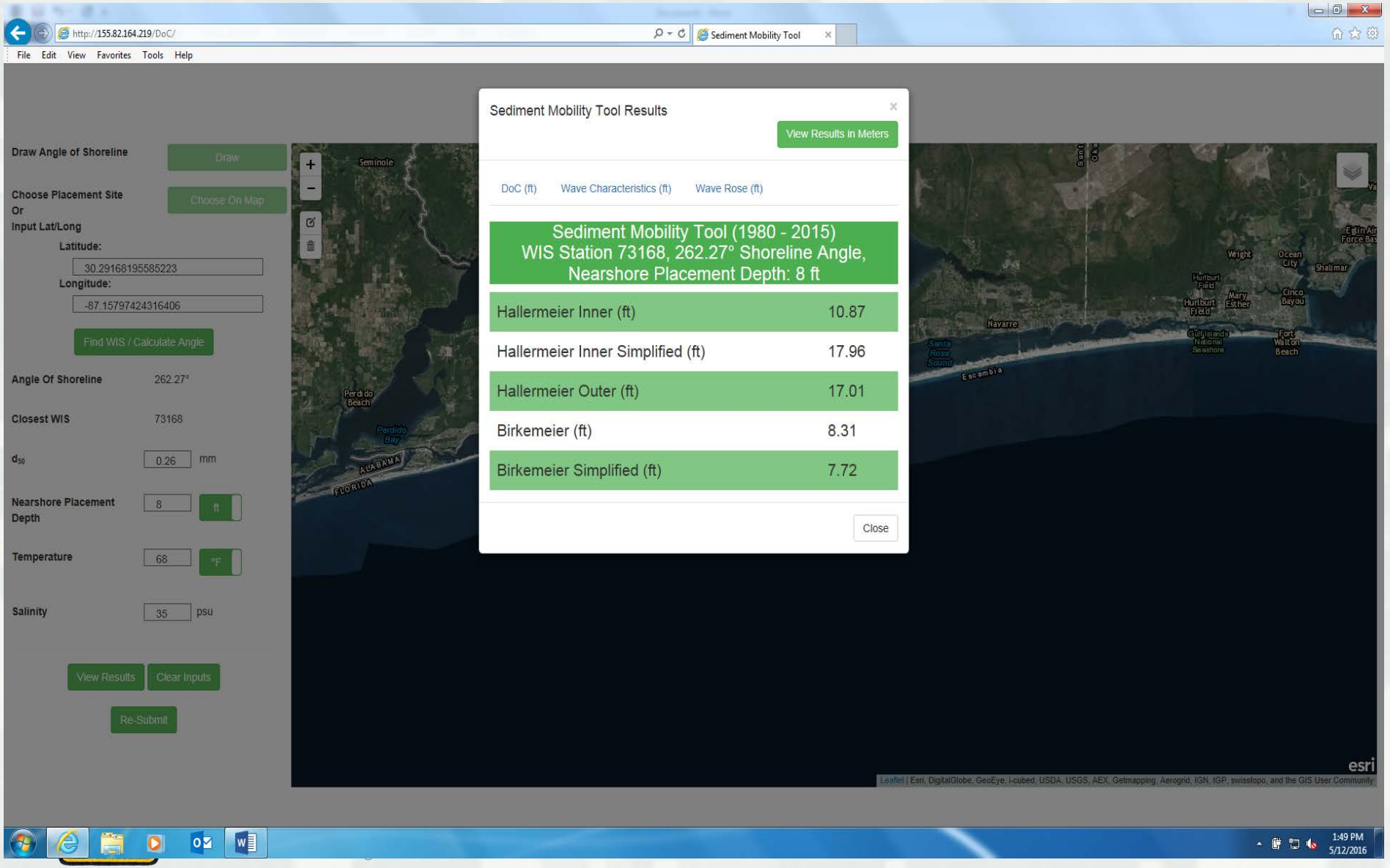
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d_{50} 0.26 mm
Nearshore Placement Depth 8 ft
Temperature 68 °F
Salinity 35 psu
View Results
Clear Inputs
Re-Submit
Sediment Mobility Tool Results
View Results in Meters
DoC (ft)
Wave Characteristics (ft)
Wave Rose (ft)
Sediment Mobility Tool (1980 - 2015)
WIS Station 73168, 262.27° Shoreline Angle,
Nearshore Placement Depth: 8 ft
Hallermeier Inner (ft) 10.87
Hallermeier Inner Simplified (ft) 17.96
Hallermeier Outer (ft) 17.01
Birkemeier (ft) 8.31
Birkemeier Simplified (ft) 7.72
Close
Seminole
Perdido Beach
Perdido Bay
ALABAMA
FLORIDA
Navarre
Santa Rosa Sound
Escambia
Wright
Ocean City
Shalimar
Hurlburt Field
Mary Esther
Cinco Bayou
Gulf Islands National Seashore
Fort Walton Beach
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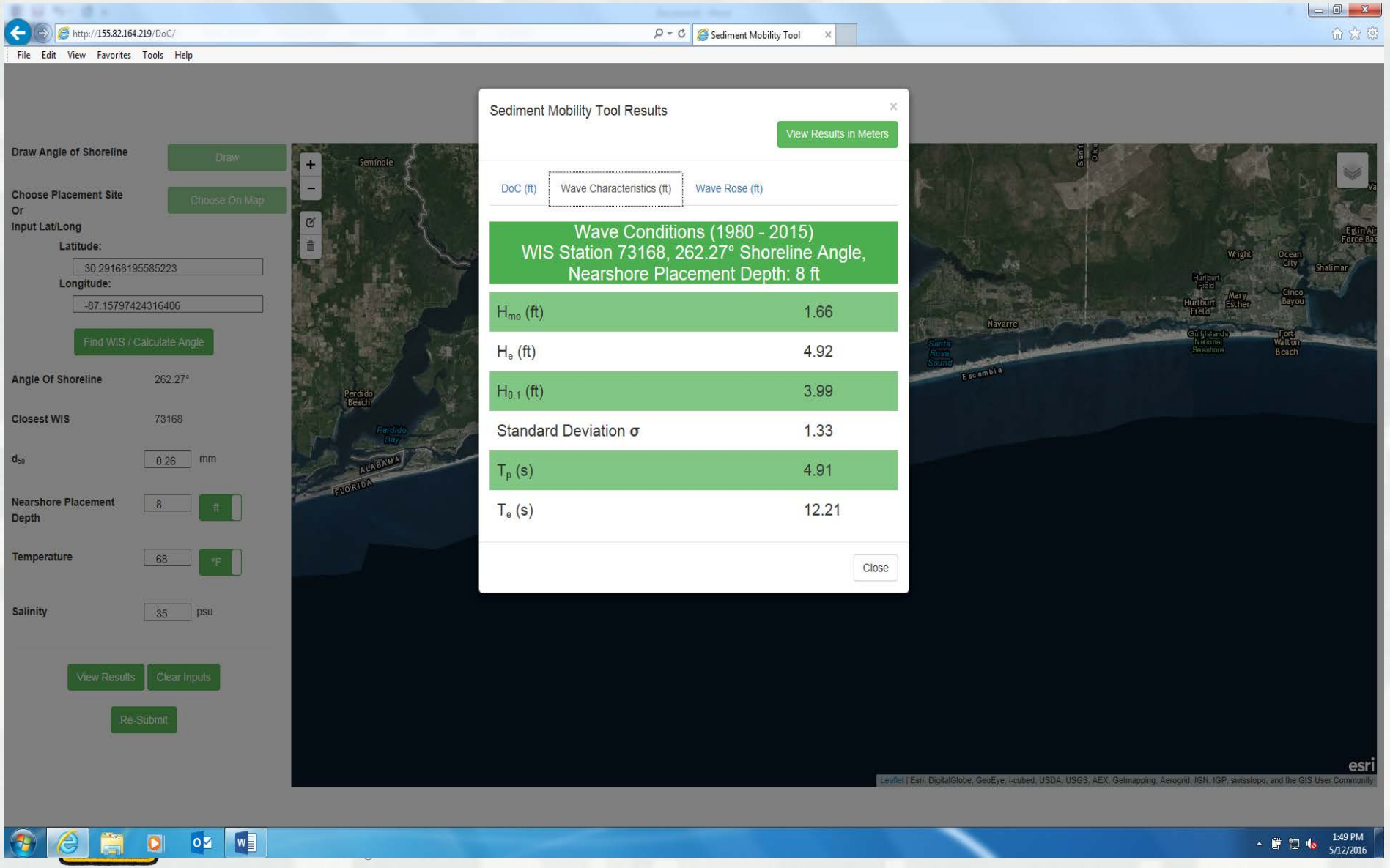
SMT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d_{50} 0.26 mm
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Salinity 35 psu
View Results
Clear Inputs
Re-Submit
Sediment Mobility Tool Results
View Results in Meters
DoC (ft)
Wave Characteristics (ft)
Wave Rose (ft)
Wave Conditions (1980 - 2015)
WIS Station 73168, 262.27° Shoreline Angle,
Nearshore Placement Depth: 8 ft
H_{mo} (ft) 1.66
H_e (ft) 4.92
$H_{0.1}$ (ft) 3.99
Standard Deviation σ 1.33
T_p (s) 4.91
T_e (s) 12.21
Close
Seminole
Perdido Beach
Perdido Bay
ALABAMA
FLORIDA
Navarre
Santa Rosa Sound
Escambia
Wright
Ocean City
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Hurlburt Field
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Fort Walton Beach
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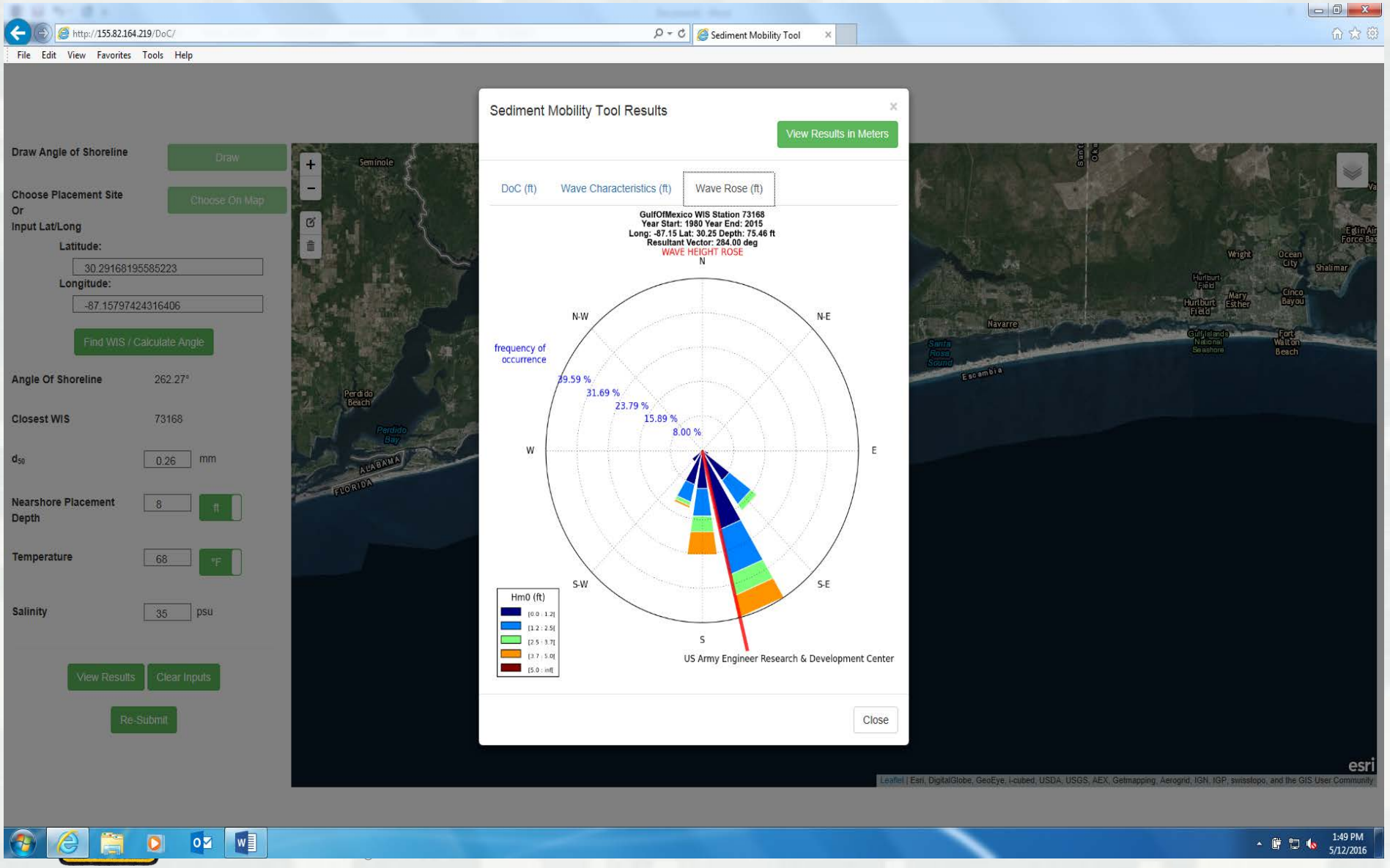
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Salinity 35 psu
View Results
Clear Inputs
Re-Submit
Sediment Mobility Tool Results
View Results in Meters
DoC (ft)
Wave Characteristics (ft)
Wave Rose (ft)
GulfOfMexico WIS Station 73168
Year Start: 1980 Year End: 2015
Long: -87.15 Lat: 30.25 Depth: 75.46 ft
Resultant Vector: 284.00 deg
WAVE HEIGHT ROSE
N
N-E
E
S-E
S
S-W
W
N-W
frequency of occurrence
29.59 %
31.69 %
23.79 %
15.89 %
8.00 %
Hm0 (ft)
[0.0 : 1.2[
[1.2 : 2.5[
[2.5 : 3.7[
[3.7 : 5.0[
[5.0 : inf[
US Army Engineer Research & Development Center
Close
Seminole
Perdido Beach
Perdido Bay
ALABAMA
FLORIDA
Navarre
Santa Rosa Sound
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Hurlburt Field
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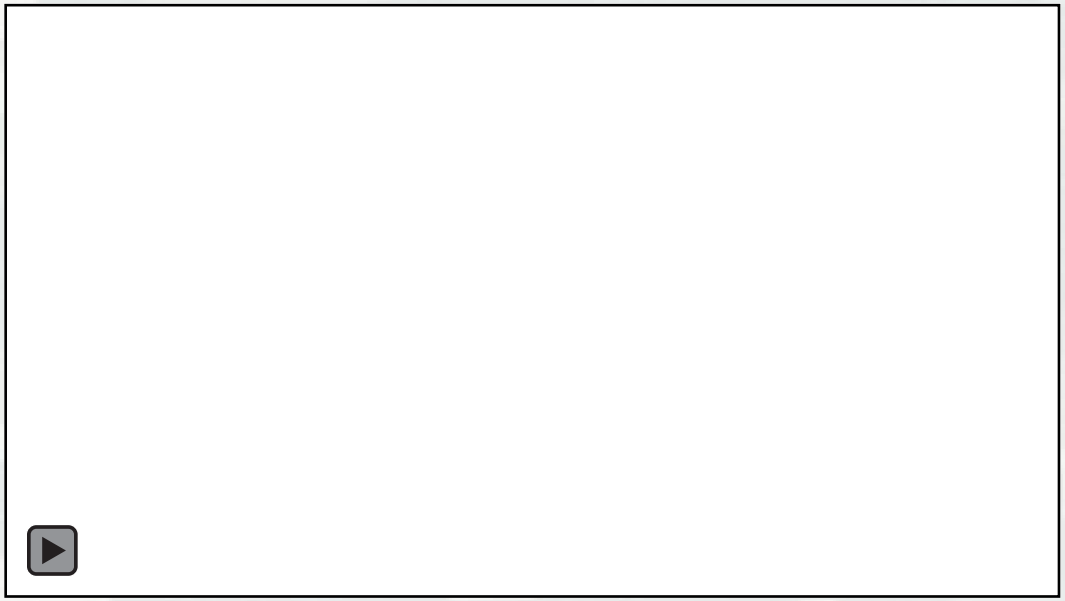
Video

Application

- 6 Sites
- Different Data Sets:
  - ► WIS
  - ► NACCS
  - ► Wave Buoy

Vilano Beach, FL



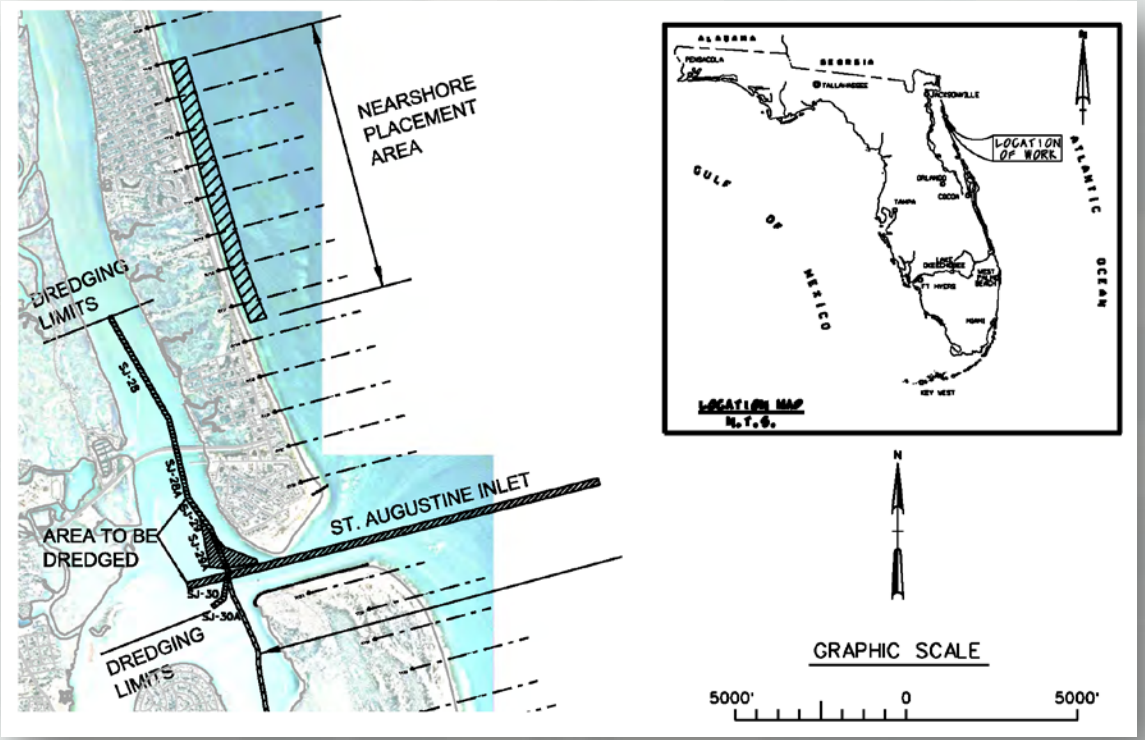
- 150,000 cy
- St. Augustine Inlet ebb shoal, flood shoal and part of the IWW
- *Murden* 500cy hopper, light loaded for NS access ~350-400cy
- Sediment coarse sand-sized shell hash and fine to medium sand

Vilano Beach, FL

- Between T-114 and R-115 and R-116 and R-117
- In front of the two property clusters
- Worked with SAJ and HOA
- Two berm methods to see if there is a differing outcome
- Validate SMT using survey data, CMS modeling, RIOS

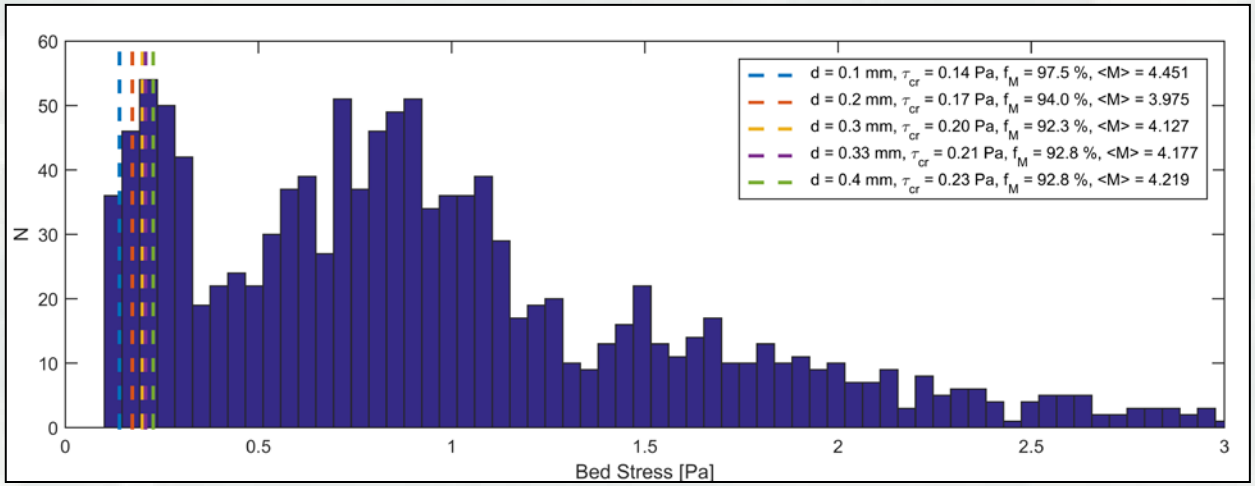
Vilano Beach, FL

- h = 10 ft
- WIS Station 63416
- d_{50} = 0.33 mm



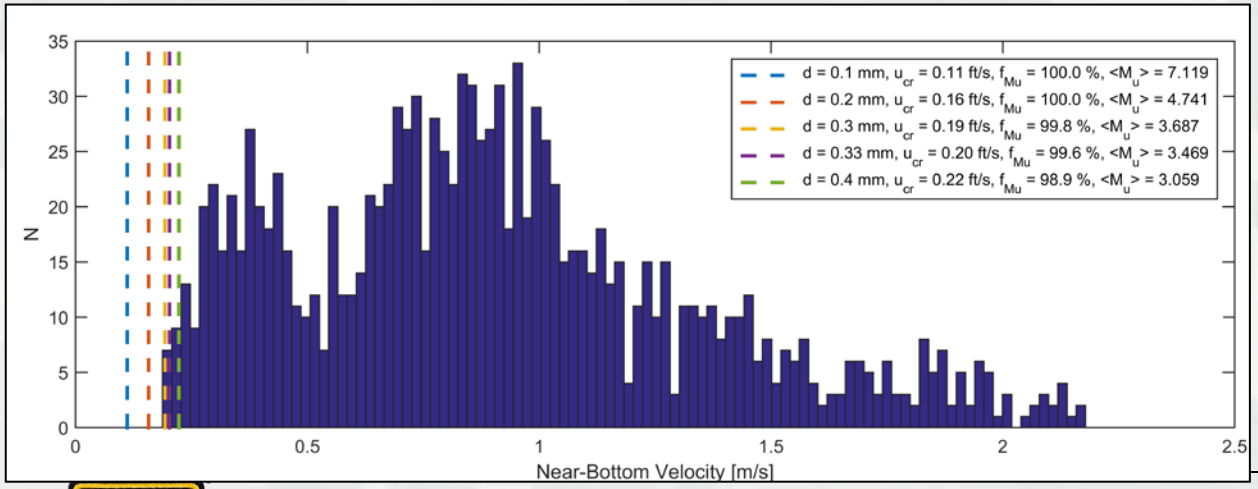
Vilano Beach, FL

Linear Wave Theory



$$M = \overline{\left(\frac{\tau_{max} - \tau_{cr}}{\tau_{cr}}\right)}$$

Nonlinear Stream-Function Wave Theory



$$M_u = \overline{\left(\frac{u_{max} - u_{cr}}{u_{cr}}\right)}$$

Sed. Migration Direction

- Dean Number

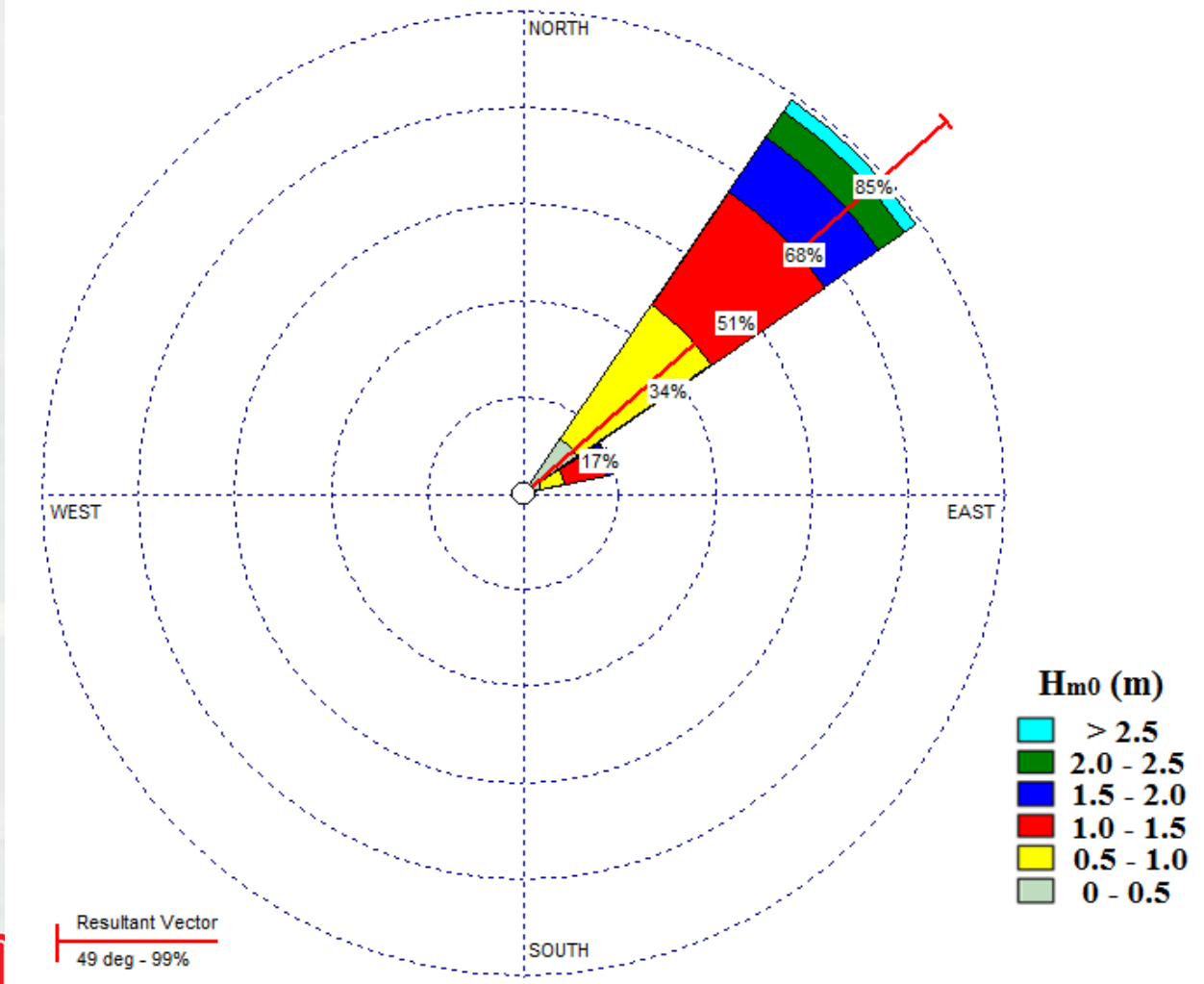
$$D = \frac{H_0}{\omega\, T}$$

> 7.2, Offshore Migration

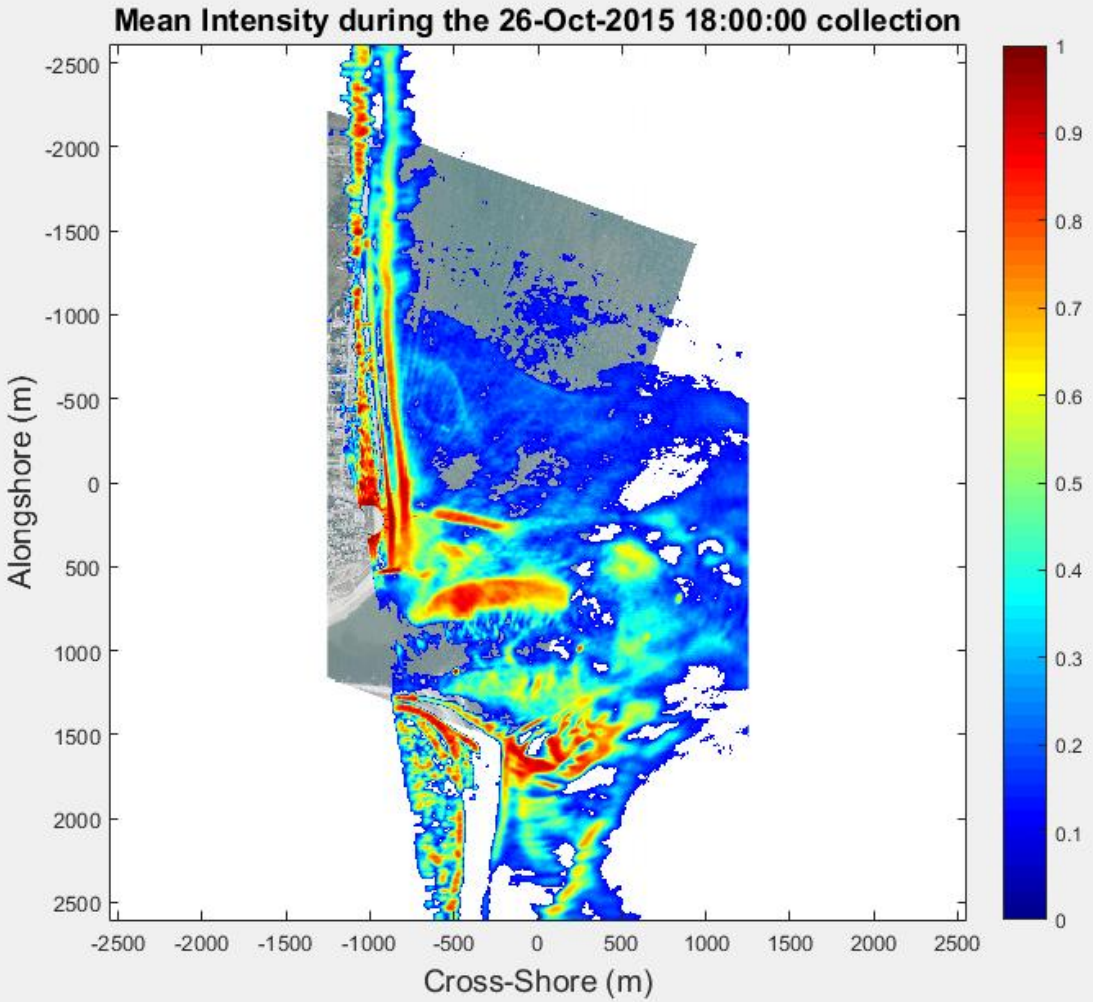
< 7.2, Onshore Migration *(Larson & Kraus, 1992)*

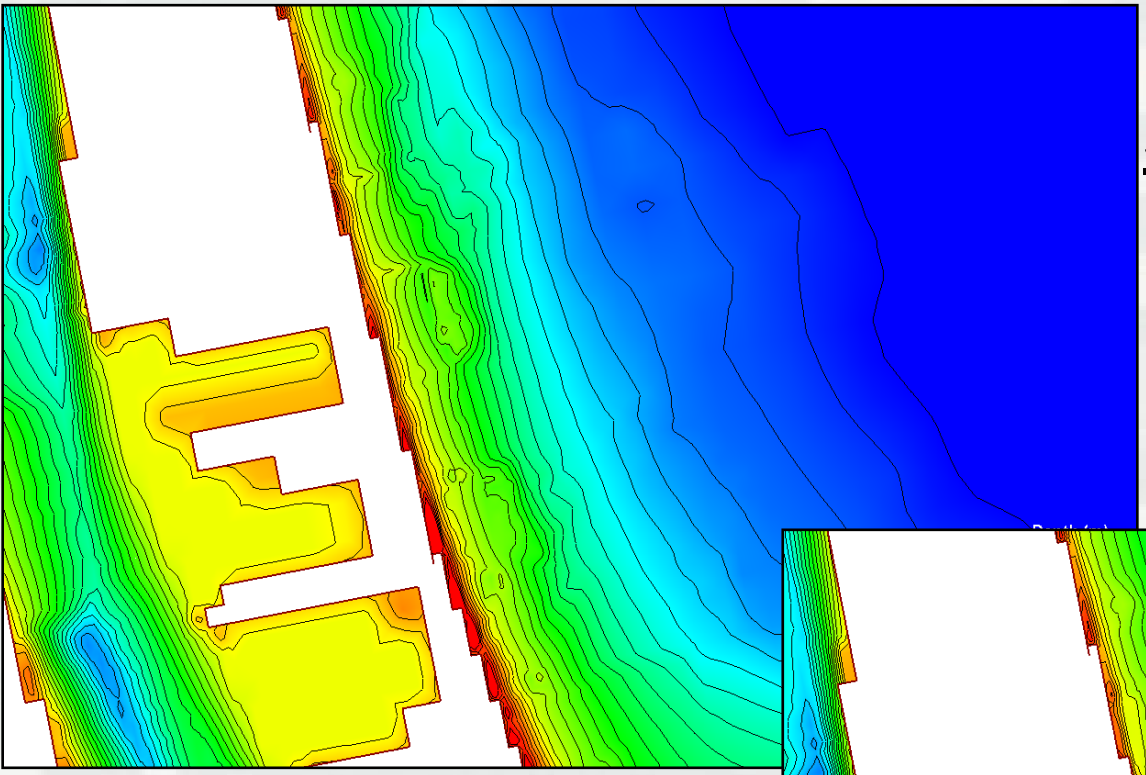
Grain Size (mm)	Predicted Sediment Migration
0.1	79% Offshore
0.2	94% Onshore
0.3	100% Onshore
0.33	100% Onshore
0.4	100% Onshore

Wave Direction

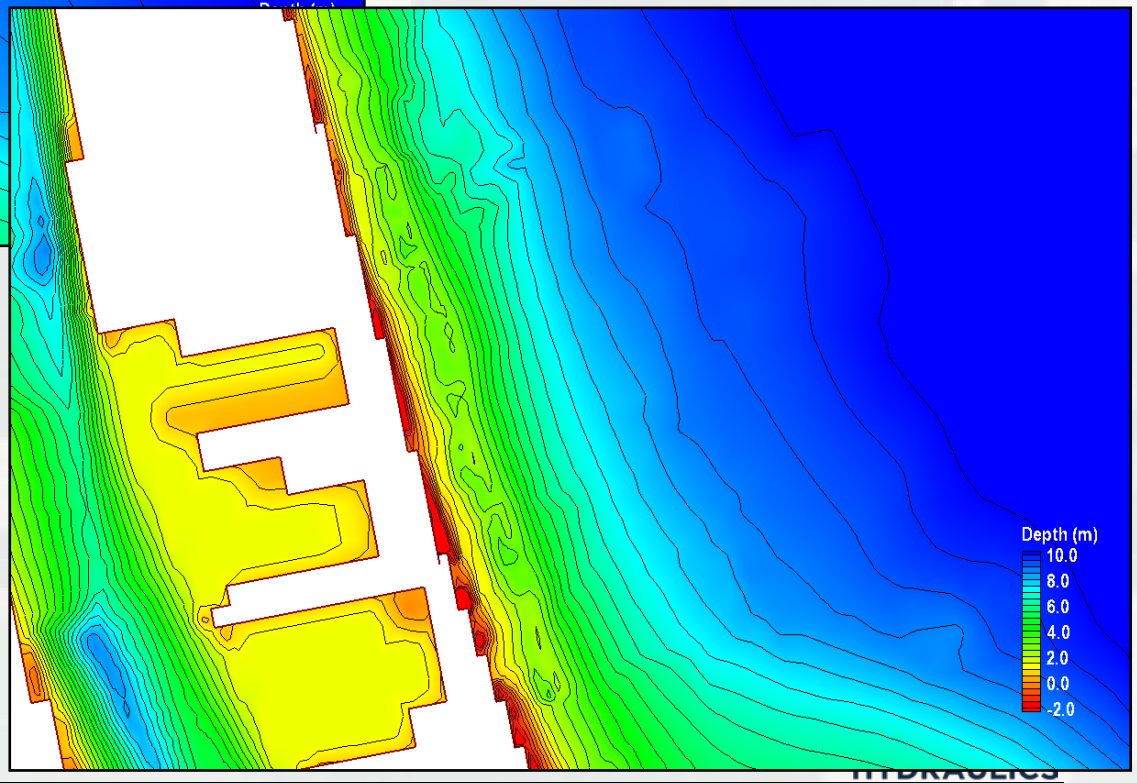


Results


Mean Intensity during the 26-Oct-2015 18:00:00 collection
Alongshore (m)
Cross-Shore (m)
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

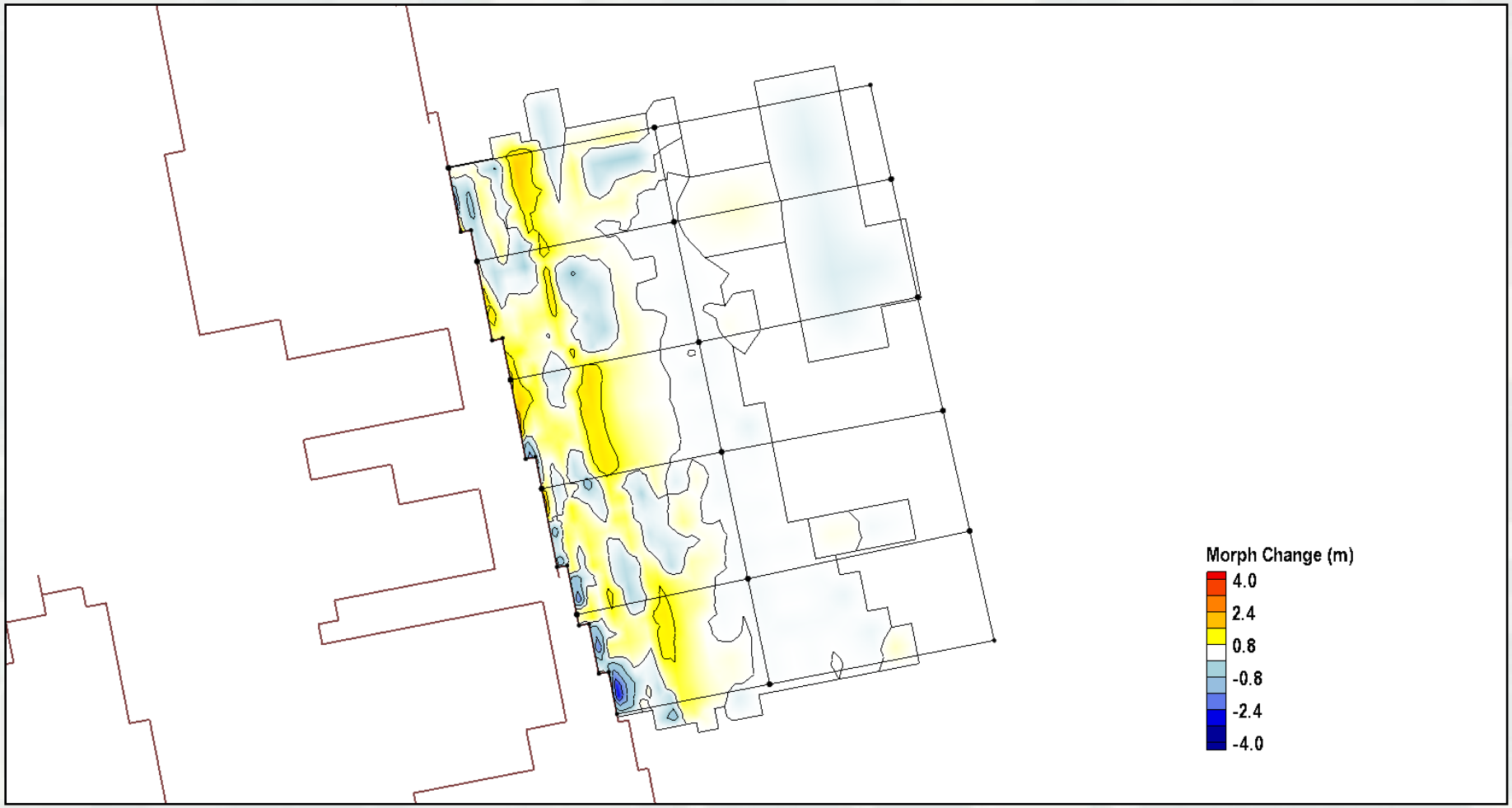


September-October 2015



December 2015

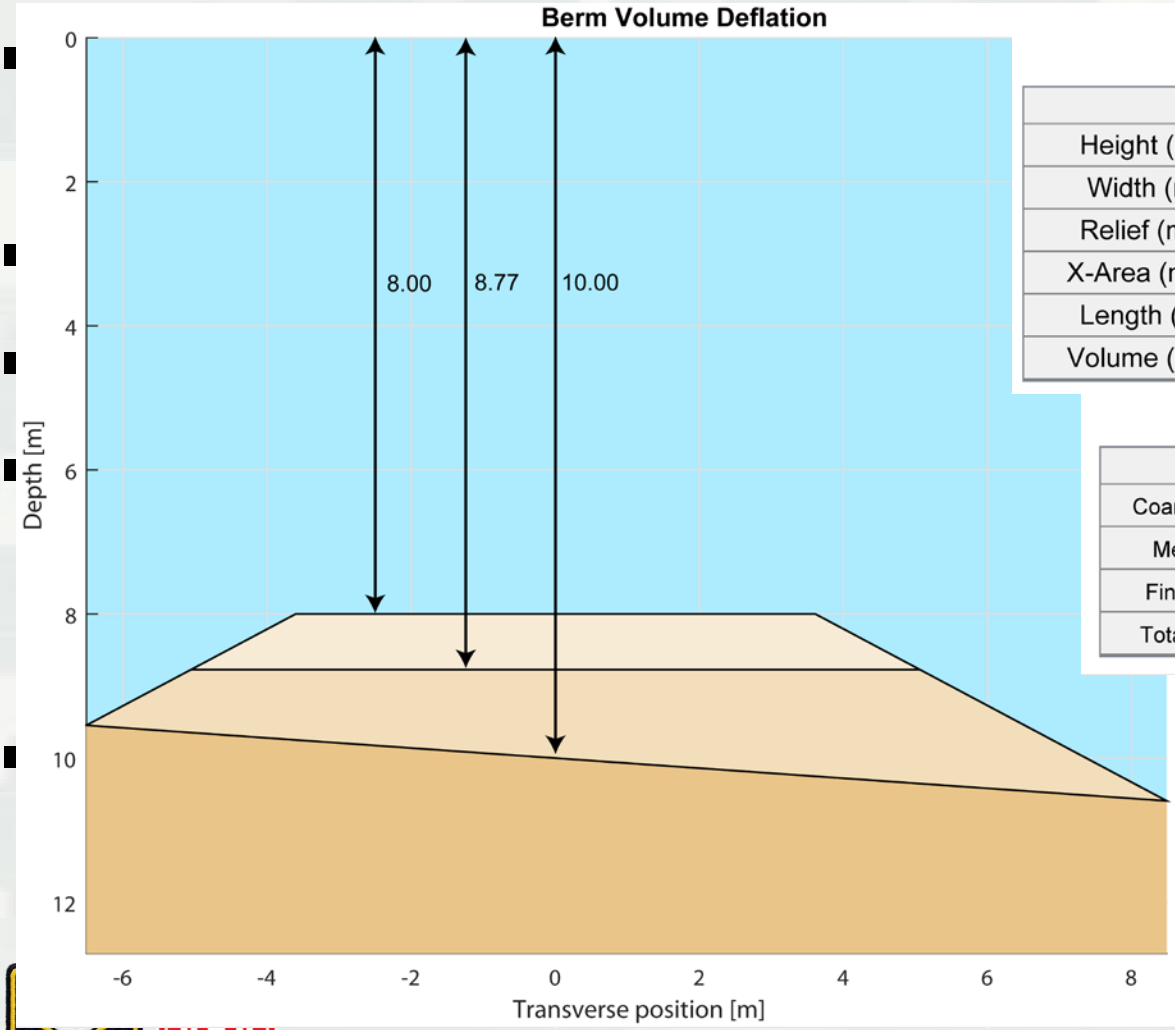
Sediment Volume Change (m^3) September 21 – December 16, 2015



Results

- Vilano Beach project is being used to help validate SMT
  - Correctly predicted that material would mobilize
  - Gain of sediment in the nearshore may indicate onshore movement of the berms
  - Alongshore dispersion of sediment

Future SMT



Berm Characteristics

	Before	After	diff	diff %
Height (m)	2.00	1.23	-0.77	-38.56
Width (m)	15.00	15.00	0	0
Relief (m)	8.00	8.77	0.77	9.64
X-Area (m^2)	22.47	15.78	-6.68	-29.75
Length (m)	20.00	20.00	-	-
Volume (m^3)	440.93	310.57	-13.37	-29.75

Sediment Characteristics

	tau_cr	h_cr	f%_before	f%_after
Coarse	0.26	8.00	10.00	14.24
Med	0.20	8.50	30.00	34.95
Fine	0.14	9.00	60.00	50.82
Total	-	-	100.00	100.00